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32nd CEIES Seminar
Innovation indicators–more than technology?

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PROGRAMME

Monday, 5 February 2007

Opening session

Welcome to the participants

Ms Karen Siune, Chairperson of the CEIES Subcommittee for Innovation Statistics, Director of the Danish Centre for Studies in Research and Research Policy

Mr Janez Potočnik, European Commissioner for Science and Research (Video message)

Mr Hans Müller Pedersen, Deputy Director General of the Danish Agency for Science, Technology and Innovation

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Producer ability to collect data – some experiences

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Mr Peter Teirlinck, Belgian Science Policy – Innovation activities and expenditures

Mr Michael Bordt, Statistics Canada – Response unit; new to firm, market and world; knowledge management

Mr Tomohiro Ijichi, National Institute of Science and Technology Policy (NISTEP), Japan – Measuring non–technological innovation: experience from the Japanese Innovation Survey

Mr Peter S. Mortensen, Danish Centre for Studies in Research and Research Policy and Mr Giulio Perani, Italian National Institute of Statistics (ISTAT) – The regionalisation of CIS indicators – the Italian and Danish cases

Ms Lynda Carlson, National Science Foundation, United States of America – Redesigning the U.S. Survey of Industrial Research and Development: implications for Statistical Data on Innovation

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Mr Patrick Corbel, SESSI, France – Some evidence about the concepts of innovation within enterprises: a pilot survey conducted among seventy enterprises in five countries – the "vignettes" pilot survey

Mr Viggo Maegaard, Danfoss A/S, Denmark – Ability to reply in a large manufacturing enterprise group

Mr Peter S. Mortensen, Danish Centre for Studies in Research and Research Policy – Some evidence of data providers' response ability and willingness

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Comparative analyses based on CIS–data

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Mr Staffan Laestadius, Royal Institute of Technology, Sweden (PILOT) – Innovation in low tech industries – conclusions from the pilot project

Mr Hannes Leo, WIFO, Austria – Sector studies

Mr Bernd Ebersberger, Management Center Innsbruck, Austria – Cross–country econometric analysis using CIS–data

Ms Heidi Armbruster, PORCH, Fraunhofer, Germany – Organisational innovation – the challenge of measuring non-technical innovation in large scale surveys

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Mr Vincent Dautel, CEPS/INSTEAD, Luxembourg – Reference period for the CIS: two or three years

Mr Aavo Heinlo, Statistics Estonia – The universe of understandings – which one is observed?

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User needs for new indicators – As well as the existing

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Mr Reinhard Büscher, DG Enterprise, European Commission – The European Innovation Scoreboard: concepts and main results

Mr Anthony Arundel, MERIT, The Netherlands – Better indicators for policy analyses; under–exploitation of the CIS at micro–data level

Mr Svein Olav Nås, NIFU/STEP, Norway – Measuring innovation processes

Mr Giulio Perani, Italian National Institute of Statistics (ISTAT) – The pros and cons of different forms of micro–data access

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Mr Fred Gault, Statistics Canada, OECD Working Party of National Experts on Science and Technology Indicators (NESTI) – How far and fast can we go?

Mr August Götzfried, Unit F.4, "Education, science and culture statistics", Eurostat – Community innovation statistics: implementation of the new Oslo Manual, new indicators, constructing time series; micro–data access

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SUMMING UP

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REACTION FROM EUROSTAT

Mr Michel Glaude, Director for Social Statistics and Information Society, Eurostat

CLOSING REMARKS

Ms Margit Epler, Vice Chairperson of CEIES

END OF SEMINAR

Background and aim of the seminar

This seminar will be providing an opportunity for national innovation statistics producers, data users and data providers to:

- review the results of CIS 4, including methodology, quality, concepts used and comparative analyses;
- discuss the new Oslo Manual 2005 and its implementation (new types of innovation, more focus on service industries and on linkages, not just technology);
- listen to the uses made and discuss the growing user needs for the next innovation surveys, including the need for more regular innovation statistics

An initial introduction will give a general overview of the current situation. The two–day seminar will then debate the following themes:

Looking back (theme 1–3). Producers will report how they have been able to collect data on innovation and of which quality the information is. The data providers' response ability and willingness will be described. Finally, results from comparative analyses based on CIS3 and CIS4 data will be presented.

Looking ahead (theme 4–6). The revised Oslo Manual 2005 will be presented and users will delineate their uses made and tell their needs for new – and old – indicators. Finally, opinions on how to address these challenges in the coming Community surveys will be presented.

What is CEIES?

CEIES stands for Comité consultatif européen de l'information statistique dans les domaines économique et social; in English: 'The European Advisory Committee on Statistical Information in the Economic and Social Spheres'. Its task is to assist the Council and the Commission in the co–ordination of the objectives of the Community's statistical information policy, taking into account user requirements and the costs borne by the information producers.

The committee was set up by Council Decision 91/116/EEC of 25 February 1991. The original decision was amended by Council Decision 97/255/EC of 19 April 1997 taking into account the accession of Austria, Finland and Sweden.

CEIES is chaired by the Commissioner responsible for Eurostat. The vice–chairman is Ms. Margit Epler from Austria. CEIES is composed of two private members per Member State, three members from the European Commission, the Chairman of the Committee on Monetary, Financial and Balance of Payments Statistics (CMFB) and the Presidents or Directors–General of the National Statistical Institutes of the Member States.

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Ms Karen Siune and Ms Lea Bregar
With the help of Ms Margit Epler, CEIES vice–president
From Eurostat: Mr Jean–Louis Mercy

CEIES Secretariat: *Mr Gerhard Wächter, Ms Marie–Paule Scheidhauer, Ms Sheena Blair*

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The proceedings are a collection of papers prepared by the speakers in advance of the seminar. They do not include the open discussions nor the discussions in the round table/panel session.

The papers presented and published herein only represent the views of their authors and do not necessarily reflect an official position of their institutions or organisations.

Opening Session

Keynote speech

Producer ability to collect data – some experiences

Data Providers' response, ability and willingness

Comparative analyses based on CIS–data

Opening Session

I

OPENING SPEECH

Karen SIUNE
Director
Danish Centre for Studies in Research and Research Policy

In my capacity as chairman of the CEIES Subcommittee on Innovation, I would like to welcome you today.

Welcome:

- to the many speakers who have accepted to participate and have produced papers for the seminar;
- to participants in their capacity as users, producers or providers of data for innovation statistics;
- also welcome from me in my capacity as Director of **the Danish Centre for Studies in Research and Research Policy**

32nd CEIES seminar

As you have seen from the programme, this is the 32nd CEIES seminar. The previous CEIES seminars have not all been about innovation statistics, a lot of other issues within the social and economic spheres have been in focus at the many seminars.

To give you a kind of understanding of the role of seminars, I need to say a few words about CEIES. Although some of you know about CEIES, we have participants here today who are not familiar with CEIES.

What is CEIES:

CEIES was established in 1991 as an advisory body to the Commission regarding statistics within the social and economic spheres. CEIES has therefore had the task and the responsibility to look at many different forms of statistics within the social and economic spheres and to look at the current or potential statistical fields.

From the very beginning, the special function of CEIES has been to give advice in the form of recommendations on the basis of discussions and analyses among users of statistics, producers and data providers.

Since its establishment, the CEIES committee has been composed of a variety of producers, users, and data providers from all Member States. The full CEIES committee meets only once a year; the daily activities are taken care of and are practically organized by the Secretariat, that is, Marie-Paule Scheidhauer, Sheena Blair and Gerhard Wächter, who have all worked hard on the preparations for this seminar.

All activities take place based on contact with the CEIES bureau which is composed of a number of CEIES members, who are chairpersons of the subcommittees, or members with special tasks. The vice-president of CEIES is currently Margit Epler, who is also present at this seminar.

The Role of Seminars

The purpose of the CEIES seminars, the first one of which was held in 1993, is to bring together producers, users and data providers. Users are of different types and even if it is presumed that there exists some sort of understanding about innovation or innovativeness as of an actual phenomenon, nevertheless it must be recognised that such understandings differ significantly depending on the type of persons involved.

Policymakers are eager to have measurements of the phenomenon of innovation so that they are praised for their wise innovation policies leading to prosperity and welfare. Their vision is limited to a few indicators and they rarely delve into the real content of assembled figures.

Researchers (including those involved in the compilation of the Oslo Manual, which is the manual guiding the data collection) care about theoretical models, universal definitions, linkages and many more theoretical problems.

And then come **statisticians**, argues Aavo Heinlo, whom you will hear as a speaker in this seminar, and the statisticians are the only persons who have studied the Oslo Manual from cover to cover. The statisticians are transforming the content of the Oslo Manual into a measurement instrument that will reach the last main group of interest - the **respondents**.

All four groups definitely have their own somewhat different understanding about innovation activities, but that of statisticians - creators of statistical instruments and performers of actual measurements - is presumably closest to the best one for the interpretation of observations, argues Aavo Heinlo.

That issue we will discuss later, but here I will say:

It is very salient for CEIES that you are all here, since it is:

1. very important that the users get the information they want, if it is possible
2. very important that we get to know what they want
3. very important that the producers can provide the information required in a reliable form
4. very important that the producers present valid data in a…
5. timely way, not too old, not too late (what that then means!)
6. without being too much of a burden to the data providers.

This is much to ask about when in addition all the data provided shall be comparative, meaning that all the data has to be collected in all those countries that want to compare themselves with others; for the EU that means first of all the Member States, the old, the new, the coming, the potential and all those countries we want to compare the EU with. US, Canada and Japan have for years been of great interest from a comparative perspective. For that reason I am also very happy that we have here today participants, not only from all Member States, but also from OECD countries outside the EU, from US, from Canada, from Japan and from China, since China increasingly is a country we all want to know more about. I am also happy that we have participants from South Africa and from new as well as old members of the EU. The participation from so many different countries illustrates the whole idea of global statistical comparisons based on statistical cooperation.

The Special Role of this Seminar

This seminar is a follow up of a CEIES seminar held in Athens in 2003 about innovation entitled **Innovation statistics - more than R&D.**

The 2003 seminar (the 21st CEIES seminar) had much discussion about the differences between statistics on R&D and statistics on innovation. Participants at that seminar expressed a clear wish for further seminars with discussions on innovation.

This year's topic is as you all know **Innovation indicators - more than Technology?**

And if you don't understand the background of these seminar titles you will soon get an understanding from listening to the presentations and from reading the papers presented here at the 32nd seminar; a lot has happened to innovation statistics within the last ten years and that is reflected in the titles of these seminars.

Organization

The planning of this seminar has been made by a subcommittee consisting of Lea Bregar and myself coming from CEIES with the help of Peter Mortensen who is head of Department for Statistics at The Danish Centre for Studies in Research and Research Policy. Peter is also member of NESTI, the OECD network of National Experts on Statistical Indicators, representing Denmark.

For the preparation of this seminar we have had very good cooperation with Eurostat and I would like now to thank Eurostat for their input to this seminar. My thanks also go to the organizers, the speakers, the chairpersons and the audience, from whom I expect much interaction during the discussions. I know from former experience that not only the formal discussions but also the many informal discussions play a great role. Without you it would not be a proper CEIES seminar.

Greetings from the Commissioner for Research: Janez Potočnik

Mr. Janez Potočnik, European Commissioner for Science and Research, has shown great interest in this seminar. He wanted to attend but for practical reasons could not make it, so we will instead listen to his video greeting. I would like to thank him very much for his interest in our seminar.

Janez Potočnik

European Commissioner for Science and Research

For technical reasons, the video message of Commissioner Potočnik cannot be included.

Hans Müller PEDERSEN
Deputy Director General
Danish Agency for Science, Technology and Innovation

Good morning ladies and gentlemen, thank you for the invitation

I'm very honoured that I have been invited to welcome this very distinguished audience, experts from all over the world on innovation statistics.

My name is Hans Müller Pedersen, I'm Deputy Director General in the Danish Agency for Science Technology and Innovation, and as such I represent the political-administrative part of the Danish society. I am thus a user of data, statistics and information generated in institutions such as Eurostat and the Danish Centre for Studies in Research and Research Policy.

In the next 10 to 15 minutes, I would like to share with you my points of view on two issues: 1) the importance of innovations statistics is increasing, why? And 2) how to improve the value of innovation statistics?

First the question: why are innovation statistics increasing in importance?

From my political-administrative point of view there are two answers to this question:

The first substantially most important answer in my opinion is obvious: because it is very widely recognized that competitiveness is **not** only a question of interest rates and the level of wages. Society's competitiveness is becoming more and more dependent on the ability to generate, distribute and exploit ideas, knowledge and creativity in institutions and in companies.

The second answer is that innovation statistics are important because fortunately modern politics tend to be increasingly based on evidence and facts.

Governmental institutions such as the one I represent are experiencing a mere "fight for the right data" and our counterparts in that game are NGOs and business organisations and the like.

The reason why, is actually very simple: One of the most forceful, sober and reasonable ways to legitimize policy initiatives and political arguments is of course by establishing those arguments on documented facts and properly conducted analyses. That is why access to data and quality of data is so essential to all parties in the political game.

I believe this is the case in all European countries. It certainly is in Denmark.

Allow me a very brief description about the Danish government strategy from May 2006: Progress, innovation and cohesion – a strategy for Denmark in the global economy. I won't go into details about the strategy but just mention that it establishes a roadmap for the transformation of Danish society. The strategy contains a total of more than 350 specific initiatives, which together entail extensive reforms within the fields of education, training and research as well as substantial improvements in the framework conditions for growth and innovation in all areas of society.

What I actually would like to emphasize on this occasion today, is the fact that this important strategy was build on a platform of analyses and statistics of hitherto unseen dimensions and depth - at least in a Danish context. All findings were published on the web in connection with the strategy process and it amounted to more than 200 fact sheets and the same number of analyses.

In my opinion this is one of the reasons why this strategy is going to keep its value for several years. It is simply convincing!

And of course the experiences from this lead to some conclusions when it comes to my second issue today: How to improve the value of innovation data? Or, if I rephrase the question: Which user demands should the statistics and data fulfil?

First I would like to give you some points of views about the **indicators**:

We – the users – would like the statistical bureaus and centres to collect information about the five following indicators:

- The **strategic approach** to innovation in companies (specific indicators are readiness and strategic thinking about innovation)
- The **resources** used for innovative activities in companies (specific indicators are human resources, economy, financing)
- The innovative **processes** (specific indicators are innovation activities, innovation management, user relations)
- The **execution of innovation** on a company level (specific indicators are new products, processes, patents, revenue)
- The **effects** on a societal level (specific indicator are productivity, competitiveness)

I would like to add just a few comments to some of the five indicators I mentioned:

Generally we are very much emphasising the performance indicators - both on the company level and of course on the societal level. I am very well aware that these indicators are the difficult ones, but nevertheless they are of extreme importance in the political context. We would **very much** like to be able to measure the impact of the governmental efforts to improve the innovative environment and competitiveness. And at the end of the day we would like to measure the impact of innovation on the national growth rate.

One last comment about indicators: We would like the surveys and the indicators to reflect that the content and meaning of the term “innovation” is changing these days due to the fact that markets are changing rapidly. This has an impact when it comes to the process indicators. In our understanding, innovation is not only a question of adding new technology to processes; it is also a question of the ability of companies to exploit the **user experiences** in the creative innovative process. What should be measured are for instance the user “input” and the companies’ dialogue with users in the innovative process.

Finally, a few remarks about the **production** of data.

When it comes to the CIS data that is produced in Eurostat and in the national centres, I believe that the wishes that we, the data users could have, are already very well known. But anyway I won’t spare you:

Comparability is extremely important. It is essential that you can compare data with other countries. It would be nice if you could also compare industry-by-industry and even cluster-by-cluster.

It is essential that you can detect **the dynamics** in the industrial innovation. In that respect it is important that data are produced regularly, and I think that the present term is too long. The Danish Agency for Science, Technology and Innovation intends to sign an agreement with the Danish Centre for Research analysis in Århus and from 2007, the Centre will produce innovation indicator data on a yearly basis.

The data should be **new**. The production of data based on surveys should be as short as possible. Data production periods that last for more than 2 years are hard to accept and also difficult to understand. The motto is: the newer, the better.

My concluding remark should be this: The importance of this seminar can hardly be overestimated. The good news are, that the political-administrative demand for high quality innovation data based on the right indicators is growing and will continue to grow in the years to come.

I would of course be very flattered if my opinions and viewpoints could inspire the lively and fruitful debate you are going to have for the next couple of days.

Thank you for your attention and good luck with the seminar.

Keynote speech

II

COMMUNITY INNOVATION STATISTICS FROM THE CIS 3 TO THE CIS 2008

Michel GLAUDE
Director for Social Statistics and Information Society, Eurostat

1. Introduction

This document provides an overview of the European policy context for innovation and of the work in progress on Community Innovation Statistics, starting with the Third Community Innovation Survey (CIS) and looking ahead to future surveys, also touching on micro-data use and access.

2. The policy context

The Lisbon and Barcelona European Councils signalled the important role of R&D and innovation in the EU. One of the goals set by the European Union was to raise overall research investment in the EU from 1.9% of GDP to approaching 3% by 2010. Based on this, in March 2005 the European Council decided to re-launch the Lisbon Strategy with the initiative on growth and jobs.

Knowledge and innovation for growth became one of three main areas for action in the new Lisbon partnership for growth and jobs. Research and innovation should be put at the heart of EU policies, EU funding and business. For further information see: http://ec.europa.eu/growthandjobs/index_en.htm.

European activities on innovation use several instruments to obtain data on innovation indicators and to assess national innovation performance. The two main instruments are the Community Innovation Surveys (CIS) and the European Innovation Scoreboard (EIS). Both are interlinked: the EIS mostly uses the data collected by the Community Innovation Surveys.

In the EIS a Summary Innovation Index is calculated to measure the innovation performance of European countries, but also to compare EU-25 with Japan and the United States. In the 2005 EIS this Summary Innovation Index is based on 26 indicators taken from Community Innovation Surveys, R&D surveys or other official data sources. For further information on the European Innovation Scoreboard see www.trendchart.org.

In 2006 and subsequent years the EIS – like the CIS - will be developed further. On the one hand more analysis will be done on innovation broken down by economic sector and by region. On the other, more work is needed in order to form a better picture of knowledge and technology dissemination, organisational and marketing innovation, or innovation and public procurement in forthcoming CIS (in particular in CIS 2008).

3. The Fourth Community Innovation Survey (CIS 4)

In most countries the CIS 4 was launched in 2005, based on the reference period 2004 and an observation period running from 2002 to 2004. The CIS 4 survey was carried out in around 30 European countries plus some non-European countries (such as South Africa). As for previous CIS, Eurostat developed the harmonised survey questionnaire and the survey methodology in close cooperation with the countries participating. These two instruments lead to a certain level of harmonisation of the data production at national level.

The main characteristics of CIS 4 are as follows:

- The harmonised CIS 4 questionnaire (based on the 1997 Oslo Manual) focuses on product and process innovation, looking mainly at the effects of innovation, sources of information about innovation activities, and innovation expenditure. The questionnaire also examines the factors hampering innovation and the use of intellectual property rights. Finally, it contains a smaller module on organisational and marketing innovation**. The CIS 4 questionnaire is shorter and considerably less difficult than the CIS 3 questionnaire previously used.**

- The core target population for the CIS 4 is industry (NACE sections C, D and E), wholesale trade (NACE 51), transport, storage and communication (NACE 60-64), financial intermediation (NACE 65-67), computer and related activities (NACE 72), architectural and engineering activities (NACE 74.2) and technical testing and analysis (NACE 74.3). All enterprises with more than 10 employees are covered.

- Eurostat prepared two tabulation schemes for collecting aggregated data from the countries participating. These cover the statistical results and the breakdowns for national and regional data respectively. Economic activities are broken down to NACE division (2-digit) level. Results broken down by size classes (in terms of number of employees) are also provided.

- The tabulated results were returned to Eurostat by 30 June 2006 (18 months after the end of the reference year 2004). Eurostat also asked countries voluntarily to transmit the national micro-data sets. Based on this data transmission, Eurostat disseminated the tabulated CIS 4 results in December 2006 and in January 2007. The CIS 4 micro-data should be made accessible to researchers from the second quarter 2007 onwards.

Although complete and comprehensive information on the national implementation of CIS 4 is not yet available, the main findings emerging are as follows:

- **The data quality from CIS 4 is much better than from CIS 3 in virtually all countries participating**. This can be seen in terms of unit or item response rates or in terms of the timeliness of the data. These improvements seem to be due mainly to the improved CIS 4 survey questionnaire broadly used, the broad compliance with the methodological guidelines issued, the greater familiarity of respondents with the questionnaire and the better overall process defined and applied by all parties involved.

- Fairly comprehensive national reports on data quality and an overall summary quality report produced by Eurostat will be available in early 2007. These reports will allow comprehensive quality assessment of the CIS 4 as well as of the costs and benefits of this survey.

- The regional CIS 4 results to be transmitted to Eurostat on a voluntary base will, however, remain incomplete as not every country applied the recommended sample stratification at regional level. Eurostat will investigate further possible actions to improve this situation.

- Also not all countries participating have transmitted the CIS 4 micro-data to Eurostat yet. On this point too, further actions are undertaken by Eurostat in order to get a comprehensive set of national CIS 4 micro-data available for central access.

Based on better data quality, better communication, free dissemination of tabulated data and better access to micro-data, Eurostat expects a strong increase in use of the CIS 4 data by a broad user community. This could also lead to the effect that the more traditional R&D indicators (such as the 3 % R&D intensity) become increasingly counterbalanced by CIS based indicators of higher quality.

See Annex 1 to this document for the harmonised CIS 4 survey questionnaire.

4. From CIS 4 to CIS 2008

4.1 CIS 2006

The Community legislation on innovation statistics increased the frequency for compiling Community Innovation Statistics from every four to every two years. In 2006 Eurostat – in close cooperation with the Member States – therefore continued the preparatory work on the next CIS based on the reference year 2006 ("CIS 2006"). It was decided that CIS 2006 should take a fairly conservative approach, keeping the harmonised survey questionnaire and the harmonised survey methodology used for CIS 4. Both components will therefore be used again for CIS 2006. This means that CIS 2006 will once again be based on the 1997 Oslo Manual.

Based on the current legal situation, countries have the option fully to repeat CIS 4 as CIS 2006 using the CIS 4 questionnaire and methodology. Countries can also use only a subset of the CIS 4 questions for CIS 2006. At this stage, more than 15 out of around 30 countries will repeat CIS 4 as CIS 2006. The other countries ask just a subset of the CIS 4 questions.

The CIS 2006 will be launched at national level in 2007. Considering that 18 months are allowed for data transmission, the tabulated data (based on the tabulations already used for CIS 4) will be sent to Eurostat by 30 June 2008 and the data will be duly released shortly afterwards.

As the questionnaire and methodology have been left unchanged from CIS 4 (2004) to CIS 2006, it will be possible to compare data and analyse trends by looking at the results from CIS 3, CIS 4 and CIS 2006.

4.2 Towards CIS 2008

In addition to the CIS 2006, Eurostat – in close cooperation with Member States – has started to prepare for the CIS 2008. Some of the basic ideas and issues for CIS 2008 are:

- The 2005 version of the Oslo Manual needs to be implemented. This means that the two new types of innovation (organisational and marketing) need to be taken into account in the CIS 2008 harmonised survey questionnaire more fully than in the small module in the CIS 4/CIS 2006 questionnaire.
- Eurostat has therefore already drawn up pilot modules on organisational and marketing innovation plus a short module on knowledge management which many countries are testing in 2007. These pilot modules deal mainly with the specifics of these two types of innovation. Depending on the results of the piloting, these modules will be incorporated into the CIS 2008 questionnaire.
- A further open question is whether the observation period for the CIS should be cut from three years to two in the light of the fact that the frequency of the CIS has been increased to every two years. This decision needs to be based on evidence provided by testing done in some countries.
- Finally, the discussions also need to focus on whether the CIS questions cover all types of innovation. If the answer is yes, this will affect the comparability of the CIS 2008 data with the previous CIS results.

This list of ideas and issues concerning CIS 2008 is certainly not exhaustive. More will emerge when the discussions on CIS 2008 will start in 2007/2008.

See Annex 2 to this document for the latest drafts of the CIS pilot modules to be tested by countries in 2007 (the final versions will be decided in October 2006).

5. Additional needs expressed towards the CIS

Over the last few months users have expressed additional needs which might affect the CIS in the medium term, e.g. in the form of adding new questions or just making better use of the existing tabulated and micro-data. More specifically, users have expressed the following needs:

- A number of users (in the European Commission, the IAEA or other users) want to keep better track of eco-innovation. This, for example, would mean that question 7.1 in the CIS 4 questionnaire would need to be fine-tuned to give more details on this subject.
- The CIS questionnaire should give a better picture of dissemination of technology. A question about the importance to the respondent of obtaining new product and process technology from external sources could be added.
- Innovation and public procurement are also rising up the EU policy agenda. At a certain stage the CIS should also be able to provide some answers on this. A question could be added to the survey asking firms whether they sell to the government and, if so, to report on the relative influence of costs versus innovative characteristics on procurement decisions.
- Some users have also asked if measurement of the linkages between innovation input (e.g. innovation expenditure) and innovation output indicators (e.g. turnover related to new or improved products) could be improved in the CIS.
- Several users have already asked for the CIS to be extended to more economic activities, in particular to public services, more services or non-market activities. The new Nace classification to be used for the CIS 2008 will have some impact hereon.

Besides these requested additions to the CIS questionnaire, much better use could be made of the existing micro-data from CIS 4/CIS 2006. New additional indicators could be compiled on knowledge dissemination (from questions 2.2, 3.2 and 6.2 in CIS 4), technology dissemination (questions 2.2 and 3.2), fast growing gazelles (e.g. questions 11.1 or 11.2), organisational innovation (question 10), demand for innovation (questions 1.2 or 8.2) and demand for technology (questions 5.1 and 5.2). The work on designing such indicators based on the CIS 4 has started at Eurostat.

6. Better access to micro-data: crucial for a better and broader data use

In order to considerably improve the cost/benefit ratio for the CIS, Eurostat – in close cooperation with Member States – wants to improve access to and use of the CIS micro-data by researchers. The necessary precondition is that Member States transmit the micro-data to Eurostat which is increasingly the case for the CIS 4.

Access by researchers to the CIS micro-data is governed by Commission Regulation No 831/2002. This access is twofold: to the anonymised micro-data (disseminated on CD-ROM) or to the confidential micro-data at the Eurostat Safe Centre in Luxembourg. Both forms of access require the explicit agreement, project by project proposal submitted by the researcher, of each country which submits its micro-data file to Eurostat.

6.1 Access to anonymised micro-data

In order to open up access to the anonymised CIS micro-data, Eurostat – in close cooperation with the countries participating - had to create a CIS anonymisation method which then had to be accepted by the countries concerned.

The CIS 3 anonymisation method finally developed is based on the micro-aggregation process (MAP) which modifies the individual data in such a way that an enterprise can no longer be identified as such, i.e. it is no longer feasible to match a respondent (enterprise) with its exact replies. The method is divided into different stages: pre-processing of the data, micro-aggregation, global recoding, evaluation of the disclosure risk, data suppression, and release of the final micro-data file.

Eurostat applied this method to the CIS 3 micro-data in the course of 2005/2006. Out of the 24 countries for which the CIS 3 micro-data sets are available at Eurostat, 15 accepted it. The anonymised CIS 3 micro-data from these 15 countries were consequently disseminated to researchers on a CD-ROM.

However, Eurostat is aiming to increase acceptance of the anonymisation method by the countries concerned, in particular with regard to the application of the method to the CIS 4 micro-data. Eurostat is therefore currently investigating ways to improve the method by changing some parameters, depending, amongst other things, on the size of the countries or the sample held. A Task Force with a number of countries participating will be installed in this respect. The plan is to start to apply the refined CIS anonymisation method to the CIS 4 micro-data in the second quarter of 2007.

6.2 Access to the confidential micro-data

Based on similar legal requirements to those for access to the anonymised micro-data, Eurostat is opening the Safe Centre in Luxembourg where researchers can access the confidential CIS 3 micro-data following a specific procedure laid down for such Safe Centre access.

Researchers can thus come to Luxembourg and work in a secure environment on the CIS 3 confidential micro-data. In accordance with the aforementioned Regulation, the output files produced by the researchers are then checked thoroughly by Eurostat with regard to data quality and data confidentiality.

Compared with access to the anonymised micro-data, as described above, the Safe Centre access is a more expensive option for all involved, both for the data users who have to travel to Luxembourg and for Eurostat which has to check thoroughly everything produced by the researchers granted access.

Both means of access to the micro-data substantially increase the use and usefulness of the CIS data. As the discussions on the burden placed on enterprises (in particular small and medium-sized firms) by statistics have recently become more intense in Europe, pooling and better use of micro-data is a crucial option for enhancing the benefits without increasing the costs of the CIS.

7. Conclusions

Good progress has been made with the preparation and implementation of the CIS 4 in Europe, and higher quality innovation statistics collected in 2006. In many places the CIS 4 will be repeated as CIS 2006. Two major pilot studies on organisational and marketing innovation have been launched to prepare for CIS 2008. Beyond that, a number of needs for additional data from the CIS have already been identified. Finally, access to the CIS micro-data is crucial for increasing the use of the CIS and for improving its cost/benefit ratio of the CIS.

(AG, 15 December 2006)

Annex

ANNEX 1:

The CIS 4 Harmonised Survey Questionnaire

THE FOURTH COMMUNITY INNOVATION SURVEY (CIS IV)

The harmonised survey questionnaire

The Fourth Community Innovation Survey **(Final Version: October 20 2004)**

This survey collects information about product and process innovation as well as organisational and marketing innovation during the three-year period 2002 to 2004 inclusive. Most questions cover new or significantly improved goods or services or the implementation of new or significantly improved processes, logistics or distribution methods. Organisational and marketing innovations are only covered in section 10. In order to be able to compare enterprises with and without innovation activities, we request all enterprises to respond to **all** questions, unless otherwise instructed.

Person we should contact if there are any queries regarding the form:

Name: ______________________________

Job title: ______________________________

Organisation: ______________________________

Phone: ______________________________

Fax: ______________________________

E-mail: ______________________________

General information about the enterprise

Name of enterprise ______________________________

Address[1] ______________________________

Postal code ______________ **Main activity**[2] ______________________________

1.1 Is your enterprise part of an enterprise group?

(A group consists of two or more legally defined enterprises under common ownership. Each enterprise in the group may serve different markets, as with national or regional subsidiaries, or serve different product markets. The head office is also part of an enterprise group.)

Yes ☐ In which country is the head office of your group located?[3] ______________

No ☐

If your enterprise is part of an enterprise group, please answer all further questions only for your enterprise in [your country]. Do not include results for subsidiaries or parent enterprises outside of [your country]

1.2 In which geographic markets did your enterprise sell goods or services during the three years 2002 to 2004?

	Yes	No
Local / regional within [your country]	☐	☐
National	☐	☐
Other European Union (EU) countries, EFTA, or EU candidate countries*	☐	☐
All other countries	☐	☐

*: Include the following countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Ireland, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Slovakia, Switzerland, Turkey, Spain, Sweden and the United Kingdom.

1 NUTS 2 code

2 NACE 4 digit code

3 Country code according to ISO standard

2. Product (good or service) innovation

A product innovation is the market introduction of a **new** good or service or a **significantly** improved good or service with respect to its capabilities, such as improved software, user friendliness, components or sub-systems. The innovation (new or improved) must be new to your enterprise, but it does not need to be new to your sector or market. It does not matter if the innovation was originally developed by your enterprise or by other enterprises.

2.1 During the three years 2002 to 2004, did your enterprise introduce:

	Yes	No
New or significantly improved goods. (Exclude the simple resale of new goods purchased from other enterprises and changes of a solely aesthetic nature.)	☐	☐
New or significantly improved services.	☐	☐

If no to both options, go to question 3.1, otherwise:

2.2 Who developed these product innovations?

Select the most appropriate option only

Mainly your enterprise or enterprise group	☐
Your enterprise together with other enterprises or institutions	☐
Mainly other enterprises or institutions	☐

2.3 Were any of your goods and service innovations during the three years 2002 to 2004:

		Yes	No
New to your market?	Your enterprise introduced a new or significantly improved good or service onto your market before your competitors (it may have already been available in other markets)	☐	☐
Only new to your firm?	Your enterprise introduced a new or significantly improved good or service that was already available from your competitors in your market	☐	☐

Using the definitions above, please give the percentage of your total turnover[1] in 2004 from:

Goods and service innovations introduced during 2002 to 2004 that were **new to your market**				%
Goods and service innovations introduced during 2002 to 2004 that were **only new to your firm**				%
Goods and services that were **unchanged or only marginally modified** during 2002 to 2004 (include the resale of new goods or services purchased from other enterprises)				%
Total turnover in 2004	**1**	**0**	**0**	%

[1] For Credit institutions: Interests receivable and similar income, for insurance services: Gross premiums written

3. Process innovation

A process innovation is the implementation of a **new** or **significantly** improved production process, distribution method, or support activity for your goods or services. The innovation (new or improved) must be new to your enterprise, but it does not need to be new to your sector or market. It does not matter if the innovation was originally developed by your enterprise or by other enterprises. Exclude purely organisational innovations.

3.1 During the three years 2002 to 2004, did your enterprise introduce:

	Yes	**No**
New or significantly improved methods of manufacturing or producing goods or services	☐	☐
New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services	☐	☐
New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing	☐	☐

If no to all options, go to section 4, otherwise:

3.2 Who developed these process innovations?

	Select the most appropriate option only
Mainly your enterprise or enterprise group	☐
Your enterprise together with other enterprises or institutions	☐
Mainly other enterprises or institutions	☐

4. Ongoing or abandoned innovation activities

Innovation activities include the acquisition of machinery, equipment, software, and licenses; engineering and development work, training, marketing and R&D[1] when they are *specifically* undertaken to develop and/or implement a product or process innovation.

4.1 Did your enterprise have any innovation activities to develop product or process innovations that were abandoned during 2002 to 2004 or still ongoing by the end of 2004?

Yes ☐

No ☐

If your enterprise had no product or process innovations or innovation activity during 2002 to 2004 (no to all options in questions 2.1, 3.1, and 4.1), go to question 8.2.

Otherwise, go to question 5.1

[1] Include basic R&D as an innovation activity even if not specifically related to a product and/or process innovation

5. Innovation activities and expenditures

5.1 During the three years 2002 to 2004, did your enterprise engage in the following innovation activities:

		Yes	No
Intramural (in-house) R&D	Creative work undertaken within your enterprise to increase the stock of knowledge and its use to devise new and improved products and processes (including software development) If yes, did your firm perform R&D during 2002 to 2004: Continuously? ☐ Occasionally? ☐	☐	☐
Extramural R&D	Same activities as above, but performed by other companies (including other enterprises within your group) or by public or private research organisations and purchased by your enterprise	☐	☐
Acquisition of machinery, equipment and software	Acquisition of advanced machinery, equipment and computer hardware or software to produce new or significantly improved products and processes	☐	☐
Acquisition of other external knowledge	Purchase or licensing of patents and non-patented inventions, know-how, and other types of knowledge from other enterprises or organisations	☐	☐
Training	Internal or external training for your personnel specifically for the development and/or introduction of new or significantly improved products and processes	☐	☐
Market introduction of innovations	Activities for the market introduction of your new or significantly improved goods and services, including market research and launch advertising	☐	☐
Other preparations	Procedures and technical preparations to implement new or significantly improved products and processes that are not covered elsewhere.	☐	☐

5.2 Please estimate the amount of expenditure for each of the following four innovation activities in 2004 only. (Include personnel and related costs)[1]

	Tick 'nil' if your enterprise had no expenditures in 2004	Nil
Intramural (in-house) R&D (Include capital expenditures on buildings and equipment specifically for R&D)		☐
Acquisition of R&D (extramural R&D)		☐
Acquisition of machinery, equipment and software (Exclude expenditures on equipment for R&D)		☐
Acquisition of other external knowledge		☐
Total of these four innovation expenditure categories		☐

[1] Give expenditure data in 000's of national currency units to eight digits.

5.3 During the three years 2002 to 2004, did your enterprise receive any public financial support for innovation activities from the following levels of government?

Include financial support via tax credits or deductions, grants, subsidised loans, and loan guarantees. Exclude research and other innovation activities conducted entirely for the public sector under contract.

	Yes	**No**
Local or regional authorities	☐	☐
Central government (including central government agencies or ministries)	☐	☐
The European Union (EU)	☐	☐
If yes, did your firm participate in the EU's 5th (1998-2002) or 6th (2003-2006) Framework Programme for Research and Technical Development	☐	☐

6. Sources of information and co-operation for innovation activities

6.1 During the three years 2002 to 2004, how important to your enterprise's innovation activities were each of the following information sources?

Please identify information sources that provided information for new innovation projects or contributed to the completion of existing innovation projects.

Degree of importance

Tick 'not used' if no information was obtained from a source.

	Information source	**High**	**Medium**	**Low**	**Not used**
Internal	Within your enterprise or enterprise group	☐	☐	☐	☐
Market sources	Suppliers of equipment, materials, components, or software	☐	☐	☐	☐
	Clients or customers	☐	☐	☐	☐
	Competitors or other enterprises in your sector	☐	☐	☐	☐
	Consultants, commercial labs, or private R&D institutes	☐	☐	☐	☐
Institutional sources	Universities or other higher education institutions	☐	☐	☐	☐
	Government or public research institutes	☐	☐	☐	☐
Other sources	Conferences, trade fairs, exhibitions	☐	☐	☐	☐
	Scientific journals and trade/technical publications	☐	☐	☐	☐
	Professional and industry associations	☐	☐	☐	☐

6.2 During the three years 2002 to 2004, did your enterprise co-operate on any of your innovation activities with other enterprises or institutions?

Innovation co-operation is active participation with other enterprises or non-commercial institutions on innovation activities. Both partners do not need to commercially benefit. Exclude pure contracting out of work with no active co-operation.

Yes ☐

No ☐ **(Please go to question 7.1)**

6.3 *Please indicate the type of co-operation partner and location*

(Tick all that apply)

Type of co-operation partner	[Your country]	Other Europe*	United States	All other countries
A. Other enterprises within your enterprise group	☐	☐	☐	☐
B. Suppliers of equipment, materials, components, or software	☐	☐	☐	☐
C. Clients or customers	☐	☐	☐	☐
D. Competitors or other enterprises in your sector	☐	☐	☐	☐
E. Consultants, commercial labs, or private R&D institutes	☐	☐	☐	☐
F. Universities or other higher education institutions	☐	☐	☐	☐
G. Government or public research institutes	☐	☐	☐	☐

*: Include the following European Union (EU) countries, EFTA, or EU candidate countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Ireland, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Slovakia, Switzerland, Turkey, Spain, Sweden and the United Kingdom.

6.4 *Which type of co-operation partner did you find the most valuable for your enterprise's innovation activities?*

(Give corresponding letter) ________

7. Effects of innovation during 2002-2004

7.1 *How important were each of the following effects of your product (good or service) and process innovations introduced during the three years 2002 to 2004?*

		Degree of observed effect			
		High	Medium	Low	Not relevant
Product oriented effects	Increased range of goods or services	☐	☐	☐	☐
	Entered new markets or increased market share	☐	☐	☐	☐
	Improved quality of goods or services	☐	☐	☐	☐
Process oriented effects	Improved flexibility of production or service provision	☐	☐	☐	☐
	Increased capacity of production or service provision	☐	☐	☐	☐
	Reduced labour costs per unit output	☐	☐	☐	☐
	Reduced materials and energy per unit output	☐	☐	☐	☐
Other effects	Reduced environmental impacts or improved health and safety	☐	☐	☐	☐
	Met regulatory requirements	☐	☐	☐	☐

8. Factors hampering innovation activities

8.1 During the three years 2002 to 2004, were any of your innovation activities or projects:

	Yes	No
Abandoned in the concept stage	☐	☐
Abandoned after the activity or project was begun	☐	☐
Seriously delayed	☐	☐

TO BE ANSWERED BY ALL ENTERPRISES:

8.2 During the three years 2002 to 2004, how important were the following factors for hampering your innovation activities or projects or influencing a decision not to innovate?

		Degree of importance			
		High	**Medium**	**Low**	**Factor not experienced**
Cost factors	Lack of funds within your enterprise or group	☐	☐	☐	☐
	Lack of finance from sources outside your enterprise	☐	☐	☐	☐
	Innovation costs too high	☐	☐	☐	☐
Knowledge factors	Lack of qualified personnel	☐	☐	☐	☐
	Lack of information on technology	☐	☐	☐	☐
	Lack of information on markets	☐	☐	☐	☐
	Difficulty in finding cooperation partners for innovation	☐	☐	☐	☐
Market factors	Market dominated by established enterprises	☐	☐	☐	☐
	Uncertain demand for innovative goods or services	☐	☐	☐	☐
Reasons not to innovate	No need due to prior innovations	☐	☐	☐	☐
	No need because of no demand for innovations	☐	☐	☐	☐

9. Intellectual property rights

9.1 During the three years 2002 to 2004, did your enterprise:

	Yes	No
Apply for a patent	☐	☐
Register an industrial design	☐	☐
Register a trademark	☐	☐
Claim copyright	☐	☐

10. Organisational and marketing innovations

An organisational innovation is the implementation of new or significant changes in firm structure or management methods that are intended to improve your firm's use of knowledge, the quality of your goods and services, or the efficiency of work flows. A marketing innovation is the implementation of new or significantly improved designs or sales methods to increase the appeal of your goods and services or to enter new markets.

10.1 During the three years 2002 to 2004, did your enterprise introduce:

		Yes	No
Organisational innovations	New or significantly improved knowledge management systems to better use or exchange information, knowledge and skills within your enterprise	☐	☐
	A major change to the organisation of work within your enterprise, such as changes in the management structure or integrating different departments or activities	☐	☐
	New or significant changes in your relations with other firms or public institutions, such as through alliances, partnerships, outsourcing or sub-contracting	☐	☐
Marketing innovations	Significant changes to the design or packaging of a good or service (Exclude routine/ seasonal changes such as clothing fashions)	☐	☐
	New or significantly changed sales or distribution methods, such as internet sales, franchising, direct sales or distribution licenses.	☐	☐

10.2 If your enterprise introduced an organisational innovation during the three years 2002 to 2004, how important were each of the following effects?

	Degree of observed effect			
	High	**Medium**	**Low**	**Not relevant**
Reduced time to respond to customer or supplier needs	☐	☐	☐	☐
Improved quality of your goods or services	☐	☐	☐	☐
Reduced costs per unit output	☐	☐	☐	☐
Improved employee satisfaction and/or reduced rates of employee turnover	☐	☐	☐	☐

11. Basic economic information on your enterprise

11.1 What was your enterprise's total turnover for 2002 and 2004?[1]

Turnover is defined as the market sales of goods and services (Include all taxes except VAT[2]).

2002	2004

11.2 What was your enterprise's total number of employees in 2002 and 2004?[3]

2002	2004

[1] Give turnover in '000 of national currency units to nine digits.

[2] For Credit institutions: Interests receivable and similar income; for Insurance services: Gross premiums written.

[3] Annual average. If not available, give the number of employees at the end of each year. Give figures to six digits.

ANNEX 2:

The CIS pilot modules on organisational and marketing innovation

MODULE ON ORGANISATIONAL INNOVATION

An organisational innovation is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.

1. Compared to other European enterprises of a similar size and sector, how close was your enterprise's organisational structure in 2004 to best practice in Europe?

Best practice is defined as an organisational structure in 2004 that maximized productivity, quality, and customer service.

- ☐ Close to or at best practice
- ☐ Above average
- ☐ Average
- ☐ Below average
- ☐ Well below average

2. During the three years 2004 to 2006, did your enterprise introduce:

		Yes	No
2.1	New or significantly improved knowledge management systems to better use or exchange information, knowledge and skills within your enterprise[1]	☐	☐
2.2	New management systems for the production and/or supply operations of your enterprise[2]	☐	☐
2.3	Significant changes to the organisation of work in your enterprise that (tick all that apply):		
	Increased employee decision making and responsibility for their work	☐	☐
	Decreased employee decision making and responsibility for their work	☐	☐
	Had no effect on employee decision making and responsibilities	☐	☐
2.4	A significant change to the management structure of your enterprise, such as creating new divisions or departments, integrating different departments or activities, adoption of a networked structure, etc[3]	☐	☐
2.5	New or significant changes in your relations with other firms or public institutions, such as through alliances, partnerships, outsourcing or sub-contracting	☐	☐

Go to question 3 if your enterprise introduced at least one organisational innovation between 2004 and 2006. Otherwise go to question 7.

3. What was the source of the ideas for yo ur enterprise's organisational innovations? [4]

Select the most appropriate option only

3.1	Mainly your enterprise or enterprise group	☐
3.2	Both your enterprise and other enterprises, institutions, publications, etc.	☐
3.3	Mainly other enterprises, institutions, publications, etc.	☐

4. How important were each of the following effects of your enterprise's organisational innovations between 2004 and 2006?

(If your enterprise introduced several organisational innovations, make an overall evaluation)

		High	**Medium**	**Low**	**None / Not relevant**
4.1	Reduced time to respond to customer or supplier needs	☐	☐	☐	☐
4.2	Improved quality of your goods or services	☐	☐	☐	☐
4.3	Reduced costs per unit output	☐	☐	☐	☐
4.4	Improved employee satisfaction and/or lower employee turnover	☐	☐	☐	☐
4.5	Improved communication or information sharing	☐	☐	☐	☐
4.6	Increased ability to develop new products or processes	☐	☐	☐	☐

5. Approximately what percent of your employees were directly affected by your enterprise's organisational innovations between 2004 and 2006? [5]

__________%

6. Were any of these organisational innovations essential to the implementation of other types of innovations introduced by your enterprise between 2004 and 2006?

(Tick not relevant if your enterprise did not introduce one of the following innovations)		**Yes**	**No**	**Not relevant**
6.1	Process innovation	☐	☐	☐
6.2	Product innovation for a new or improved service	☐	☐	☐
6.3	Product innovation for a new or improved good	☐	☐	☐

Go to question …

7. Why did your enterprise not introduce an organisational innovation between 2004 and 2006?

		Yes	No
7.1	Organisational innovations were introduced before 2004 and no need for further change	☐	☐
7.2	Lack of funds or staff to implement an organisational innovation	☐	☐
7.3	Resistance of staff or management to organisational change	☐	☐

MODULE ON MARKETING INNOVATION

A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.

1. During the three years 2004 to 2006, did your enterprise introduce the following marketing innovations:

			Yes	No
Design	1.1	Introduce significant changes to the **design** of a good or service (Exclude routine/ seasonal changes such as clothing fashions)	☐	☐
	1.2	Introduce significant changes to the **packaging** of a good	☐	☐
Promotion	1.3	Implement a new marketing strategy to **target new customer groups or market segments**	☐	☐
	1.4	Use **new media or techniques to promote products**, such as new advertising concepts, a new brand image or new techniques to customize promotion to individual customers or groups	☐	☐
Placement	1. 5	Use **new sales channels**, such as direct selling, internet sales, or product licensing	☐	☐
	1. 6	Introduce new concepts for **product presentation** in sales outlets (e.g. sales rooms, websites, other types of outlets)	☐	☐
Pricing	1. 7	Use **new pricing methods** to market goods or services	☐	☐

Go to question 2 if your enterprise introduced at least one marketing innovation between 2004 and 2006. Otherwise go to question...

2. Who developed these marketing innovations?

Select the most appropriate option only

2.1	Mainly your enterprise or enterprise group	☐
2.2	Your enterprise together with other enterprises or institutions	☐
2.3	Mainly other enterprises or institutions	☐

3. How important were each of the following effects of your enterprise's marketing innovations between 2004 and 2006?

(If your enterprise introduced several marketing innovations, make an overall evaluation)

	High	Medium	Low	None/Not relevant
1. Sales growth for your goods and services[1]	☐	☐	☐	☐
2. Introduced products to new markets or customer groups	☐	☐	☐	☐
3. Increased visibility of products or business	☐	☐	☐	☐
4. Strengthened relationships with customers	☐	☐	☐	☐
5. Improved customer satisfaction	☐	☐	☐	☐

4. How important were the following market-related activities for your enterprise's innovation projects between 2004 and 2006?[2]

	High	Medium	Low	None/ Not used
4.1 Maintaining close links between your marketing department and departments or groups involved in developing or implementing your innovations	☐	☐	☐	☐
4.2 Systematic analysis of your customer's needs by your marketing division	☐	☐	☐	☐
4.3 Systematic analysis of the effectiveness of your marketing techniques	☐	☐	☐	☐

5. If your firm introduced a marketing innovation <u>and</u> introduced a product innovation between 2004 and 2006:

	Yes	No
5.1 Were any of these marketing innovations an integral part of any of your enterprise's product innovations? (For example, a design change was an essential part of a technical innovation, or a new marketing method was part of a process innovation) [3]	☐	☐
5.2 Were any of these marketing innovations <u>necessary</u> for the successful introduction of your enterprise's product innovation(s)?	☐	☐

MODULE ON KNOWLEDGE MANAGEMENT

1. Is your firm currently using each of the following knowledge management practices? [1]

If yes, please indicate if your firm first introduced or made a significant change to each practice between 2004 and 2006 inclusive

	No	**Yes** *(tick both if relevant)*
1.1 A written knowledge management policy	☐	☐ Introduced/changed 2004-2006 ☐ Introduced/changed **before** 2004
1.2 Incentives for employees to share knowledge within your enterprise	☐	☐ Introduced/changed 2004-2006 ☐ Introduced/changed **before** 2004
1.3 Dedicated resources to monitor and obtain knowledge from outside your enterprise	☐	☐ Introduced/changed 2004-2006 ☐ Introduced/changed **before** 2004
1.4 A policy to bring in external experts from universities, research institutes, or other firms to participate in project teams, as needed[2]	☐	☐ Introduced/changed 2004-2006 ☐ Introduced/changed **before** 2004
1.5 Regular updates of internal databases or manuals of good work practices, lessons learned, or expert advice	☐	☐ Introduced/changed 2004-2006 ☐ Introduced/changed **before** 2004

POWERPOINT PRESENTATION OF MR. GLAUDE

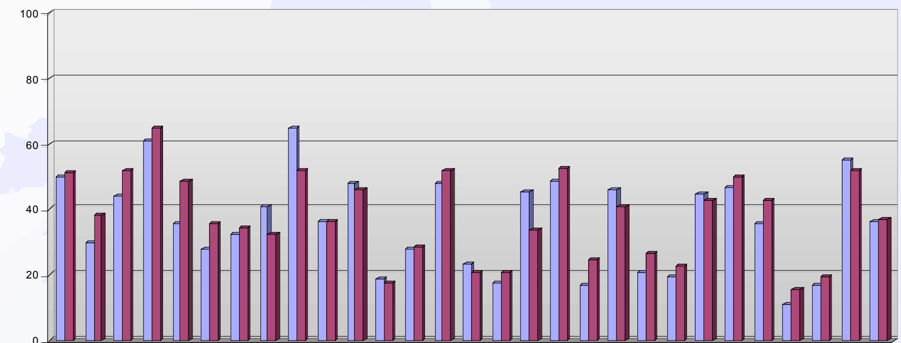
Is Europe getting more innovative or is Europe losing ground ?

A European hydrogen bus

eurostat

Data from the Third and Fourth Community Innovation Surveys (CIS 3 and CIS 4)

Share of enterprises with innovation activity (%)



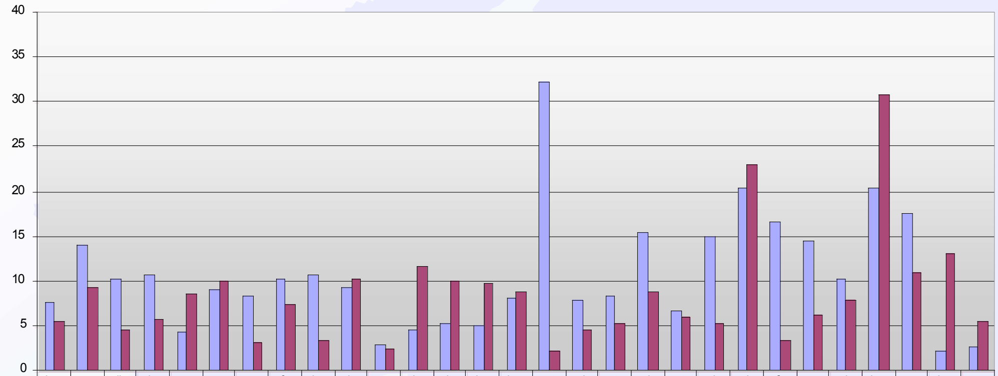
	be	cz	dk	de	ee	gr	es	fr	ie	it	cy	lv	lt	lu	hu	mt	nl	at	pl	pt	si	sk	fi	se	uk	bg	ro	is	no
2000	50	30	44	61	36	28	33	41	65	36	48	19	28	48	23	18	45	49	17	46	21	19	45	47	36	11	17	55	36
2004	51	38	52	65	49	36	35	33	52	36	46	18	29	52	21	21	34	52	25	41	27	23	43	50	43	16	20	52	37

In most European countries the proportion of enterprises with innovation activity slightly increased in 2004 compared to 2000

eurostat

Data from the Fourth Community Innovation Surveys (CIS 4)

Share of turnover with new or significantly improved products (new to the market) in total turnover of innovative enterprises (%), 2004



	be	cz	dk	de	ee	gr	es	fr	ie	it	cy	lv	lt	lu	hu	mt	nl	at	pl	pt	si	sk	fi	se	uk	bg	ro	is	no
Industry	8	14	10	11	4	9	8	10	11	9	3	5	5	5	8	32	8	9	16	7	15	20	17	15	10	21	18	2	3
Services	6	9	5	6	9	10	3	8	4	10	2	12	10	10	9	2	5	5	9	6	5	23	4	6	8	31	11	13	6

Industry Services

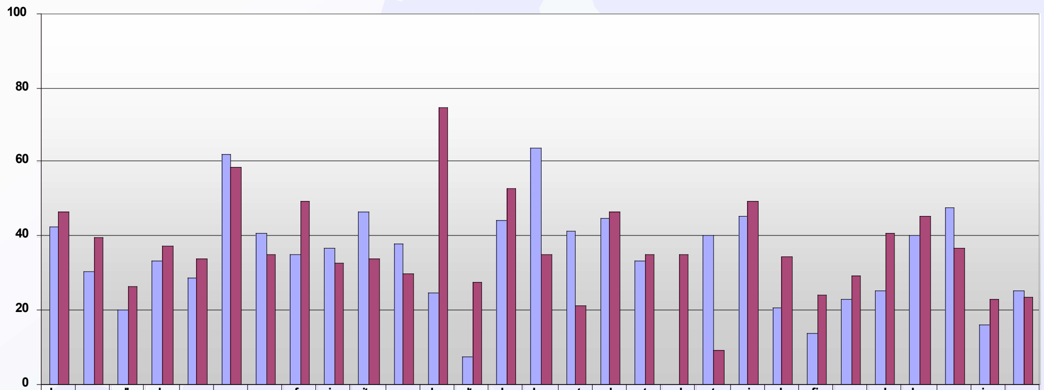
New Member states often with higher shares of turnover related to new or significantly improved products compared to old Member states

eurostat

Data from the Third and Fourth Community Innovation Surveys (CIS 3 and CIS 4)

The most important effect of innovation

Improved quality in goods or services (% of innovative enterprises)



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2000	43	30	20	33	29	62	41	35	37	47	38	25	8	44	64	41	45	34	0	40	46	21	14	23	26	41	48	16	26
2004	47	40	27	38	34	59	35	49	33	34	30	75	28	53	35	22	47	35	35	9	50	35	24	29	41	46	37	23	24

2000 2004

In many countries innovation improved the quality of goods and services thoroughly.

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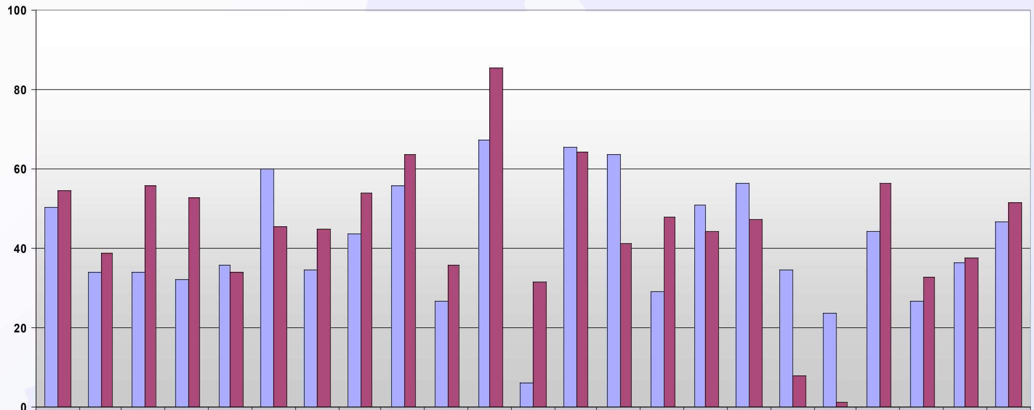
Data from the Third and Fourth Community Innovation Surveys (CIS 3 and CIS 4)

The highly important source of information for innovation

Within the enterprise or enterprise group (% of innovative enterprises)



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2000	51	34	34	33	36	60	35	44	56	27	68	6	66	64	29	51	57	35	24	45	27	37	47
2004	55	39	56	53	34	46	45	54	64	36	86	32	65	42	49	45	48	8	2	57	33	38	52

2000 2004

Enterprises mostly used internal information sources for their innovation activity.

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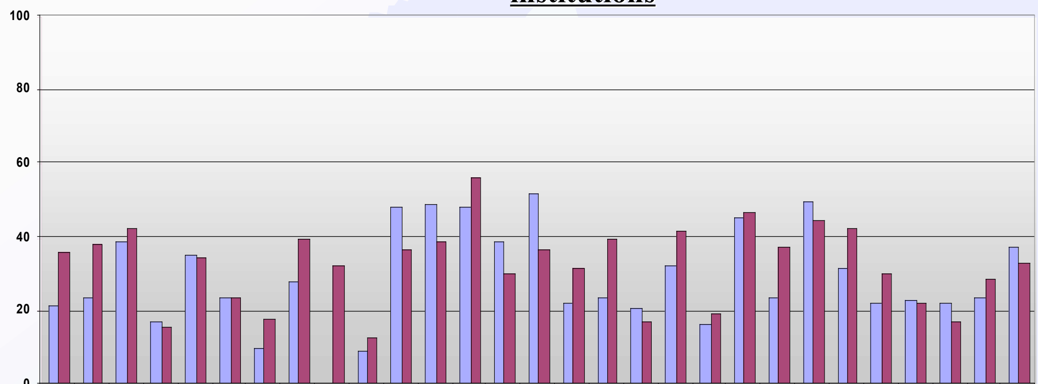
Data from the Third and Fourth Community Innovation Surveys (CIS 3 and CIS 4)

Innovative enterprises with co-operation with other enterprises or institutions



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2000	22	24	39	17	35	24	10	28	0	9	49	49	48	39	52	22	24	21	32	17	46	24	50	32	23	23	22	24	38
2004	36	38	43	16	35	24	18	40	32	13	37	39	56	30	37	32	39	17	42	19	47	38	44	43	31	22	17	29	33

2000 2004

Innovative enterprises increasingly cooperate with other enterprises or institutions.

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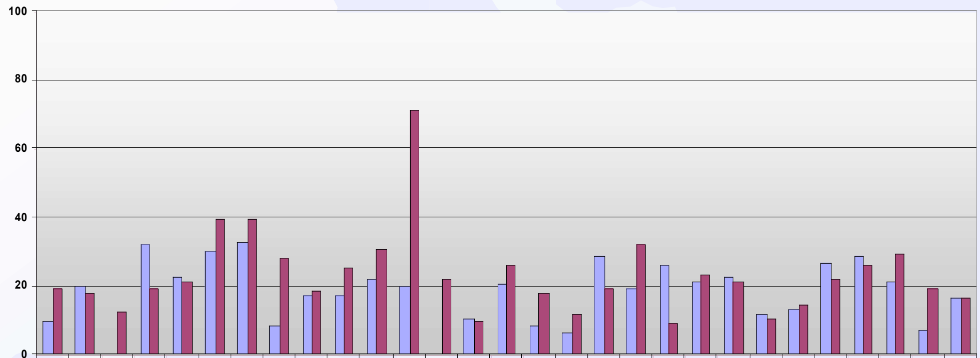
Data from the Third and Fourth Community Innovation Surveys (CIS 3 and CIS 4)

The main hampering factor of innovation

Innovation cost too high (% of innovative enterprises)



	be	cz	dk	de	ee	gr	es	fr	ie	it	cy	lv	lt	lu	hu	mt	nl	at	pl	pt	si	sk	fi	se	uk	bg	ro	is	no
2000	10	20	0	32	23	30	33	9	17	17	22	20	1	11	20	9	6	29	19	26	21	22	12	14	27	29	21	8	16
2004	19	18	12	19	21	39	40	28	19	26	31	72	22	10	26	18	12	19	32	9	24	21	11	15	22	26	30	19	17

2000 2004

For many enterprises, too high costs slowed down their innovation activity or even made them give it up.

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The EU policy context

The Lisbon process and its re-launch in 2005: The new Lisbon partnership for jobs and growth: Research and innovation at the heart of the EU policies

The Annual Policy Strategy 2007 of the European Commission: “Knowledge as priority area with clear targets to improve Europe’s education, research and innovation framework as drivers for growth”

In addition: the AHO report (2006): Creating an innovative Europe: …”path to prosperity through research and innovation is open, action has to be taken before it is too late”

The Community Innovation Surveys (CIS) are the main harmonised surveys for measuring innovation in Europe and beyond

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From the CIS 1 to the CIS 2006

Until now several waves on Community Innovation Surveys

The CIS 1 and the CIS 2

The starting-up phase from the beginning of the '90s with the design of the harmonised questionnaire and methodology, the CIS 2 with the reference year 1996, dissemination of tabulated and micro-data

The CIS 3

More consolidated with a quite sound harmonised survey questionnaire and survey methodology, based on the reference years 2000/2001, broad participation of countries, the CIS 3 data started to be disseminated as micro-data, some non European countries followed

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From the CIS 1 to the CIS 2006

The CIS 4

- Focuses mainly on product and process innovation, in however also covering organisational and marketing innovation
- Is mainly based on the OECD Oslo Manual 1997
- Is again based on a harmonised survey questionnaire and survey methodology and a Commission Regulation
- Is around 20 % shorter and also easier than the CIS 3
- Covers industry and many services sectors (with enterprises above 10 employees)
- Is – in a first attempt - disseminated as tabular data from 12/2006 onwards
- Is increasingly also used outside Europe (in China, South Africa, etc.)

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From the CIS 1 to the CIS 2006

CIS3 and CIS 4
Un-weighted unit response rates (%)

	CIS3	CIS4
Denmark	43	51
France	82	87
Latvia	90	96
Lithuania	68	94
Austria	43	59
Portugal	46	75
Slovakia	91	73
Finland	50	74
Romania	83	78
Norway	94	95

The unit response rates often went up from the CIS 3 to the CIS 4

From the CIS 1 to the CIS 2006

The CIS 2006

- Keeps the main characteristics of the CIS 4 (such as the survey questionnaire and the survey methodology) stable
- Faces a broad implementation at national level, often on voluntary bases
- Adds – in the view of preparing the CIS 2008 – pilot modules on organisational and marketing innovation as well as on knowledge flows
- Faces a broader implementation of these pilot modules in many countries
- Will be disseminated from mid 2008 onwards

Towards the CIS 2008

- The new Oslo Manual 2005 needs to be implemented in the CIS 2008 with a better recording of organisational and marketing innovation and knowledge flows
- Pilot modules on those new types of innovation as well as on knowledge flows were created and are implemented in countries in 2007
- In addition: many user needs for the CIS 2008 are piling up, e.g. on :
  - Full regional innovation data
  - Eco-innovation
  - Innovation and public procurement
  - The better measuring of innovation linkages (between input and output indicators)
  - Innovation in public or other services

Many of these questions will be touched upon during the seminar.

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The micro-data access to the CIS data

- In general: the broader and central micro-data use considerably improves the cost/benefit ratio of a statistical survey
- Eurostat wants to push the micro-data access forward
- Considerable progress was made hereon for the CIS:
  - Access to the anonymised micro-data: a micro-data anonymisation method was created and applied, 15 national anonymised CIS 3 micro-data sets are currently in dissemination to researchers
  - Access to confidential CIS 3: data was opened at the Eurostat Safe centre, but this is the more expensive option for all parties involved.

The CIS micro-data transmission from countries to Eurostat needs to be assured, the micro-data access for researchers needs to be opened for the CIS 4, the procedures need to get easier

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The CIS and the European Innovation Scoreboard (EIS)

One of the main uses of the CIS: The EIS with the Summary Innovation Index 2006 based on the following indicators:

Innovation Input (16)

Innovation Drivers
- New S&E graduates
- Population with 3rd education
- Broadband access
- Lifelong learning
- Youth education attainment level

Knowledge Creation
- Public R&D expenditures
- Business R&D expenditures
- Share of medium and high tech R&D
- **Share of firms receiving public funding for innovation**

Innovation & Entre-preneurship
- **SMEs innovating in-house**
- **Innovative SMEs cooperating**
- **Innovation expenditure**
- Early-stage venture capital
- ICT expenditures
- **SMEs using organisational innovation**

Innovation Output (10)

Innovation Applications
- Employment high tech services
- High tech exports
- **Sales of new to market products**
- **Sales of new to firm products**
- Employment in medium & high tech manufacturing

Intellectual Property
- EPO patents
- USPTO patents
- Triadic patents
- Community Trademarks
- Community industrial designs

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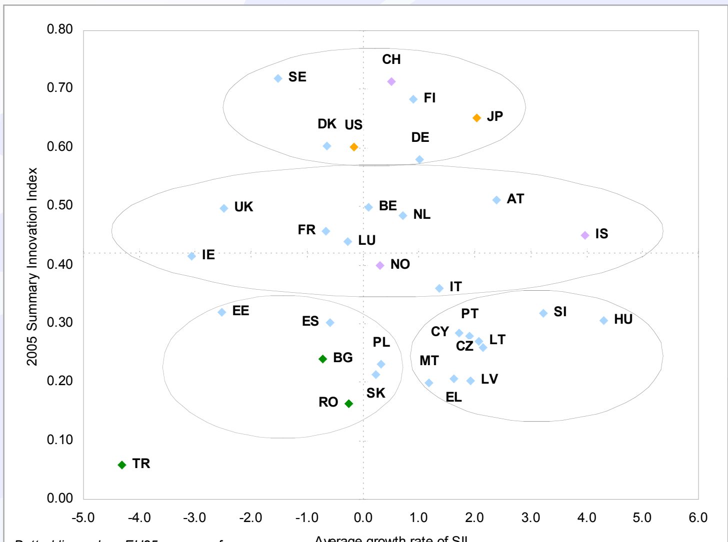
The CIS and the European Innovation Scoreboard

The European Innovation Scoreboard 2005: some results



Dotted lines show EU25 mean performance.

leading

average

catching up

losing ground

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32 nd CEIES seminar
Innovation Indicators – more than technology ?

After 2003, this is the next CEIES seminar on innovation indicators with 6 sessions:

Session 1: Producer ability to collect data – some experiences
From Belgium, Canada and Italy: national data production experiences (including regional data); from the US: innovation data as part of the R&D survey; from Japan: non-technological innovation

Session 2: Data provider response ability and willingness
From France, Slovenia and Denmark: how do enterprises perceive innovation? Are enterprises able to answer to the questionnaire? From Denmark again: CIS data quality issues, combining R&D and CIS surveys ?

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The CEIES seminar
Innovation Indicators – more than technology ?

Session 3: Comparative analysis based on CIS-data
Now the data users: from WIFO and the PILOT project: sectoral innovation and sectoral differences; from the Fraunhofer Institute: cross-country analysis; from the PORCH project: organisational innovation

Session 4: The revised Oslo Manual and the implementation into CIS
From Norway and Denmark: the new types of innovation and innovation linkages; from Luxembourg: 2 or 3 years reference period for the CIS ? From Estonia: from the Oslo Manual to the survey questionnaire

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The CEIES seminar
Innovation Indicators – more than technology ?

Session 5: user needs for new indicators as well as the existing

From DG ENTR: The European Innovation Scoreboard and other data needs; from Merit: the under-exploitation of the CIS, more micro-data use; from Norway: measuring innovation processes; from Italy: the pros and cons of the micro-data access

Session 6: CIS 2006, CIS 2008 and beyond

From Canada: how do we go ahead with STI indicators after the Bluesky conference 2006? From Eurostat: how might the CIS 2008 look like? How can we better use the CIS micro-data? From Finland: problems with micro-data from small countries

This seminar can be seen as the kick-off for the CIS 2008

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Finally

Europe can build on innovation such as

But: the world competitors do not sleep

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Conference Papers

Producer ability to collect data – some experiences

INNOVATION ACTIVITIES AND EXPENDITURES

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and
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Abstract

This paper deals with the comparability of innovation activities both over time (comparison of CIS3 and CIS4 results) and between countries, as well as on issues for measurement of such activities. The focus of the paper is on innovation active firms in terms of product and process innovations. For these firms, a distinction can be made between seven types of innovation activities. Each of these activities can be measured both in qualitative (whether or not firms engage in such activities) and quantitative (expenditures) terms. The main outcomes of the paper highlight remaining problems of comparability over time and between countries and a necessity for careful screening of the micro-data.

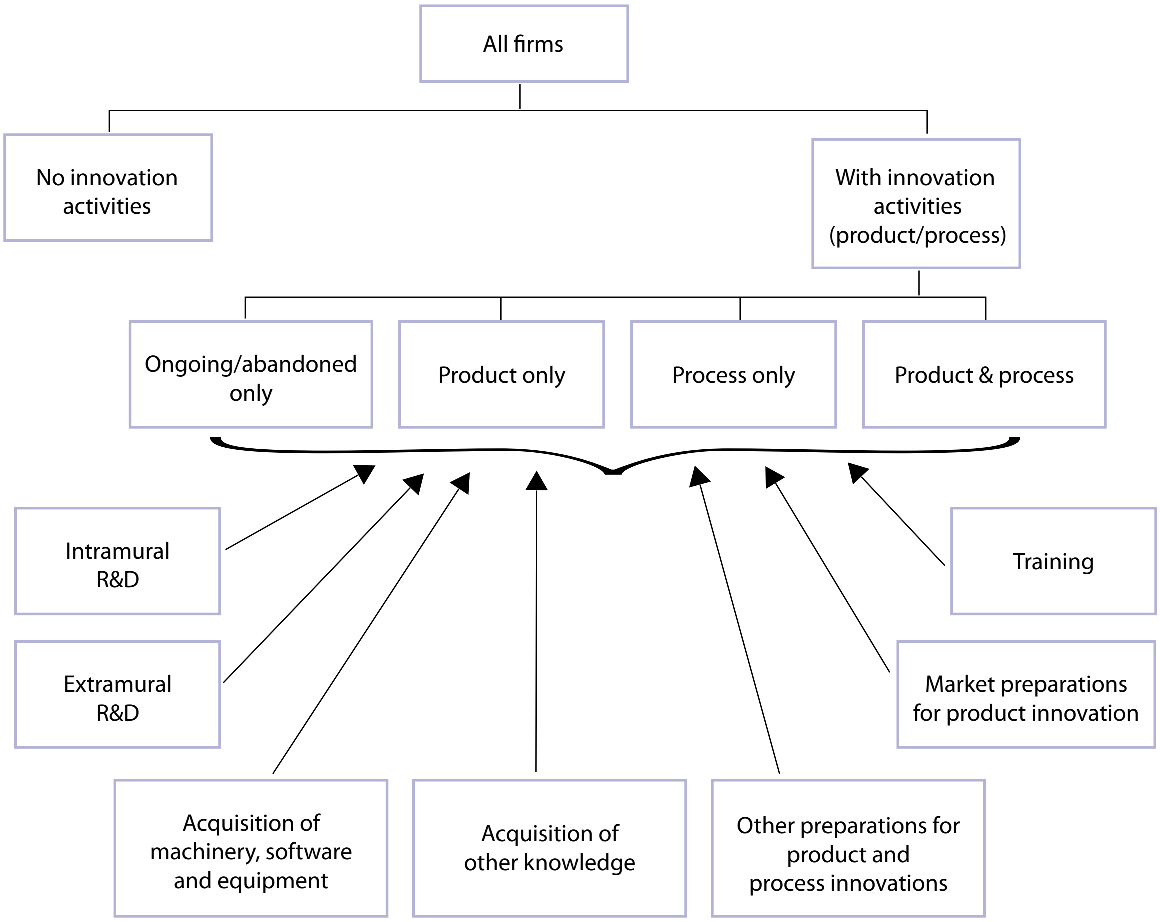
1. Introduction

Before exposing measurement issues and data quality of innovation activities and expenditures, we will set ideas about what we are exactly trying to measure, and about how we measure it. To start with, what do we call innovation activities and expenditures?

Innovation activities are performed by innovation active firms. They appear as the natural complement of innovation activity. According to the 3rd edition of the Oslo Manual (OECD 2005, p. 47, §149): "*Innovation activities include all scientific, technological, organisational, financial and commercial steps which actually lead, or are intended to lead, to the implementation of innovations (...) Innovation activities also include R&D that is not directly related to the development of a specific innovation*". We will elaborate more in depth below on the precise nature of these activities. For now, let us emphasize that the concept of "innovation" tackles many different situations. Indeed, the Oslo Manual (p. 46, §146) defines an innovation as "*the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practice, workplace organisation, or external relations*". There are thus four, non-mutually exclusive, types of innovators: product innovators, process innovators, marketing innovators and organisational innovators. However, as acknowledged by the Oslo Manual (p.47, § 153): "*The broad definition of an innovative firm may not be appropriate for all policy and research needs. More narrow definitions can be useful in many cases (...). An example of a more narrow definition is a product or process innovator*". Accordingly, the CIS questionnaire restricts its attention to innovation activities and expenditures only by firms active in product or process innovations only.

To become an innovator of a given type, a firm must have performed some innovation activities upstream. Which doesn't imply that innovation has actually been implemented. Indeed, some entrepreneurs may have been unlucky: though they incurred expenses and made efforts to innovate, they didn't succeed. Others may have engaged in a long-term innovation process and these are still in the "pipeline" at the time they answer the CIS questionnaire. This leads to the creation of an "ongoing or abandoned activity only" category that exactly represents the difference between innovation active firms and innovative firms. The CIS questionnaire on activities is interested in innovation active firms, i.e. includes this latter category. The upper part of Figure 1 illustrates the questionnaire architecture we have just discussed.

Figure 1: Typology of firms and activities according to the CIS Questionnaire



The lower part of the figure describes the nature of the activities and expenditures under scrutiny. The Oslo Manual (pp. 97-98; § 351) breaks down these activities into: "

- *Research and experimental development*

  1. *Intramural R&D: creative work undertaken on a systematic basis within the enterprise in order to increase the stock of knowledge and use it to devise new applications (...)*
  2. *Acquisition of extramural R&D: same activities as intramural R&D but purchased from public or private research organisations or from other enterprises (including other enterprises within the group)*

- *Activities for product and process innovations*

  3. *Acquisition of other external knowledge: acquisition of the right to use patents and non-patented inventions, trademarks, know-how, and other types of knowledge (...)*
  4. *Acquisition of machinery, equipment, and other capital goods: Acquisition of advanced machinery, equipment, computer hardware and software, and land and building (...) Acquisition of capital goods that is included in intramural R&D activities is excluded*

5. *Other preparations for product and process innovations: other activities related to the development and implementation of product and process innovations, such as design, planning, and testing for new products (…), production processes, and delivery methods that are not already included in R&D*
6. *Market preparations for product innovations: activities aimed at the market introduction of new or significantly improved goods or services*
7. *Training: Training (including external training) linked to the development of product or process innovations and their implementation*

- *Activities for marketing and organisational innovations*

8. *Preparations for marketing innovations: activities related to the development and implementation of new marketing methods. Includes acquisition of other external knowledge and other capital goods that is specifically related to marketing innovations*
9. *Preparations for organisational innovations: activities undertaken for the planning and implementation of new organisation methods. Includes acquisition of other external knowledge and other capital goods that is specifically related to organisational innovations"*

In this paper the focus will be on activities one to seven and as such activities for marketing and organisational innovations are not included. The Oslo Manual recommends gathering data on these innovation activities both from a qualitative and from a quantitative point of view. Qualitative data refer to the question: did the surveyed firm engage in a given activity? Quantitative data address the issue of how much money the firm spent in (some of) the various activities it engaged in.

The OSLO-manual recommendations were to a high degree integrated in the CIS3 and CIS4 questionnaire. A filter question is included in both the CIS3 and the CIS4, so that only enterprises with (completed or ongoing or abandoned) product or process innovation activities answer the questions on innovation activities. Accordingly, for the qualitative part, innovation active firms are asked, in both questionnaires, whether or not they were engaged in the various items between no 1 and no 7 in the list above. Marketing and organisational innovations were left out of the picture.

As to quantitative expenditures questions, the questionnaire does not adopt the "object approach" (i.e. disaggregating expenses for specific innovations) but abides by the "subject approach" (i.e. firms are asked for their total expenditures). More precisely, firms are asked to provide the total innovation expenditures as well as a breakdown by activity. In this respect, some changes occurred between the CIS3 and CIS 4 questionnaires. In the CIS 3, enterprises were asked the amount they spent on each of the seven items in the list. On the contrary, the CIS 4 questionnaire focuses on the first four items in the list only. Moreover, the CIS3 also investigated the number of persons involved in intramural R&D as well as the level of highly educated people employment.

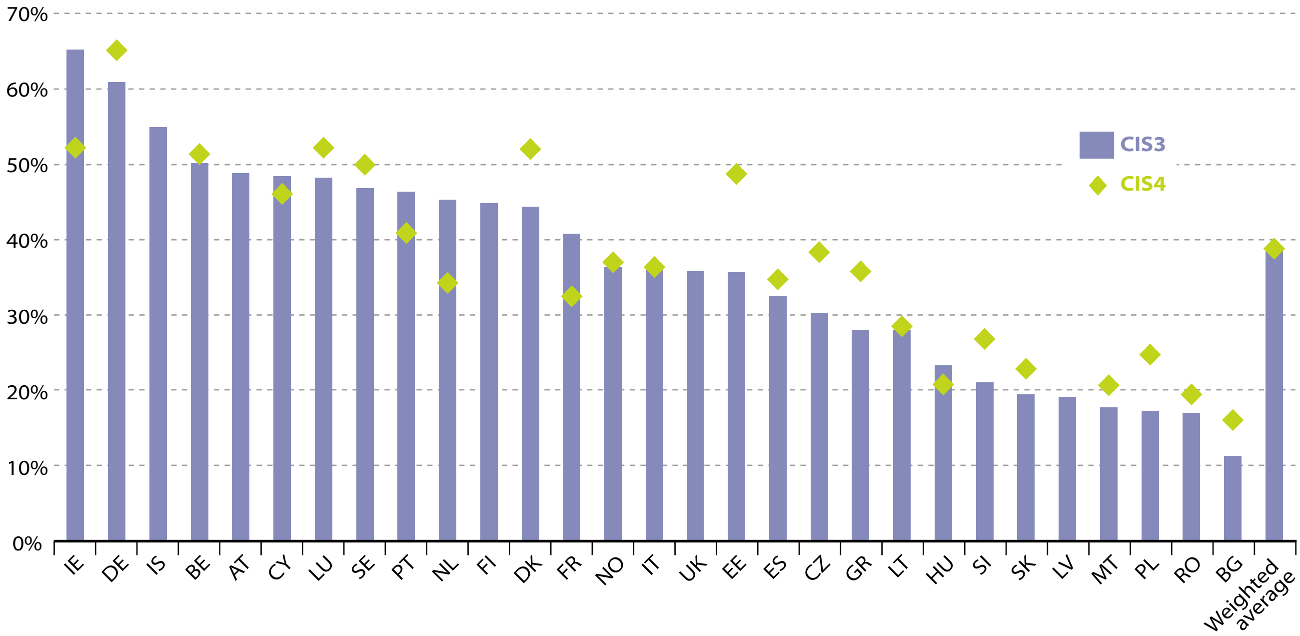
A large part of the harmonized CIS questionnaire is devoted to innovation activities and expenditures. The present document aims at bringing a practical and methodological contribution to the measurement of these issues. In section two a comparison is made of the outcomes of the CIS results both between countries as over time (comparison of CIS3 results with CIS4 results). A clear distinction is made between innovation activity in qualitative and in quantitative terms. It will become clear that some questions can be raised about comparability and consistency of the outcomes of the CIS survey. Section 3 handles with measurement problems from a micro-level based approach. It presents the Belgian experience.

2. Presentation of results at EU level: comparison (CIS3 + CIS4)

Figure 2 highlights the proportion of innovation active enterprises, both across countries and over time (comparing the results of the CIS 3 (reference year 2000) and the CIS 4 (reference year 2004). Some interesting findings pop-up regarding the reliability of the data.

On average, the overall weighted average of innovation active firms remains more or less stable between CIS3 and CIS4. Also, the innovation activity turns out to remain lower in the New Member States. Remarkable differences between CIS3 and CIS 4 can be found in a sharp decrease in the proportion of innovation active firms in Ireland, the Netherlands and France. A significant increase can be noted in Germany, Estonia, Czech Republic, Greece, Slovenia and Poland.

Figure 2: Proportion innovation active firms in the CIS 3 and in the CIS 4



Source: Eurostat, NewCronos Database

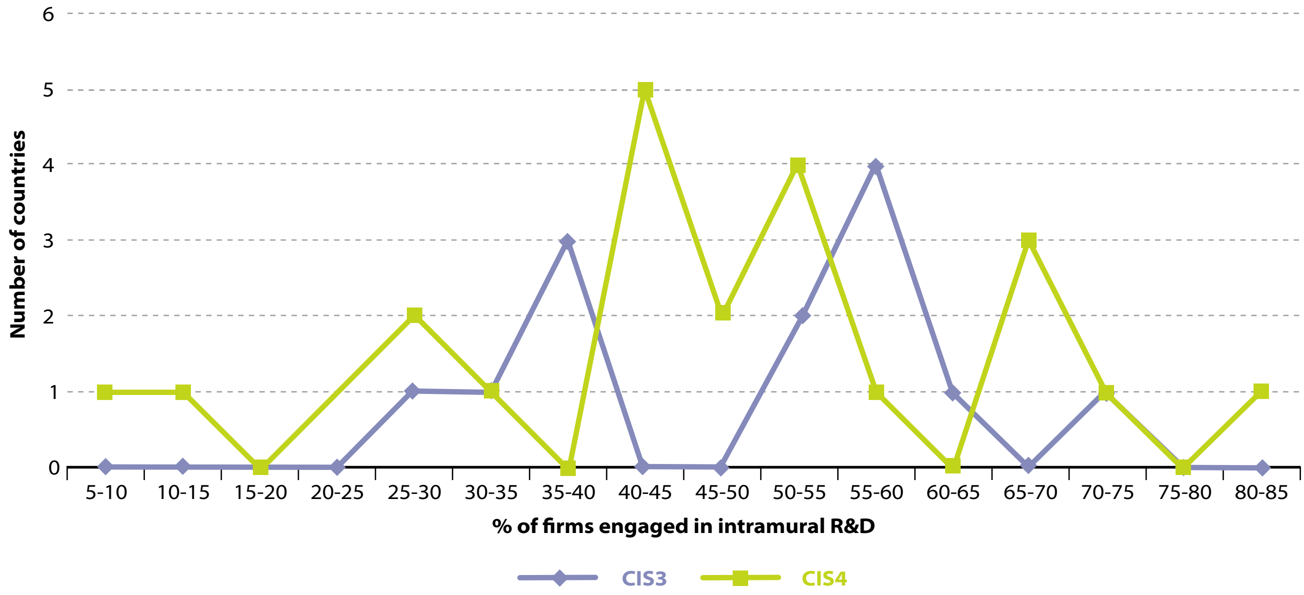
As explained in the introduction, innovation activity can be divided by type of activity. For this both data on the fact whether or not an innovative active firms is engaged in a certain type of activity as well as the budgets spend on each of the different activities is available.

2.1 Engagement by type of activity

Figure 3 describes the distribution of innovation active firms performing the various activities under scrutiny in the CIS3 and CIS 4, as a percentage of the number of firms with innovation activities. Data are available for 13 countries for CIS3 and for 23 countries for CIS4.

Regarding intra-mural R&D activities, based on CIS3 results, 12 out of 13 countries reported to have between 30 and 65% of their firms engaged in this kind of activity. One outlier (Finland) was found with a share between 70 and 75%. For CIS4, at the lower end, three countries (Cyprus, Poland, Bulgaria) were found with less than one fourth of their firms engaged in intramural R&D, whereas in six countries over two thirds of the firms are engaged in this activity (Norway, Sweden, the Netherlands, and France around 70% and Ireland with over 85%). Comparing CIS3 with CIS4 on an individual country base reveals important changes for Denmark (-24%); France (+12%); Italy (+24%); the Netherlands (+13%); and Norway (+10%). In general the results for CIS 3 seem to be more bipolar, whereas CIS4 results tend to be concentrated around three nodes.

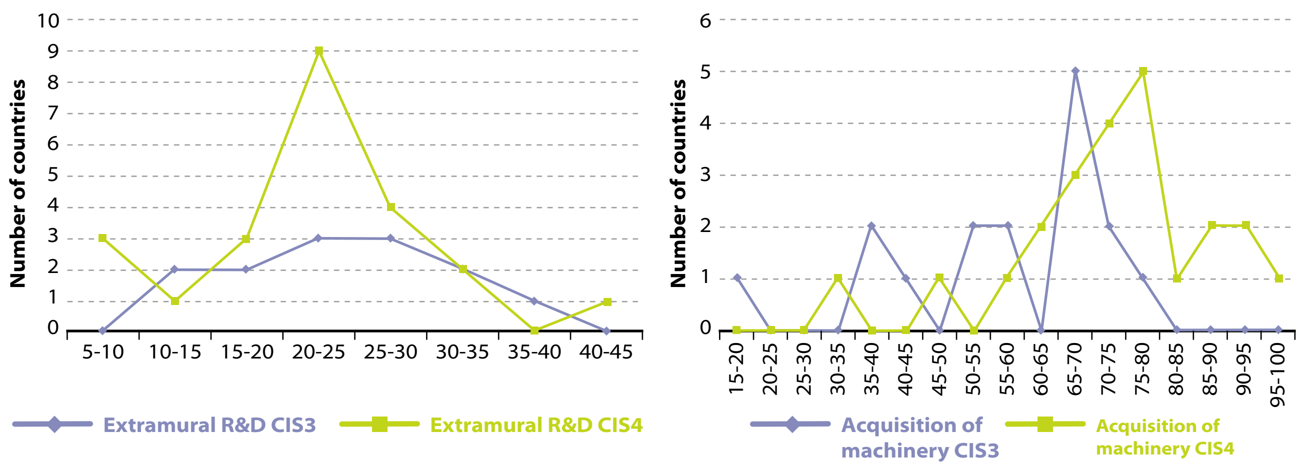
Figure 3: Distribution of % of firms included in intramural R&D activities, CIS3 and CIS4



Source: Eurostat, NewCronos Database

A similar exercise for engagement in extra-mural R&D activities reveals a more concentrated distribution with over three quarters of countries reporting between 15% and 35% of their innovation active firms engaged in this type of activity. For acquisition of machinery a similarly high concentration is to be found between 55% and 85% for CIS3 and between 60% and 90% for CIS4 (i.e. a displacement to the right).

Figure 4: Distribution of % of firms included in extramural R&D activities and the acquisition of machinery, CIS3 and CIS4



Source: Eurostat, NewCronos Database

It should be taken into account that the sectoral scope of the CIS survey has changed between CIS3 and CIS4. The above made comparisons were made taking into account only the core NACE activities for CIS4 (NACE sections C, D, E, I and J and NACE divisions 51, 72, 74.2 and 74.3). The sum of these core activities is to a large extent comparable with the overall results for CIS3. A more detailed analysis by country and (aggregated) sector of activity is presented in Table 1.

Table 1. Innovation activity between 2000 and 2004, by sector and by type of activity, % change

	Belgium	Denmark	Germany	Greece	Spain	France	Italy	Netherlands	Portugal	Norway
Intramural R&D_ Total*	1%	-32%	-1%	54%	22%	98%	62%	1%	-10%	16%
c_d_e _ Total industry (excluding construction)	-11%	-29%	18%	6%	5%	57%	47%	-10%	-19%	24%
g_to_k _ Services (excluding public administration)	78%	-24%			181%	490%	311%	15%	41%	8%
g _ Wholesale and retail trade	90%	-47%			514%	941%	605%	27%	11%	-8%
i _ Transport, storage and communication	40%	-77%	43%	368%	48%		367%	5%	194%	32%
j _ Financial intermediation	44%	-38%	-41%	126%	50%		228%	-33%	-71%	-25%
k _ Real estate, renting and business activities	92%	35%			67%	370%	126%	20%	129%	14%
Enterprises, engaged in extramural R&D_ Total*	16%	-22%	-7%	234%	67%	95%	76%	11%	-14%	27%
c_d_e _ Total industry (excluding construction)	16%	-17%	14%	129%	47%	69%	57%	2%	-0%	30%
g_to_k _ Services (excluding public administration)	75%	-1%			274%	465%	331%	25%	-12%	25%
g _ Wholesale and retail trade	88%	-19%			303%	863%	634%	47%	-33%	66%
i _ Transport, storage and communication	-27%	-24%	-40%	1190%	23%		192%	58%	42%	32%
j _ Financial intermediation	54%	12%	-36%	56%	147%		109%	-61%	-78%	-33%
k _ Real estate, renting and business activities	293%	18%			343%	351%	189%	21%	282%	14%
Acquisition of machinery, equipment and software_ Total*	43%	34%	-7%	100%	36%	158%	32%	16%	-10%	-20%
c_d_e _ Total industry (excluding construction)	27%	33%	8%	33%	10%	92%	17%	21%	-14%	-7%
g_to_k _ Services (excluding public administration)	143%	62%			387%	835%	306%	11%	22%	-33%
g _ Wholesale and retail trade	113%	98%			402%	1095%	487%	7%	-5%	-46%
i _ Transport, storage and communication	149%	-30%	10%	604%	95%		133%	18%	16%	-13%
j _ Financial intermediation	148%	29%	5%	106%	89%		40%	-10%	-61%	-81%
k _ Real estate, renting and business activities	226%	74%			147%	694%	184%	20%	235%	-14%
Acquisition of other external knowledge_ Total*	18%	82%	-7%	50%	-26%	170%	11%	33%	-28%	-1%
c_d_e _ Total industry (excluding construction)	60%	91%	23%	15%	-37%	165%	-2%	59%	13%	35%
g_to_k _ Services (excluding public administration)	29%	103%			70%	463%	130%	15%	-38%	-22%
g _ Wholesale and retail trade	18%	96%			61%	600%	257%	26%	-68%	-34%
i _ Transport, storage and communication	24%	-8%	-14%	-11%	-45%		22%	28%	40%	39%
j _ Financial intermediation	22%	42%	-35%	-61%	80%		-0%	-1%	-66%	-66%
k _ Real estate, renting and business activities	58%	280%			0%	418%	101%	1%	148%	-2%
Training_ Total*	37%	119%	-10%	133%	58%	133%	51%	3%	37%	-16%
c_d_e _ Total industry (excluding construction)	38%	107%	7%	59%	31%	75%	42%	5%	42%	-15%
g_to_k _ Services (excluding public administration)	100%	198%			340%	644%	197%	1%	64%	-16%
g _ Wholesale and retail trade	112%	181%			647%	970%	345%	-4%	23%	-27%
i _ Transport, storage and communication	45%	21%	3%	618%	112%		137%	6%	242%	4%
j _ Financial intermediation	67%	60%	-17%	163%	59%		23%	-28%	-66%	-70%
k _ Real estate, renting and business activities	122%	433%			93%	531%	118%	18%	237%	8%
Market introduction of innovation_ Total*	19%	54%	-38%	108%	50%	91%	47%	-18%	53%	-11%
c_d_e _ Total industry (excluding construction)	18%	75%	-14%	55%	37%	43%	36%	-19%	56%	-0%
g_to_k _ Services (excluding public administration)	59%	64%			228%	492%	171%	-17%	85%	-19%
g _ Wholesale and retail trade	35%	30%			263%	555%	199%	-8%	86%	-25%
i _ Transport, storage and communication	92%	-54%	-59%	605%	26%		181%	-52%	156%	-36%
j _ Financial intermediation	40%	-23%	-50%	154%	0%		34%	-20%	-73%	-78%
k _ Real estate, renting and business activities	114%	359%			117%	490%	153%	-13%	182%	11%
Other preparations_ Total*	37%	-5%	-9%	8%	69%	88%	71%	-37%	132%	17%
c_d_e _ Total industry (excluding construction)	3%	-9%	16%	-32%	51%	40%	63%	-39%	80%	27%
g_to_k _ Services (excluding public administration)	194%	23%			295%	501%	241%	-35%	432%	5%
g _ Wholesale and retail trade	205%	28%			326%	262%	183%	-39%	281%	-17%
i _ Transport, storage and communication	150%	-52%	-22%	61%	88%		211%	-34%	741%	85%
j _ Financial intermediation	84%	-1%	-26%	6%	47%		71%	-36%	63%	-67%
k _ Real estate, renting and business activities	253%	71%			221%	666%	345%	-28%	730%	25%

* Core NACE CIS4 = NACE sections C, D, E, I and J and NACE divisions 51, 72, 74.2 and 74.3/ All NACE CIS3= CDE,G,I,J,K

Source: Eurostat, NewCronos Database

The results highlight large fluctuations within countries between years. For example for Belgium, the Netherlands and Germany, the status quo at first sight of the number of firms engaged in intramural R&D masks important fluctuations both in manufacturing and services sectors between CIS3 and CIS4. Similarly high fluctuations can be found for the other types of innovation activities. Unfortunately, we were able neither to find a systematic pattern in these fluctuations, nor to attribute these changes to structural macro-economic trends.

A possible explanation could be found in the amount of missing values for each of these variables (Table 2). For the CIS3, particularly France and Iceland and to a lesser extent also Denmark and Spain were faced with a high rate of missing values. For Spain and France this was especially the case for the services sector. By contrast, for Denmark and Iceland the percentage of missing values was the highest in manufacturing. An interesting remark is to check whether there has been a correction for these high missing values in the weights on a variable basis and not on a case-level base.

Table 2. Enterprises with innovation activities, missing information by activity as a percentage of enterprises with innovation activities, total and by sector, CIS3

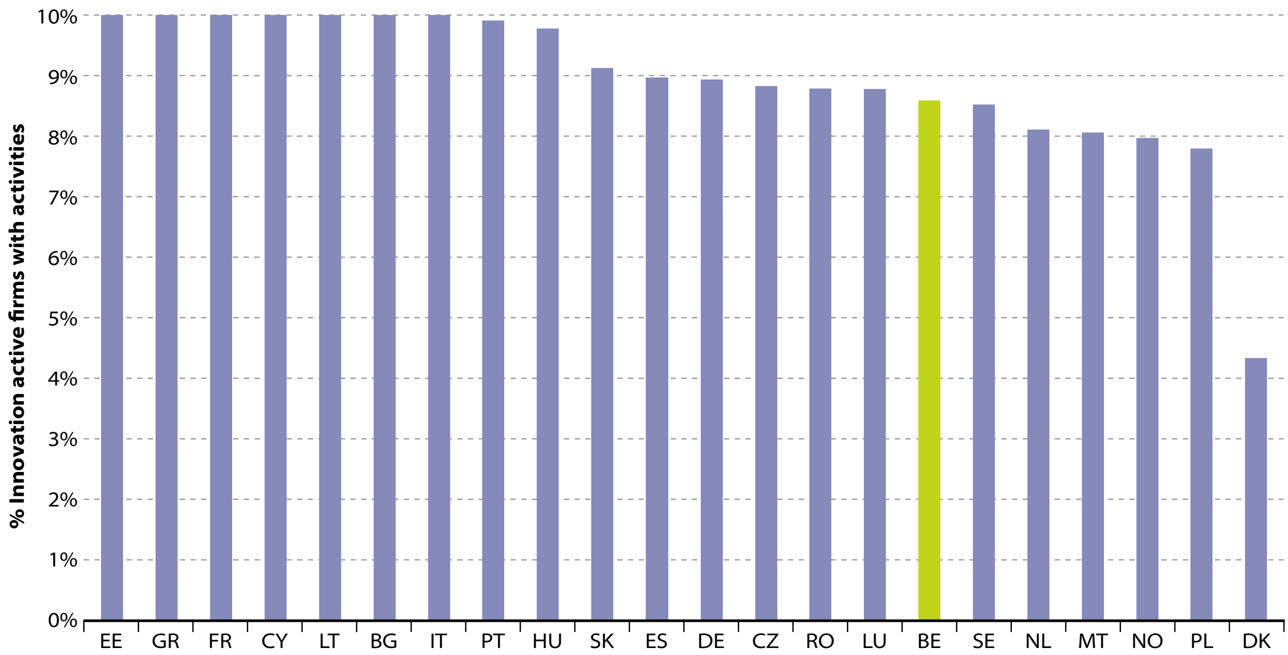
Total	Belgium	Denmark	Germany	Greece	Spain	France	Italy	Luxembourg	The Netherlands	Portugal	Finland	Iceland	Norway
Intramural R&D	2%	8%	4%	1%	11%	24%	0%	2%	0%	4%	0%	58%	0%
Extramural R&D	2%	10%	5%	1%	12%	24%	0%	2%	0%	4%	0%	60%	0%
Acquisition of machinery	2%	10%	3%	1%	9%	24%	0%	2%	0%	4%	0%	60%	0%
Other external knowledge	2%	10%	5%	1%	12%	24%	0%	2%	0%	4%	0%	60%	0%
Training	2%	10%	6%	1%	12%	24%	0%	2%	0%	4%	0%	60%	0%
Market introduction of innovation	2%	10%	6%	1%	12%	24%	0%	2%	0%	4%	0%	60%	0%
Design, other preparation	2%	10%	5%	1%	13%	24%	0%	2%	0%	4%	0%	60%	0%
Manufacturing (excluding construction)_cde													
Intramural R&D	1%	11%	3%	1%	8%	18%	0%	-	0%	4%	0%	62%	0%
Extramural R&D	1%	12%	5%	1%	9%	18%	0%	-	0%	4%	0%	64%	0%
Acquisition of machinery	1%	12%	3%	1%	7%	18%	0%	-	0%	4%	0%	64%	0%
Other external knowledge	1%	12%	4%	1%	9%	18%	0%	-	0%	4%	0%	64%	0%
Training	1%	12%	6%	1%	10%	18%	0%	-	0%	4%	0%	64%	0%
Market introduction of innovation	1%	12%	5%	1%	10%	18%	0%	-	0%	4%	0%	64%	0%
Design, other preparation	2%	12%	5%	1%	10%	18%	0%	-	0%	4%	0%	64%	0%
Services (excluding public administration)_gtok													
Intramural R&D	2%	5%	5%	0%	17%	36%	0%	-	0%	3%	0%	54%	0%
Extramural R&D	2%	6%	5%	0%	17%	36%	0%	-	0%	3%	0%	55%	0%
Acquisition of machinery	2%	6%	4%	0%	15%	36%	0%	-	0%	3%	0%	55%	0%
Other external knowledge	2%	6%	6%	0%	18%	36%	0%	-	0%	3%	0%	55%	0%
Training	2%	6%	7%	0%	17%	36%	0%	-	0%	3%	0%	55%	0%
Market introduction of innovation	2%	6%	6%	0%	19%	36%	0%	-	0%	3%	0%	55%	0%
Design, other preparation	2%	6%	6%	0%	19%	36%	0%	-	0%	3%	0%	55%	0%

Note: no data available for Chzech Republic, Estonia, Ireland, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Poland, Slovenia, Slobakia, United Kingdom, Bulgaria, Romania

Source: Eurostat, NewCronos Database

Based on CIS4 data, it can be noted that there is no one-to-one correspondence between product and process innovation active firms and firms having undertaken one of the seven activities described above. After imputations over half of the countries missed responses or presented inconsistencies for at least 10 % of the innovation active firms. The inconsistencies are related to firms reporting being an innovator but indicating to be involved in none of the seven innovation activities. We will discuss these discrepancies in depth in Section 3.

Figure 5: Percentage innovation active firms having undertaken one of the 7 activities - CIS 4 data

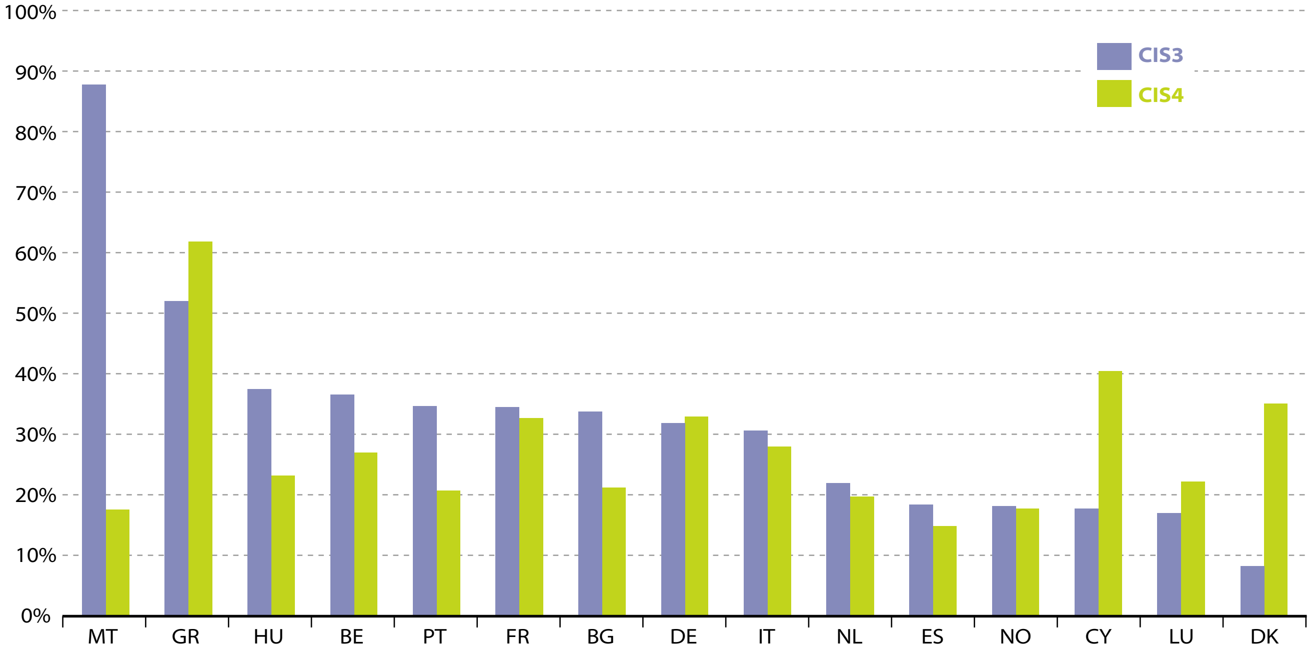


Source: Eurostat, NewCronos Database

2.2 Innovation budgets by type of activity

So far, the focus was on whether or not firms were engaged in innovation activities. Complementary information on expenditures by type of activity is collected via the CIS. There are several ways to display the information arising from such inquiries. We have chosen to start with displaying the innovation intensities (i.e. the ratio between the turnover and the innovation expenses of innovation active firms) for the sample of countries for which we had the necessary data. Figure 6 reports the results. As is obvious, the results largely vary from one wave to the other. Especially the results for Malta, Cyprus and Denmark changed highly. Also, the results for Greece for 2004 turned out to be quite high.

Figure 6: Innovation intensities across CIS enquiries and countries



Source: Eurostat, NewCronos Database

A country based comparison over time by type of activity and by country is presented in Figure 7. With the exception of France and Denmark, variations in terms of expenditures on intramural R&D in the former EU-15 countries remained relatively modest. The same can be said for extramural R&D (this time Germany and Spain are the outliers). Expenditures for acquisition of machinery, equipment and software exceptionally rose in France. It should be noted that in the CIS4 questionnaire software was explicitly added. This was not the case for CIS3 and could be an explanation for changes in this variable over time. Finally, also in terms of acquisition of other external knowledge, fluctuations are quite high (with only Italy, Germany and Spain remaining within a 50% interval).

Figure 7: Change in innovation expenditures by country CIS4 - CIS3, in %

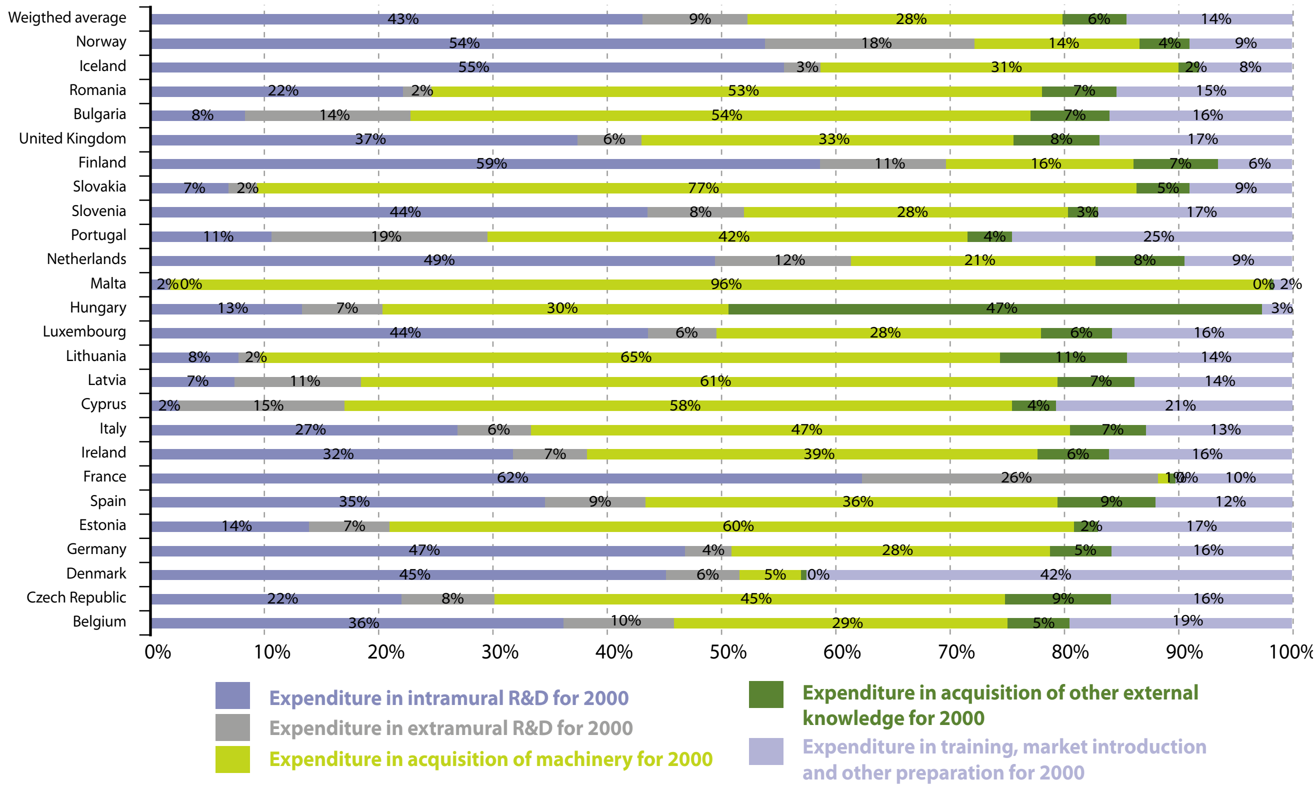
	Total expenditure	Intramural R&D	Extramural R&D	Machinery & equipment	Other external knowledge
Belgium	0%	-6%	33%	18%	248%
Czech Rep	136%	130%	290%	143%	386%
Denmark	-44%	-23%	20%	89%	697%
Germany	16%	9%	128%	11%	-34%
Estonia	78%	153%	10%	117%	120%
Spain	4%	11%	124%	-8%	-46%
France	33%	46%	-15%	1537%	552%
Ireland	42%	8%	-29%	116%	188%
Italy	-6%	12%	1%	5%	17%
Cyprus	82%	154%	-12%	169%	66%
Lithuania	14%	170%	58%	35%	-76%
Luxembourg	-6%	-12%	-21%	30%	115%
Hungary	37%	78%	44%	227%	-92%
Malta	-71%	390%	145%	-80%	144%
Netherlands	-10%	9%	17%	-6%	-74%
Portugal	-51%	-29%	-83%	-17%	-19%
Slovakia	18%	23%	3%	31%	35%
Bulgaria	29%	24%	-73%	99%	7%
Romania	43%	-20%	65%	68%	375%
Norway	-17%	-2%	-10%	-30%	-22%

*Data for Denmark, Ireland for CIS3 2000 were corrected by a factor 10

Source: Eurostat, NewCronos Database

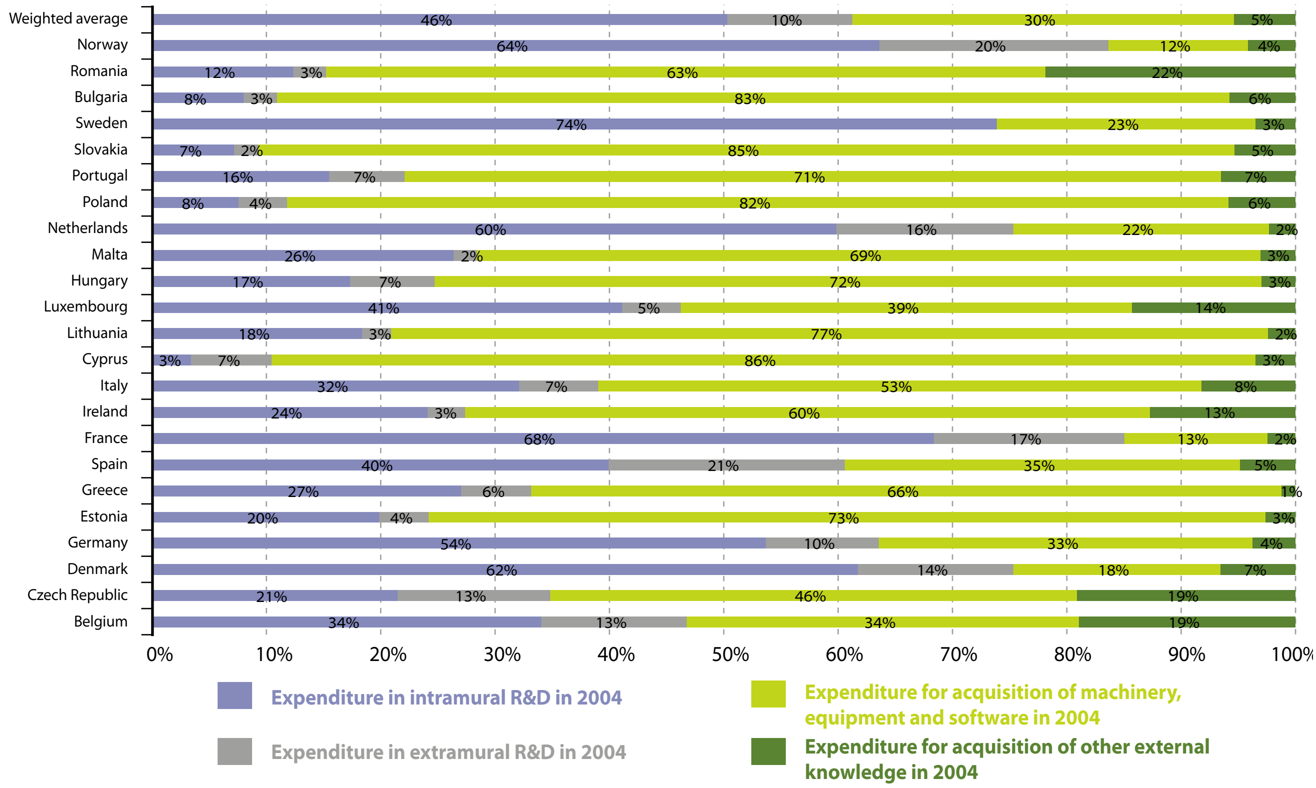
A repartition of the innovation expenditures by type of innovation activity for CIS3 (Figure 8) and CIS4 (Figure 9) shows that over 40% of these expenditures is related to intramural R&D. Machinery is the second most important expenditure with a share of around 30%. Scandinavian countries tend to have a higher share in the former category, whereas some of the new EU member states are very high in terms of acquisition of machinery. Between CIS3 and CIS4, our attention goes to the high increase of the share of intramural R&D in Denmark, Spain and the Netherlands. The share of machinery sharply decreased in Denmark and sharply raised e.g. in Ireland and Lithuania.

Figure 8: Repartition of innovation expenditures by type of innovation activity, 2000, CIS3



Source: Eurostat, NewCronos Database

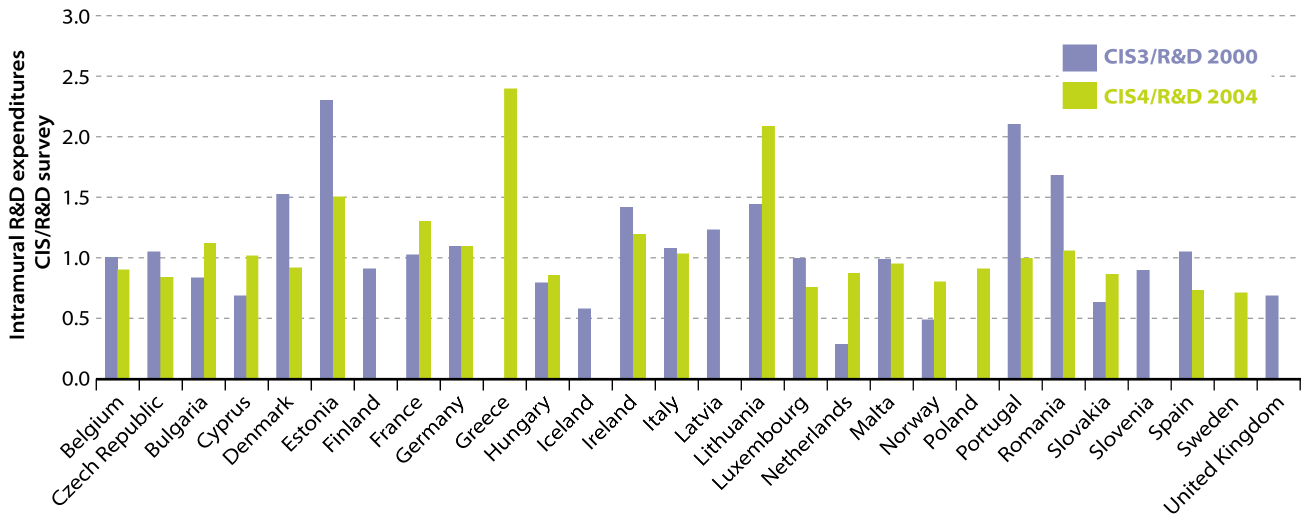
Figure 9: Repartition of innovation expenditures by type of innovation activity, 2004, CIS4



Source: Eurostat, NewCronos Database. Note: only core NACE codes for CIS4 are included

A benchmark of the intramural R&D expenditures of the CIS3 and CIS4 survey with the results of the R&D survey results for the year 2000 and 2004 (Figure 10) reveals good overall results: intramural R&D based on CIS3 was within a 1% (underestimation) interval of official R&D statistics, for CIS4 this amounted to 6% (overestimation). However, on a country level base, important differences are to be noted for Denmark (CIS3), Estonia (CIS3 and CIS4), Greece (CIS4), Lithuania (CIS4), Malta (CIS3), Norway (CIS3), Portugal (CIS3), and Romania (CIS3). By contrast, Belgium, Germany, Italy, and the Netherlands present comparable and more or less stable results over time.

Figure 10: Comparison of intramural R&D expenditures: CIS survey versus R&D survey



Source: Eurostat, NewCronos Database

3. The Belgian case

3.1 Qualitative data, inconsistent answers, and the problems of item nonresponse

3.1.1 Innovation active firms and firms with innovation activities

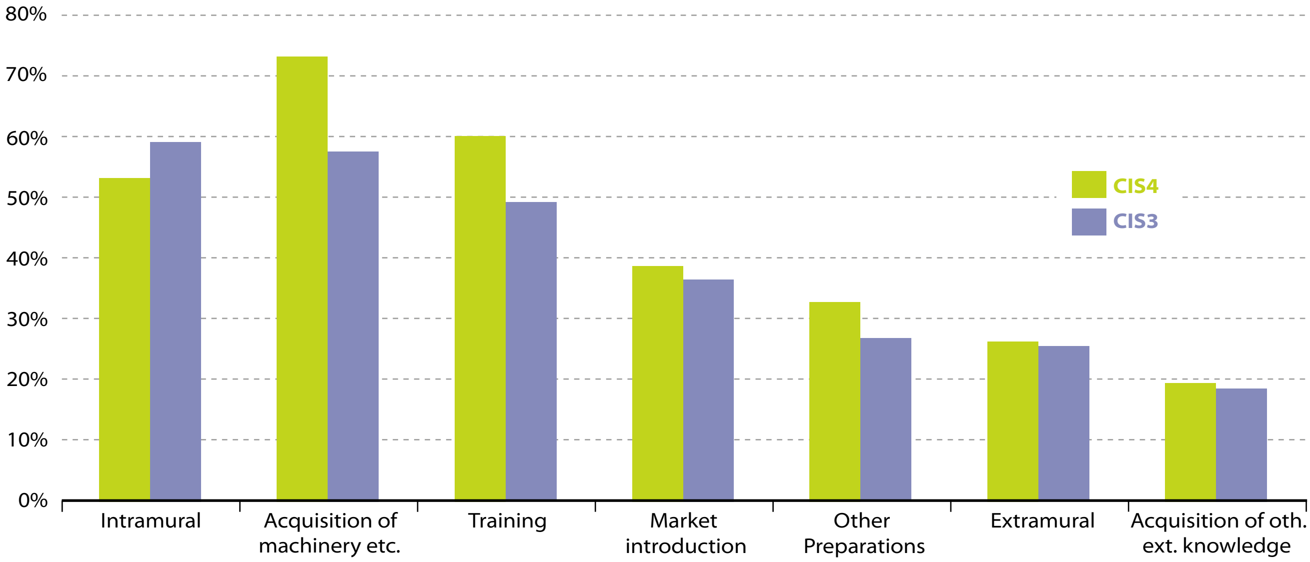
Qualitative data are likely to suffer both from low response rates and from imprecise answers. To illustrate this, we would like to go back to Figure 5 that shed light on some discrepancies between innovation active firms and firms with innovation activities. A large part of the discrepancy presented in Figure 5 can actually be explained by a rather large item nonresponse rate (after imputations!) regarding the various innovation activities. If we look at the overall final dataset, we have 3322 records at total. Among those, there are 1453 innovation active firms (i.e. either product, process or ongoing/abandoned innovators). On the other hand, only 1357 firms have reported at least one of the 7 proposed innovation activities, hence a "gap" of 96 firms. All these 96 firms are innovation active. However, 24 among these 96 records (i.e. 25%) did not answer to any of the 7 innovation activity items. So, one fourth of the discrepancy can be explained purely by item nonresponse. This figure indicates that other forces are also at work. Purely "inconsistent" answers - records for which the enterprise has answered "no" to all 7 proposed activities while at the same time reporting some form of innovation activity - represent 68 records, i.e. 72% of the discrepancy. The remaining 4 records are "hybrid" ones.

This finding raises concerns about the weighting procedure. Typically, weights are computed as the inverse of the ex-post (realized) sampling fraction and are uniform across questions. However, if, as is the case in actual data, item nonresponse rate proves to be higher for some questions than for other questions, then it might be wise to take this fact into account in the computation of the weights and let those differ from one question to another. The problem with such a procedure is that computations would become ways more cumbersome.

3.1.2 Engagement by type of activity

Figure 11 compares CIS3 and CIS4 findings for Belgium. There are some major differences, with the rise in "acquisition of machinery, equipment and other capital goods" and in "training" as well as the fall in intramural R&D.

Figure 11: Innovation activities: comparison between CIS 3 and CIS 4 results for Belgium



Source: Eurostat, NewCronos Database

As pointed out in Section 3.1.1., there have been missing values and coding errors. Table 3 and Table 4 summarize the recodings that have been performed for the CIS 3 and for the CIS 4, respectively. For intramural R&D coding errors seems to be higher for small and medium-sized enterprises. For the acquisition of machinery the same can be said especially for small enterprises. Overall, coding errors seem to be less problematic for extramural R&D and for the acquisition of other external knowledge.

Table 3: Changes between original responses and final responses CIS3

		10-19	20-49	50-99	100-249	250-499	500-999	>=1000	Total
Intramural R&D	Number	31	27	8	3	2	0	1	72
	%	9%	7%	4%	2%	2%	0%	2%	5%
Extramural R&D	Number	7	5	3	1	1	1	2	20
	%	2%	1%	1%	1%	1%	2%	5%	1%
Acquisition of machinery	Number	28	30	11	3	1	2	1	76
	%	8%	8%	5%	2%	1%	3%	2%	6%
Other external knowledge	Number	5	8	0	0	2	3	2	20
	%	1%	2%	0%	0%	2%	5%	5%	1%
Training	Number	18	19	7	2	6	1	1	54
	%	5%	5%	3%	1%	5%	2%	2%	4%
Market introduction of innovation	Number	18	19	9	2	2	1	3	54
	%	5%	5%	4%	1%	2%	2%	7%	4%
Design, other preparation	Number	14	11	8	4	3	3	3	46
	%	4%	3%	4%	3%	2%	5%	7%	3%
Number of observations		350	396	225	154	126	65	42	1358

Source: Third Community Innovation Survey Belgium, Belgian Science Policy

Table 4. Changes between original responses and final responses CIS4

Data	10-19	20-49	50-99	100-249	250-499	500-999	>=1000	Total
Intramural R&D	2	4	4	5	1	1	0	17
Extramural R&D	1	4	0	2	2	1	0	10
Acquisition of machinery	8	14	3	5	3	2	2	37
Other external knowledge	1	0	1	1	2	1	2	8
Training	15	20	6	7	5	2	2	57
Market introduction of innovation	13	10	2	5	3	1	0	34
Design, other preparation	7	10	6	10	7	1	3	44
Number of observations	*1079*	*1054*	*476*	*383*	*165*	*91*	*74*	*3322*

Source: Fourth Community Innovation Survey Belgium, Belgian Science Policy

Based on an experiment for CIS3 for the Flemish region in which data were collected both by postal mailing and by computer aided personal interview (CAPI) it turned out that the way in which data are collected influences both on the outcomes of the survey as on the consistencies of the answers (Table 5). In the interview technique, engagement in the different types of innovation activities tended to be higher whereas item correction was quite lower.

Table 5. Differences in outcomes and item inconsistencies between postal mailing and interview

	Technique				Technique		
	CAPI	Mailing	Total		CAPI	Mailing	Total
Number of observations	601	757	1358		601	757	1358
Results				Item correction			
Intramural R&D	76%	70%	73%		2%	8%	5%
Extramural R&D	35%	30%	32%		0%	2%	1%
Acquisition of machinery	69%	59%	64%		2%	8%	6%
Other external knowledge	25%	21%	23%		0%	3%	1%
Market introduction of innovation	42%	40%	41%		1%	6%	4%
Training	65%	59%	61%		1%	6%	4%
Design, other preparation	25%	29%	27%		0%	6%	3%

Source: Third Community Innovation Survey Belgium, Belgian Science Policy

3.2 Quantitative data: item nonresponse and problems caused by imputation

In this Section we examine in more detail the poor quality of the original responses for quantitative data for innovation activities (for Belgian firms). We will invoke several reasons to explain this. The two main factors are, as already hinted above, the item nonresponse rate and the presence of inconsistencies and errors. Furthermore, attention will be paid to changes in the aggregate outcomes of the survey due to the correction of inconsistencies and item nonresponse.

Table 6 gives the item nonresponse rate upstream in the process, both for the whole (before cleaning and imputation) dataset and for among firms that declare themselves as innovation active (in dataset before cleaning and imputation). To provide a benchmark, the order of magnitude of the item nonresponse rate for basic variables like "product innovator" or "process innovator" is on average about 6%.

Inconsistencies and errors constitute the second factor in the process. For instance, after cleaning (but before imputation), 27 records remained (over 3348) where the total expenditures were not equal to the total of the expenditures. There are several causes to this:

- the breakdown into the various components is not specified and will have to be imputed
- coding or computation errors

In theory, imputation can handle this kind of problems. However, for metric variables, a special danger arises. In face of outliers or aberrant values, it may also propagate and demultiply the error. This will be the case when, as we have seen in a large number of instances:

- firms report their expenditures in euros instead of thousands of euros
- firms are part of multinational corporations and report for their whole group instead of for their own entity only

In the case such a firm receives a large weight, such errors may imply dramatic consequences for the broad picture. So, at total, between the first final output file after imputation (which had already undergone a number of manual corrections) and the definitive one, we had to revise data for 183 companies and downgrade the innovation expenditures. To assess the magnitude of this correction, Table 7 compares expenditures amounts (in '000 euros) between our first (initial) estimates and the final dataset that was reported to Eurostat. The differences are striking: in relative values, figures had to be downgraded by 25% to 75%.

Table 6. Item nonresponse rate before cleaning and imputation

Before cleaning and imputation	Nonresponse within Innovation active firms
Engaged in intramural R&D	8,59%
Continous vs. occasional intramural	39,91%
Engaged in extramural R&D	10,86%
Acquisition of machinery etc.	8,79%
Acquisition of other external knowledge	10,59%
Training	10,26%
Market introduction	11,59%
Other preparations	14,66%
Expenditures in intramural R&D	17,26%
Expenditures in extramural R&D	16,66%
Expenditures on machinery etc.	20,72%
Expenditures on other external knowledge	16,72%
Total expenditures	20,59%

Table 7. Variations in Estimations of Innovation Expenditures ('000 euros)

	1st estimation	Final dataset	% difference
Intramural R&D	8 893 543	6 475 904	-27%
Extramural R&D	1 843 700	1 374 967	-25%
Acquisition of machinery etc.	10 771 448	3 804 556	-65%
Other external knowledge	8 065 142	1 909 935	-76%
Total innovation expenditures	29 573 186	13 566 064	-54%

To achieve this result and to identify the "suspect" companies, we first assessed the plausibility of figures by means of comparison with accounting data. In the case the comparison does not remove our doubts, we recontacted the companies whenever possible. We also compared our R&D figures with those reported in the R&D inquiries. Finally, we also used repartition keys based on turnover and employment when it was obvious we were reported figures for the whole group and no further indication was available.

We can also examine the repartition of the absolute values of the changes by type of expenditure (Table 8). As already stated, the majority of the modifications were made in the Acquisition of machinery, equipments and softwares category, both in terms of amounts and in terms of number of enterprises. More surprising are the changes that had to be made regarding the acquisition of other external knowledge.

Table 8. Variations in innovation expenditures between first and final estimations in absolute values

Category of expenditure	# changed records	Total changes (th. euros)
Intramural R&D	111	986760
Extramural R&D	60	278497
Acquisition of other external knowledge	43	2 257 370
Acquisition of machinery, equipments and softwares	155	2 030 507
Total expenditures	183	5 476 813

The distribution of changes in terms of amounts across regions, sizes and sectors is provided both for total expenditures (Table 9) and for other external knowledge (Table 10). It appears that the bulk of the changes was done for large enterprises in the Brussels region, especially in the sectors 24 ("Manufacture of chemicals and chemical products") and other 74 ("other business services", except "technical testing and analysis" and "engineering activities"). That changes have been mainly concentrated in these sectors for large enterprises of the Brussels Region is even more true when we look at the expenditures for the acquisition of other external knowledge. In the chemical sectors in Brussels, 2 enterprises only account for 1.5 billion Euros changes and in the other business services, 2 enterprises account for nearly 600 million Euros changes. The relatively higher problems for the Brussels region can be supposed closely related to the fact that a lot of firms have their administrative headquarter in the capital region.

Table 9. Records for which total expenditures have changed (in euros)

Nuts	Size												
	BRUSSELS			BRUSSELS	FLANDERS			FLANDERS	WALLONIA			WALLONIA	Grand Total
NACE	Large	Medium	Small	Total	Large	Medium	Small	Total	Large	Medium	Small	Total	
15			936	936	6 351	65 961	243 989	316 322		2 373	26 918	29 292	346 550
17					275 000	53 000		328 000		18 437	267 687 000	267 705 437	268 033 437
20							265 309	265 309			325	325	265 634
21					5 917 728			5 917 728					5 917 728
22		261 851 728	57 111	261 908 838	137 887		26 668	164 555		936		936	262 074 329
24	1 835 806 000	549 837		1 836 355 837	63 062 164	1 751 648	174 733	64 988 546		17 717	2 920 707	2 938 424	1 904 282 807
25						390 000	1 875	391 875		53 331	100 354	153 685	545 560
26						106 058		106 058		147 669 000		147 669 000	147 775 058
27					184 277			184 277		55 992 387		55 992 387	56 176 664
28	698 106	1 048		699 154	117 963		6 647	124 610			948 334	948 334	1 772 097
29		18 653	22 569 377	22 588 030		300 082	127 406 784	127 706 866			8 988 903	8 988 903	159 283 799
31			9 325	9 325	16 829 037		230 000	17 059 037					17 068 362
32					326			326					326
33							28 635	28 635			200 781 000	200 781 000	200 809 635
34		10 441		10 441		350 604		350 604					361 044
35	167 550 000			167 550 000									167 550 000
36							6 266	6 266			5 479	5 479	11 745
37						13 014	201 458	214 473					214 473
45		7 137	7 723	14 860		35 562		35 562					50 422
50			1 020	1 020							2 240	2 240	3 259
51		4 053	419 935	423 988	124 791	73 220	35 534 420	35 732 431		4 501	10 525	15 026	36 171 445
52	50 077 332		1 294	50 078 627	59 692		18 000	77 692	908 514			908 514	51 064 833
60	11 142 219		86 521	11 228 740	30 503 526		296 471	30 799 997		851	160 904	161 756	42 190 493
61					12 116			12 116					12 116
62			24 659	24 659									24 659
63			40 506	40 506	4 798 268	190 666	94 467	5 083 401					5 123 908
65	23 379 000			23 379 000									23 379 000
72		213 441		213 441	351		225 484	225 835					439 276
73	60 698 885		131 919 388	192 618 274	34 666 159		504 000	35 170 159		109 589 000		109 589 000	337 377 433
core 74					5 303 000		11 123 439	16 426 439		2 291		2 291	16 428 731
other 74	1 764 598 426	10 301	22 347	1 764 631 074	6 126 413	171 074	1 114 652	7 412 138			14 684	14 684	1 772 057 896
Grand Total	3 913 949 968	262 666 638	155 160 143	4 331 776 750	168 125 051	3 500 908	177 503 298	349 129 257	908 514	313 350 824	481 647 373	795 906 711	5 476 812 718

Table 10. Records for which “Acquisition of other external knowledge” have changed (in euros)

Nuts	Size											
	BRUSSELS			BRUSSELS	FLANDERS			FLANDERS			WALLONIA	Grand Total
NACE	Large	Medium	Small	Total	Large	Medium	Small	Total	Medium	Small	Total	
15						20 519		20 519				20 519
22		22		22								22
24	1 566 600 000	72 492		1 566 672 492	72 861 047			72 861 047	7 129		7 129	1 639 540 668
25					5 483			5 483				5 483
26						2 075		2 075				2 075
28					203 588			203 588				203 588
29							14 985 592	14 985 592				14 985 592
32					131			131				131
36							3 000	3 000				3 000
50			1 020	1 020						5 190	5 190	6 210
51		4	362	366	334	111		445	6	592	598	1 409
60					984 095			984 095				984 095
62			533	533								533
63					344	144 156	91 313	235 813				235 813
65	4 087 200			4 087 200								4 087 200
72		20 675		20 675	444			444				21 119
73	4 502			4 502	101 522			101 522				106 024
core 74	597 076 000	137		597 076 137		74	18 464	18 538				597 094 674
other 74					72 000			72 000				72 000
Grand Total	2 167 767 702	93 330	1 914	2 167 862 946	74 228 988	166 935	15 098 369	89 494 292	7 135	5 782	12 917	2 257 370 155

4. Conclusions

The measurement of innovation activities and expenditures is one of the most difficult parts of the CIS survey. Comparisons both between countries and within countries over time, cast some doubts on the reliability of some of the results.

Awareness of these problems and more attention to it, as well as careful screening of the micro-data can avoid part of these problems. For Belgium it was calculated that careful screening and correction of original responses dramatically changed the innovation expenditures (changes varying between 25% and 75% depending on the type of activity). Currency problems and reporting for larger entities were found to be major causes of inconsistencies. These mistakes seem to be more or less homogenously spread across sectors and size classes and tend to occur more frequently for enterprises located in regions with a high administrative function.

Besides the common sense of consistency and comparability, the – after imputation - high item non-response (over 10% for more than half of the participating countries) rises questions on the use of a unique unit-response based weight to calculate aggregate results of innovation activities and expenditures.

Finally, based on Belgian data it was found that the way in which data are collected, i.e. by postal mailing not always seems to be the most optimal way to avoid inconsistencies and item non-response. Although, one should be aware that the use of other data collection techniques not only influences item response and consistencies, but also the outcomes of the survey in terms of innovation activities.

RESPONSE UNIT; NEW TO FIRM, MARKET AND WORLD; KNOWLEDGE MANAGEMENT

Michael BORDT
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Executive summary

The paper covers three issues related to innovation surveys: the response unit (or institutional unit), novelty of innovation (new to firm, market or world) and knowledge management. All three of these issues have been applied in past and current national innovation surveys but the Third Edition of the Oslo Manual introduces some new aspects that require further consideration:

- Expanding the definition of innovation to explicitly cover organizational change and marketing innovation expands the notion of where in an organization the decisions are made. Decisions on product and process innovation may be localized at the top corporate levels (e.g., senior management of the ISIC or EU "enterprise") but decisions about organizational change and marketing may be made at more local levels (the legal unit or "establishment").

- The concept of "new to the market" is understood in different ways. The intended meaning is that the innovation is new to the market that the industry sector serves. For example, an LCD screen may be new to the television industry but not new to the computer industry. In testing this concept in Canada, the common interpretation is that the innovation is new to the market that the particular organization serves. This could be a local market as in the case of a printing company being the first in the local region to offer an on-line print service.

- Measuring knowledge management was not originally intended to fit within the measurement of innovation but has found a niche within the "organizational change" component of the Oslo Manual. Practices to improve knowledge management can be important contributors to innovation.

The paper discusses some inter-relationships among the issues. For example, the concept of "new to the market" varies with the institutional level. A large multi-national will interpret its market much more broadly than one of its establishments. In addition, the certain knowledge management practices are more appropriate for one institutional level than another. A company may develop a written knowledge management strategy. An establishment within that company may develop its own approach to mentorship to minimize knowledge loss due to succession.

Some of the challenges inherent in these issues have already been met in Canadian and other national innovation surveys. The degree to which these surveys implement the recommendations of the Oslo Manual will be discussed and further recommendations will be made.

1. Introduction

The third edition of the Oslo Manual (OECD/EuroStat, 2005) poses several new challenges to measuring innovation. The third edition (the following quotes are all from paragraph 7):

- "places a greater emphasis on the role of linkages with other firms and institutions in the innovation process"
- "it recognizes the importance of innovation in less R&D-intensive industries such as services and low-technology manufacturing"
- expands "the definition of innovation…to include…organizational innovation and marketing innovation"
- contains "an annex on innovation surveys in non-OECD countries".

All of these changes have some impact on selecting the appropriate response unit (who has the information we need?), defining the degree of novelty in a way that is internationally comparable (what does "new to the market" mean?) and incorporating knowledge management (is it an innovation or not?).

2. Response unit and statistical unit

2.1 At which level of an organization are innovation decisions made?

We well know that some firms are simple while others are complex. Simple firms have one independent organizational structure (the enterprise, establishment and location are all the same). Complex firms, usually larger ones, can have multiple locations, lines of business and international subsidiaries. With a simple firm, there is little question as to who has the information we need. With a complex firm, the answer is less obvious. Decisions on product and process innovation may be localized at the top corporate levels (e.g., senior management of an "enterprise") but decisions about organizational change and marketing may be made at more local levels (the legal unit or "establishment").With the expansion of the definition of innovation, it will be necessary to capture information from various levels in the organization. What is not clear is the degree to which one level in the organization can provide information about another level. For example, can a plant manager tell us about the corporate strategy? Can a CEO tell us about the innovative human resource practices of the firm's establishments?

Table 1 provides an assessment of where in an organization decisions about certain aspects of innovation are likely made. Note that this is based on "expert opinion" rather than empirical research. **Further research should be conducted to better determine at which levels of an organization which innovation decisions are made.**

The Oslo Manual recommends a two-tiered approach to statistical units (para 244) by which information is gathered from the enterprise unit as well as from the establishment. This has been implemented in the past in Canada (Statistics Canada, 1993) with some success.

Subsequent Canadian innovation surveys were conducted exclusively at the establishment level (1996, 2003, 2005) or a higher level dubbed the "provincial enterprise" (1999) since it represented all establishments with the same 4-digit NAICS code within one province. The 1999 survey was the most similar to the Eurostat CIS surveys but the understanding is that establishments are capable of responding on behalf of their enterprise. The added benefit of sampling at the establishment level is that small-area (sub-provincial) aggregates are simpler to produce. A complex enterprise may exist in many locations, an establishment usually occupies a single location.

The assumption in the recent Canadian innovation surveys is that the statistical unit is the same as the response unit. That is, if the questionnaire is answered at the provincial enterprise level, it is assumed that all the establishments belonging to that enterprise are represented. If the questionnaire is answered at the establishment level, it is assumed that the establishment can answer on behalf of the enterprise about broader innovation activities and strategies.

The two-tiered approach recommended by the Oslo Manual opens the possibility of treating two statistical units together. This could be implemented by sampling establishments belonging to a specific enterprise and submitting distinct questions to both. Statistics Canada uses a similar approach for the Workplace and Employee Survey (Statistics Canada, 2003). With this survey, employees are selected from sampled workplaces.

2.2 What is an enterprise?

A complicating factor in international discussion about response units is that although Eurostat's definition of statistical units (EEC, 1993) is compatible with the UN ISIC Rev 3.1 (United Nations, 2003), there are variances with national statistical systems. Canada, for example, defines "enterprise" as the top of the hierarchy whereas Eurostat and ISIC consider "enterprise groups" as the top level. The Canadian definitions are included in Table 2.

Further complications occur when we consider the complexities of language, corporate culture and statistical systems in OECD and non-OECD countries. **It is important to know the definition of a given statistical unit before translating it into another language, culture and statistical system.**

An earlier assessment of some countries was conducted in 1997 (Han 1997) but there is no internationally-accepted concordance.

During the development of the third edition of the Oslo Manual, the focus groups recommend producing a concordance of statistical units across OECD and EU countries. Steps are being taken at the OECD in terms of harmonizing statistical units across member countries (OECD 2006). **A concordance should be created and made available to all countries conducting innovation surveys, especially if there is any variance from the EU standard.**

2.3 Multinationals

Statistics Canada (Hamdani 2003) has conducted some analysis of globally-operating corporations and the conclusion is that the different types need to be considered in terms of innovation surveys: "There are four identifiable types of globally operating corporations: global, multinational, international and transnational. Although these terms often get used synonymously, each represents a different business model and corporate strategy to cope with uncertainties of rapidly changing business environment and to participate in the world market." (Hamdani 2003)

The distinction, for example, between a global corporation, in which knowledge production is generally centralized at the headquarters and a multinational in which innovations are specialized for the local market, is important to understand when conducting innovation surveys. If the national entity that is being surveyed is the research subsidiary of a transnational in which functions are distributed across many nations, it is important to understand the relationship between the unit being surveyed and its parent corporation. A respondent may, for example, be undertaking extensive innovation activities yet not have any product or process innovations. The reason for this may that its innovations are marketed by another part of the corporation.

The Oslo Manual (OECD/Eutostat 2005, para 243) recommends

"to collect data on the institutional status of the observation unit:

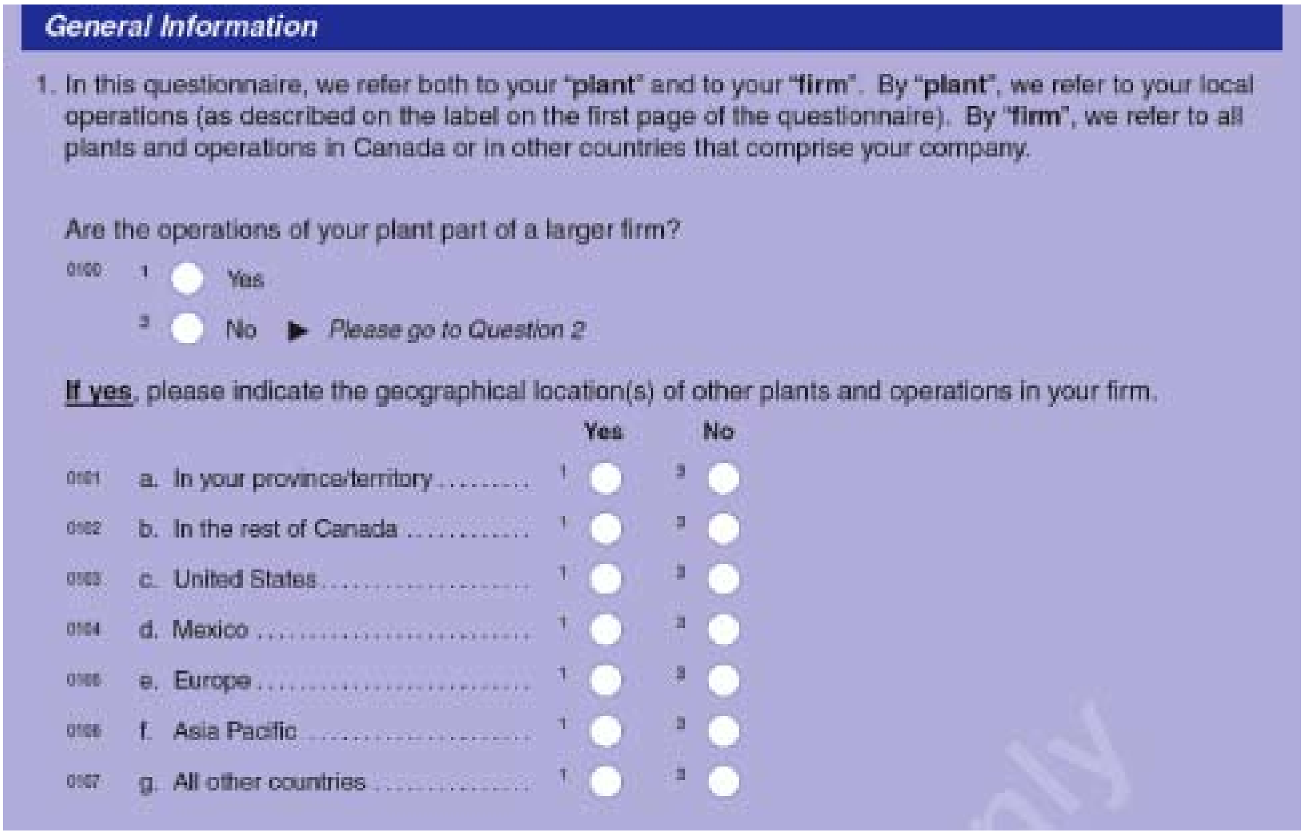
- Whether the observation unit is part of an enterprise or enterprise group and, if so, what its function is, for example, headquarters, research centre, administrative centre, marketing, other.
- Whether the observation unit is part of a multinational enterprise and, if so, what its function is, and where the headquarters is situated."

The Canadian Survey of Innovation 2003 (Figure 1) explicitly asks if the respondent is part of another firm. While this does not explicitly identify its role in that firm, this information can be used to analyze differences between innovation activities and expected outcomes.

2.4 Joint ventures

This topic has not been treated specifically in the Oslo Manual but should be considered for further assessment. In analyzing one of the earlier innovation surveys in Canada (Statistics Canada, 1999), it was realized that operations in some sectors were conducted in terms of joint ventures. Several petroleum producers, for example, would form a project with no apparent legal or statistical status. The project may undertake innovation activities and result in process innovations but the participating companies may either be unaware of the innovations or may each report the innovations as their own.

Figure 1: Statistics Canada Survey of Innovation 2005



General Information

1. In this questionnaire, we refer both to your "**plant**" and to your "**firm**". By "**plant**", we refer to your local operations (as described on the label on the first page of the questionnaire). By "**firm**", we refer to all plants and operations in Canada or in other countries that comprise your company.

Are the operations of your plant part of a larger firm?

0100 1 ○ Yes

3 ○ No ▶ *Please go to Question 2*

If yes, please indicate the geographical location(s) of other plants and operations in your firm.

		Yes	No
0101	a. In your province/territory	1 ○	3 ○
0102	b. In the rest of Canada	1 ○	3 ○
0103	c. United States	1 ○	3 ○
0104	d. Mexico	1 ○	3 ○
0105	e. Europe	1 ○	3 ○
0106	f. Asia Pacific	1 ○	3 ○
0107	g. All other countries	1 ○	3 ○

Source: Statistics Canada 2005.

There is also the possibility that the project is incorporated as a legal entity but the decision making would remain with the parent companies. This is a challenge to track with current statistical systems. **One approach may be to expand the nature of the Oslo Manual recommendation on the institutional status of the observation unit to include information on the decision making structure (e.g., is this unit a joint venture? If so, what are the participating companies?)**

3. New to firm, market and world

The current Oslo Manual definition of "new to the market" leaves much of the scope to the respondent:

> *"Innovations are new to the market when the firm is the first to introduce the innovation onto its market. The market is simply defined as the firm and its competitors and can include a geographic region or product line. The geographical scope of new to the market is thus subject to the firm's own view of its operating market and thus can include both domestic and international firms."* (OECD/Eurostat, 2005, para 213).

"New to the market" was intended to replace "first in the country" presumably since national distinctions in European business are not as distinct as those in other countries. The most recent Canadian innovation survey (Statistics Canada 2006) covers both "new to the market" (Figure 2) but separate from the other levels of novelty (Figure 3).

The reason for this separation was that in testing, it was determined that respondents applied such varied definitions to "new to the market" that the information was not considered as high a quality as "new to the country". For example, a printing company may serve only the city in which it operates. In this case, the interpretation in terms of novelty of innovation is closer to "new to the firm" than "new to the country".

Figure 2: New to the market in the Canadian Survey of Innovation 2006

12. Did your plant introduce **ANY** new or significantly improved products (goods or services) onto your market before your competitors during the three years, 2002 to 2004?

1201 1 ○ Yes

3 ○ No ▶ *Please go to question 13*

If yes, please estimate (as best you can) the percentage of your revenue in 2004 from these first-to-the-market product (good or service) innovations introduced during the three years, 2002 to 2004.

1202 [ ] %

Source: Statistics Canada 2006.

Figure 3: Novelty of innovation in the Canadian Survey of Innovation 2006

15. During the three years, 2002 to 2004, were **ANY** of your new or significantly improved products (goods or services) introduced by your plant:

		Yes	No	Do not know
1501	a. A first in your province/territory?	1 ○	3 ○	0 ○
1502	b. A first in Canada?	1 ○	3 ○	0 ○
1503	c. A first in North America?	1 ○	3 ○	0 ○
1504	d. A world first?	1 ○	3 ○	0 ○

Source: Statistics Canada 2006.

According to Arundel (2006), this broad interpretation of "new to the market" is also causing difficulties in interpreting CIS-3 results. The reason Spain and Portugal have higher proportions of revenues from "new to the market" innovations than Germany and France may be because "new to the market" is defined as "new to that firm's local market" in Spain and Portugal but as "new to the industry's market" in the other countries.

The broad definition of "new to the market" should likely be revisited and possibly refined to exclude local, one-firm markets.

4. Knowledge Management

The third edition of the Oslo Manual explicitly recognizes knowledge management (KM) as a part of organizational innovation:

> *"…organisational innovations may involve the implementation of significant changes in practices for knowledge management. Thus, some information on knowledge management can be gained through questions on organisational innovation. However, detailed examinations of knowledge management activities would require a specialised survey. This information can then be linked with information from general innovation surveys." (OECD/Eurostat 2005, para 309)*

This is based on an international collaboration to develop an OECD pilot survey on knowledge management in the business sector (OECD/Statistics Canada 2003). Related pilot surveys were conducted in Canada, Denmark, France and Germany. In the French case, four KM questions were included in the Community Innovation Survey (CIS3):

- Did your firm have a written knowledge management policy?
- Did it have a culture to promote knowledge sharing?
- Did it put into practice an incentive policy to retain employees and executives?
- Did it forge partnerships or alliances for knowledge acquisition?

The Canadian Survey of Knowledge Management Practices 2001 (Statistics Canada 2002) covered 22 practices (Table 4). Some of the most common practices (Table 5) overlap with other aspects of innovation. For example, "*Firm captured and used knowledge obtained from other industry sources such as industrial associations, competitors, clients and suppliers*" would have been covered in most recent innovation surveys as sources of information (OECD/Eurostat, 2005, Chapter 5).

Other aspects of knowledge management would be covered in human resource practices aspects of organizational change. For example, aspects of the Canadian questions on:

- Policies or programs intended to improve worker retention
- Firm encouraged workers to continue their education by reimbursing tuition fees for successfully completed work-related courses, and
- Firm offered off-site training to workers in order to keep skills current are covered conceptually in the Oslo Manual as organizational innovations (OECD/Eurostat 2005 para 523).

In developing questions on organizational change and linkages, the experience in knowledge management should be taken into account. For example, the full list of practices in the OECD Pilot and country pilot surveys should be considered for inclusion in various components of innovation surveys.

Gault and Earl (OECD/Statistics Canada 2003) analyse the importance of size of firm with respect to the number of KM practices in which a firm engages. Larger firms would be expected to engage in more practices simply because their diverse nature allows for more activities and more kinds of activities. **It would be useful to use a two-tiered approach to understand if larger firms engaged in more KM activities at the enterprise level or if their component establishments engaged in different activities, which are then reported at the enterprise level.**

The focus on number of practices could also be enlightened with some analysis of the relative ease of implementation of KM practices and the historical order in which they are implemented (see Bordt in OECD/Statistics Canada 2003). **Such an analytical approach would also benefit the analysis of innovation surveys since relatively effortless linkages (e.g., obtaining knowledge from clients) are sometimes given equal weight to the more costly ones (e.g., having an R&D capacity).**

5. Conclusions

Response units and the size of respondents will be an ongoing challenge in conducting and interpreting innovation surveys. Large firms have a variety of activities that can take place in many locations. One part of the firm may be able to respond on behalf of another part but this should not be left to chance. The two-tiered approach recommended in the Oslo Manual will be a challenge to implement but the results would be a much clearer interpretation.

The challenge of "new to the market" when interpreted by very small firms will be to distinguish the analysis from larger firms.

Some issues addressed in international collaboration and national pilot surveys on knowledge management are being absorbed into innovation surveys. There are opportunities to further understand organizational innovation if these studies are taken into account more comprehensively.

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Table 1. Innovation decisions by level of firm

Aspect of the innovation process	Product/process innovation (PP)	Marketing/organisational innovation (MO)
General	Generally, the enterprise is more appropriate.	The objectives of MO-innovation would be different and would be likely appropriate to both enterprise and establishment.
Sources of information	Internal sources, competitors, acquisition of technologies for enterprise	broader and appropriate for establishments as well as enterprises.
Factors hampering innovation activities (barriers)	Economic factors, enterprise factors, other factors for enterprise	different for MO-innovations and appropriate for both statistical units.
Identifying innovative firms	Enterprise for PP innovations	Enterprise and establishment
The proportion of sales due to technologically new or improved products	Usually enterprise (establishment may not be involved in sales)	Question may not be appropriate for MO innovation
Results of the innovation effort	Exports and operating margin are more appropriate for enterprise. Sales and employees could apply to establishment as well.	Same as PP innovations although results may be more difficult to attribute to MO-innovations
Impact of PP innovation on the use of factors of production	Establishment	Establishment but impacts may be more difficult to attribute
Aspect of the innovation process	Product/process innovation (PP)	Marketing/organisational innovation (MO)
User sectors	Enterprise	This may not be appropriate for MO-innovation.
R&D	Enterprise	This may not be appropriate for MO-innovation.
Patents and the appropriability of innovations	Enterprise	This may not be appropriate for MO-innovation.
Acquisition / diffusion of technology	Enterprise	This may not be appropriate for MO-innovation.
Current innovation expenditures	Expenditures on labour and other current costs may be more appropriate at the enterprise level.	MO-current expenditures may have to be accounted for at both enterprise and establishment level.
Capital expenditures on innovation	Expenditures on land and buildings may be more appropriate at the enterprise level. Expenditures on instruments and equipment and computer software may be more appropriate at the establishment level.	This may not be appropriate for MO-innovation.

Source: Bordt 2004.

Table 2. Canadian definitions of Statistical units in Business Surveys

Collecting, aggregating and analysing data mapped directly to the infinite variety of real world business structures would be an impossible task. Accordingly, statistical agencies develop statistical models, in which every business, from multi-national conglomerate to corner grocery store, can be represented in a standardised form.

The standardised model developed at Statistics Canada for business surveys consists of a four level hierarchy of Statistical Entities. The four Statistical Entity subtypes are - the Enterprise, the Company, the Establishment and the Location. Each subtype is associated with a particular class or level of economic data:

The **Enterprise** (the top of the hierarchy), is associated with a complete set of financial statements. The enterprise, as a statistical unit, is defined as the organisational unit of a business that directs and controls the allocation of resources relating to its domestic operations, and for which consolidated financial and balance sheet accounts are maintained from which international transactions, an international investment position and a consolidated financial position for the unit can be derived. It corresponds to the institutional unit as defined for the System of National Accounts.

The **Company** is the level at which operating profit can be measured. The company, as a statistical unit, is defined as the organisational unit for which income and expenditure accounts and balance sheets are maintained from which operating profit and the rate of return on capital can be derived.

The **Establishment** is the level at which the accounting data required to measure production is available (principal inputs, revenues, salaries and wages).The establishment, as a statistical unit, is defined as the most homogeneous unit of production for which the business maintains accounting records from which it is possible to assemble all the data elements required to compile the full structure of the gross value of production (total sales or shipments, and inventories), the cost of materials and services, and labour and capital used in production.

The **Location** (the bottom of the hierarchy) requires only the number of employees for delineation. The location, as a statistical unit, is defined as a producing unit at a single geographical location at which or from which economic activity is conducted and for which, at a minimum, employment data are available.

Source: Statistics Canada (no date).

Table 3. Classification of globally operating corporations according to their knowledge management and innovation strategies

Characteristics	Type of corporation			
	Global	Multinational	International	Transnational
Business strategy	Economies of scale	Expansion through new products and new markets	Efficiency and innovation, with emphasis on efficiency	Efficiency and innovation, with emphasis on innovation
Market selection	National markets chosen for their contribution to cost reduction	National markets chosen for their stand-alone potential	Market selection primarily driven by economies of scale	Market selection driven by cost reduction and innovation
Knowledge production and management strategy	Knowledge production is centralized	Knowledge produced and retained within each national entity	Knowledge production is centralized and transferred to national entities	Knowledge is developed jointly by the centre and national entities and shared worldwide
Configuration of assets and capabilities	Centralized	Decentralized and nationally self-sufficient	Core competencies centralized; complementary competencies decentralized	Capabilities are dispersed worldwide but are interdependent and specialized
Role of national entities	Implementing parent firm's strategies	Spotting and exploiting local (national) opportunities	Adapting and leveraging parent firm's competencies	Differentiated contributions by national entities to integrated worldwide operations
Product innovation	Minimal change to a core global product; adaptation occasionally in host country	Specialized for each national market; most work done in host country	Duplication of a global product with modification done in the host country	Varies between national and global
Process and delivery innovation	Innovation takes place in one country, not necessarily the headquarters worldwide	Nationally differentiated and largely independent for each national entity	Same processes worldwide with some national adaptation	Coordinated and independent; some aspects similar and some differentiated

Source: Hamdani 2003.

Table 4. Knowledge Management Practices Covered in the Canadian Survey of Knowledge Management Practices 2001

Policies and Strategies

Written knowledge management policy or strategy
Values system or culture intended to promote knowledge sharing
Policies and programs intended to improve worker retention
Used partnerships or strategic alliances to acquire knowledge

Leadership

Knowledge management practices were a responsibility of managers and executives
Knowledge management practices were a responsibility of non-management workers
Knowledge management practices were a responsibility of the knowledge officer or knowledge management unit
Knowledge management practices were explicit criteria for assessing worker performance

Incentives

Knowledge sharing was rewarded with monetary incentives
Knowledge sharing was rewarded with non-monetary incentives

Knowledge Capture and Acquisition

Firm captured and used knowledge obtained from other industry sources such as industrial associations, competitors, clients and suppliers
Firm captured and used knowledge obtained from public research institutions including universities and government laboratories
Firm dedicated resources to detecting and obtaining external knowledge and communicating it within the firm
Firm encouraged workers to participate in project teams with external experts

Training and Mentoring

Firm provided formal training related to knowledge management practices
Firm provided informal training related to knowledge management
Firm used formal mentoring practices, including apprenticeships
Firm encouraged experienced workers to transfer their knowledge to new or less experienced workers
Firm encouraged workers to continue their education by reimbursing tuition fees for successfully completed work-related courses
Firm offered off-site training to workers in order to keep skills current

Communications

Workers shared knowledge by regularly updating databases of good work practices, lessons learned or listings of experts
Workers shared knowledge by preparing written documentation such as lessons learned, training manuals, good work practices, articles for publications, etc. (organisational memory)
Workers shared knowledge in collaborative work by project teams that are physically separated (“virtual teams”)

Source: Earl 2003.

Table 5. The most common knowledge management practices in use (users of knowledge management practices)

Practice	Percent of firms using the practice
Knowledge management practices were a responsibility of managers and executives	94
Firm captured and used knowledge obtained from other industry sources such as industrial associations, competitors, clients and suppliers	92
Firm encouraged experienced workers to transfer their knowledge to new or less experienced workers	82
Firm provided informal training related to knowledge management	81
Used partnerships or strategic alliances to acquire knowledge	68
Policies or programs intended to improve worker retention	66
Firm encouraged workers to continue their education by reimbursing tuition fees for successfully completed work-related courses	63
Values system or culture intended to promote knowledge sharing	59
Firm offered off-site training to workers in order to keep skills current	51

Source: Earl 2003.

MEASURING NON-TECHNOLOGICAL INNOVATION: EXPERIENCE FROM THE JAPANESE INNOVATION SURVEY[1]

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Executive Summary

Non-technological innovation has concentrated interests as well as technological innovation. In the revised *Oslo Manual*, organisational and marketing innovations were added to the scope of innovation that should be observed. In European countries, the Community Innovation Survey 2006 (CIS 2006) was launched, which included questions on those types of innovation on the basis of the revised *Oslo Manual*. In Japan, the first National Innovation Survey (J-NIS 2003) was conducted in 2003, which was designed to be comparable with the third Community Innovation Survey (CIS 3) by following the core questionnaire and the methodology for the survey. The Japanese survey also modified and added questions, which included some detailed questions on non-technological changes prior to the revision of the *Oslo Manual*.

This paper introduces the experience of measuring non-technological innovations, including a description of our approaches to designing questions, review of data quality in terms of response rates, and findings from major survey results, while referring to an outline of J-NIS 2003. Among non-technological changes, the question items composing the core questionnaire for the CIS 3 were subdivided into those for J-NIS 2003. As for strategy and organisation, detailed question items were designed on the basis of the major concepts proposed by previous research. Concerning knowledge management, J-NIS 2003 adopted the same approach as CIS 3 conducted in France. The survey used key questions from the questionnaire for knowledge management.

The survey results indicate that the questions on non-technological innovation are informative and useful for understanding the innovation system. The Japanese results reveal that non-technological changes had been implemented not only by most of the (technological) innovators but also by a considerable ratio of (technological) non-innovators, whereas the major types of changes differed between innovators and non-innovators. Some literature tells us that organisational innovation is included in process innovation in a broad sense. When we presume this view, we can consider that many Japanese firms have implemented changes, although the ratio of (technological) innovators in Japan is less than those in many other OECD countries on the basis of the number of enterprises. Also, the characteristics of the Japanese innovation activities observed from the survey results are consistent with those specified in previous studies. On the other hand, the survey results suggest that (technological) innovators should still be discerned from technological non-innovators because both types of innovator differ in activity, such as the main market.

The information on non-technological changes requires our deepest insights into innovation. It is expected that progress in measuring and analysing non-technological innovation will lead to a better understanding of the innovation system, and contribute towards formulating and monitoring innovation policy.

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[1] The views expressed in this paper are solely those of the authors, and do not necessarily represent the view of the National Institute of Science and Technology Policy.

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1. Introduction

Non-technological innovation has concentrated interests as well as technological innovation. In the revised *Oslo Manual* [OECD and Eurostat, 2005], organisational and marketing innovations were added to the scope of innovation that should be observed. In the European countries, the Community Innovation Survey 2006 (CIS 2006) was launched, which included questions on those types of innovation on the basis of the revised *Oslo Manual*. In Japan, the first national innovation survey (J-NIS 2003) was conducted in 2003, which was designed to be comparable with the third Community Innovation Survey (CIS 3) by following the core questionnaire and the methodology for the survey. The Japanese survey also modified and added questions, which included some detailed questions on the non-technological changes prior to the revision of the *Oslo Manual*.

This paper introduces the experience of measuring non-technological innovations, including a description of our approaches to designing questions, review of data quality in terms of response rates, and findings from major survey results, while referring to the outline of J-NIS 2003.

2. Outlines of the Japanese Innovation Survey

2.1 Survey methodology

The Japanese National Innovation Survey 2003 (J-NIS 2003) was launched in January 2003 for the first time in Japan as a national, comprehensive, and statistical survey. It was conducted by the National Institute of Science and Technology Policy (NISTEP) of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), as an official statistical reporting from private entities approved by the Minister for Internal Affairs and Communications, who is responsible for government statistics in conformity with the Statistical Reporting Co-ordination Law (Law No. 148 of 1952).

The survey used most of the core questionnaire, and generally followed the methodology recommended for CIS 3 to ensure international comparability. The survey was voluntary according to the statutory basis. The observation period was the calendar years 1999 to 2001; the reference year was 2001. The statistical unit was the enterprise.

The sampling frame used for J-NIS 2003 was data extracted from the results of the prompt version of the Establishment and Enterprise Census 2001, which was conducted in October 2001 by the Statistics Bureau of the Ministry of Internal Affairs and Communications (MIC) for purposes including the provision of master sampling frames that should be used to select samples to be surveyed for various statistical surveys on establishments and enterprises. The target of J-NIS 2003 covered all of the industries recommended for CIS 3. It also included agriculture, forestry and fisheries.

The target population was 622,457 enterprises including those with less than 10 persons engaged. The cut-off point for inclusion was 10 persons engaged in any of the industries. The frame population was 216,585. The stratification variables used for the survey were size of enterprise according to number of persons engaged (10–49, 50–249, and 250–) and major groups of sectors based on the Japan Standard Industrial Classification (JSIC), Rev. 10, or groups for a few specific sectors. Enterprises were selected by a simple random stratified sampling. A census was carried out in strata where enterprises had 250 or more persons engaged, or where the population was small. As for precision, it was planned that the 95% confidence level for the ratio of innovators should be within a 5% sampling error for manufacturing and utilities sectors and within a 10% sampling error for other sectors. In consequence, the sample size was 43,174.

The questionnaires were dispatched on 24 January 2003. Postal reminders were sent out on 10 February 2003 and on 4 March 2003. Telephone reminders were also made to many non-respondents until 31 March 2003, the last date on which NISTEP was allowed to ask for sampled private enterprises to respond to the questionnaire.

2.2 Questionnaire

The survey used most of the core questionnaire of CIS 3. It also included additional or modified questions specific to Japan. The following items were added:

- Appropriability, in relation to intellectual property and knowledge
- Category, location, and range of activities of enterprise
- Industry that is closest to the field where the most important product innovation and the most important process innovation had been realised

In addition, the following questions were modified:

- Strategic, managerial, and organisational changes
- Enterprise's most significant market
- Description of the most important product innovation and the most important process innovation
- Public funding for innovation

As indicated above, questions on non-technological changes were modified to collect more detailed information. With regard to the topic, this paper provides a description later.

Also, some questions related to regions and countries, such as enterprise's activity and innovation partner, were modified. From a regional perspective, the choice of prefecture in which any office of an enterprise is located was added. The choices of countries and regions were modified according to the Japanese economic and trade situation.

There were challenges in terms of language and wording. First, the core questionnaire of CIS 3 written in English was translated faithfully into Japanese as much as possible. After the J-NIS 2003 questionnaire was designed, the Japanese version was translated carefully into English. Homogeneity between questionnaires and between versions was checked. In a kind of pre-testing phase for obtaining approval, some enterprises noticed difficulties in understanding questions because of unfamiliar expressions, especially among people who were responsible for statistical reporting in the firms. The English version of J-NIS 2003 was also required to be prepared, and to be sent upon request as a necessary condition of approval.

Second, the wording of "innovation", "product", and "process" was important. Japanese is written using both ideograms of Chinese characters and phonograms of *kana*, Japanese syllabics. As for terms imported from the West, our predecessors usually created a set of ideograms that would be suitable for the concepts using existing expressions. Recently, more and more words have been introduced, especially in technical areas. Now, most words of a foreign origin are written in *katakana* to maintain the original concepts. "Technological innovation" was translated as '*gijutsu kakushin*' around half a century ago, and this is still used. '*Gijutsu kakushin*,' however, has a meaning closer to "radical technological innovation". It is likely that '*gitutsu kakushin*' lacks the concept of product introduction into market. For this reason, the survey used '*inobêshon*' so as to express the concept of "innovation" defined in the core questionnaire as closely as possible, although some enterprises, especially non-innovating firms, noted concerns.

However, the linguistic situation dramatically changed within a few years. Now, the word '*inobêshon*' is familiar to the public, and has been used in government policies and documents.

2.3 Methodological challenges to international comparison

In Japan, the statistical surveys conducted by central governmental organisations shall use or are recommended to use JSIC for industrial classification. According to the regulations, J-NIS 2003 used JSIC, Rev. 10, for stratification. The major groups of JSIC do not correspond well to the divisions of the International Standard Industrial Classification (ISIC), Rev. 3 or to those of NACE. However, the best corresponding major group(s), or group if needed, of JSIC were attributed to each division/group/class of the industry of NACE (and ISIC) recommended for CIS 3.

2.4 Publication

A national report presenting the survey results was published in December 2004 as "Statistics on Innovation in Japan – Report on the Japanese National Innovation Survey 2003 (J-NIS 2003)" [Ijichi, *et al.*, 2004]. The report includes 77 statistical tables, which are divided mainly by 54 industries and by 3 firm-size levels. The report also includes a summary of the findings, an outline of the survey and the questionnaire and its related documents.

2.5 Interpretation and data analysis

Policy-makers have gradually become interested in the report. Although the producers have attempted to convey proper explanations, the ratio of innovators/innovation-active firms, for example, is often interpreted as if it meant the national strength of innovation. To tackle this challenge, we need to develop further relevant indicators on the basis of the variables observed by the survey. Arundel and Hollanders [2005], for instance, proposed a set of indicators called "innovation modes" to differentiate innovating firms.

It is expected that the innovation survey data can provide useful information. In Japan, researchers affiliated with NISTEP have already started to analyse the national innovation system, and to clarify the characteristics of specific industries that are not covered by the national report using innovation survey data.

3. Questions on non-technological innovations in J-NIS 2003

3.1 Approaches to designing questions

Organisational and marketing innovations were introduced into the scope of the *Oslo Manual* at the last revision in 2005. J-NIS 2003 was conducted before revision of the manual was started. In Annex 2 of the previous edition, the manual referred only to a limited number of experiences for measuring non-technological innovation, and showed the minimum data set that was required to be collected in an innovation survey. However, it neither provided definitions nor elaborated upon the concepts for the recommended question items.

On the other hand, questions on strategy, organisation, and management in the core questionnaire for CIS 3 only dealt with changes in each category. As a consequence, we decided to divide it into several questions that would provide us with more information on the content of implemented strategy, organisational change and management.

Many concepts and types have already been proposed (e.g. Sakakibara [2002]). If we observe the entire contents of changes in strategy and organisational structures, we have to take account of many variables, such as:

- Corporate strategy, business strategy
- Resource development, domain definition
- Market penetration, market development, product development, diversification
- Differentiation, cost leadership, focus
- Market positioning, e.g. leader, challenger, niche, follower
- Organisational structures:
  - Complexity: horizontal (specialisation, e.g. functional specialisation / departmentalisation) / vertical / spatial
  - Formalisation
  - Authority: centralisation / decentralisation
- Factors causing changes in organisational structures: internal, e.g. age and scale of organisation, production system; external, e.g. organisational environment
- Co-ordination mechanism within organisation, e.g. integral / modular, direct control or supervision, standardisation of processes, outputs, or skills and knowledge

- Functions differentiation, e.g. line / staff, work / management / service staff / general staff
- Organisation configuration, e.g. functional organisation, divisional organisation, matrix organisation

For use in a large-scale statistical survey, we assumed the following conditions:

- Unit of observation should be an enterprise, to be in line with other questions in the survey.
- Only changes in strategy and organisation should be observed. Relations between the changes and other factors should not be taken into account of because of limited length of the questionnaire.
- As for strategy, the status of implementation during the observation period should be observed; as for organisation, changes during the observation period and conditions at the end of the reference period should be observed.
- As for strategy, the intentions of firms should be inquired.
- Frameworks of traditional strategy and organisation theories should be covered by fewer questions as much as possible.

Under these prerequisites, we classified changes in strategy into several types as shown in Table 1.

Table 1. Types of strategy used for the Japanese National Innovation Survey 2003

Type of strategy	Purpose	Product	Market	market share
Technological innovation strategy	External	Original / New		
Domain strategy	External	Existing	New	
Competitive strategy				
Differentiation strategy	External	Existing	Existing	Expanding
Cost strategy	External	Existing	Existing	Constant
Resources strategy	Internal			
Others	Others			

First, a firm is asked whether the strategy implemented during the observation period aims at causing changes in the external situation and/or the internal situation of the enterprise. Changes in the internal situation include establishment of core internal resources in the enterprise, which is related to "resource strategy;" i.e., how an enterprise acquires, accumulates, and distributes the internal resource as competence.

Second, a firm is asked whether the strategy aims at creating new or original products and/or using existing ones. The strategy for innovative new products could be called a "product innovation strategy;" i.e., how an enterprise introduces a new product to the market.

Third, a firm is asked whether the strategy aims at developing a new market and/or retaining an existing one. The strategy for new market is related to "domain strategy;" i.e., how an enterprise finds new business fields or domains.

Fourth, a firm is asked whether the strategy aims at expanding the market shares of products and/or keeping them. The strategy in terms of a market share is related to "competitive strategy;" i.e., how an enterprise gains more outputs and/or maintains high performance in its processes. A strategy focusing on "differentiation" would be expected to lead to expanding market share; a strategy focusing on "cost" would be based on the premise that the market share is stable.

In terms of changes in organisation, we set a simple set of types as shown in Table 2. A firm is asked whether or not the change is accompanied by a movement of an organisational boundary. When a boundary is moved, a firm is further asked whether the functions are internalised and/or externalised. When a boundary is not moved, a firm is asked whether the business processes are restructured. Redefinition of an organisational boundary may lead to changes in methods of workplace organisation in a firm, or of organising external relations with other entities.

Table 2. Types of organisational changes used for the Japanese National Innovation Survey 2003

Type of organisational changes	Organisational boundary	Changes of functions
Restructuring of business processes	Unchanged	
Changes in organisational structure		
Function internalisation	Changed	Internalised
Function externalisation	Changed	Externalised
Others	Others	

Regarding management, we can also find many theoretical frameworks and concepts. In the knowledge-based economy, knowledge management issues have attracted the attention of researchers, practitioners, and corporate managers. For this reason, we followed the same approaches as France [Foray and Gault, 2003]. The key questions for the knowledge management practices survey were used for the questions for J-NIS 2003, while expressions were modified to bring them into line with other questions on technological innovation.

Table 3 compares question items for non-technological innovations between J-NIS 2003 and recent Community Innovation Surveys. It indicates that changes in corporate strategy and functional and structural reorganisations used in J-NIS 2003, have not been covered by recent CISs.

Table 3. Comparison of question items on non-technological innovations: the japanese Innovation Survey and the recent Community Innovation Surveys

J-NIS 2003		CIS 3		CIS 4, CIS 2006		CIS 2006 (extended version)		OM, 3rd ed.
Strategy	Corporate strategies (elaborated)	Strategy	Corporate strategies	Organisational innovation		Organisational innovation		Organisational innovation
Management	Knowledge management systems	Management			Knowledge management systems		Knowledge management systems	
	Other management techniques		Management techniques					
Organisation	Organisational changes (elaborated)	Organisation	Organisational structures					
							Business practices	
					Organisation of work		Workplace organisation	
					External relations		External relations	
Marketing	Marketing concepts / strategies	Marketing	Marketing concepts / strategies	Marketing innovation		Marketing innovation		Marketing innovation
					Sales / distribution methods		Product promotion	
							Product placemet	
							Pricing	
Aesthetic change	Changes in aesthetic appearance / design	Aesthetic change	Changes in aesthetic appearance / design		Design / packaging		Product design	

Source: The questionnaires for J-NIS 2003, CIS 3, CIS 4 and CIS 2006.

3.2 Data quality

The questions were implemented rather successfully. Tables 4 and 5 show the item non-response rates for each question on non-technological changes. The results indicate that these questions were rather easy to understand and respond to by both innovators and non-innovators, in comparison with other questions. Firms in industry responded somewhat more than those in services; medium-sized firms responded slightly more than small-sized and large-sized firms.

Table 4. Item non response rates: innovators (%)

	StrChg	MgtChg	OrgChg	Mktng	Aesth	StrPdt	StrDmn	StrMkt	StrCst	StrRsc	StrOth
Total	5.5	6.5	6.1	8.2	8.4	7.5	7.4	7.7	7.7	8.7	13.9
Agriculture, forestry and fisheries	0.0	2.6	2.6	2.6	5.3	2.6	2.6	5.3	0.0	2.6	7.9
Industry	4.1	5.3	5.0	7.1	7.4	6.2	6.1	6.4	6.4	7.4	12.9
Services	10.0	10.2	9.6	11.7	11.4	11.7	11.7	12.0	12.0	13.0	17.0
Small-sized	4.7	6.2	5.7	8.1	8.2	7.3	7.5	8.2	7.6	8.6	13.8
Medium-sized	2.9	3.7	3.2	5.0	5.5	5.0	4.2	5.2	5.3	6.3	11.7
Large-sized	9.0	9.6	9.6	11.6	11.5	10.4	10.7	10.0	10.3	11.4	16.3
	MgtPlc	MgtShr	MgtRtn	MgtAcq	MgtOth	OrgRe	OrgInt	OrgExt	OrgOth		
Total	8.1	8.7	9.0	8.1	9.8	7.1	7.8	8.0	11.7		
Agriculture, forestry and fisheries	2.6	2.6	5.3	2.6	2.6	2.6	7.9	5.3	7.9		
Industry	7.1	7.7	8.0	7.1	8.9	6.1	6.9	6.9	10.6		
Services	11.1	12.0	12.2	11.4	13.1	10.5	10.6	11.4	15.3		
Small-sized	8.2	9.1	9.6	8.0	11.2	6.8	7.3	7.4	12.0		
Medium-sized	5.5	5.8	5.8	5.2	6.6	4.9	5.1	5.3	8.7		
Large-sized	10.6	11.3	11.6	11.3	11.8	10.0	11.3	11.4	14.6		

Notes: StrChg: Implementation of management strategy
MgtChg: Implementation of knowledge management
OrgChg: Implementation of organisational changes
Mktng: Implementation of marketing changes
Aesth: Implementation of aesthetic changes
StrPdt: Implementation of strategy for providing original products
StrDmn: Implementation of strategy to cultivate new markets by expanding to other business domains
StrMkt: Implementation of strategy to expand market or the market share
StrCst: Implementation of strategy for reducing costs related to products
StrRsc: Implementation of strategy for constructing internal resources
StrOth: Implementation of strategy for other purposes
MgtPlc: Implementation of documented policies related to knowledge management
MgtShr: Implementation of a values system or corporate culture to promote sharing of knowledge
MgtRtn: Implementation of policies or programs to improve retention of employees
MgtAcq: Implementation of partnerships or strategic alliance with other enterprises for acquiring knowledge
MgtOth: Implementation of other management techniques new to the enterprise
OrgRe: Implementation of reorganisation of business process for efficiency
OrgInt: Implementation of internalisation of new functional departments or functions
OrgExt: Implementation of externalisation of specific functional departments or functions
OrgOth: Implementation of other changes in organisational structure

Source: Japanese National Innovation Survey 2003 (J-NIS 2003), National Institute of Science and Technology Policy (NISTEP)

Table 5. Item non response rates: non-innovators (%)

	StrChg	MgtChg	OrgChg	Mktng	Aesth	StrPdt	StrDmn	StrMkt	StrCst	StrRsc	StrOth
Total	7.9	8.5	8.6	9.4	9.9	9.1	9.0	9.2	9.0	9.5	12.4
Agriculture, forestry and fisheries	8.0	9.4	10.8	12.3	13.2	9.9	9.9	10.8	9.0	10.4	11.3
Industry	7.7	8.2	8.5	9.4	9.9	8.8	8.6	9.0	8.6	9.2	12.6
Services	8.5	9.0	8.6	9.2	9.4	9.9	10.0	9.7	9.9	10.2	12.1
Small-sized	8.6	9.3	9.5	10.5	10.8	9.9	9.7	10.1	9.8	10.4	12.8
Medium-sized	5.1	5.5	5.7	6.3	6.9	6.3	6.3	6.3	6.0	6.6	10.3
Large-sized	12.0	12.2	12.1	12.9	13.4	12.8	12.9	12.8	12.9	13.0	16.2
	MgtPlc	MgtShr	MgtRtn	MgtAcq	MgtOth	OrgRe	OrgInt	OrgExt	OrgOth		
Total	9.4	9.6	9.5	9.3	10.2	9.2	9.8	9.7	12.1		
Agriculture, forestry and fisheries	10.4	11.3	10.8	10.4	11.3	11.8	11.8	12.3	12.7		
Industry	9.1	9.4	9.3	8.9	10.0	9.1	9.7	9.5	12.3		
Services	10.0	10.1	9.8	10.0	10.7	9.1	10.0	9.8	11.7		
Small-sized	10.4	10.5	10.3	10.2	11.2	10.1	10.8	10.8	12.9		
Medium-sized	6.2	6.7	6.6	6.2	7.2	6.2	6.8	6.6	9.3		
Large-sized	13.0	13.5	13.3	12.9	13.8	12.9	13.5	13.1	15.7		

Notes: See Table 4

Source: Japanese National Innovation Survey 2003 (J-NIS 2003), National Institute of Science and Technology Policy (NISTEP)

4. Outcome of measuring non-technological innovations

4.1 Survey results on non-technological innovations

This section explains briefly how the survey results can provide useful information and the implications for the innovation system.

The survey results from J-NIS 2003 indicate that non-technological changes were largely associated with innovation activities in Japan. As shown in Table 6, 92%, 75%, and 70% of innovators in Japan implemented changes in strategy, knowledge management, and organisation, respectively. In the EU, on the other hand, 46%, 39%, and 53% of innovation-active enterprises implemented such changes, respectively [Eurostat, 2004]. The comparison suggests obvious differences between Japan and the EU, although the question items were subdivided in J-NIS 2003, and the denominators differed between J-NIS 2003 and CIS 3. As for strategy, many innovators implemented “strategy for providing original products”, “strategy to cultivate new markets by expanding other business domains”, and “strategy for constructing internal resources”, as well as strategies aimed at market expansion and cost reduction. As for knowledge management, many innovators implemented “a values system or corporate culture to promote sharing of knowledge” and “partnerships or strategic alliance with other enterprises for acquiring knowledge”.

Also, even among non-innovators, the contrast between Japan and the EU is remarkable in the implementation of non-technological changes. Japanese non-innovators were more willing to change practices. As shown in Table 7, 54%, 37%, and 43% of non-innovators in Japan implemented changes in strategy, knowledge management, and organisation, respectively; 17%, 14%, and 23% of enterprises without innovation activities in the EU did so, respectively.

Table 6. Implementation of non-technological changes, 1999-2001: proportion to total innovators (%)

	Total	Small	Medium	Large	Total	Small	Medium	Large	Total	Small	Medium	Large
	Implementation of management strategy				Implementation of knowledge management				Implementation of organisational changes			
Total economic activities	92	92	94	97	75	71	80	86	70	65	76	90
Agriculture, forestry and fisheries	79	79	78	:	48	45	72	:	40	36	65	:
Industry	92	91	93	97	74	70	79	85	70	64	77	89
Services	94	93	94	95	77	73	83	87	71	67	76	91
	Implementation of marketing changes				Implementation of aesthetic changes							
Total economic activities	19	17	21	27	32	32	32	36				
Agriculture, forestry and fisheries	18	18	18	:	20	19	24	:				
Industry	18	16	21	26	35	34	35	38				
Services	20	19	19	29	30	31	26	32				
	Implementation of strategy for providing original products				Implementation of strategy to cultivate new markets by expanding to other business domains				Implementation of strategy to expand market or the market share			
Total economic activities	62	61	64	72	51	49	53	54	64	60	69	79
Agriculture, forestry and fisheries	38	34	65	:	25	25	27	:	35	34	45	:
Industry	61	58	65	73	51	50	52	54	62	58	65	81
Services	65	66	61	69	51	49	56	53	67	63	76	77
	Implementation of strategy for reducing costs related to products				Implementation of strategy for constructing internal resources				Implementation of strategy for other purposes			
Total economic activities	64	59	71	83	45	41	53	62	32	29	33	48
Agriculture, forestry and fisheries	37	37	31	:	44	44	51	:	24	20	54	:
Industry	69	63	76	88	44	39	52	62	29	26	31	46
Services	58	55	62	73	47	43	54	63	36	34	36	52
	Implementation of documented policies related to knowledge management				Implementation of a values system or corporate culture to promote sharing of knowledge				Implementation of policies or programs to improve retention of employees			
Total economic activities	35	32	39	48	46	42	50	59	28	28	27	27
Agriculture, forestry and fisheries	14	9	51	:	40	40	39	:	17	17	20	:
Industry	36	31	42	48	43	39	49	58	25	25	26	25
Services	34	33	33	47	50	48	54	60	32	33	28	29
	Implementation of partnerships or strategic alliance with other enterprises for acquiring knowledge				Implementation of other management techiques new to the enterprise							
Total economic activities	42	39	45	55	10	6	11	31				
Agriculture, forestry and fisheries	20	19	27	:	2	0	13	:				
Industry	41	39	41	52	11	6	13	35				
Services	44	39	53	60	8	6	10	25				
	Implementation of reorganisation of business process for efficiency				Implementation of internalisation of new functional departments or functions				Implementation of externalisation of specific functional departments or functions			
Total economic activities	53	46	63	75	39	34	46	52	23	19	27	43
Agriculture, forestry and fisheries	28	25	52	:	13	12	22	:	13	11	33	:
Industry	54	47	63	74	37	33	42	48	22	19	23	42
Services	52	46	64	78	42	36	54	59	25	20	34	45
	Implementation of other changes in organisational structure											
Total economic activities	16	13	21	37								
Agriculture, forestry and fisheries	5	4	17	0								
Industry	15	13	21	37								
Services	17	15	22	37								

Source: Japanese National Innovation Survey 2003 (J-NIS 2003), National Institute of Science and Technology Policy (NISTEP)

Table 7. Implementation of non-technological changes, 1999-2001: proportion to total non-innovators (%)

	Total	Small	Medium	Large	Total	Small	Medium	Large	Total	Small	Medium	Large
	Implementation of management strategy				Implementation of knowledge management				Implementation of organisational changes			
Total economic activities	54	52	59	71	37	36	42	50	43	41	50	64
Agriculture, forestry and fisheries	47	47	53	100	27	26	37	80	22	20	39	50
Industry	56	53	67	77	37	35	46	50	43	41	52	64
Services	51	51	51	66	38	37	39	49	44	42	49	63
	Implementation of marketing changes				Implementation of aesthetic changes							
Total economic activities	7	7	5	6	11	11	10	13				
Agriculture, forestry and fisheries	7	7	9	0	7	7	11	50				
Industry	5	5	5	4	12	12	11	16				
Services	8	8	5	7	10	11	9	10				
	Implementation of strategy for providing original products				Implementation of strategy to cultivate new markets by expanding to other business domains				Implementation of strategy to expand market or the market share			
Total economic activities	19	19	20	24	18	18	19	22	28	27	30	44
Agriculture, forestry and fisheries	26	26	25	40	11	10	17	0	26	25	28	100
Industry	19	19	21	24	18	17	22	22	25	23	31	44
Services	18	18	19	23	18	18	16	21	31	31	29	44
	Implementation of strategy for reducing costs related to products				Implementation of strategy for constructing internal resources				Implementation of strategy for other purposes			
Total economic activities	39	37	44	57	20	18	23	31	13	12	16	24
Agriculture, forestry and fisheries	27	25	39	100	9	8	22	67	11	10	14	67
Industry	44	41	55	65	20	19	24	30	13	12	16	23
Services	34	33	34	49	19	18	22	32	14	13	16	25
	Implementation of documented policies related to knowledge management				Implementation of a values system or corporate culture to promote sharing of knowledge				Implementation of policies or programs to improve retention of employees			
Total economic activities	16	14	23	24	17	16	22	27	14	14	16	16
Agriculture, forestry and fisheries	10	9	16	60	8	6	25	50	10	9	24	25
Industry	16	14	24	25	15	13	21	26	14	14	14	15
Services	16	13	23	23	20	19	23	27	14	14	17	17
	Implementation of partnerships or strategic alliance with other enterprises for acquiring knowledge				Implementation of other management techiques new to the enterprise							
Total economic activities	18	18	17	22	3	2	4	8				
Agriculture, forestry and fisheries	17	17	15	25	0	0	4	0				
Industry	18	18	19	21	2	1	4	9				
Services	17	18	14	22	4	3	4	8				
	Implementation of reorganisation of business process for efficiency				Implementation of internalisation of new functional departments or functions				Implementation of externalisation of specific functional departments or functions			
Total economic activities	33	31	38	49	16	14	22	28	11	10	14	19
Agriculture, forestry and fisheries	14	13	26	33	10	10	13	25	7	7	11	0
Industry	32	30	38	51	16	14	22	28	12	11	15	15
Services	34	33	37	48	16	14	23	27	11	10	13	22
	Implementation of other changes in organisational structure											
Total economic activities	13	11	18	26								
Agriculture, forestry and fisheries	6	5	13	0								
Industry	12	11	16	27								
Services	14	12	21	25								

Source: Japanese National Innovation Survey 2003 (J-NIS 2003), National Institute of Science and Technology Policy (NISTEP)

However, the types of change were vastly different between innovators and non-innovators. Regarding strategy, non-innovators tended to implement "strategy for reducing costs related to products" and "strategy to expand market and the market share". Regarding knowledge management, the proportions of non-innovators implementing changes were lower than those of innovators.

By definition, non-innovators neither introduce new or significantly improved products into markets nor implement new or significantly improved processes in firms by definition. It is presumed that non-innovators are likely to conduct efficient business activities on the premise that existing business fields are maintained. In Japan, non-innovators, which had tended to implement non-technological changes at higher ratios than those in the EU, accounted for 78% of private firms, whereas (technological) innovators were limited to a small proportion of the firms. In addition, large firms have dominated innovation activities. In the business sector, the J-NIS 2003 results show that 82% of the innovation-related R&D workforce was concentrated in large-sized firms.

These findings suggest one of the features of the Japanese innovation system, which seems to have remained unchanged for a few decades. Freeman [1987], which is famous as the first publication to use the expression "national system of innovation" [Edquist, 2005], described the Japanese innovation system in the mid- 1980s, and attributed the basis of the Japanese success to organisational and marketing innovations made to improve information flows and co-ordination within firms.

Assuming that organisational innovation is included in process innovation in a broad sense (e.g. Edquist *et al.* [2001]), the J-NIS 2003 results mean that the current Japanese system as a whole can be regarded as being "process innovation" oriented.

4.2 Relevance

The J-NIS 2003 results have gradually attracted the interest of policy makers, although references to the data remain in only a few policy documents. In Japan, the concept of "innovation" is still blurred for a lot of policy makers, industrialists, and academicians, and is not yet shared well by them, although the *Oslo Manual* provides a determinate definition of innovations for observation and interpretation. lso, the meanings of innovation indicators seem not to have been properly understood by users.

Nevertheless, even the current analysis can provide policy implications to some extent. As the (technological) innovators are a minority in small and medium-sized enterprises, for example, the innovation policy for those targets should be more focused. In satisfying the needs of more firms, the industrial policy does not necessarily reflect the policy for facilitating and accelerating (technological) innovation activities. Furthermore, as non-technological innovators without technological changes occupy no small part of the Japanese system, they may be distinguished from technological innovators and non-innovators, and be stimulated to improve economic performance, or even to become technological innovators.

This paper only takes examples from an analysis using statistical tables derived from the Japanese survey. The academic literature on non-technological innovations using CIS data (e.g. Schmidt and Rammer [2006]) has been produced recently. Further analysis using not only statistical tables but also micro-data sets is expected to be conducted in order to bring about policy development as well as academic progress.

5. Concluding remarks

This paper describes the experience of measuring non-technological innovations, while referring to the outlines of J-NIS 2003.

Among non-technological innovations, the question items composing the core questionnaire for CIS 3 are subdivided into those for J-NIS 2003. As for strategy and organisation, the detailed question items are designed on the basis of major concepts proposed by previous research. Concerning knowledge management, J-NIS 2003 adopts the same approach as French CIS 3. The survey uses key questions from the questionnaire for knowledge management.

The survey results indicate that the questions on non-technological innovations are informative and useful for understanding the innovation system. The Japanese results reveal that non-technological changes were implemented not only by most of the (technological) innovators, but also by a considerable ratio of (technological) non-innovators, whereas the major types of change were differed between innovators and non-innovators. Some literature tells us that organisational innovation is included in process innovation in a broad sense. When we presume this view, we can consider that many Japanese firms have implemented changes, although the ratio of (technological) innovators in Japan is less than in many other OECD countries on the basis of the number of enterprises. Also, the characteristics of Japanese innovation activities observed from the survey results are consistent with those specified in previous studies. On the other hand, the survey results suggest that (technological) innovators should still be discerned from technological non-innovators because both types of innovator differ in activity, such as main market.

The information on non-technological changes requires our deepest insights into innovation. It is expected that progress in measuring and analysing non-technological innovation will lead to a better understanding of the innovation system, and contribute towards formulating and monitoring evidence-based innovation policy.

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Appendix. Questions on non-technological changes in J-NIS 2003

12. Important strategic and organizational changes in your enterprise

So far, this survey has only dealt with new or significantly improved products and processes. This final question asks you about non-technological creative improvements including changes in strategy, management, and organization.

During the period 1999–2001, did your enterprise undertake any of the following activities? For each of the following, please place a checkmark for the appropriate answer.

	Yes	No
Strategy		
Implemented strategies for providing your enterprise's original products different from other enterprises	☐	☐
Implemented strategies to cultivate new markets by expanding your products to other business domain than where you used to provide them	☐	☐
Implemented strategies to expand the market or market share in the range of specific products of your enterprise	☐	☐
Implemented strategies for reducing costs related to your enterprise's products	☐	☐
Implemented strategies for constructing your enterprise's internal resources, which would serve as the core for competition	☐	☐
Implemented strategies for other purposes than stated above	☐	☐
Management		
Implemented documented policies related to knowledge management (systematic activities related to acquisition and sharing of knowledge within an organization) within your enterprise	☐	☐
Had a values system or corporate culture intended to promote sharing of knowledge within your enterprise	☐	☐
Implemented policies or programs intended to improve retention of employees within your enterprise	☐	☐
Implemented partnerships or strategic alliance with other enterprises for the purpose of acquiring knowledge	☐	☐
Implemented other management techniques new to your enterprise than stated above within your enterprise, e.g. supply chain management (SCM), Six Sigma (6σ)	☐	☐

Organization

Implemented reorganization of business process for efficiency... ☐ ☐

Implemented internalization of new functional departments or functions,
i.e. introduction of new organizations or personnel with functions
that had not been carried out within your enterprise.. ☐ ☐

Implemented externalization of specific functional departments or functions,
i.e. procurement of organizations or personnel outside your enterprise
that carry out functions used to be carried out within your enterprise .... ☐ ☐

Marketing

Implemented significant changes
in your enterprise's marketing concept/strategy,
such as newly implementation of data mining.. ☐ ☐

Aesthetic change (or other subjective changes)

Made significant changes in aesthetic appearance or design,
or other subjective changes that users can tell
in at least one of your enterprise's products.. ☐ ☐

THE REGIONALISATION OF CIS INDICATORS THE DANISH EXPERIENCE

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Abstract

The regional aspect of innovation is of high political interest in many European countries, including Denmark. A proper sampling is needed, if the CIS indicators are to be calculated by region. This includes stratification by region, taking into account the size of the regions and the variability of the regional indicators. Also, larger enterprises often have establishments and so innovation activities in more than one region. Information on this is needed, and a simple method for a correction for this, used in Denmark, is described.

1. Introduction

On all political levels – local, regional, National, EU – one finds an increasing interest in the regional aspect of innovation, the aim being to promote innovation in different regions in a more focused way, depending on the conditions and needs of each region. One can, however, not just split up the National CIS-sample into the regions needed, due to sampling problems and innovations in more regions by some of the larger enterprises.

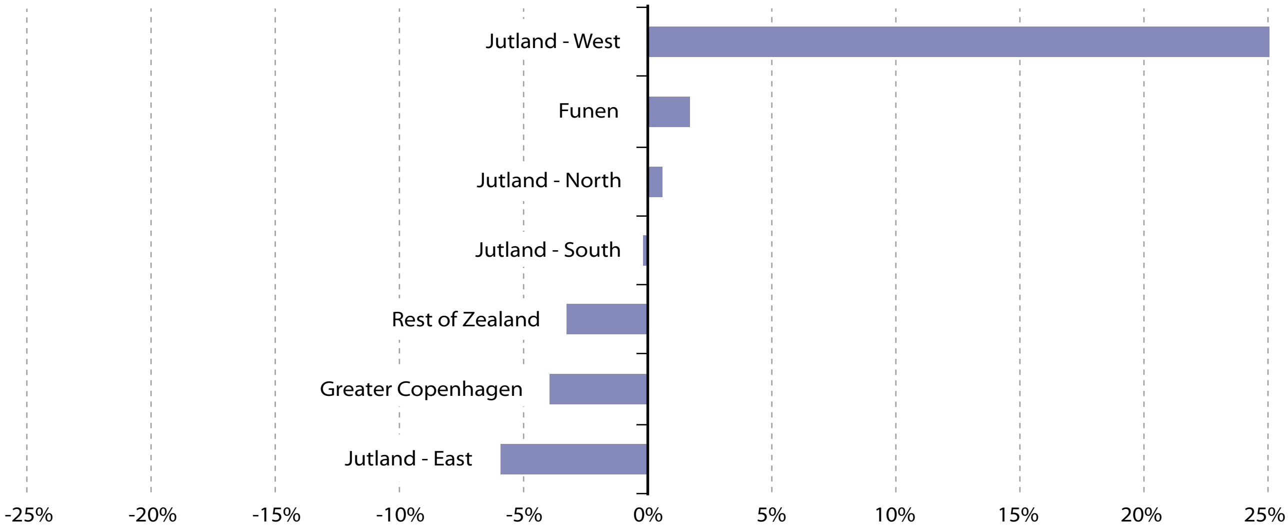
2. Sampling aspects

If the CIS-survey is not a census, one has to take into account the regional aspect in the sampling plan, if it is planned to calculate reliable regional innovation indicators. It is not a good idea just to split a sample in regions and then calculate the regional indicators. The sample is not balanced and the response propensity may vary over regions. This means that the weighted respondents will not automatically be equal to the total number of enterprises in the region. This is illustrated in Figure 2.1, using Danish data from the CIS4-survey. Here, one can see that the number of weighted respondents is 25 % higher than the actual number of enterprises in one of the smaller regions.

A post-stratification by regions may correct this, but this has the effect that

- the weights are recalculated, so the value of the National indicators also are revised
- the reliability of the regional indicators will still vary a lot, being low in smaller regions due to small sample sizes

Figure 2.1: Difference between respondents (weighted) and population, regions, Denmark, CIS4



If regional innovation indicators are in demand, this should be included in the sampling planning from the very beginning. The first step will be to decide how to demarcate the regions, so all expected demands can be met, including indicators for specific areas like *city innovation*. Next, the sampling planning has to take into account both the need of a National balanced sample and samples in each region. One way to ensure this would be:

- Calculate a preliminary national sample size using the industry and size strata and achieving the level of precision requested by the methodological guidelines of Eurostat
- Calculate the sample size separately for each region using the same industry and size strata and a precision requested by National authorities (elements to be included: precision, size of population, design effect, response rate).

In regions, where the preliminary national sample size is smaller than the regional sample size, the regional sample size will be the one used. In this way the final national sample will be larger. For the regional indicators, some of the larger regions will probably be over sampled, while no regions will be under sampled.

3. The establishment level

Larger enterprises often have establishments and thus also innovation activities in more than one region. Information on this is needed, so that valid regional indicators can be calculated and used for comparisons. A simple method for this is used in Denmark.

The method goes like this: All enterprises reporting some innovation expenditure are asked whether all innovation activities take place in the postal code of the headquarters of the enterprise. In enterprises, where this is not the case, they are asked to estimate the proportion of their total innovation expenditure for each of the postal codes where the innovation activities take place – summing up to 100%, see excerpt from the questionnaire in Figure 3.1.

In the Danish CIS4, 22 % of the innovation active respondents reported that some of their innovation activities took place in other postal codes. In all, these enterprises were conducting and acquiring 42 % of all the innovation expenditure[1] in the business sector, and more than half of these innovation expenditure (52 %) was spent in other postal codes.

[1] Smaller non-innovative enterprises receives a short-form questionnaire, and do not reply to the question on regional innovation. The results of these enterprises are not included in these figures.

Figure 3.1. Question on geographical placement of innovation activities (Danish CIS4-questionnaire)

5. The geographical placement of the innovation activities in 2006:

5.1 Did all innovation activity take place in the postal code of the headquarters? **Yes** ☐ **No** ☐

If not:

5.2 Estimate the proportion of innovation expenditure for the postal codes, where the innovation activities take place (including R&D)

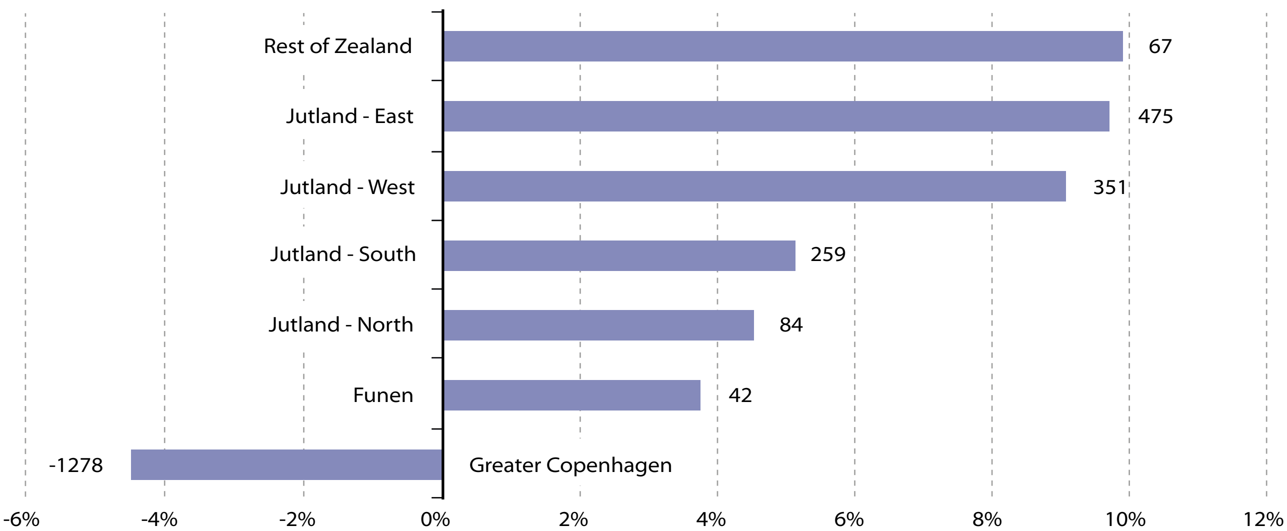
(Notice: acquired services should be included in the postal code of their use)

If more than 4 postcodes, attach a separate list

Postal code	**In Percentage**	
		%
		%
		%
		%
Total	**1 0 0**	%

In the Danish publications on STI, Denmark is divided in 7 regions. This means that many of the placements of innovation activities outside the headquarters still is within the same region. Also, the correction for the innovation activities outside the headquarters is going in all directions between the regions. Probably like in many other countries the net result is that the innovation expenditure in the capital decreases and in all other regions the innovations expenditure increases, when correcting for innovation expenditure in establishments.

Figure 3.2: Effect on innovation expenditure when correcting for innovation activities outside the region of the headquarters, DK, CIS4



In Figure 3.2 one can see that *Greater Copenhagen* "loses" nearly 5 %, while other regions "win" up to 10 % of their innovation expenditure from establishments with headquarters – mostly in Copenhagen.

The indicator *Share of enterprises with innovation expenditure* can be calculated from the question on placement of innovation activities. However, this introduces a problem concerning the most relevant weighting, which the second part of this presentation will address.

4. Conclusions

This paper has stressed the importance of a proper sampling plan, when CIS-surveys are planned to be used for extracting regional innovation indicators. Also, the Danish example has illustrated that it is necessary to do some kind of sampling among the establishments of enterprises with innovation activities in more regions to get valid indicators.

THE REGIONALISATION OF CIS INDICATORS THE CIS4 TWO-TIERED SURVEY IN ITALY[1*]

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Abstract

Analysts and policy makers require information about innovation activities at regional level. CIS surveys currently carried out on the basis of the Oslo manual do not allow to build satisfactory regional indicators: innovation activities carried out by multi-plant, multi-region enterprises are attributed to the head office. This introduces a bias, in particular where head offices are concentrated in particular regions – Italy is a case in point. Another approach is based on the collection of data at the establishment level, departing from the "subject" approach at the core of the Oslo manual.

This paper describes a methodology which allows to build regional indicators in the Oslo framework. The methodology, which is currently being tested by ISTAT, implies a two-stage approach: collecting information at the enterprise level and, in the case of multi-regional enterprises, also at the sub-enterprise level. The reconciliation between the information collected at the two levels is made on the basis of one of the few quantitative variables of the CIS questionnaire: the innovation expenditure. This reconciliation implies some rather strong assumptions about the "unity" of the enterprise and about the technological capabilities of establishments. Furthermore, the methodology allows to built only a limited number of indicators at regional level.

1. The development of a two-tiered innovation survey in Italy

In 2005 ISTAT launched a project on the regionalisation of innovation indicators in the framework of the European CIS4 survey. One of the main objectives was to exploit, as much as possible, the CIS4 infrastructure to collect data relevant to the regional level of analysis. On top of the ordinary survey of innovating firms, a statistical survey of around 1,200 Italian multi-plant innovative enterprises was planned in order to collect information about the innovation activities of their establishments located in regions different from the region of localisation of the head office.

The Italian CIS4 was based on a two-tiered approach which consists of treating separately:

- primary statistical units in the framework of the EU harmonised CIS4, and,
- secondary statistical units (that is, local units including all the activities within a region at NUTS2 level) to be surveyed through computer-assisted personal interviews (CAPI).

As a consequence, the structure of the Italian survey was designed as follows (Table 1):

- first stage: mail survey of all enterprises (with some additional questions on their innovation activities at regional level);

[1*] An extensive version of this paper has been presented to the Blue Sky II Forum held in Ottawa on 25-27 September 2006.
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- second stage: CAPI survey of innovative enterprises with establishments in more than one Italian region using an additional questionnaire on the regional distribution of their innovation activities.

Table 1. Structure of the ISTAT two-tiered innovation CIS4 survey

Stages	Respondents	Data collected on regional activities
First stage *(main CIS4 mail survey - Eurostat survey)*	Single-plant innovative enterprises	All CIS4 variables + innovation information from locally based sources + innovation cooperation with locally based institutions
	Multi-plant innovative enterprises	All CIS4 variables but no specific questions on the regional breakdown of their innovation activities in the main questionnaire
Second stage *(CAPI survey)*	Multi-plant innovative enterprises	CAPI questionnaire on: local units performing innovation activities + regional breakdown of turnover, employees and innovation expenditure + public funding at regional level + locally-based institutions providing innovation information + innovation cooperation with locally based institutions

While the CIS4 survey was completed within July 2006, the second-stage survey on multi-plant enterprises is being carried out, using a CAPI approach, in the period December 2006 – January 2007. The initial sample of multi-plant innovative enterprises includes about 1,200 enterprises Only limited information from testing interviews is available so far.

Since regional data had to be collected in both stages of the CIS4, special attention was paid to the inclusion into the Eurostat CIS4 questionnaire of a few questions on the innovation activities undertaken at regional level by innovative enterprises in order to make available some "regional" indicators consistent with those which will be produced by the CAPI survey. In fact, final data will result from the consolidation of "regional information " collected from single-plant enterprises through the main CIS4 and of "regional information" collected on the regional activities of multi-plant enterprises in the second stage (CAPI) of the survey.

2. The expected outcome of the Italian two-tiered survey

In order to produce a set of regional indicators consistent with that available at national level, data collected through the two main stages of the innovation survey have to be consolidated according to pre-defined rules.

The variable on "innovation expenditure" is a special case in this context. Since data on expenditure are strongly localised, information collected on expenditures both at enterprise-level (for single-plant enterprises) and at regional level (for multi-plant enterprises) can be summed up and weighted up to the total population of enterprises to estimate regional totals.

Much more complex is the data processing for the remaining set of variables. For these variables, a conceptual difficulty rests with the methodological problem of how weighting them. The problem can be defined as follow. For single-plant enterprises, which are based by definition only in one region, enterprise-level weights can be used for producing both the national and the regional totals for all variables. For multi-plant enterprises a more elaborated approach has to be developed in order to break down the enterprise-level weights according to the regional distribution of their innovation activities. For example, if an innovative enterprise is assumed to represent a number n of enterprises in the sampled population and it undertakes innovation activities in three different regions, a fraction of the original weight n should be assigned to each region in order to identify the contribution by the three regions to the overall innovation effort by the enterprise (and by similar enterprises in the sampled population).

Under the assumption that data collected through the second stage of the survey have to be weighted using enterprise-level weights, several issues have to be tackled:

- how to weight the contribution of each single region (i.e. of one or more establishments based in that region) to the innovation effort of a multi-plant enterprise,

- how to classify the establishments (or groups of establishments located in the same region) belonging to an innovative enterprises in terms of "innovation capacity"; that is, providing a definition of the "innovative establishments (or groups of establishments)",
- whether to built regional estimates based on an enterprise-level indicator (thus accepting to consider fractions of enterprises, for instance "4,658.7 innovative enterprises in Region X") or calculating alternative indicators at establishment-level ("23,546.8 innovative establishments in Region X") or as absolute value ("the innovative performance of the Region X is 6.7 out of ten").

2.1 Weighting

As for weighting, the ISTAT proposal is to split the enterprise-level weight by region according to the relevance of the innovation activities developed at regional level. As a result, the total number of enterprises will remain the same as for the indicators at national level, and a breakdown in terms of number of enterprises will be available at regional level. For instance, an indicator will be produced on the "number of innovative enterprises in Region X", as well as an indicator on the "percentage of innovative enterprises in Region X on all enterprises in the country". Since the population at country level will be kept as the reference population, an indicator such as "percentage of innovative enterprises in Region X on all enterprises in Region X (innovation intensity at regional level)" will not be available.

2.2 Classifying

The second problem rests with the classification of establishments (or groups of establishments located in the same region) in terms of "innovation capacity". In order to split the enterprise-level weight into two or more "regional weights", it is necessary to identify which establishments (as well as, groups of establishments) can be defined as "innovative" and to measure their relative contribution to the overall enterprise's innovation activity. It is quite possible that only some of the establishments of a multi-regional enterprise are innovative, while others are not. A method, which is being tested in the framework of the ISTAT project, is based on a classification of the surveyed establishments:

- head offices of "innovative enterprises" will be considered "innovative" by definition, being the place where innovation strategies and activities are designed and managed,
- establishments other than the head office (including R&D laboratories and design centres) will be considered "innovative" if they reported innovation expenditure during the last reference year of the survey.

After the identification of the establishments (or groups of establishments) which are considered "innovative" and, as a result, of the regions where the concerned enterprises carried out relevant innovation activities, the contribution from each region will be measured. A preliminary method for measurement, which will be tested by ISTAT, was defined as follows.

- a percentage[1] of the enterprise-level weight will be attributed to the region where the head office is located;
- the remaining part of the enterprise-level weight will be attributed to each region with innovative establishments, as a proportion of the share of the enterprise's innovation expenditure covered by the local units based in each region.

The use of the innovation expenditure's regional breakdown as main criteria for evaluating the distribution of the innovation burden among an enterprise's local units is considered to be reasonable and acceptable since "innovation expenditure" is the only purely quantitative variable collected through innovation surveys to measure the innovation activity carried out by enterprises. Furthermore, the use of alternative variables for weighting the contribution of each "regional" group of establishments to the overall enterprise innovation activity – for instance, the total turnover or the total employment at regional level – can not be ruled out and will be tested as well[2].

[1] Any assumption about the value of such percentage not resulting from a detailed analysis of the costs supported on average by the head office of a multi-plant enterprise to manage one or more innovation projects would be arbitrary. In the framework of the ISTAT CAPI survey, company managers will be asked to provide estimates of the costs of managing multi-regional innovation projects in order to calculate this percentage.

[2] The use of qualitative variables to take into account the "type of innovation activity" carried out at regional level will be tested in the weighting process.

Some aspects of the two-tier approach deserve further consideration:

- whether it is appropriate to consider innovative the head office of a multi-regional firm even if it is merely an administrative location without production or commercial activities,
- whether it is appropriate to consider innovative establishments like R&D or design departments which, according to the Schumpeterian definition adopted by the Oslo manual, are not innovative as they do not commercialise new products and products,
- whether it is appropriate to consider innovative establishments those which innovate merely buying new machinery, but which have no technical capabilities. In this case these establishments, even though they may have some impact on the local environment, most likely are not part of the regional innovation system.

2.3 The indicators to be built

Various innovation indicators can be produced on the basis of the two-tier approach. However, the difficulties in matching enterprise-level and establishment-level information implies strong limitations. Thus, several indicators recommended by the Oslo manual may not be available with a regional breakdown. The ISTAT project is currently aimed at producing the following indicators:

Indicators of *innovation activity*

- "number of innovative enterprises[1] in Region X";
- "percentage of innovative enterprises in Region X on all innovative enterprises in the country";
- "percentage of innovative enterprises in Region X on all enterprises in the country";

Indicators of *innovation expenditure*

- "innovation expenditure in Region X, total and by type of expenditure";

Indicators of *innovation cooperation*

- "number of innovative enterprises involved in innovation cooperation in Region X";
- "percentage of innovative enterprises in Region X involved in innovation cooperation on all innovative enterprises involved in innovation cooperation in the country";
- "percentage of innovative enterprises in Region X involved in innovation cooperation on all innovative enterprises in the country";

Indicators of highly important *sources of information for innovation*

- "number of innovative enterprises in Region X that indicated highly important sources of information for innovation";
- "percentage of innovative enterprises in Region X that indicated highly important sources of information for innovation on all innovative enterprises that indicated highly important sources of information for innovation in the country";
- "percentage of innovative enterprises in Region X that indicated highly important sources of information for innovation on all innovative enterprises in the country";

In principle, the calculation of some indicators based on ratios should be excluded because of the peculiarity of the definition of the "innovative enterprises" adopted in the two-tier approach that does not allow for a denominator including "all innovative enterprises in a region" which would result from bringing together enterprises as well as fractions of them.

[1] In this context, by "innovative enterprises" we mean enterprises, or fractions of them, having undertaken innovation activities in a specific region. It can be stressed that, at country level, the sum of the "innovative enterprises" based in all regions will equal the total of "innovative enterprises" at country level.

A possible alternative would be to produce ratio indicators calculated in terms of percentage of "total turnover" or "total employees", thus considering a lower level of detail. According to this approach a few additional indicators might be made available:

Indicators of *innovation activity*

- "percentage of turnover of innovative enterprises in Region X on total turnover in Region X";
- "percentage of employees of innovative enterprises in Region X on total number of employees in Region X";

Indicators of *innovation cooperation*

- "percentage of turnover of innovative enterprises involved in innovation cooperation in Region X on total turnover of innovative enterprises in Region X";
- "percentage of employees of innovative enterprises involved in innovation cooperation in Region X on total number of employees of innovative enterprises in Region X";

Indicators of highly important *sources of information for innovation*

- "percentage of turnover of innovative enterprises that indicated highly important sources of information for innovation in Region X on total turnover of innovative enterprises in Region X";
- "percentage of employees of innovative enterprises involved that indicated highly important sources of information for innovation in Region X on total number of employees of innovative enterprises in Region X".

3. Final remarks

The proposed two-tier approach to the regionalisation of innovation data collected with the Oslo manual methodology is expected to yield indicators of a higher quality than those built on the other approaches (mainly those based on the head office and on subsidiaries). Its strengths are:

- the consistency with the "subject" approach of the Oslo manual,
- the opportunity to collect information about the relationship between the different branches of a multi-localised enterprise in developing and implementing innovation projects. This information is not totally exploited in the current statistical practice but may be used as supplementary information and may even lead to the development of new indicators,
- the possibility to provide a special focus on large enterprises and their innovation strategies. Even though small and medium enterprises play a key economic role in the diffusion of innovation in several countries, large enterprises are still the main producers of knowledge. Thus, even though a number of innovation policies are targeting small and medium enterprises, a more complete statistical information on large companies' regional (and international) innovation strategies is of great relevance.

On the other hand, the two-tier methodology has its own limitations, namely:

- the collection of data at regional level on multi-regional enterprises is expensive,
- the number of indicators allowed by the methodology is limited,
- the outcome of the survey is constrained by the *a priori* definition of the geographical level of analysis.

REDESIGNING THE U.S. SURVEY OF INDUSTRIAL RESEARCH AND DEVELOPMENT: IMPLICATIONS FOR STATISTICAL DATA ON INNOVATION[1]

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Executive summary

Responsibility for statistical data on research and development as well as innovation within the U.S. structure falls to the Division of Science of Science Resources Statistics (SRS), National Science Foundation (NSF). NSF is the primary government funder of basic research in the United States. The legislative mandate for SRS as stated in the National Science Foundation Act of 1950, as amended, is "…to provide a central clearinghouse for the collection, interpretation, and analysis of data on scientific and engineering resources and to provide a source of information for policy formulation by other agencies of the federal Government…." To meet this mandate, SRS, in its role as a federal statistical agency with responsibility to cover the science and engineering enterprise, provides policy makers, researchers, and other decision makers with high quality data and analysis for making informed decisions about the nation's science, engineering, and technology enterprise. The work of SRS involves survey development, methodological and quality improvement research, data collection, analysis, information compilation, dissemination, web development and customer service to meet the statistical and analytical demands of a diverse user community, as well as preparation of the congressionally mandated *Science and Engineering Indicators* and *Women, Minorities and Persons With Disabilities in Science and Engineering* biennial reports.

Over the last fifty years, SRS, through ongoing surveys of research and development and the science and engineering workforce has built a substantial base of data on the science and engineering enterprise in the United States. However, the very nature of that enterprise has been changing dramatically, and through lack of both monetary and staffing resources, SRS had not been able to keep up with the changes. Over the last 7 years, attention has been drawn to the changes underway and adequate resources have begun to be provided to update and modernize both the data collected and how it is collected as well as processing and analytical capabilities. This paper will describe the changes presently underway with respect to the Survey of Industrial Research and Development which is designed and developed by SRS but utilizes the U.S. Census Bureau as its data collection agent. This arrangement, which permits SRS to utilize one of the most complete business register frames and provide complete confidentiality to data providers, is not without issues as will be discussed in the paper.

This paper is about the systematic redesign of the Survey of Industrial Research and Development, NOT about either the development of a survey of innovation or about analysis plans for innovation. Rather, it is about a very systematic redesign of a long-standing survey and how within the confines of the redesign, mechanisms may be developed to obtain much needed data on innovation in the U.S. industrial sector. Coverage of the industrial sector within the U.S. is currently quite broad and includes all of manufacturing and non-manufacturing except for the agricultural sector.

The impetus for the reevaluation and redesign activities for the SRS surveys were two reports from the National Research Council of the National Academy of Sciences (NRC). The first in 1998,[4] covered the entire SRS portfolio of data collections

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1 The views expressed in this document are those of the authors and do not necessarily reflect the views of the National Science Foundation

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3 Senior Mathematical Statistician, Division of Science Resources Statistics, NSF

4 National Research Council, (2002) Measuring the Science and Engineering Enterprise

and analytical activities. The second, entitled *Measuring Research and Development Expenditures in the U.S. Economy,*[1] covered only the SRS portfolio of research and development surveys and related activities. The second was quite strong in indicating that SRS had done an adequate job considering resources available, but it was now time for major evaluations and redesigns of all its research and development surveys—industry, academic, federal and facilities (which was already underway) to insure that they reflect how research and development was actually being conducted in the U.S., within the broader global context, and most importantly, the redesigns would position the surveys to be able to capture changes as they occur in the future.

How the Redesign is Being Undertaken

As part of the agreement in establishing the second NRC in 2003, SRS and NRC agreed that as SRS learned something from the meetings and investigations of NRC, it would be free to begin implementing changes or improvements rather than await the completion and publication of the report which occurred in 2005.

The NRC group focused primarily on the Survey of Industrial Research and Development and was concerned with two aspects. The first was that the survey did not adequately reflect how research and development was currently being conducted. The second concerned the quality of the data. Quality reviews of the data and of the processing procedures had not been undertaken in many years, and in some cases where they had occurred, they were not necessarily implemented.

The report was extremely influential as it was released shortly before Dr. Marburger, Director of the U.S. Office of Science and Technology Policy issued a call for the development of better science metrics which would permit better choices to be made between competing research priorities. Further, in the release of the FY 2007 Presidential Budget Request, there was a new initiative entitled The American Competitive Initiative (ACI), calling for enhanced funding for the physical sciences and science and math education and metrics to be used in conjunction with the ACI.

Hence, all of these forces were very powerful impetuses in insuring that the redesign of the Survey of Industrial Research and Development would have substantial impact and would result in the collection of more detailed, higher quality data on research and development---still not really touching on the issue of how to collect and measure "innovation."

The stages that the redesign has been going through are multiple and relate directly to classic redesign procedures. We have and are undertaking quality reviews of existing data and of the statistical and data processing procedures utilized by the Census Bureau. Over 40 recordkeeping visits were conducted with industrial companies (we do not know if in fact they are respondents) to determine what data they have available and track routinely on research and development activities. Cognitive interviews were held with existing respondents to determine how they perceive what the existing questions on the questionnaire mean—as opposed to what SRS and Census planned for the questions to mean. We were further interested in what data they used to respond to the questions.

Next a series of meetings and workshops were held with high level industry representatives to understand what they considered to be the most important issues facing the industrial sector related to research and development. We were very interested in obtaining their understanding of how research is actually conducted within the global context. Another series of workshops were held with academic researchers and policy makers on how innovation takes place, and these concerns are going to be addressed, in a limited way, through a module(s) on innovation. Finally, a series of workshops were held with data users in both the government and private sectors.

All of the above are part of the basic background steps that are being undertaken in redesigning a major statistical survey. We are now at the stage where the data needs have been rank ordered and compared with the existing data now being collected. We have identified which of the existing data probably do not need to be collected either annually or have in fact outlived their relevance. We know the new data that is needed—not necessarily how to collect that data or to phrase the questions. Further, we understand the concerns of both policy makers and analysts to have the data at a lower level of disaggregation than company. We do not yet know if it is feasible to collect at this level which was the high priority of many users. Finally, we understand the concerns for data on innovation. We realize that the Company Financial Officer, who is the individual that usually completing the survey, likely does not have all of the information and that we should involve the research and development departments also.

[1] National Research Council, (2005) Measuring Research and Development Expenditures In The U.S. Economy

Over the next two years we plan to: compose and test questions; determine the proper respondents for components of the questionnaire and how to get to them; develop an innovation module and determine the proper respondents for that module; redesign our processing systems and operating procedures; revise our statistical methods; undertake cognitive interviews with potential respondents; pretest limited components of the questionnaire and conduct a full scale pilot of the new questionnaires and procedures as well as debriefings prior to fielding a new survey. The full scale implementation is likely to occur for the 2009 survey.

A Systematic Redesign:

The redesign of the Survey of Industrial Research and Development is critical to SRS/NSF for several reasons. The primary reason is the dramatically and rapidly changing nature of how research and development is conducted in a global world and that the present SRS/NSF survey does not adequately reflect. Hence, the data which is used by both US and international researchers and policymakers is probably missing important components and may lead to potentially misleading assumptions. The second reason is to establish a formal model for the redesign of all SRS/NSF surveys as well as the development of any new upcoming surveys. The model which SRS/NSF has followed has five steps, these are:

- Step 1. Content: Define Data and Information Needs
- Step 2. Content: Identify Data Sources and Availability
- Step 3: Evaluate (in the case of new surveys, Develop) Operations and Methodology
- Step 4: Content and Collection: Identify New Content and New Ways of Collecting Data
- Step 5: Implementation

Prior to utilizing the formal model for the redesign, there were a number of false starts by SRS as we started the redesign in late 2003. We were examining and evaluating the components of the existing survey, but without a framework for determing the usefulness of the data, the survey operations or the series of methodological studies, it was difficult to determine how to put these pieces together or how useful or relevant the activities were. In late 2005, SRS made the decision to formally separate the activities related to the redesign from the ongoing survey operations. Staff in the redesign and ongoing survey operations kept each other informed, and often attended the same meetings, but there were different staff leading the two operations. Different staff leads for redesign and ongoing survey implementation were designated in both SRS and Census. Both activities were to occur simultaneously, both with very different goals. Ongoing survey operations were to maintain the existing survey and produce the data in a timely fashion. The questionnaire and procedures for the ongoing survey would be frozen, little to no incremental changes made, with changes and improvements directed to the redesign activity. The redesign was given the goal of rethinking every component of the survey plan, continuity of data series was not considered to be a governing goal.

A matrix management staffing schema was developed for the redesign. Within SRS/NSF the effort is lead jointly by a mathematical statistician and an economist with technical expertise in research and development (R&D) and innovation. These individuals come from different staffs within SRS and actually, neither of these individuals has extensive experience in questionnaire/question development. These skills will come from outside consultants and the Census staff. Next, funds were provided for the Census Bureau, the data collection agent for the survey, to hire a dedicated separate staff for the redesign.

The SRS redesign leaders took the initiative in developing the initial model to be used. But, at every step of the way they have made a very extensive effort to build consensus and include all relevant SRS staff and Census staff and to develop "buy-in" on the approaches to be used. There was an understanding that unless everyone was onboard and agreed that the plan and procedures were optimal, we would not have success.

Step One: Data Content

The first, and rather time consuming stage was to define the data users and the specific data needs for statistical data on industry research and development (R&D). The aim was to include both the usual SRS customers as well as to make a very systematic and concerted effort to include users whom we had not interacted with previously. The primary data usage within NSF is for the National Science Board (NSB) report *Science and Engineering Indicators* written by SRS staff. The data needed for the chapters relating to industry and research and development provide the minimal requirements for data. Literature reviews were undertaken to determine how the data had been used in the past. An extensive set of meetings were held with the Bureau of Economic Analysis (BEA) which is responsible for the estimates of the GDP and the US IO tables. BEA provided a data gaps recommendation report to NSF which was very extensive and explicit as to data items and level of detail needed. The BEA recommendation report serves as the second major driver in determining data needs. An Industry Expert Panel was established with the R&D directors of about 10 major US corporations and representatives from several smaller start-up R&D companies. Three meetings were held with industry representatives who provided overviews of how their companies conducted R&D; where data were kept; what questions they had to data to answer; and what areas they would be reluctant to provide data about –which related generally to competitive issues and questions where they could only provide "best guess estimates." The major trends that industry stressed:

- Companies are increasingly looking abroad for new markets and new technological capabilities
- S&T advances are dramatically changing the way R&D is conducted in many industries.
- Companies are being pressed by customers to provide not just technology products but services in the form of business models and processes.
- Industrial R&D sections within companies are changing from stand-alone units to more networked and integrated organizations that acquire new ideas and technology external from their unit.
- R&D is being managed within companies as a portfolio of projects with various levels of risk as well as stages of development. R&D is under pressure to be profitable to companies.
- Human resources are critical for success and companies are competing world wide for the best talent.
- Companies do not seem to have clear cut metrics for measuring the value of R&D to their overall bottom line.

Workshops were held with both federal data users and non-government data users. The second group included state government representatives, industry representatives, researchers and representatives of various trade and professional associations. The surveys were described and participants discussed how these used the data and what data would be important to them. They then took part in several exercises to identify their data needs and rank order their data priorities.

Priorities of Federal Data Users

- R&D below the company level (by product type/by line of business/at establishment level/at customer sector)
- Sources of funding (where the funds were coming from for the research such as company, government, other firms, etc)
- Data on R&D infrastructure and capital investments
- Outcomes and outputs of R&D (such as sales of new or improved products, patents, licensing, etc)
- Type of R&D technology area (software, biotechnology, nanotechnology, etc)
- Data on how R&D is done (collaboration, contracted out, outsourcing, grants, etc)

- Character of R&D (basic, applied, development or other categories)
- R&D labor force data
- Area of application (health, defense, energy, etc)
- Detail on type of costs (labor, materials, etc)

It was quite striking that the priorities of the non-federal participants were quite similar. Those data needs are:

Priorities of Non-Federal Data Users

- R&D below the company level (by product type/by line of business/at establishment level/at customer sector)
- Sources of funding (where the funds were coming from for the research such as company, government, other firms, etc)
- Data on foreign R&D operations
- Character of R&D (basic, applied, development or other categories)
- R&D labor force data
- Data on how R&D is done (collaboration, contracted out, outsourcing, grants, etc)
- Type of R&D technology area (software, biotechnology, nanotechnology, etc)
- Area of application (health, defense, energy, etc)
- Finer geographic detail (state, city, county)
- Outcomes and outputs of R&D (such as sales of new or improved products, patents, licensing, etc)

Input was also received from an Innovation Workshop[1] held by SRS in June 2006. The participants were academic researchers and federal government representatives involved with innovation. The workshop was one in a series NSF has held as background for a new solicitation on the Science of Science and Innovation Policy. The workshop focused on the indicators or metrics needed to understand innovation and then explored ideas as to the research that might be needed to operationalize the metrics. Workshop participants identified eleven major categories for which data are needed:

- Innovative Activities (many of these are R&D related)
- Key Drivers, Inputs and Institutional Mechanism
- Outputs and Outcomes of Innovation
- Effects of Government Policies on Innovation
- Relationships, Knowledge Flows and Networks
- Accounting for Innovation and its Relationship to Finances
- Adoption and Diffusion of Innovation
- Mobility of Individual Scientists and Graduate Students

[1] National Science Foundation, Division of Science Resources Statistics. 2006. *Advancing Measures of Innovation: Knowledge Flows, Business Metrics, and Measurement Strategies, 6–7 June 2006.* Pierre Perrolle and Francisco Moris, project officers. Arlington, VA., http://www.nsf.gov/statistics/nsf07306/.

- Intangibles and Disembodied Knowledge
- University-Industry Knowledge Flows
- Data Needed to Support the R&D Satellite Account

The workshop recommendations will form a major input to the design of the planned innovation module. The module will be developed in a separate stream from the redesign of the Industry Research and Development Survey.

Step Two: Identify Data Sources and Availability

As important as determining what data is needed by researchers and policymakers is understanding what data is actually "knowable." The first step undertaken was a series of recordkeeping trips to a range of companies which SRS staff conducted with experts in cognitive interviewing. At this stage we did not knowingly visit companies in the survey sample, rather we were trying to gain an understanding of the data companies have to answer the existing questions on the survey as well as an understanding of how companies actually do research and development. Visits were conducted with approximately 40 different companies across the United States. The basic findings of these recording keeping visits were:

- Companies have difficulty distinguishing between the definitions of basic and applied research, and the concepts of basic and applied research and development used on the SRS surveys are not generally tracked in the accounting systems.
- Innovation means different things to different companies.
- Organizationally, there is a large amount of diversity in where R&D is conducted within a company.
- Relatively few companies conduct their own basic research any more but rather acquire basic research or technology from various sources.
- Recordkeeping for R&D is more detailed at project level than at the company level.
- Companies, especially the larger ones, use off the shelf software for project accounting.
- Data on human resources is maintained separately in different data bases from the financial and project tracking systems.

Debriefings with respondents to the existing Survey of Research and Development were held. These debriefings were generally concerned with how the respondent answered the questions---where they obtained the information from and occasionally, what they interpreted the questions to mean to them. Census Bureau methodological staff conducted cognitive interviews with survey respondents to determine their understanding of the questions which they answered. The basic findings appear to show:

- A number of the questions on the survey are complicated and request very detailed breakouts. Detailed breakouts have higher non-response rates.
- Respondents "self-definition" of their product lines or business activities do not necessarily coincide with Census classification and hence the data collected at that level may not be consistent.
- The concepts of "contract R&D" and "collaborative R&D" are not well understood by respondents and they do not understand the difference between the two concepts.
- The current respondents may not be the best individuals within the company to collect all the data from. For example, questions concerning R&D technology area are better answered by the R&D department rather than financial department.

- The breakdown of R&D by basic, applied and developmental detail is very confusing for respondents, leading to inconsistent data, and is likely being asked of the wrong individuals.

- Data on human resources is kept at the person level and is often reported as headcounts instead of as full-time equivalents.

During this period, SRS and Census staff also consulted with accounting experts to understand how companies were required to keep their books under various accounting standards and the Sarbanes-Oxley Act of 2002 legislation. This legislation has not only required additional accounting reporting by companies but also a certification of the accuracy of the data reported by the company CEO's in their annual and quarterly reports with penalties where appropriate. Hence, there is a concern on the part of companies about providing data in terms of "best guesses" or approximations. SRS plans to hold meetings with representatives of major accounting/software to understand what data are generally being collected through these various systems within companies. Of special interest to SRS is whether special modules could be developed with these software companies which would allow respondents to the survey to easily use their existing software systems to respond to the survey. This idea will be more fully pursued when the actual survey content is finalized.

Step Three: Evaluate Operations and Methodology

Equally important to identifying data sources and availability of data was an understanding of the entire survey collection, processing and statistical operations. SRS had been conducting the Industry Research and Development Survey for a number of years without any systematic review of the survey operations. Hence, even before the exploration of user data requirements began, SRS began a systematic review and evaluation of both the current survey operations and statistical procedures. The following studies and reviews were and are being conducted:

- Flowcharting all the stages of the existing survey processes

- Demonstrations and reviews of the present data processing and survey collection software systems presently used by the Census Bureau. Alternate systems have been used and the full capabilities of the new system have not yet been utilized.

- Onsite visits to the Census Bureau National Processing Center in Jeffersonville, Indiana

- Review of all edits and edit specifications on the existing surveys in order to develop revised edits for the existing survey and plan for the new survey.

- Review all procedures and programming of imputations for missing data from the existing survey. Short term changes to correct problems in the imputation procedures have been made for the existing survey.

- Fund research on imputations and multivariate imputation research for the new survey.

- Undertake review of implications of classifying a company to a NAIC code by its sales rather than products.

- Measure unit response and nonresponse to existing survey questions and create question response rate tables.

- Conduct an experiment to study the implications of preprinting data from the previous year's survey onto the current year data collection. This practice is now utilized and its implications have been questioned by various methodologists.

Step 4: Identify New Content and News Ways to Collect the Data

SRS is now at the stage where the various streams are coming together. From these streams a decision has been made as to the data that will be collected and how to begin this collection. Taking the lists of data priorities, we have broken the data needs into high, medium and low priority items. We then reconceptualized the survey structure into three components. A core component which would be asked of all respondents and appear, from all research to be relatively easy for respondents. Next would be sections which would also include high priority items, but not all companies/respondents might receive a section or there might be different versions of a section for different types of companies. Finally, there would be modules that would be asked of different frequency, would collect medium and low priority data or would have to go to a different respondent within a company. Indeed, not all questions could or would be asked of all companies.

What has become very clear through the various activities is that a single respondent cannot be expected to either be knowledgeable or have the data or access to systems to answer all the questions on the present or future surveys. Rather, a format will need to be established that would allow for different respondents in different areas of the company such as R&D, human resources and finances. A similar strategy could be utilized for a module on innovation in the future.

Step Five: Bringing it All Together

NSF/SRS has now begun to bring all the steps together and develop the prototype of a new questionnaire, components and a revamped survey design. The prioritization of data items has been synthesized, with the determination of how to potentially cross-cut the core (or highest priority) data items. The following table provides this synthesis:

Table 1. Core items and cross-cuts

	Total R&D Performed		Total R&D Financed		Capital Expenditures for R&D		Sales	
	U.S.	Global	U.S.	Global	U.S.	Global	U.S.	Global
Type of Cost (wages, materials, supplies)	Yes	?	Yes	?	No	No	No	No
Line of Business	Yes	Yes	Yes	Yes	?	?	Yes	Yes
State	Yes	No	No	No	?	?	No	No
Source of Funds (Federal, Company and Other by U.S. and abroad)	Yes	Yes	NA	NA	?	?	No	No
Budgeted R&D	Yes	Yes	Yes	Yes	?	?	No	No
The following items do not have cross-cuts. All apply to domestic only.								
Contracted Out (Grants vs contracts) Collaboration								
Company Characteristics								
R&E Tax Credit								
Employment	(Is there a desire for global employment?)							

The remaining data items of interest to collect fall into four modules:

1. **R&D Technical Questions** – Includes: Character of Work, Total Sales/Shipments, Application area, and Technology area.
2. **Human Resource Questions** – Includes R&D Workforce
3. **Intellectual Property (IP) and Licensing**
4. **Innovation** – To be worked on separately

NSF/SRS plans to complete the initial draft of the core questionnaire by late this winter and begin cognitive interviewing and pre-testing as soon as possible after that. Concurrent with the testing of the core questionnaire, work will begin on revising the entire survey process and developing a new data collection system. This work will include developing and testing respondent contact strategies, determining who and how to get to the best respondents with the companies, development of the database and data collection system, developing new frame construction and sampling procedures, and creating coding, editing and imputation procedures. All systems and procedures will be pre-tested. NSF/SRS will undertake a full scale pilot of the new survey and survey design system no later than 2009.

It is hoped that NSF/SRS will be begin to develop the modules shortly after the initial core questionnaire is designed, but the cognitive interviewing, pretesting and survey processing system design for the modules will be on a different time schedule.

Present plans are to begin development on an innovation module late this year, based on input from the workshops NSF has held, input from policy makers and researchers as well as the recordkeeping studies and various NSF grants. It may be possible to include this module in the planned pilot with test results available within the year.

Data Providers' response, ability and willingness

SOME EVIDENCE ABOUT THE CONCEPTS OF INNOVATION WITHIN ENTERPRISES: A PILOT SURVEY CONDUCTED AMONG 70 ENTERPRISES IN FIVE COUNTRIES – THE "VIGNETTES" PILOT SURVEY

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Abstract

Some evidence about innovation conception among enterprises is given here through the results of a pilot survey conducted in the framework of the Oslo manual revision. This survey has been carried on in March-April 2004. About 70 enterprises have been surveyed in four countries (France, Belgium, Spain and Australia) and partly integrated in the Danish pilot survey conducted by the same time.

The purpose of this exercise was two-fold:

- first business's respondents were presented with fourteen "study-cases" in the form of short "stories" ("vignettes"). Then respondents were asked then a very short set of questions: "*Would you consider this manufacturer as innovative? If so, would you say the innovation is related to the product?... that the innovation is related to the marketing of the product... or...*" etc.
- the second part of the questionnaire was designed to provide the profile of the enterprise: "*Would you say that innovation in your industry is? (frequent/not frequent) Could you place yourself in relation to your competitors in terms of innovation? (open answer)" etc.;* the whole questionnaire intended to collect answers based on the enterprise experience and understanding of innovation; therefore respondents were also asked to describe the "most important" innovation in their activity during the past five years and in their own enterprise as well (if relevant).

An equal focus was set on industry and services industry (number of firms surveyed etc.). The study-cases: "vignettes" were also designed to be appropriate to respondents in both sectors. A major emphasis was given to the marketing and organizational "might be innovations".

The main findings of this exercise are as follows:

- given the study-cases: "vignettes", respondents are mainly "cautious". Among given examples in services industries, 9 cases out of 14 let the respondents say that these enterprises are "innovative", and only 7 out of 14 in industry examples;
- innovations can be traced to marketing rather than to product itself: this proposal is validated in a majority of cases; on the other hand respondents appear to be more reluctant about might be or could be organizational innovations. In manufacturing only one proposed example validated: "a new system for project management".

These findings are usefully supplemented by those coming out of the second part of the questionnaire:

- when asked about their activity: 60% of the enterprises state that innovation is rather frequent in their sector and 70% out of them (42% of the total) think they have an innovative advance;
- major innovations in their sectors reported by respondents – frequently connected with advanced technologies - and in no way purely organizational even if organizational changes could be frequently involved;
- when asked about their own major innovations, respondents deliver innovation cases which are less advanced technologies related and give a large part to organizational changes and management;
- when asked about main factors determining innovation in their own enterprise, respondents cite: "strategy" and "knowledge", followed by "competitors", and then "R&D and technology", and then "standards", "enterprise growth" or "rationalization".

When merging the two set of results, two directions can be derived:

- given the sets
- the concept of "organizational innovation" is harder to delineate according to enterprises own judgement: if such an innovation occurs it's in combination with others types of innovation and probably might be a pure organizational innovation if traced back to "knowledge", "project management" and "strategy".

As an expected result: the frequency of each type of innovation is suspected to be different between manufacturing and services industries.

Introduction

This survey has been carried on in March-April 2004. About 70 enterprises have been surveyed in four countries (France, Belgium, Spain and Australia) and partly integrated in the Danish pilot survey conducted by the same time. This exercise has been undertaken in the course of the Oslo manual revision process (OECD-Eurostat).

Context

As a logical results of the previous innovation surveys and other data collection and innovation measurement, there has been a growing concern about the increasing share of services industries in economies and therefore a need to better encompass new innovation patterns, especially in these activities where the technological approach of innovation looked unsuitable. The first edition of the Oslo manual focused on innovation in manufacturing, the second one broadened the scope including services industries but without achieving an effective integration in definitions. Therefore the recommendations of the second manual fell short when trying to design new surveys and perform a better measurement of innovation in the broader economic field. As a consequence there was a general agreement (2000, 2001) on the need to revise the recommendations and to design a new set of core definitions. This work has been undertaken in the process of elaborating a proposal for a new set of core definitions of innovation.

Problematics

A lot of work had already been done. The problematics was to assess to which extent these preliminary works and attempts to draw a new enlarged framework were operational, i.e.:

- were the proposed new guidelines including new types of innovation definitions really adapted to better describe and measure innovation as it happens in real economics (consistency).

- were these new definitions and underlying approach robust enough to let us collect valid and reliable responses from enterprises (data collection effectiveness and quality);
- were these new definitions accurate enough and not leading to a too broad approach and measurement of innovation.

Preliminary work

The work has been conducted in two steps. At the beginning a large set of "innovation study cases" ("vignettes") has been referred to the experts of the NESTI (OECD) Network, with the purpose to make clearer how experts understand the actual definitions and to cast some light on points in debate. The "vignettes" had been taken from previous open answers of enterprises in the course of the CIS3 survey and some had been designed from a mix of theoretical or controversy points and examples given by CIS3 respondents. We tried to focus on six main questions in debate:

- Statistical unit: in the frame of a group, which firm can be considered to be innovative?
- Technological versus non technological innovation: which criteria are used to define the "technological" nature of an innovation
- Innovation and R&D: is any product or process coming from R&D especially as defined in the new version of the Frascati manual an innovation, especially in services industries
- Marketing innovation: is there a need to define a new type of innovation that could be called "marketing innovation"? If yes, how can we define it?
- Organizational changes and innovation: among organizational changes are there some that could be considered to be innovations? If yes, which of them? How to make the distinction between organizational innovations and organizational changes
- ISO standards and innovation: are ISO standards adoptions to be considered as innovations? If yes, how should we classify these innovations? Are they process or eventually product innovations? Are they organizational innovations?

We collected 20 answers from experts coming from 18 countries. These detailed responses show the difficulty to fully derive innovation assessment from the actual set of definitions (Oslo 2). As regards "vignettes" dealing with possible new types of innovation, some of suggested cases were stated to be acceptable innovations, but with a general concern about the need to specify these possible proposed types of innovations thoroughly. The ISO and standards cases were generally pointed as "not an innovation by itself". Taking into account this first set of results, we designed a new set of "vignettes", with a narrower scope of concerns, in order to collect enterprises understanding based on the same "vignettes" method.

Pilot survey design

The pilot survey was designed to cover only concerns about the new possible types of innovations, that is marketing, organization, and standards related innovations. We first used a refined set of "vignettes" and added to the questionnaires a more general part about the general conception or statement about innovation among enterprises often based on qualitative evaluations and referring to enterprises' own context.

This two folded approach was designed to:

- test enterprises understanding - accuracy, relevance, judgement - and assessment of new types of innovations
- test the efficiency and capacity of this new approach (statistician definitions) i.e. the capacity to suit to criteria used in the enterprises and then test the consistency of the two approaches.

Vignettes design

We designed two sets of "vignettes", each with 14 cases, one for manufacturing enterprises, and on for services industries, including trade, enterprises. Each set of "vignettes" has been elaborated separately but with an attempt to cover equally the three main concerns at stake - the three new envisaged occurrences or types of innovations - in the two main activity fields.

As regards to the "vignettes" methodology some explanations are needed. After each "short story" giving a presentation of the case in his context, respondents were asked:

- "Is the enterprise innovative?",
- and then a short set of (sub) questions judged relevant on a case to case basis:
  - "Is the innovation related to the product (process, marketing of the product, respectively)"
  - "Is it an organizational change?" (optional)
    - "if yes does it contribute to innovation activity of the enterprise?" (optional)
- and then as a follow up of the main question: "(if you answered no to "is the enterprise is innovative?") Would you say it is contributing to the innovation activity of the enterprise?"
- and finally "Has your enterprise already undertaken such an innovation or a similar one?"

When designing the questions it was decided to avoid a direct question with respect to organizational changes, such as "is it an organizational innovation?" but decided to ask first "is it an important organizational change" to be used in connection with the answer to the follow-up question "would you say it is contributing to the innovation activity of the firm?". The final question was designed to give a control about the relevancy of the "vignettes" and secondarily to give the opportunity to control for possible bias depending whether or not the enterprise had already realized such innovations.

General questions

The purpose was to collect information regarding:

- enterprises' assessment of relative innovativeness in their activity, and enterprise own relative innovativeness as compared to it's own competitors in it's activity
- enterprises observations about:
  - main factors driving innovation: in day to day activity with respect to suppliers or clients role in fostering the innovation process, and more generally speaking which other key factors determine the innovation process for each enterprise
  - what they consider to be main innovations:
    - in their activity (i.e. among their competitors) during the last five years
    - in their own enterprise during the same period (literal answers in both cases)
    - for each given example of innovation respondents were then asked to classify it among product, process, marketing, organization innovations (multiple answers possible)
- what they consider to be "change only" (example to be given - literal answer)
- the best criteria to measure the relative importance of an innovation in their own acceptance
- other important dimensions of innovation not mentioned before

Pilots survey organization and number of responses

Seventy three answers have been collected (see appendix Table 1): thirty one in manufacturing and forty two in services industries.

Regarding the French part of the pilot survey (44 respondents): - the survey has been conducted through the national institute (INSEE) enterprise interview network which is in charge of pilots surveys among enterprises or data collection by interview in complex surveys, - the sample had been designed to be representative on an activity and size-class basis, with an average over-proportional representation of CIS3 surveyed enterprises. The sample was three or four time the final achieved number of surveys. The interviewers had to get in touch with enterprises, and then find the best interlocutor and obtain participation. The whole process lasted a little longer than one month. The interviewers had previously attended a one-day training. Respondents were seen to be cooperative and interested in the initiative. In Spain the survey has been realized through an arrangement with an enterprises' organization, and conducted by the National Institute Australia (ABS).

Main findings

"Vignettes" part

The first result is that the "marketing" type of innovation seems to be validated. As opposed to the results from the first round of the pilot survey among experts, respondents within enterprises are able to make the (main) distinction between innovation related to the product and innovation related to the marketing of the product and often with a clear assessment (percentages of answers - see Table 2, Table 3).

As regards to "organizational changes" the answers cast some light on what might be the organizational type of innovation. But there is no clear assessment.

In services industries (see below) the organizational dimension seems to be often implied in other types of innovation and in the same time some changes are also judged as highly contributing to "the innovation activity (of the enterprise)". In manufacturing, answers suggest that specific organizational innovations could be acknowledged, and one should note, with a clearer distinction between what is the core activity of the enterprise and the rest of activity.

Regarding the last type or case of innovation, respondents answer is clear. The cases of standards related innovation are rejected with no doubt: respondents don't state the enterprise is innovative.

- *marketing:*

In manufacturing and services industries, there were five cases more specifically designed to assess "marketing innovations" i.e. with a sub-question: "(if you answered yes to innovation... Is this innovation related to the marketing of the product, or to... (with other possible items among product, process)".

<u>In services industries four out of five occurrences are validated: enterprises are said to be innovative; and in each case a majority of responses goes to "innovation is related to the marketing of the product" before any other item.</u>

A typical case of innovation validated and assessed as (rather) related to the marketing of the product is: "*A commercial chain of stores designs a new packaging and a new concept in order to sell its product in a new area (airports, for example)*".

<u>In manufacturing two (and one fifty-fifty) occurrences out of five cases are validated.</u>

A typical example is: "*A manufacturer who sells only to wholesalers develops an internet site to reach individual customers, allowing them to order on the web and to have it delivered within 8 days*".

With respect to the "control-question": in services industries a majority of respondents state "not having already done undertaken such an innovation", as opposed to manufacturing answers where the major part of respondents say that their enterprise has already undertaken such a project. In both activities, the rather low percentage of non-responses to "Have you already..." exhibits a good understanding of the "vignettes" cases.

- *Organizational change (service industries):*

In services industries, there were 13 cases including "(possible) organizational innovations", among which two were specifically targeted at organizational innovation i.e. with only the two questions "is the enterprise innovative" and "Is it an (important) organizational change?"

The two specific cases are rejected by respondents (-"*A service company sets up functional departments (studies, marketing…). This allows a gain of productivity*", " *A company relocates its consulting activity to a country where it realises half of its turnover. This allows a gain of productivity*"). In both occasions respondents state nevertheless that it is contributing to the innovation activity of the enterprises (very highly in the second case).

Among the remaining 11 cases, 8 are validated as innovations, and often judged to be important organizational changes (more than 60% of responses), but innovation is estimated to be related mainly to product, process or marketing.

In one case of "not an innovation" respondents exhibit a strong yes answer to "it is contributing to innovation activity...": "*A business services firm establishes a new procedure for conducting its studies*".

Organizational (important) changes appear whether to be highly implied in product, process (and marketing) innovations, or when specifically oriented towards organization are often assessed to contribute strongly to the innovation activity of the enterprise. Nevertheless this doesn't make quite clear what could be the answer if respondents had been asked "is it an organizational innovation?" (or if better designed cases could have been given).

- *Organizational change (manufacturing):*

In manufacturing, 11 cases including "(possible) organizational innovations" were designed with again two examples specifically designed to organizational (possible) innovations i.e. with only the two questions "is the enterprise innovative" and "Is it an (important) organizational change?"

Among the two specific cases, one is validated as an innovation: "*A manufacturer establishes a team of engineers who work directly at its client's location in order to ensure the adaptation of the products to the clients needs*".

The other specific case is rejected ("*A firm introduces a procedure to monitor continually the risks in the different production units (equipment destruction, fire, risks for workers*").

Among the remaining 9 cases, 5 are validated as innovations, and often judged as important organizational changes (more than 60% of responses). Innovation is appreciated more often to be related mainly to product, process or marketing, sometimes without a strong assertion of type of innovation and a high rate of responses to important organizational change organizational: "*A firm establishes a new project management system*", "*A firm enters a foreign market by creating a subsidiary in that country to **manufacture** products adapted to the local market*".

In some cases the assertion of the type of innovation based on a more normative set of questions could probably have given more assessments of "organizational innovations".

- *Standards (ISO):*

The two suggested cases of "standards related innovations", one in services industries and one in manufacturing, are both rejected and not judged to be innovative.

General questions

Innovativeness according to the enterprises is not so different from what statisticians measure

When asked about the relative position of their enterprise regarding innovation among its competitors, 44% of respondents report that their enterprise is "above average" (Table 5). This rate reaches 55% in manufacturing and 36% in services industries. These figures are very close to those obtained in CIS4 survey (in France) with respect to the rate of innovators, all types of innovation being included i.e. organization and marketing included. This rate is estimated to 46% on average and 55% in manufacturing.

In activities where innovation is frequent (according to respondents), 76% of respondents in manufacturing (respec. 46% in services industries) set forth that their enterprise is "above average" with respect to innovation performance (Table 4). Once again these figures (especially in manufacturing) are near to results exhibited in the CIS4 survey in France. As 60% of respondents belong to the French sample this allows for an acceptable consistency assessment.

These findings are important because they may account for a good fitting between what statisticians intend to measure and enterprises' own statement.

Which factors are driving innovation according to the enterprises? Respondents set forth "capacities and strategy" followed by "technology" and "competitors" with equal emphasis

Instead of the usual questioning based on "market driven" as opposed to "technology driven" process of innovation, the questionnaires were designed to collect first a statement about the relative importance of clients and providers followed by an open question: "which other factors do you value?" This was supposed to avoid a normative framework with too general and not actually informative statement.

A little less than one enterprise out of three thinks that providers play an important role in innovation process (Table 7). The estimation is almost the same as regards to the role of clients. This emphasizes the place of usual business relations in innovation promoting. Both providers and clients appear as important sources of innovation.

With respect to the question "which other factors do you value?", the literal answers to give an interesting approach of how enterprises perceive the innovation process. The answers have been reasonably "post-classified" by us (Table 8). The accuracy of this post-classification can be discussed, but our finding is that enterprises value first and foremost the presence of a "strategy" and the availability of "capacities": knowledge, know-how, to drive the innovation process (16 answers).

This can be judged trivial, but it nevertheless underlines that in day to day business, these questions are of immediate interest for enterprises and might be taken into account in designing the questionnaires in innovation surveys.

The other driving factors (our classification) according to respondents are:

- competitors and technology (14 quotations both)
- rules and reglementation (11 quot.)
- enterprise growth and rationalization (9 quot.)

Market and technology triggers are of equal importance according to respondents. This reinforces an innovation conception taking in equal balance the two dimensions of innovation and therefore but not underestimating the preliminary step of capitalization including strategy, and capacities building in order to engage in the innovation process. These points appear to be more of crucial concern for a great number of enterprises.

When stating about major - or most important - innovations in enterprise's activity respondents cite examples which are clearly technology based but with a high frequency of combined types of innovation

In manufacturing, the greatest part of given examples heavily rely on technology side (Table 9). But there are a few examples of judged major innovations which are not linked with industrial technologies or which include a marketing specific approach: "e-business development", "Production of medicinal products that are more effective in a more clearly defined client population".

In services industries, the main reference is oriented towards so-called "new" technologies. But these examples rely also very often on defining new business patterns or new product concepts. For both sides ("new" technologies, and "new" patterns) the traditional technology based definitions do not apply easily.

When taking into account the whole context depicted in the given answers, very often, in manufacturing activities as well, these major innovations look like entailing components of marketing and even organization innovations. This is underlined by respondents' answers when qualifying the type of innovation for these innovations (table 10).

Considering both manufacturing and services industries, only one out of four among major innovations are qualified by respondents as simple product, process or both product-process innovations. In all remaining occurrences at least one other type of innovation (marketing, organization) is cited. The two most frequent combinations are equally: product and marketing innovations, and product and process innovation. Specific innovations (described as - only or mainly - one type of innovation) account only for one case out of six. Organization type of innovation appear very often as one type included among others (44% of given examples). Less frequently but significantly, this type of innovation appear as specific innovation (4 examples).

These results are rather consistent with results of the "vignettes" examples. The concept of organization innovation type is acceptable, this assertion to be linked with the evidence that can be cases of specific innovations, even with respect with major innovations. Another noticeable fact support this view of "suitability": there were no reports of misunderstanding remarks neither from respondents through collected enterprises' last comments, nor through interviewer reports.

Concerning the marketing type of innovations the evidence is clear. The concept is validated through vignettes examples and trough these given examples of major innovations. Nevertheless marketing specific innovations are less frequent than results from the vignettes could suggest.

Relative innovations are less technology based and a little less often combined innovations

As regarding relative innovations, that is the most important innovation relative to the enterprises even if already done by its competitors, the examples given are far less based on technology (Table 111). Once again product, process or product and process account approximately for one innovation out of four. But specific innovations (defined as only one qualifying type of innovation) are relatively more frequent (35%) as compared to the evidence regarding major innovations (26%). Among these specific innovations, organizational of innovations account for one tenth of total.

These results support the preliminary findings based on "vignettes". Nevertheless, on one point the answers seem to differ from results given by "vignettes" assessments. A significant number of examples given include standards and ISO reference, and this contradicts with previous answers. An explanation to this difference could be that respondents, given a case such as "introduction of an ISO..." focus on the standard adoption point without envisaging the background or what is often related with the standard adoption. This suggests that when designing questionnaires the reference to standards should appear as a possible occasion of innovation and not a case of innovation.

Examples of "not an innovation but only change" according to respondents

Respondents were later asked: "Could you give a few examples of changes, eventually important, experimented in your firm and that you don't consider as innovative?" (see Table 13).

The given responses are here classified in four tiers:

- changes which consist in investment or equipment renewal (some examples given): this is consistent with actual manual definitions;
- unsuccessful innovations (one example given): again in accordance with statistician definitions;

- "business as usual": this of course in agreement with statisticians definitions (referring to criterium of "significance"); lot of examples are given here: "new product range with special design" "the development of a cell for the automatic milling of very small and precise parts"; "total digitalization of an entire manual process of one of our customers"; enterprises respondents take into account a relative importance scale for each project case (without explicit explanation).
- a lot of examples of organizational changes: including reorganizing enterprise structure, standards and ISO adoptions, launching of subsidiaries, skills and human resources management; a lot of given examples don't differ in literal expression from some cited as major or most important relative innovations; this underlines the difficulty to make more explicit the border lines between organization innovation "only organizational changes".

"In your industry, what describes (qualifies) an innovation the best?"

Respondents were asked to choose between a limited set of items in order to state the "best" criterion (Table 14). Among respondents "the impact on the firm's global performance" takes the lead followed by "the advance towards your competitors" and "the importance of technological change". Once again this suggests the need of enlarging the scope not only focusing on the technological approach of "significance", but better taking into account a larger set of criteria.

Are there other dimensions that have not been treated in that questionnaire and that need to be taken into account to better describe innovation in your firm or in your industry?

The answers can be classified as follows (Table 15):

- Enterprise know-how (1), knowledge (3), information (5)
- Rules and law (2), public policies (2), standardization (1), environment (1), ethics-social concern (2)
- Collaborations (1), competitiveness (2)

Again respondents underline criteria which are consistent with the importance of capacity building in order to innovate.

The other dimensions quoted here are generally covered in innovation questionnaires. One notices nevertheless the emphasis put on environmental and ethic or public concerns.

Concluding remarks

There is a real consistency between the proposed statisticians approach and enterprises observations. The answers given in this pilot survey seem to validate the concepts of marketing and organizational types of innovation, even though there is in the later case, a need of better specifying what type of innovation should be focused on.

Appendix

Table 1. Number of respondents by activity and country

	Manufacturing	Services industries	Total
Australia	/	8	8
Belgium	6	4	10
France	19	25	44
Spain	6	5	11
Total	31	42	73

Table 2. Vignettes pilot survey – Results to the "vignettes" – Service Industries

All results: yes / no / not answered, as percentage of total surveyed enterprises
Ordered by descending rate of answer "yes" to the question "Is the enterprise innovative?"

	Is the enterprise innovative? Œ	*Would you say the innovation is related to the product?*	*Would you say the innovation is related to the production process?*	*Would you say the innovation is related to the marketing of the product?*	*Is it an organizational change?*	*Has your entreprise already had such an activity or a close one?*	*If no to Œ, would you say it is contributing to the innovation activity of the firm?*
A commercial chain of stores designs a new packaging and a new concept in order to sell its product in a new area (airports, for example).	**83**/10/7	43/26/31	17/45/38	69/5/26	24/48/28	0/14/86	(14/17/69)
A commercial chain of stores reorganizes the supply chain of its stores, putting small quantities of new models in its boutiques every 6 weeks. This new organization allows the chain to increase its current market share of 20%.	**67**/21/12	/	38/17/45	45/7/48	60/14/26	/	(31/17/52)
A firm establishes a new project management system.	**59**/31/10	/	50/10/40	/	64/17/19	71/19/10	(21/24/55)
A business services firm uses a new software that allows it to change its working method (vertical treatment of work flow instead of horizontal treatment).	**57**/29/14	5/31/64	50/0/50	/	60/14/26	55/31/14	(29/14/57)
A mail-order company sets up a partnership with a transportation company in order to drastically reduce the delivery delay. It expects an increase of its market share of 10%.	**55**/38/7	17/38/45	36/14/50	/	69/14/17	31/55/14	19/19/62
A bank establishes a branch in an area predominantly populated by an ethnic community. In order to enlarge its client base, it organizes training courses in the language used by this community.	**53**/33/14	/	/	38/17/45	26/50/24	31/55/14	14/14/71
A firm enters a foreign market by creating a subsidiary in that country to commercialize products adapted to the local market.	**50**/45/5	31/21/48	/	40/12/48	45/36/19	40/55/5	21/24/55
An business services firm improves its responsiveness towards a mail-order client. This impacts on its sales concept and work flow management.	**50**/38/12	19/31/50	36/17/47	/	60/19/21	33/48/19	21/19/60
An insurance company puts on the market a product intended to enlarge its market share. For this purpose, it conducted a sociological study on its potential customers and mathematical simulations to evaluate the premium's price.	48/48/4	38/19/43	/	/	/	31/60/9	/
A firm introduces an ISO 9000 certification concerning its products/services in order to reach the standard required by its potential client and enter the market.	41/**52**/7	14/19/67	33/7/60	/	60/21/19	52/36/12	26/31/43
A business services firm establishes a new procedure for conducting its studies.	31/**60**/9	/	26/17/57	/	62/29/9	74/19/7	40/24/36
A tourism hotel (without restaurant) creates a food service for its clients to improve the service to its clientele.	31/**55**/14	26/2/72	5/19/76	14/12/74	62/14/24	26/57/17	26/26/48
A service company sets up functional departments (studies, marketing…). This allows a gain of productivity.	24/**74**/2	/	/	/	90/5/5	74/24/3	38/36/26
A company relocates its consulting activity to a country where it realises half of its turnover. This allows a gain of productivity.	17/**74**/9	/	/	/	14/83/3	21/74/5	81/10/9

Table 3. Vignettes pilot survey – Results to the "vignettes" – Manufacturing

All results: yes / no / not answered, as percentage of total surveyed enterprises
Ordered by descending rate of answer "yes" to the question "Is the enterprise innovative?"

	Is the enterprise innovative? Œ	*Would you say the innovation is related to the product?*	*Would you say the innovation is related to the production process?*	*Would you say the innovation is related to the marketing of the product?*	*Is it an organizational change?*	*Has your entreprise already had such an activity or a close one?*	*If no to Œ, would you say it is contributing to the innovation activity of the firm?*
A manufacturer who sells only to wholesalers develops an internet site to reach individual customers, allowing them to order on the web and to have it delivered within 8 days.	**61**/26/13	7/32/61	10/22/68	39/13/48	/	42/42/16	/
A manufacturer establishes a team of engineers who work directly at its clients location in order to ensure the adaptation of the products to the clients needs.	**58**/26/16	/	/	/	55/23/22	39/39/22	(48/13/39)
A manufacturer, after a marketing study, decides to better target its clientele. It develops a packaging policy that presents different packages for each market segment.	**52**/19/29	10/39/51	52/3/45	/	/	32/36/32	/
A manufacturer wants to launch a new distribution trademark based on a new marketing concept. It will disseminate its products under this trademark.	**52**/32/16	10/39/51	/	52/6/42	26/13/61	39/35/26	13/16/71
A firm engages a designer to regularly renew its models and take part in the conception of new models.	**45**/39/16	/	/	/	36/29/35	52/26/22	(48/10/42)
A firm enters a foreign market by creating a subsidiary in that country to **manufacture** products adapted to the local market.	42/42/16	32/10/58	/	26/10/64	61/16/23	42/32/26	(36/16/48)
A firm establishes a new project management system.	**39**/32/29	/	16/23/61	/	55/13/32	61/10/29	/
A manufacturer establishes an electronic data exchange between its production location and its supplying unit in order to adjust the stocks to the production needs.	39/**48**/13	/	/	/	74/3/23	61/16/23	32/23/45
A company associates its new products with a free insurance contract.	39/**51**/10	19/16/65	/	26/13/61	/	32/55/13	/
A manufacturing firm sets up a partnership with a transportation company in order to drastically reduce the delivery delays. It expects an increase of its market share by 10%.	36/**45**/19	7/19/74	39/10/51		29/48/21	42/26/32	(61/10/29)
A firm sets up an integrated economic intelligence or monitoring system (industrial, financial, strategic, or marketing).	32/**45**/23	/	19/19/62	/	48/23/29	55/16/29	32/13/55
A firm introduces an ISO 9000 certification concerning its products in order to reach the standard required by its potential client and enter the market.	32/**55**/13	19/16/65	26/10/64	/	49/19/32	68/10/22	7/35/58
A firm enters a foreign market by creating a subsidiary in that country to **commercialize** products adapted to the local market.	26/**52**/22	13/10/77	/	23/3/74	65/6/29	52/22/26	26/16/58
A firm introduces a procedure to monitor continually the risks in the different production units (equipment destruction, fire, risks for workers).	10/**80**/10	/	/	/	42/35/23	55/26/19	13/64/23

Table 4. Q1 Would you say that innovation in your industry is?

	Frequent	Rare	na	Total
Service Industries	28	13	1	42
Manufacturing	21	7	3	31
Total	49	20	4	73

Na: not answered

Table 5. Q2 Could you place yourself in relation to your competitors in terms of innovation (open question)?

	First or above average	Average	Below average	na	Total
Service Industries	15	17	4	6	42
Manufacturing	17	4	2	8	31
Total	32	21	6	14	73

Na: not answered - all answers have been post-coded using the literal answer

Table 6. Q1 X Q2 Industry innovativeness and enterprises's innovativeness

	"place yourself in relation to your competitors in terms of innovation"				
Frequency of innovation in enterprise's industry	First or above average	Average	Below average	na	Total
Frequent (n=48)	56	4	27	13	100
Rare (n=20)	25	20	10	15	100
Total (n=68)	47	9	31	13	100

Na: not answered

Table 7. Q3 Would you say the innovation in your industry is determined by your suppliers or clients...

	Yes, very important	Yes, of average importance	Yes, not much important	No effect	no
More or less determined by your suppliers	30	20	6	11	6
More or less determined by your clients	27	13	13	13	7
Do you value other important factors to explain innovation?	30	12	3	4	24

Table 8. Q3 bis If you value other important factors to explain innovation: which one (open question)?

Facteur	Quotations
Enterprise know-how and strategy (16)	"Our ideas generated within the company" - "high personnel wages forces us to create high added value for our customers. This we can only realize by continuous innovations" "should follow a clear strategy, should make use of the strengths that are present within the company" "creativity" "Starting from our own key-competences" "internal capabilities" "ideas – novelty pursuit" "competence – multi-channel strategy" "volonté d'un autre positionnement" "stratégie de l'entreprise" "should follow a clear strategy, should make use of the strengths that are present within the company" "- compétences internes" "Idées - recherche de nouveauté" "compétences des individus"
Competitors (14)	"Competitors products" "funding outcomes" "competition" "firm image" "being the first" "market trend" "improve the position in the market" "Concurrence" "prendre le leadership du secteur" "The market imposes constraints. Therefore, the innovation processes are tools to improve the position in the market arena versus the rest of competitors" "The search of new markets for already developed applications and solutions"." Par l'attitude de la concurrence" "la concurrence" "Les pressions concurrentielles et réglementaires"
R&D, Technology (14)	R&D (2) "technology in generally spoken" "shift to new technologies" "new technologies" "technology intelligence" "shift to new technologies in general (incl. in fields that are not directly related to our own industry). Innovation is not a goal in itself, but strongly related to economic, financial, cultural, pol" "Nouvelles technologies". "suivi technologique" "Evolution technologique" "Evolution technologique très rapide (comme les ordinateurs qui sont obsolètes au bout de 5ans) Adéquation entre demande des clients et le niveau de maturité de la technologie" "the gurus, ICT...(sic)" "Mutations technologiques" "L'évolution technologique".
Standards (11)	"Drugs regulation" "market deregulation" "public health requests" "changes in regulations and new regulations and laws" "- contraintes réglementaires" "Evolution de la réglementation, des normes techniques et des règles de sécurité" "la réglementation" "Evolution réglementaire technologique" "Normes et réglementation sécurité et environnement" "Contraintes de normes environnementales, évolution des normes de qualité, d\'hygiène." "Les pressions concurrentielles et réglementaires"
Enterprise growth, rationalization (9)	"accompanying firm's expansion" "rationalizing costs" "organizational changes" "improve the internal productivity and efficiency of processes" "synergy with different industries" "Adaptation to the expansion of the company. Rationalization of costs" "improve the internal productivity and efficiency of processes" "possibility to dedicate special resources in times of market and budget pressure" "gains de productivité" "La recherche de coûts de production plus faibles est le premier aiguillon.Productivité."

Table 9. Q4 Could you give an example of a major innovation realized in your industry during the past 5 years (open question)?

Major innovation	Answer
Manufacturing	"Production of medicinal products that are more effective in a more clearly defined client population" "new technologies in the blast furnaces developments" "e-business development" "Introduction of lighting ballasts that are individually addressable and digitally dissiminable – integration of light controls in luminaries" "Nanotechnology" "Telemetry to automatically follow product inventory in a customers product silo" "deregulation of the electric power market" "High speed cutting to cut very hard materials" "sticks (to be put on tongue) –(medical)" "patented Bio paper" "stratified floorboards" "Flight Data Processing system (Air Traffic Management) based in a new hardware". "patch medicaments" "viagra" "development of high speed/capability of onboard payload processors for telecommunication satellites" "Réorganisation complète du marché de l'électricité." "Système Xstream de commande des gilets de stabilization" "Carte à puces" "médicament par patch – viagra" "robots à application médicale unique en terme technologie (brevet) et innovant en marketing (marché émergeant télémédecine)" "Nouvelles technologies dans le développement des hauts fourneaux" "design of new bottling line and a suspended rail transport system" "Flight Data Processing system (Air Traffic Management) based in a new hardware (2K x 2K display) developed by SONY." "Développement d'un produit dit écologique permettant aux opérateurs de manipuler les conteneurs sans toucher aux produits dangereux qu'ils contiennent" "Transport multitempérature sur lequel l'entreprise est leader, compartimentage des camions pour transport à la fois des surgelés et des produits frais." "Intégration dans les textes d'images scanner" "Produit d'une technologie différente permettant 1 seul passage de colle au lieu de 2 passages (d'où moins cher)"
Service industries	"Re-link program - community network initiative" "Voice over IP (IP telephony) Wireless hotspots, WIFI. Broadband to the home" "Beverages: launch of alcoholized RTDs (ready-to-drinks), changing also the competitive positioning of alcoholic beverages vs several other beverages" "Quality assurance, accreditation policy direction" "The development and introduction of the RFID technology, as support of information in the logistic, shopping and security fields." "Development of new Broadband Telecommunication services, platforms and systems for its management" "Adopting web based specific property systems" "new satellite with 3D capacities for geographic mapping" "Beverages: launch of alcoolized RTDs (ready-to-drinks), changing also the competitive positioning of alcoholic beverages vs several other beverages" "The energy tyre (less consumption of fuel)" "Targetting different market sectors" "Le développement du commerce électronique" "New Services lines based in market trends and regulatory matters" "Complementing the task of our employees in the branch with ATMs and Internet services." "Adopting web based specific property systems" "SPT5: nouveau satellite qui a la capacité de faire des prises de vue en relief. Mise en place d'un catalogue en ligne pour les clients" "Siège automobile: insertion d'un airbag dans le fauteuil" "Numérisation complète de notre société: micro-informatique..." "Réservation par internet" "la télé-expertise en dommage automobile" "Fabrication d'un automat qui permet de malaxer les déchets, sucessivement sur plusieurs bennes sans intervention des employés" "certification ISO, Automatisation de la surveillance, Sécurité informatique et réseau" "Banque par internet: majeure Banque sans guichet: important" "breakthrough of system-on-chip concept" "Evolution technologique Guichet unique" "Le couplage Téléphonie/Informatique et applicatifs dérivés" "Progrès informatiques: possibilité de connaître exactement la composition des plateaux." "L'utilisation de nouveaux réactifs pour le traitement des fumées." "Capacité à proposer un engagement global au client" "ISO 9001 ISO9014 (environnement);" "outsourcing as a key new area of business and the introduction of new products such knowledge management tools, balance score cards..." "innovations liées aux progrès de la biologie moléculaire" "diffusion des produits d'assurance par les banques" "Automatisation des procédés, mise en place des "bus" de terrain: capteurs qui prennent plus de mesures afin d'accélérer la productivité entre autres." "Bouleversement complet de l'utilisation de l'informatique dans le domaine de l'ingénierie." "Création d'un secteur marchand du déchet - Méthanisation / Transport fluvial (et ou multimodal)/Mise en place des ambassadeurs du tri" "Innovation majeure: le grand développement du relationnel avec les clients par la généralisation des automates pour opérations courantes et la banque à distance - Innovation importante: l'exploitation des banques de données pour la gestion évènementielle des clients."

Table 10. Q4bis Would you consider this example as: a product innovation, a process innovation, a marketing innovation, an organizational innovation

Respondents could mention more than one. Results are given as frequencies of combined types of innovation (absolute figures).

Type of combined innovations…	Service industries	Manufacturing	Total*
Product & Process	3	4	7
Product & Marketing	3	4	7
Process only	5	1	6
Product & Process & Organization	4	2	6
Product & Process & Marketing & Organization	4	2	6
Product & Process & Marketing	3	2	5
Process & Marketing & Organization	3	3	5
Organization only	3	1	4
Process & Organization	3	1	4
Product only	1	2	3
Product & Organization	1	2	3
Marketing only	1	1	2
Marketing & Organization	1	1	2
Product & Marketing & Organization	1	0	1
Total	36	25	61*

*12 non-response

Table 11. Q5 Could you give an example of a major innovation developed (or at least the most important one) in your firm during the past 5 years (open question)?

Innovation	Quotations
Manufacturing	"new product range with special design" "The development of a cell for the automatic milling of very small and precise parts. Total digitalization of an entire manual process of one of our customers" "New plastic compounds for automative applications" "concept of luminaires with "size on demand" – dimensions can be specified by the customer, development of flexible production machines and tools" "ISO14000 (certification for environment)" "0,13 micron technology - ISO9000 et 14001" "orphan diseases – global medical package" "matrix organization between secondary sites and subsidiaries" "development of a new wine for the UK market" "Electronic ballot box fully developed by our firm." "Mise en place d'une gestion prévisionnelle de l'emploi et des compétences." "Sortie de nouvelle collection avec dessin particulier." "Démarche ISO14000 (certification environnementale)" "Système de largage de poches à lest sur gilets de stabilisation." "mise en place d'organisation matricielle sur les sites secondaires éloignés etla filiale - logiciels de gestion type ERP intégrés (outils)" "On-line surface inspection system of hot slabs in steelmaking" "developement of equipement for high digital videao transmissions over optical fiber links" "Groupes thermiques pour remorques électriques VECTOR" "Site de ventes en ligne avec paiement sécurisé" "Réorganisation de la chaîne logistique avec la centralisation des flux logistiques" "L'entreprise a déposé un brevet concernant un système d'Abs installé sur les VTT"
Service industries	"Implementation of Leisure Program (an innovative Mental Health Program) for region, started 6 years ago." "BioInsight: developing biotechnology clusters" "Segmentation of our market and our target audience, combined with a fundamental shift of our sales, marketing policy." "Conversion of management information from paper to computerized formats" "Developing an strategic plan, with reorganization and redesign of services portfolio, Obtained ISO9000" "The development of an electronic device that automatically validates the authenticity of euro banknotes" "developing information systems for forecasting models" "Change our branch style and the way we attend our customers" "Utilisation de la PAO en 3D" "expérimentation: équipement des commerciaux nomades d'un PC portable, connecté sans fil (GPRS)" "création d\'une remorque porte-contenaire permettant de transporter 16 contenaires" "novel programmable chip architecture" "Crédit immobilier pour fidéliser les adherents" "La facture unique, le guichet unique (1 interlocuteur pour 4 produits, filaire, cellulaire, ADSL, numéros spéciaux)" "Mise en place d'un environnement de management à 2 niveaux et mise en place d'une organisation par pôles de compétences dédiées." "Système d'encaissement, les convives ont des cartes de paiement qu'ils peuvent recharger." "mise au point de projets optimisant les consommations d'énergie" "knowledge management tool" "innovation liée à la synthèse de tensio actifs d'origine végétale. Innovation majeure par rapport à notre activité" "diffusion des produits d\'assurance IARD" "nouveaux outils de conception 3D permettant une meilleure approche et une meilleure fiabilité" "Innovation majeure: la conception d un vehicule prototype permettant d integrer les tests de l ensemble de l electronique automobile."

Table 12. Q5bis Would you consider this example as: a product innovation, a process innovation, a marketing innovation, an organizational innovation

Respondents could mention more than one. Results are given as frequencies of combined types of innovation (absolute figures).

Type of combined innovation …	Service industries	Manufacturing	Total*
Product only	3	5	8
Product & Process & Marketing & Organization	6	1	7
Process & Organization	3	3	6
Product & Process & Organization	3	2	5
Organization only	1	3	4
Product & Marketing	1	2	3
Marketing only	1	1	2
Product & Process & Marketing	1	1	2
Procédé & Marketing & Organisation	1	1	2
Product & Process	1	0	1
Process & Marketing	1	0	1
Marketing & Organization	1	0	1
Product & Marketing & Organization	1	0	1
Total	24	19	40*

Table 13. Q6 – Could you give a few examples of changes, eventually important, experimented in your firm and that you don't consider as innovative?

Changes which "are not innovations"	Examples
Industry	"provisional management of skills and workforce" "machines equipment park robotization" "ISO9000 and ISO 14000 – investment in environment respectful equipments" "Admin timesheets. Contact database" "-Organizational change towards concurrent engineering: everybody becomes more polyvalent and responsible for same projects technically instead of "over the wall" - changing our ERP-software - installing intranet in our firm" "Product and process development portfolio management. Local implementation of global strategy by local hires" "Some "human resources" initiatives (competence management). Centralize technical support for production sites" "Quality management system. Reorganization of 2 departments" "renovation of machinery in existing lines. Concentration policy of warehouses. Manual processes automation" "Création du système de communication interne." "Organisation change. Technological change that did not result in commercially acceptable products investements in biotechnology that were not succesfull." "- structure du groupe - privatisation - management des risques - mise en place d'un nouveau système de gestion (SAP) - réorganisation en centre de profits (unités de production séparées)" "Création de filiales de distribution et de fabrication. Passage aux normes ISO. Nouvelles méthodes de management par mise en place de nouveaux logiciels. Création de site internet pour diffuser des produits" "Projet TQM (Total Quality Management)" "- groupes de projet (stratégie industrielle), entraînant changement de méthodes, gains de productivité, amélioration du climat social, promotions internes" "passage ISO9001 V2000 / certification JAR145" "important revampings of facilities for improving processes and products ending of environmental management systems setting up and achievement of certificates ISO14000 for several sites of the firm" "renovation of machinery in existing lines. Concentration policy of warehouses. Manual processes automatization" "- Movement to a new Corporate office. - Acquisition of a couple of firms just to increase our market share. - Changes of shareholders." "developement of internal software tools for the comprehensive management of the logistic and productive processes in the company" "Les opérateurs disposent d'un poste de travail indépendant où ils surveillent le fonctionnement d'un automate et en même temps ils peuvent effectuer d'autres tâches. Ils n'ont pas un seul travail à effectuer mais un double travail." "Qualification ISO 9000: Changements organisationnels pas innovation" "Politique de qualité et de sécurité qui sont un changement d'organisation nécessitant la responsabilisation de tous les acteurs" "l'utilisation de l'usinage à grande vitesse" "Evolution permanente du monde informatique et de l'acquisition de donnees numeriques, cela entraine une adaptation permanente de nos outils."
Service industries	"introducing ISO 9001. Automate some processes for services. to employees." "Restructuring our sales, marketing teams. new operational methodologies. integration of new tools" "Quality assurance, revenue sourcing" "- group structure - privatization – risk management - setting-up of a new management system – business units implementation" "Creation of subsidiaries (manufacturing and distribution) – adoption of ISO standards – e-business website creation" "Organizational changes that don't affect any essential workflow in the company" "New software, marketing techniques, staff training" "Restructuring our sales, marketing teams. new operational methodologies. integration of new tools"."Admin timesheets. Dial in technical problems. Contact database." "introducing ISO 9001. Automate some processes for services. to employees." "Changes in day to day procedures for claims – policies" "Centralisation of staff to areas where they concentrate their work" "Change the branch IT platform to Windows OS. ELearning iniciatives" "1.- The introduction of a new software package to support certain business aspect that remain unchangeable. 2.- Organizational changes that don't affect any essential workflow in the company." "Changes in the funding of the projects. New offices in new cities and countries. New sales process. Organizational changes." "Computer system development information management" "en 1990, 90% de la production était livrée en 4 semaines ; fin 1994, même livraison en 5 jours ; actuellement en 5 heures" "Changement de logiciel / mise à jour (beta-test)" "Changement d'organisation interne Création d'établissement infra régional" "Adapter les plannings aux réductions d'horaire" "Mise en place d'un plan de reprise d'activité. Rénovation du parc applicatif (urbanisation)" "réorganisation exceptionnelle (embauche de personnels qualifiés ou très qualifiés), ingénieur chef de projet" "changement de système d'information pour aller sur une plateforme progicielle (1995-2005)" "1) Amélioration des process en soutien des nouveaux apports technologiques. 2) Système de management des équipes avec l'amélioration continue des outils RM." "réorganisation de l'entreprise avec la constitution de pôles (niveau régional)" "mise en place d'une méthodologie de gestion de projet" "Réorganisation sur l'ensemble du personnel de leur travail (ex: nouveaux procédés de nettoyage avec produits NFT S7)." "incorporation of new people

(mainly young people), a better approach within the company..." "mise en place GMAO, contrôle de gestion, changement d'organisation (comités de travaux)" "changements de matériels et logiciels informatiques" "Création de bases de données pour suivi d'affaires certification MASE (sécurité chimie). Mise en réseau informatique" "Changement de mode d organisation. Mise en place de reference sur la qualite." "Création, d'une Société d'Economie Mixte Locale Regroupement des Services Les 35 heures Le travail en éseau Mise en ligne du Site Internet" "Toutes les demandes réglementaires et les adaptations à des normes européennes comptables sont des changements auxquels les banques sont tenues de s'aligner."

Table 14. Q7 In your industry, what describes (qualifies) an innovation the best?

	Service industries	Manufacturing	Total
The impact on the firm's global performance	26	20	46
The advance towards your competitors	25	18	43
The importance of the technical change	21	12	33
The extent of the changes	10	3	13
The financial amounts involved in the project	5	5	10

Table 15. Q10 – Are there other dimensions that have not been treated in that questionnaire and that need to be taken into account to better describe innovation in your firm or in your industry?

Other important dimensions of innovation	Quotations
Enterprise know-how (1), "knowledge"(3), information (5)	"The need for cultural changes in an organization e.g. from hierarchical to networked organization. Knowledge diffusion system (spread of technology knowledge)" "intellectual innovation client felt the survey focused on goods producing industries (note of the interviewer)" "IT, web based information management" "everything related to technology intelligence" "The need for cultural changes in an organisation e.g. from hierarchical to networked organisation. Knowledge diffusion system (spread of technology knowledge)" "tout l'aspect sur la veille technologique" "Il faut de plus en plus un personnel formé et très pointu. La part de la formation devient de plus en plus importante. Un employé bien formé permet des gains de productivité." "Information et veille technologique, technique concurrentielle. Etre à l'écoute de ceux qui innovent dans d'autres secteurs d'activité"
Rules and law (2), public policies (2), standardization (1), environment (1), ethics-social concern (2)	"market changes (deregulation)" "innovation and R&D have definitions depending on public incentives, especially UE ones" "Administration contribution on the companies innovation policies promotion (of our sector): aids, incentives" "Where we focus innovation? Product, Process, Strategy? How we receive the necessary inputs to innovate? How we can be innovative reacting to social changes?" "Introduction d'une nouvelle norme pour les produits dans le but d'améliorer la qualité." "évolution du marché (déréglementation, ouverture, suppressions de monopoles)" "Mesure de préservationde l'environnement" "Le positionnement de l'entreprise par rapport à une certaine éthique. La mise en cohérence de la stratégie de l'entreprise avec des concepts reconnus tels les développements durables, l'éthique, le soutien à l'emploi."
Collaborations (1), competitiveness (2)	"external collaboration with technological based companies, technological centers and universities", "In search of excellence of productivity. Define new products for future service", "Leadership. Experience in the field. Flexibility"

ABILITY TO REPLY IN A LARGE MANUFACTURING ENTERPRISE GROUP

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Abstract

Danfoss has activities in many different business units all over the world. The main manufacturing activities are within Motion Controls (green), Heating (red) and Refrigeration and Airconditioning (blue) (see main paper).

Below each of these – there can be many different Business Units. An example is Heating: Comfort Division manufactures thermostats for heating control in family houses and in the same division there is a business unit making preheater, injection valves and pumps for oilburners.

As the business units are quite different – so are their interpretation of the questionnaire.

As an example, conversion of headcounts to full time equivalent and salaries are done very individually.

Departments which are mainly working with R & D are converting 100 %, other says that they use 20 % on administration. Other internal groups are only using 50 % full time equivalent – assessing that the rest of the time is on non R&D projects. A comparison of these internal departments can thus be hard.

Pay and related costs can be very different for two countries like Germany and Denmark, i.e. insurance cost. But as an indicator it is still OK and the total numbers still explain the real R & D cost in different areas.

Due to changes of the questionnaire during years makes it difficult to get an equal response. We would really like to do that as it shows the trends over time.

Innovation at Danfoss, alongside other companies, is important. However, all the issues above exist and due to the nature of the data request, there is no easy solution to evaluate the output.

In general we omit answering questions if the data is defective.

In spite of being a big group with more than 20.000 employees, we have chosen only a few persons to select the data; in addition, the main R & D activities are situated in Denmark; therefore, it is easy for two supporters to make the data comparable.

1. Definitions on R & D activities

At Danfoss research is planned search aimed at the discovery of new knowledge with the hope, that such knowledge will be useful in developing a new product, service, process, technique or in bringing about a significant improvement to an existing product or process. It can be laboratory research, searching for applications of new research findings, conceptual formulations and design of products or process alternatives or testing in search for or evaluation of product or process alternatives.

Development is the translation of research findings or other knowledge into a plan or design for a new product or process for a significant improvement to an existing product or process. It can be modification of the formulation or design of a product/process. Design, construction and testing of pre-production of prototypes and models, design of tools, jigs, moulds and dies involving new technology.

Excluded from R & D activities are: engineering follow-through in an early phase of commercial production, quality control, trouble-shooting, routine, ongoing efforts too refine, enrich or otherwise improve upon qualities of an existing product.

2. General comments to the reporting

We find different issues as a multinational and multi-business company. With lack of relevance of statistics requested to our business – due to mismatch between internal structure and scope of the demanded data as our business units are not limited to Denmark.

It is a challenge to ensure a consistent reporting, due to definitions provided in the schema are so wide – which require internal processes to develop internal standards. And this effort is only justified, if there is an internal reason to use the data.

The internal need to set up a process to gather data is limited to the very few people reporting. The changing nature of the schema means the process must be reviewed and adapted each year.

Additional figures and explanations are then needed.

To solve these challenges for R & D data we have collected them globally, so that the data can have some value internally to the business units as well as externally. However as it is only cost that is reported, it will always be very limited value internally - output is more relevant internally.

Therefore we have developed a very simple 'core' data request sheet, that collects data globally and by business units – in that way it fits to our internal structures for the main data requested.

R & D at Danfoss is a finite number of departments, so we do not need to contact too many people and the data requested are something they have relatively easy access to. We can cut the data afterwards for the reporting. We also leave out many of the data requests that vary year to year or are too vague to have a consistent definition.

We supplement the final data with what corporate data is available and leave the rest blank.

3. Results of the reporting

The main objectives of the reporting are to get an overview concerning the R & D in the Danish companies. For our company - however – most of the R & D activities are going on in Denmark, but only about a third of the turn over is in Denmark. And so is the number of employees.

We have no central R & D department, but all the activities are placed in the business units. They work individually, buy R & D, buy patents and apply for patents.

In Denmark about 500 people were involved in R & D and world wide about 875 full time equivalent. The total spend in Denmark was about 260 mio DKK with 324 FTE's and the average salary was 450.000 DKK.

About 80 % is carried out in the head quarter in Nordborg and more than 90 % within industrial controls.

Almost all the products are mechanical/electrical devices, where we spend about 90 % in development.

About two thirds of our R & D has focus on the products and the rest is equally spread on processes and general building up of knowledge. This is typically different sort of test of the assembly and test of the quality of the products.

We work together with different universities, knowledge institutes, suppliers and customers world wide. The activities are bought from other Danfoss companies and from suppliers outside and account about 20 % of our R & D.

The questions concerning innovation make no sense, as all ongoing companies are mainly using the most of their resources on innovation.

4. Survey form used at Danfoss

We have developed a very simple 'core' data request sheet, that collects data globally and by business units, which fit to our internal structures – for the main data requested. It includes chapter A, B, C, D, E and F.

In 2006 we collected the data for the Danfoss Group, rather than just Danfoss in Denmark. In that way the survey presents the breakdown of figures reported to give a snap shot of our spend in R & D. The purpose is to provide feedback to respondents and transparency internally.

The total R & D spend was 747 mDKK, this was equivalent to 4,6 % of group turn over.

A headcount of 1011 people were recorded as working on R & D activities providing a full time equivalent (FTE) of 875 people. Of these, 601 were engineers/developers.

In fig. 1 we have split the consumption in corporate departments and in three divisions with various business units below them.

Changing in the organisation during the year demands that we have kept some of them together, wish minimize the output of the information.

Fig. 1: R & D consumption in various divisions and business units.

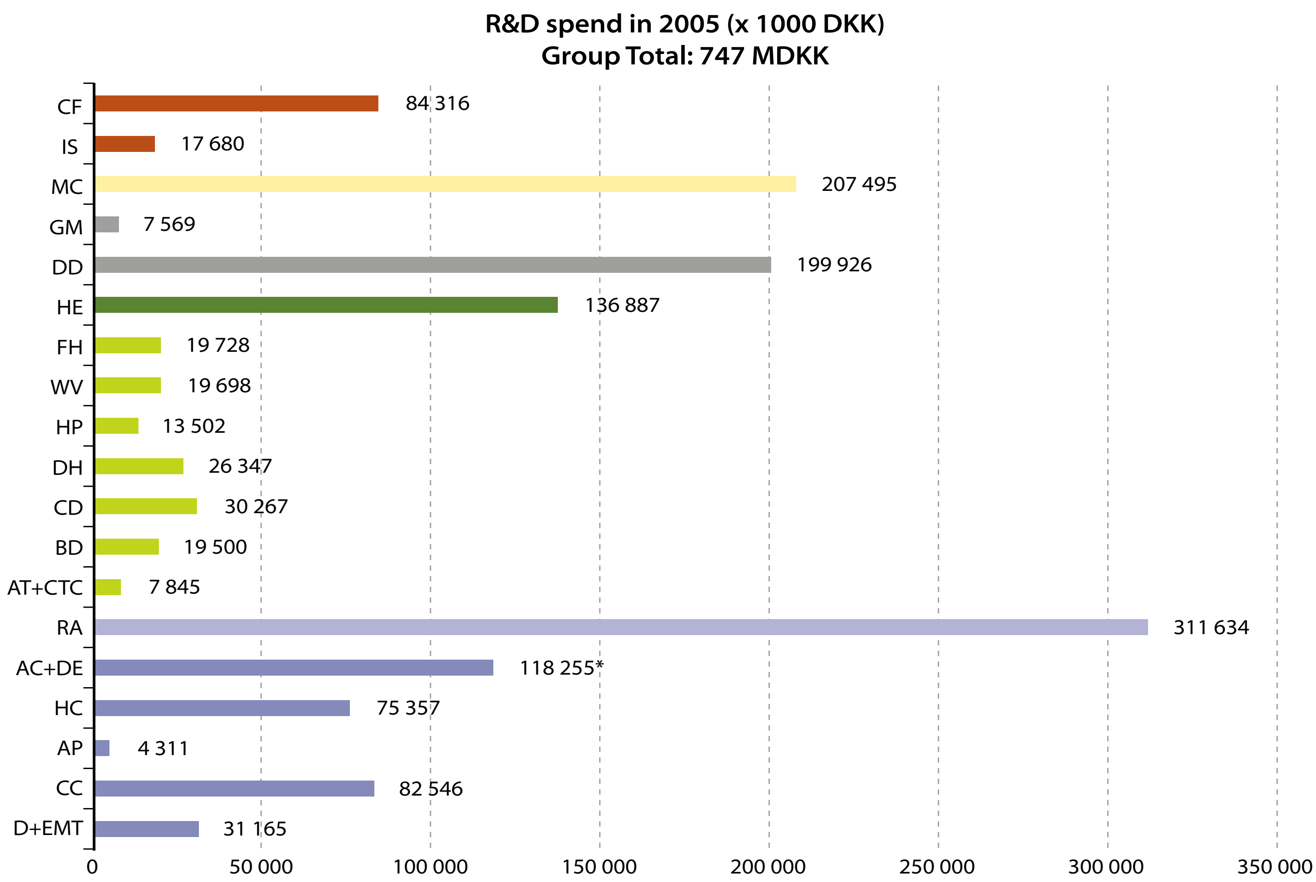
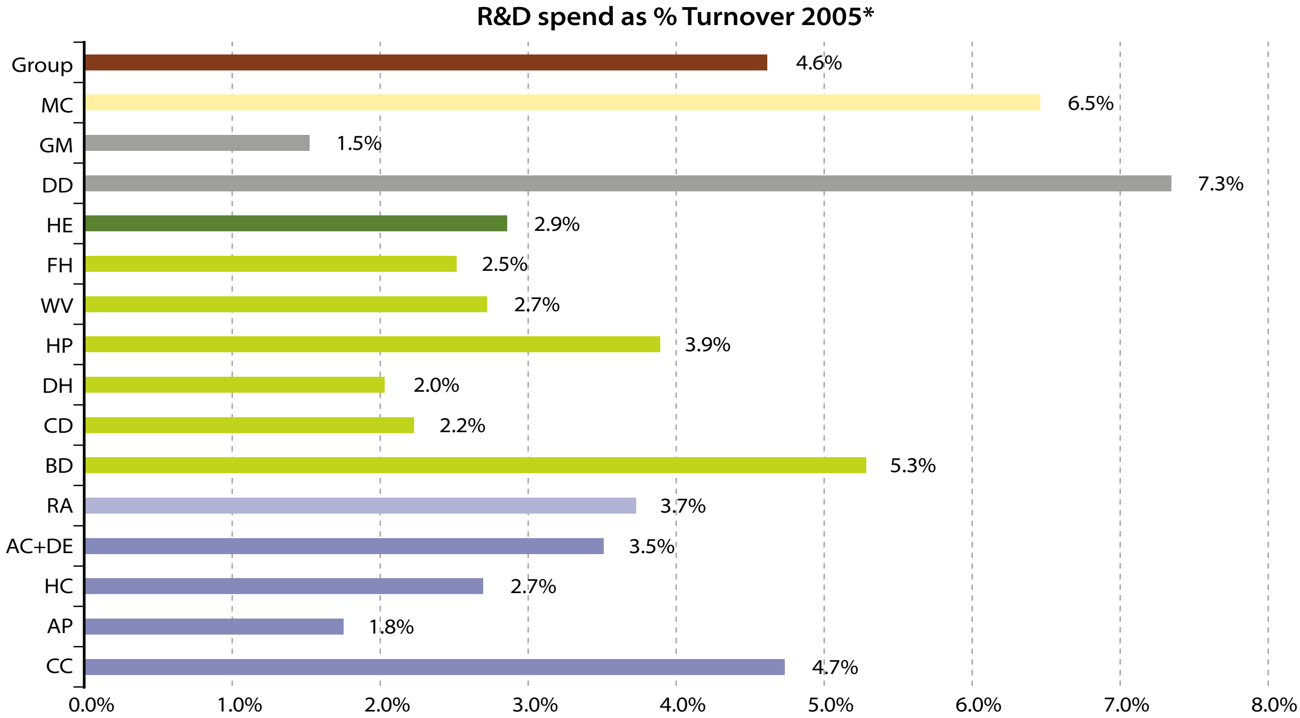


Fig. 2: R & D consumption as % of turnover.

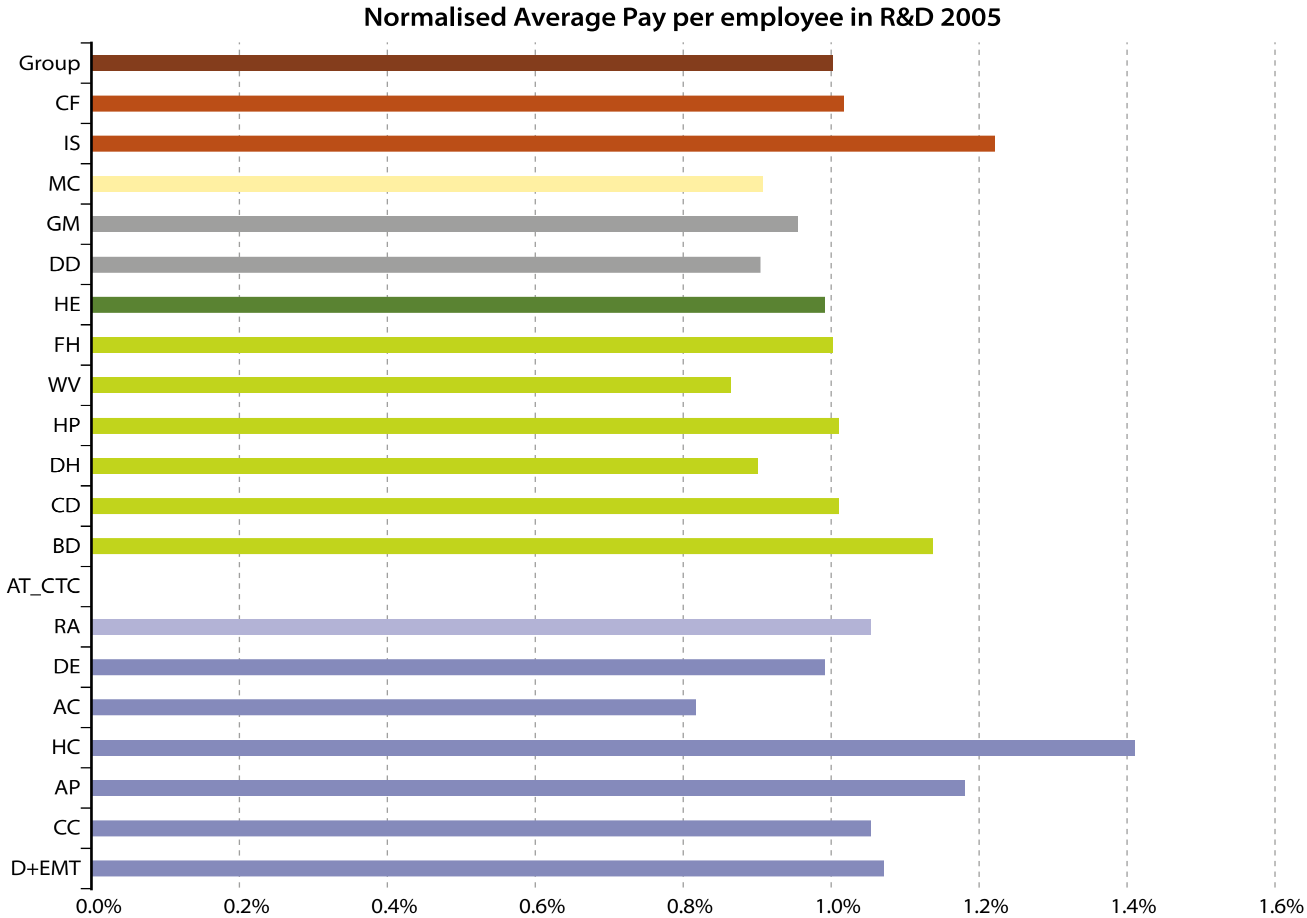


* Turnover figures used are from CF-A - considated turnover from 2005 accounts

In fig. 2 R & D spend as per cent of turn over is shown. In average it was 4,6 % for the group. Looking at the three divisions we can see, that MC has the highest level at 6,5 % and below that DD is the highest business units level with 7,3 %.

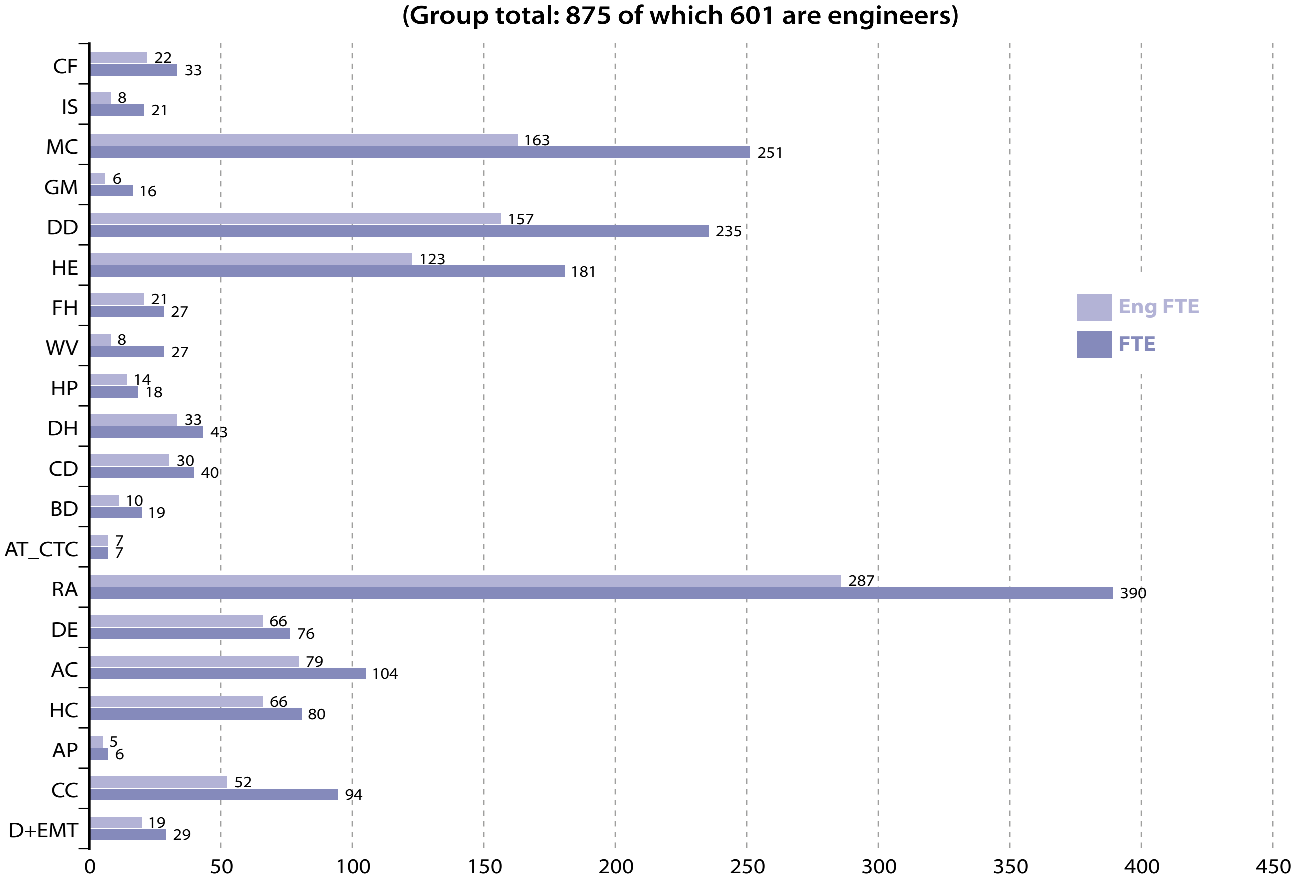
In fig. 3 we have normalised the average pay per employee. Here we can recognize the cost, but at the same time, we should keep in mind, that the business units are placed in many different countries all over the world. Anyway – we can compare the cost in a good overview.

Fig.3: Normalised average pay per employee in R & D



In fig. 4 we have the full time equivalent employees and engineers in R & D. There were 875 (FTE) of which 601 were engineers/developers persons. The difference is made up of technicians and other who support the R & D activities. Both engineers working on process and product improvements are included. The FTE figure is the business units (BU) best estimate on how much time its people spend on R & D activities. The method to do the transformation has been up to the individual BU and therefore the picture does not necessarily compare like with like across BU's.

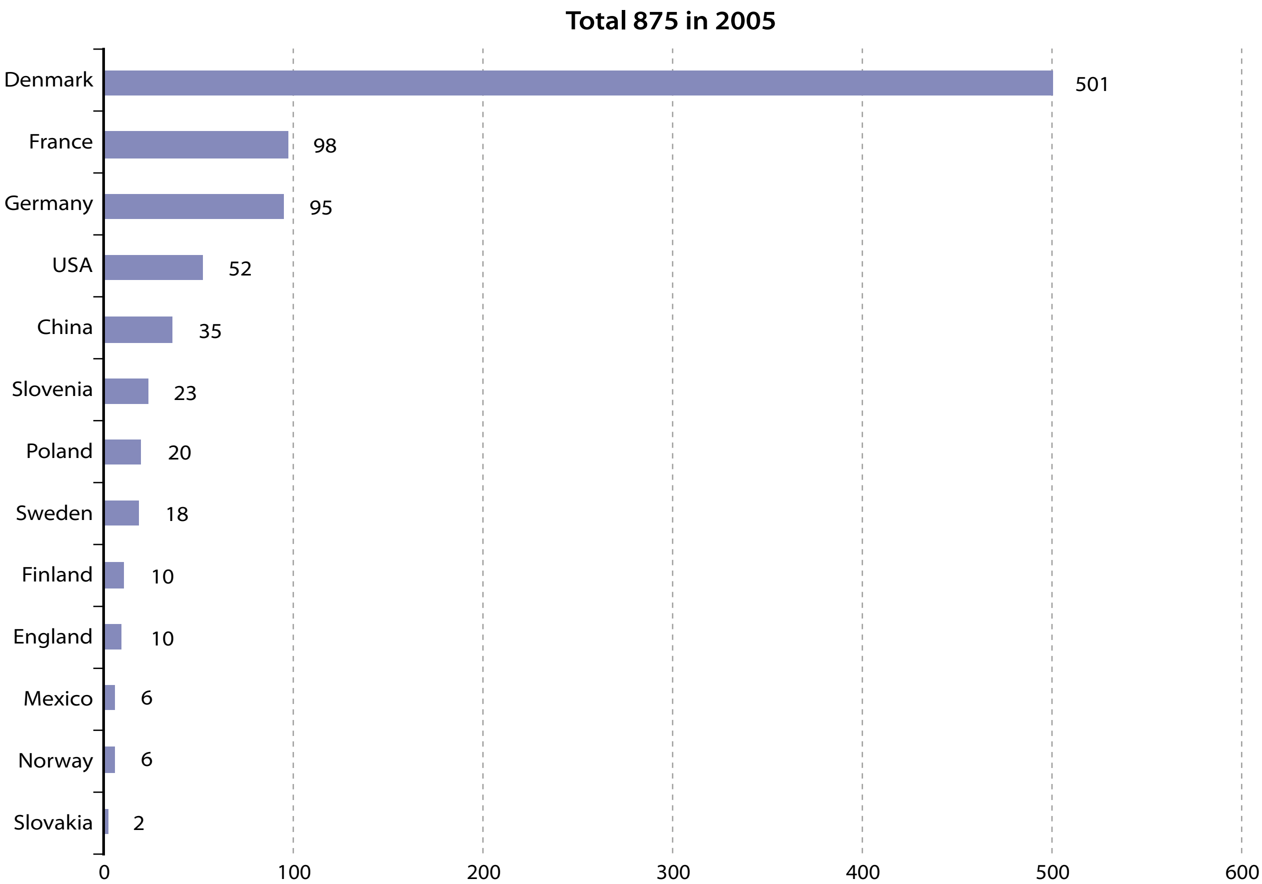
Fig. 4: Full time equivalent employees/engineers in R & D



Departments which are mainly working with R & D are conversing 100 %, other say that they use 20 % on administration. Other internal groups are only 50 % FTE due to the part time they can bill there costumers.

In fig. 5 we have the numbers of employees per country (FTE), which shows as earlier mentioned, that the main R & D is situated in Denmark followed by France, Germany, USA and China.

Fig. 5: Number of employees per country



5. Future challenge

Innovation at Danfoss – alongside other companies – we agree this is important. However, all the issues above exist and due to the nature of the data request – there is no easy solution unless Danfoss decides to invest significant time and resources. The internal value of doing this is hard to see at a country specific level.

Innovation based on country specific cuts of the data, has no meaning at all – as our value chains are global. Innovation cost is the focus of the statistics, but this is only of limited value in Danfoss. If we did want to assess innovation as innovation output this is much more relevant internally.

There are big demands to the uniformity of the reporting – the definitions are very wide and open to huge interpretation across the different departments and BU's – nearly all what we are doing is innovation.

In general Danfoss does not like submitting rough estimate, if we cannot carry out any form of verification – so we are reluctant to provide this type of data – even though we are asked to estimate, if we cannot get the data.

6. Summary

In general we get an overview for our R & D cost, but country specific cuts of the data are artificial and have little internal value – meaning the surveys do not fit to any internal reporting structures.

Data across our business units are more useful as they give the overall cost – and we can use this to see cost trends and compare our cost with other global companies.

Definitions from questionnaires are very broad and open to interpretation. We overcome part of this with internal definitions, but some, like the conversion from head count to FTE work in the area of R&D have no guidelines and as such result in internal differences between our business units. This means that we cannot use this to compare internally, although for external reporting, as long as each BU keeps to its own definitions, we can maintain consistency.

Consistency becomes difficult if questionnaires change year to year.

Uniform guidelines in questionnaires on FTE/headcount would improve data usefulness, also for between company comparisons.

R&D reporting in our businesses is possible with a small central resource as there are a limited number of R&D departments and the definitions are understandable.

Innovation reporting, if it is not integrated into existing reporting and part of our reporting demands, is seen as difficult. It involves reporting from many departments across the value chain. Each area needs to understand the definitions as they apply to them, requiring an internal process to align these. Additionally, making country specific cuts of the data become much harder. As an example – take one of our business units (District Heating). It has 3 factories in DK, one in Finland, one in Poland, one in Ukraine and one in Slovenia. R&D exists in most sites, innovation for a new product can easily involve several sites, marketing in DK and Slovenia and national sales offices across Europe.

SOME EVIDENCE OF DATA PROVIDERS' RESPONSE ABILITY AND WILLINGNESS (RESPONSE RATES; SHORT FORM QUESTIONNAIRE; VALIDITY OF RESPONSES)

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Summary

Some evidence of data providers' response willingness and their ability to answer the questionnaire on innovation performance can be found in the responses given by the enterprises in the survey – and in the responses not given. This is investigated in this paper.

First, CIS4 response rates for a number of countries are evaluated and compared, also in relation to the last innovation survey, CIS3. The overall response rate for all EU is higher than in CIS3, but there are still large differences among the countries and some countries have even experienced a declining response rate in CIS4.

In Denmark, smaller enterprises with no former reporting of innovation activities receive a short form of the questionnaire. An experiment of the effect of doing this is reported, the average effect being an extra 11 percentage points in response rate by using the short form.

In the questionnaires returned by the enterprises there are some questions that are not replied to. Compared to CIS3, the amount of these item non-responses is smaller, but still there are certain questions that some enterprises are not able or willing to answer. From the reporting of 13 countries 6 questions are pointed out, especially innovation expenditure, effects of product- and process-innovation and hampering factors. Also, the question on headquarters of enterprise groups is suffering from low response, while the answers to whether the enterprise is part of a group are rather faulty. Some revisions, replacements or even removal of these questions is recommended.

When analysing questions jointly, one finds some inconsistencies in the combination of answers. Some have been corrected in the validation process of the data producers, but others remain. Among the inconsistencies described are market (Local/regional vs. National), the share of innovation expenditure being acquisitions, novelty vs. turnover from innovated products, effects vs. product- and process-innovations. These inconsistencies are documented by a mix of European macro data and Danish micro data. Ways to minimise them are proposed.

Finally, an external validation of one of the elements of innovation expenditure, intramural R&D-expenditure, is performed with the National R&D-surveys for 2004. In a number of countries, the two estimates from the CIS- and R&D-survey differ significantly. This was also the case in Denmark in 2000, so the Danish CIS- and R&D-surveys have been integrated, the latter in a shortened form. The effect of this has been very good, also by lessening the response burden for the enterprises.

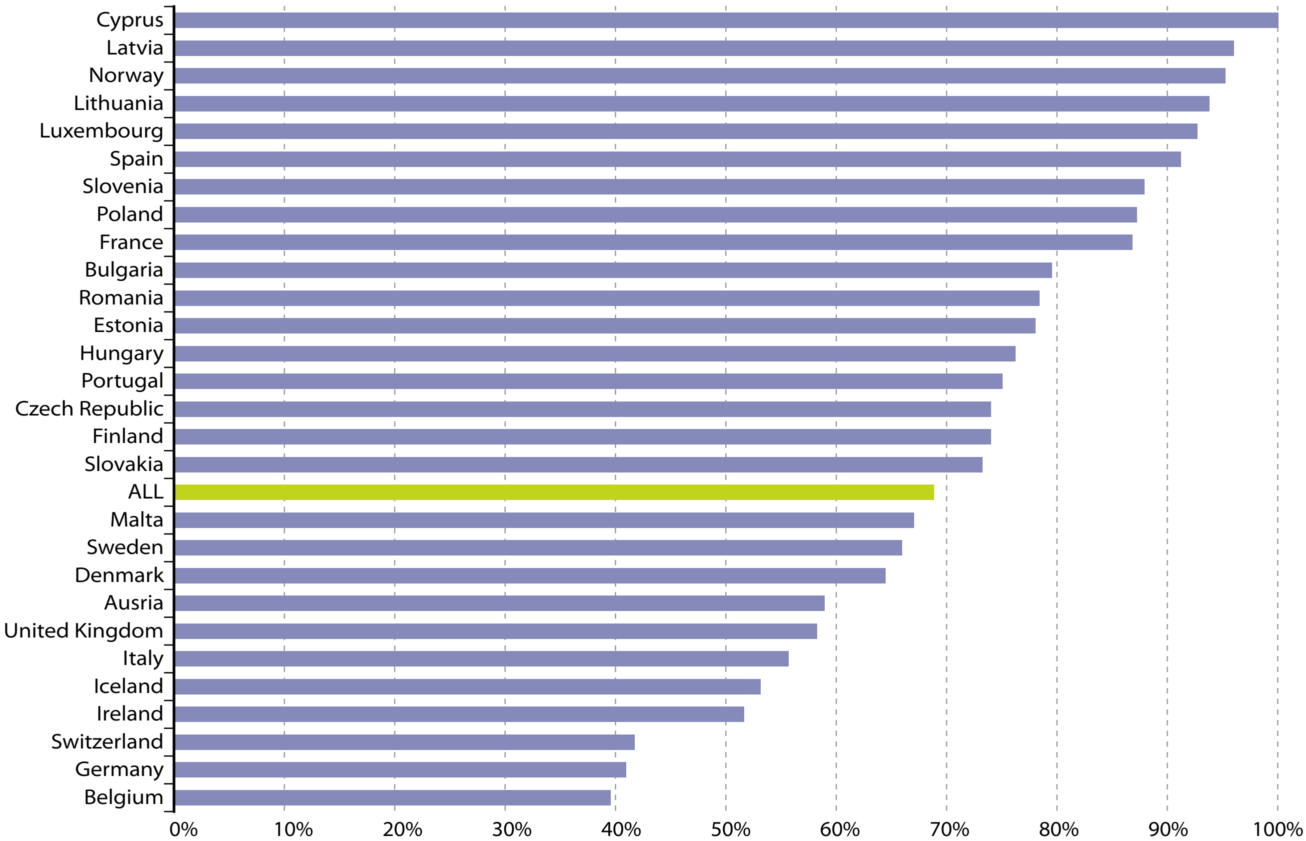
1. Introduction

Some evidence of data providers' response willingness and their ability to answer the questionnaire on innovation performance can be found in the responses given by the enterprises in the survey – and in the responses not given. This is investigated in this paper.

2. Unit Response Rates

The unit response rate is the main measure of the respondents' willingness and ability to reply to the questionnaire. First, CIS4 response rates for a number of countries are evaluated and compared. In Figure 2.1 response rates for 28 European countries are presented. The range of response rates is very broad, from 40%[1] to 100%.

Figure 2.1: Response Rates, CIS4



One major reason for these differences is whether the survey is mandatory – and how the reaction to mandatory surveys is in different countries. Also, the mix of industry and size has an influence, as the response rate differs, typically with higher response rates in larger enterprises and enterprises in High-Tech manufacturing and Knowledge Intensive Services. One might think that the understanding of the innovation concept would influence the response rates, but with countries like Germany, UK and Sweden below the average, this does not seem to be the case. Further, different "cultures" in the business sector for responding to questionnaires from the authorities is part of the reason for different response rates. Finally the data collection procedures may vary over country and time.

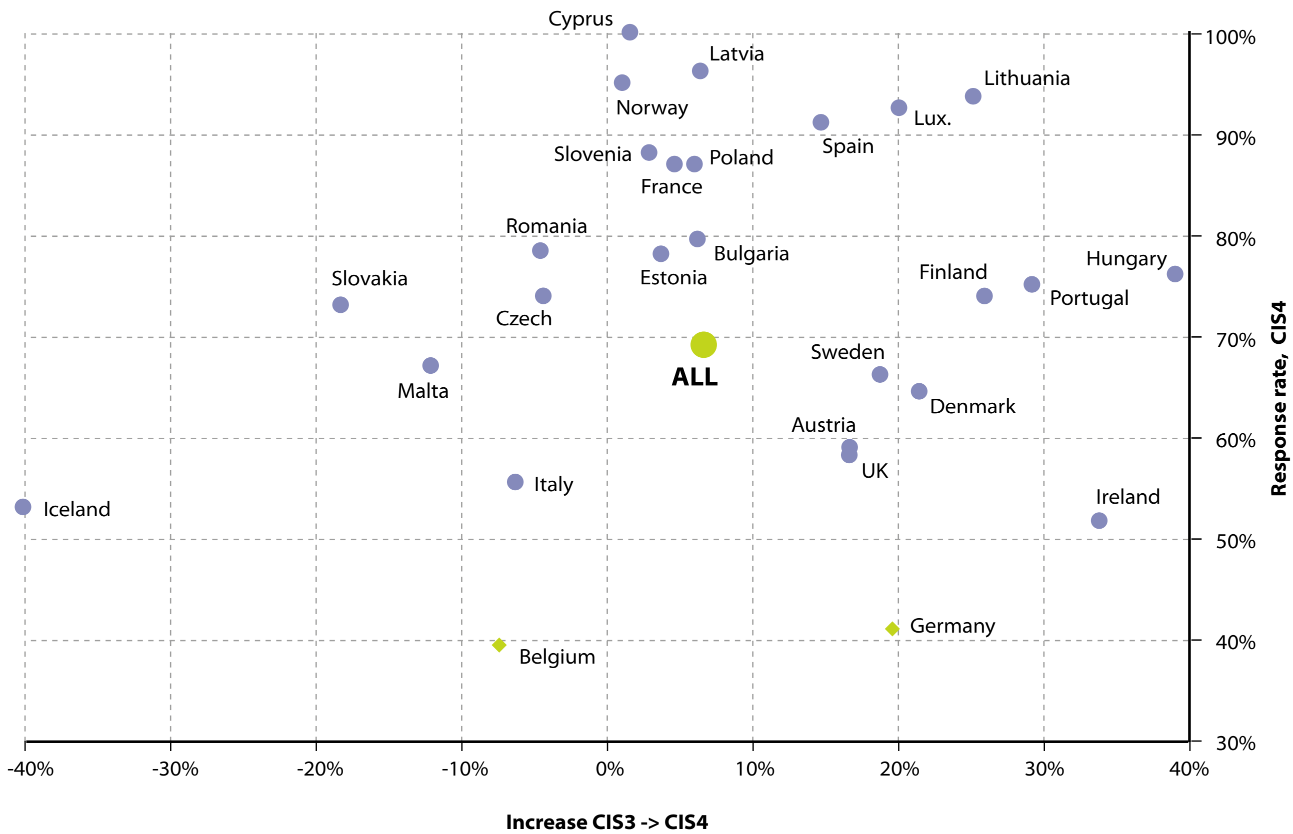
[1] The German response rate includes responses from a non-response survey with only a few questions and the Danish response rate includes cold decked responses. Greece and Netherlands have not reported their response rate for CIS4, and Switzerland has not reported for CIS3.

In the methodological guidelines for the CIS4-survey a response rate above 70% seems to be regarded as acceptable, as non-response surveys are only asked for, if the response rate is below 70%. The overall average is in fact a little below 70%, and still 11 out of 28 countries are below that threshold. One could say that these countries just could make the CIS-survey mandatory, but again the "culture" around which kind of surveys that can be mandatory for the business sector differs, so this might not be an option in some countries for a survey like CIS.

An impression of the possibilities for improving the response rate of CIS may be obtained by comparing the response rate with that of other business surveys in the same country. Here, only some evidence for Denmark can be given. The ordinary Danish business R&D-survey is conducted in the same way as CIS4, but the response rate is 11-13 percentage points higher than CIS4, even though there were put more effort in the data collection of CIS4 (3rd reminder as CATI). On the other hand, a competing survey on regional innovation only reached a response rate "in the late twenties". These results show that innovation is still a complicated topic to respond to for business people and further improvements in the questionnaire would be welcome.

An important issue is whether the response rates of CIS4 have improved compared to CIS3. The overall response rate for the 27 countries having reported response rates for both surveys has increased by 6.6 percentage points, so in general a larger willingness to respond has been achieved. In Figure 2.2 the changes from CIS3 to CIS4 are illustrated for each country, the second dimension of the graph being their CIS4 response rate. One can see that the changes from CIS3 to CIS4 differ markedly between countries, and 7 countries even experienced a decrease in their response rate. This indicates that a major reason for the changes in response rates is to be found in specific conditions in each country, while changes in the CIS-questionnaire and other methodological changes seem to have had a smaller, but positive influence on the response rates. In spite of the increases in response rates, there is only a small improvement in the number of countries with a response rate above the quality threshold of 70% – from 15 in CIS3 to 17 in CIS4 among the 27 countries – so more improvements that would increase the willingness of replying are needed.

Figure 2.2: Response rates CIS4 and increase from CIS3



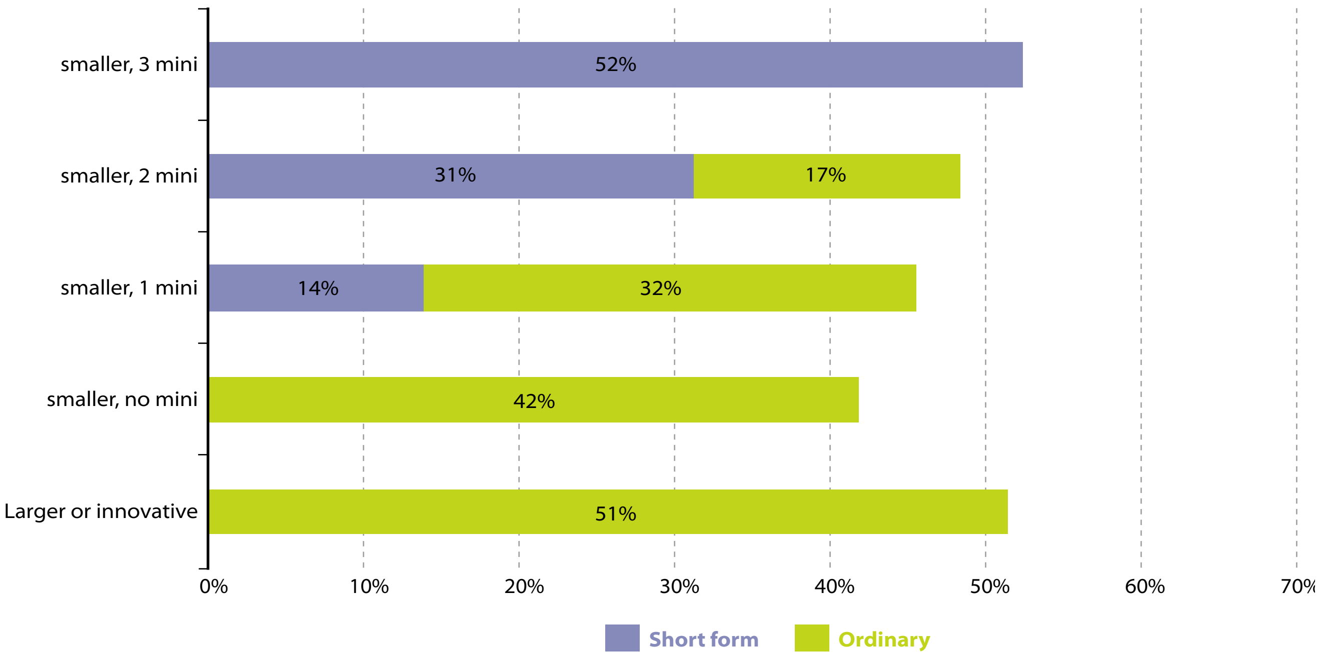
The total sample size has increased by 37% (172.000 to 236.000), but in some countries the sample size has been halved and in others doubled. This means that the change in the overall response rate from CIS3 to CIS4 may be (partly) caused by these National changes in sample size. By weighting the response rates of CIS4 by the sample sizes of CIS3 one gets a comparable response rate for CIS4, which would have been the response rate of CIS4, if the same mix in sample size as in CIS3 had been realized. The corrected response rate for CIS4 is calculated to 70.1%. This is an increase in the real growth in the willingness of the respondents to answer of 7.6 percentage points.

3. Short-form questionnaire

In §456 of the revised Oslo Manual it is described as a useful method to develop and send out a short-form questionnaire to small units and units in industries with little innovation activity that have not reported any innovation activity in former surveys. Also, short-form questionnaires may be sent to those units in other industries and size classes that in former surveys have reported no innovation activities. In Denmark, we decided to implement this recommendation for smaller enterprises with no former reporting of innovation activities of above 10 mill DKK (€ 1.34 mill). At the same time it was also decided to conduct an experiment to measure the effect on the respondents' willingness depending on the kind of questionnaire they received.

The 2,400 enterprises (including non-core enterprises) were randomly divided into 4 groups, one group only receiving ordinary questionnaires in the mail out and the two postal reminders, one receiving short-form questionnaires in the second reminder, one receiving short-form questionnaire in both reminders and one only receiving short-form questionnaires in the mail outs[1].

Figure 3.1: Response rates after two reminders, Denmark, CIS4



The response rates in these 4 groups and among the larger or innovative enterprises are presented in Figure 3.1. First, one can see that the larger or innovative enterprises are more willing to answer than smaller, less innovative enterprises, when both groups receive ordinary questionnaire – 51.3 % vs. 41.7 %. Next, the willingness to respond increases, as more of the 3 mail outs is short-form questionnaires. With the second reminder being a short-form questionnaire the response rate increases with 4 percentage points and further 2½ when both reminders are short-forms. An even higher response rate than among the larger or innovative enterprises is achieved, when all 3 mail outs are short-form questionnaires, namely

[1] Some telephone reminders were undertaken afterwards. These answers are not included in the results.

52.3 %. This means that among smaller or less innovative enterprises the response rate can be raised by 10.6 percentage points when using short-form questionnaires all the way through, compared with ordinary questionnaires.

Among the responses submitted in the short-form questionnaires only 3.4 % reported innovation expenditure above the limit of 10 mill DKK. An ordinary questionnaire was sent to these enterprises and 85 % did answer this second questionnaire as well. Among the responses submitted from smaller, less innovative enterprises by the ordinary questionnaire 2.7 % reported innovation expenditures above the limit of 10 mill DKK. Another indicator of influence from the type of questionnaire can be observed in the proportion of the innovative firms, being 46.5 % among the short-form respondents and 45.1 % among the smaller, less innovative firms that responded through an ordinary questionnaire. Among the larger or innovative enterprises there was 79.3 % innovation active. Hence, the reporting seems not to be influenced by the type of questionnaire.

The drawback of using short-form questionnaires is that not all questions are presented for the smaller, less innovative enterprises – or the questions are presented in a shorter form, i.e. cooperation only being asked for domestic/foreign enterprise/governmental institution. In the CIS-surveys it is however a better way than non-response surveys when trying to reach the response rate threshold of 70 %. As long as this threshold cannot be reached in Denmark, we will be using short-form questionnaires to improve the willingness of the sampled enterprises.

4. Item non-response

In most postal surveys some questions are not replied to by some of the respondents. The main reason for such item non-response is that some respondents are not able to give valid answers, sometimes caused by the question itself. Another reason might be that some respondents are not willing to give the information, due to confidentiality.

Eurostat has tried to collect information on item non-response from the 30 data providers on two occasions, first to the Task Force work for CIS2006 and then in the Quality Reports for CIS4. However, information has only been received from 13 countries, as 11 countries have not yet sent in their Quality Report and 6 countries have not answered that part of the Quality Report.

A look through all the questions in CIS4 for the 13 countries shows that for most questions the non-response is close to nil, and for these questions there is no problem in imputing the few item non-responses. There are, however, 6 groups of questions where there are higher levels of item non-response, but only in some of the 13 countries. In fact, 2 countries reported no item non-response at all, while some did not report on some of the questions due to various reasons, see Appendix 4.1. In Table 4.1 a summary of the item non-response of the 6 groups of questions is presented.

Table 4.1. Item non-response for 6 questions in 13 countries, CIS4.

Question	Min. item non-response	Max. item non-response	No. of countries, non-response>5%	No. of countries not reporting
1.2 Geographic market	0 %	27 %	4	2
5.2 Expenditure	0 %	33 %	4	3
6.4 Valuable co-partner	0 %	11 %	3	3
7. Effects (product/process)	0 %	52 %	5	0
8.2 Hampering factors	0 %	60 %	6-8	0
11.1 Turnover	0 %	27 %	5	3

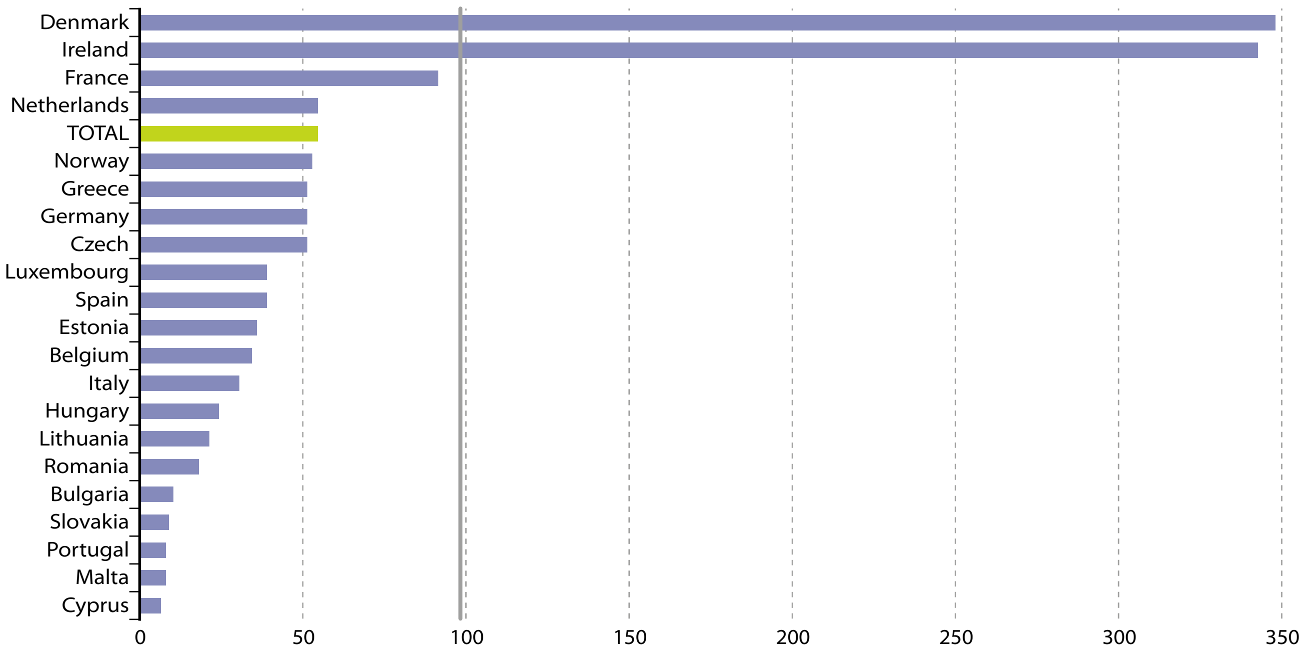
For each of these question(groups) one needs to consider why some of the enterprises do not have the ability to answer. For the first question, **the geographic markets**, it is a bit difficult to understand the problems in responding. Perhaps the wording on regional vs. national market could be improved (see Part 4) and maybe the question should be positioned later in the questionnaire. The question is important, as the responses reveal, what is meant by "*new to the market*" of a product innovation (regional, National or world wide) and also whether enterprises are operating globally.

The question on **innovation expenditure** includes four of the seven innovation activities that are asked for. The reduction from seven to four was caused by the high item non-response and low quality in CIS3. However, it seems also to be very difficult for some enterprises to assess the expenditure of the machinery and acquired services for innovation activities, as this is not booked separately. In some countries the willingness to make loose estimates seem to be higher than in other countries. During the data collection of CIS4 all larger enterprises in Denmark with item non-response in one or more of the expenditure questions were contacted and asked to try to make estimates. Still, up to 10 % of the Danish innovating enterprises did not respond to the questions on acquisitions for innovation.

7 of the 13 countries reporting item non-response did either report item non-response of more than 5% or reported that the questions either were not asked, were optional or were asked in another way. In the published results of CIS4 there are 4 out of 27 countries not having estimates of the innovation expenditures. Compared to CIS3, the number of non-reporting countries has increased by 1.

The item non-responses were, however, much higher in CIS3, and the handling of the non-response also seems to have been problematic. This is indicated by the comparison of the reported innovation expenditure in CIS3 and CIS4 for the 21 countries with reporting in both surveys, see Figure 4.1:

Figure 4.1: Innovation expenditure, CIS4 indexed to CIS3



According to these figures the total innovation expenditure has been halved from CIS3 to CIS4 – and the Irish and Danish innovation expenditure increased 3½ times! For Denmark, the reasons are to be found in a very high item non-response in CIS3 combined with an inappropriate data processing at Eurostat. It is the impression that these reasons are the same in most countries. Hence, the innovation expenditure in CIS4 is more reliable than CIS3, but still the CIS4-figures are rather unreliable, due to little ability and willingness to answer. At the same time, these expenditure questions are stressing some respondents, making some give up answering the full CIS-questionnaire.

A new question on the most **valuable kind of co-partner** (to be chosen from 7 categories) also caused some trouble in a number of countries. 3 of the 13 countries decided not to ask the question and 3 other countries experienced high item non-response. At the same this question only rank the most valuable of kind and do not rank geographically. So, other ways of ranking should be considered – or perhaps no ranking should be included.

The questions on the **product- and process-oriented effects and other effects** of the product- and/or process-innovations that have been introduced by the respondents are reported to have high item non-response in 5 of the 13 countries. One reason for this could be the placement of the questions between *cooperation* and *hampering factors*, far away from the questions on product- and process-innovation. In fact, this placement also seems to give rise to some inconsistencies, see the analysis in the next part. A new placement could increase the ability of responding.

The question of the importance of a number of **hampering factors** is causing problems in the majority of countries, as item non-response is exceeding 5 % in 6-8 out of the 13 countries. There is no obvious reason why it is so. Perhaps it is just because it is the 5th battery of qualitative questions nearly in a row. If that is the reason, one might consider whether all batteries should be part of the CIS-questionnaire every time or whether some of them should only be included every second time a CIS-survey is conducted.

There are 5 countries reporting more than 5 % item non-response for the questions on **turnover**. 3 countries do not report, probably because the information is collected from registers. This would also be the recommendation, as it is well-known that turnover in some countries and in some industries are seen as confidential information by some of the enterprises.

There is only low – or no – item non-response to the question on whether the enterprise is part of an **enterprise group**. However, when checking with Danish business registers it seems that the ability to correctly answer that question is not present at the respondent in all enterprises: Among those declaring their enterprise part of a group 4 % is not part of a group, while among those reporting not being part of a group 18 % is in fact part of a group.

There is no reporting in the Quality Reports on the supplementary question **Country for the head office** (for those belonging to a group), but at least among the Danish respondents this question causes further problems, the item non-response being 24 %. The responses have been checked, using business registers and the internet. The result was that around 6 % of the responses seem not to be the ultimate controller of the enterprise group.

5. Inconsistencies between questions in CIS4

When analysing more questions from a questionnaire at one time, one might find some inconsistencies in the combination of answers, often caused by lack of some respondents' ability to answer or bad formulation of the questions. Such findings may be used to make corrections during the validation process by the data producers, but others remain. Some of these inconsistencies in the CIS4-questionnaire are documented in this part of the paper and ways to minimise them are proposed.

The questions to be looked at are the markets of the enterprise, innovation activities and expenditure, co-operation and information sources, novelty and turnover and effects of PP-innovation.

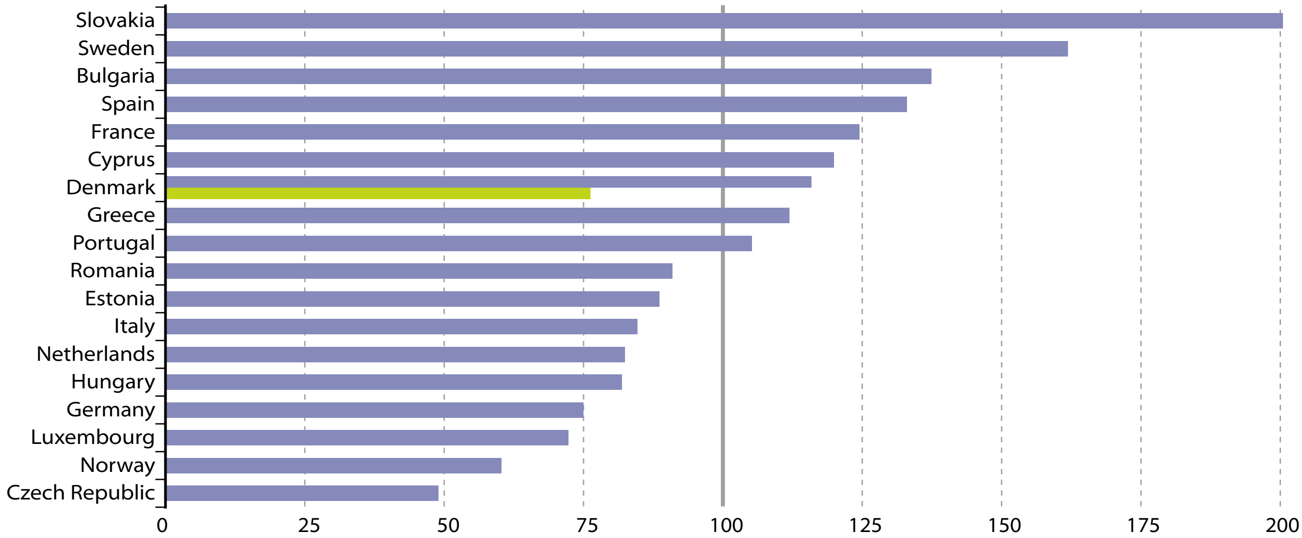
The enterprises are asked which of four **markets** they sell goods and services (*local/regional, National, other European, all other*) by ticking *Yes* or *No* to each of the four. However, a common reaction of respondents to such a list are not to tick the *No*'s, and this was also the reaction from among Danish enterprises: 40 % of those with at least one tick in *Yes* had not ticked one, two or three of the other outcomes, see Appendix 5.1. Normally, these item non-responses are coded as *No* in the data processing, but in this case there is a more serious problem with the question, further confusing the respondents.

The problem is whether the outcomes *Local/regional* and *National* are mutually exclusive, that is whether it is only *Local/regional* or whether a tick in *National* automatically is a tick in *Local/regional*. The respondents seem to be in doubt. This is revealed in the Danish CIS4: Among the enterprises 45 % ticked both of the outcomes, while 37 % only ticked *National*. Further, there are three times as many item non-responses as *No*-ticks for the question on *Local/regional*, while only half as many item non-responses as *No*-ticks for the three other markets – and nearly all item non-responses in *Local/Regional* had a *Yes*-tick in *National* market.

These empirical findings made us decide to recode all *Local/regional*-ticks to *Yes*, if *Yes* has been ticked in *National* market. This changed the index between *Local/regional* and *National* from 76 to 123[1]. By calculating the same index for the countries that have reported CIS4-results by the end of 2006 one finds that there seems to be the same problem in most countries – and that the problem has been handled differently, see Figure 5.1. It seems that 8-9 countries chose the same procedure as in Denmark (index>100), while 9-10 countries accepted the *National* market to be exclusive of *Local/regional* markets. Further, 6 of the 24 reporting countries decided not to ask the question on *Local/regional* market.

[1] Which ended up being index 116 for the core-group of CIS4 and taking into account the non-postal responses.

Figure 5.1: Index: Local/regional market vs. National market, CIS4



A consequence of these findings is a recommendation to reformulate the *Local/regional*-question to

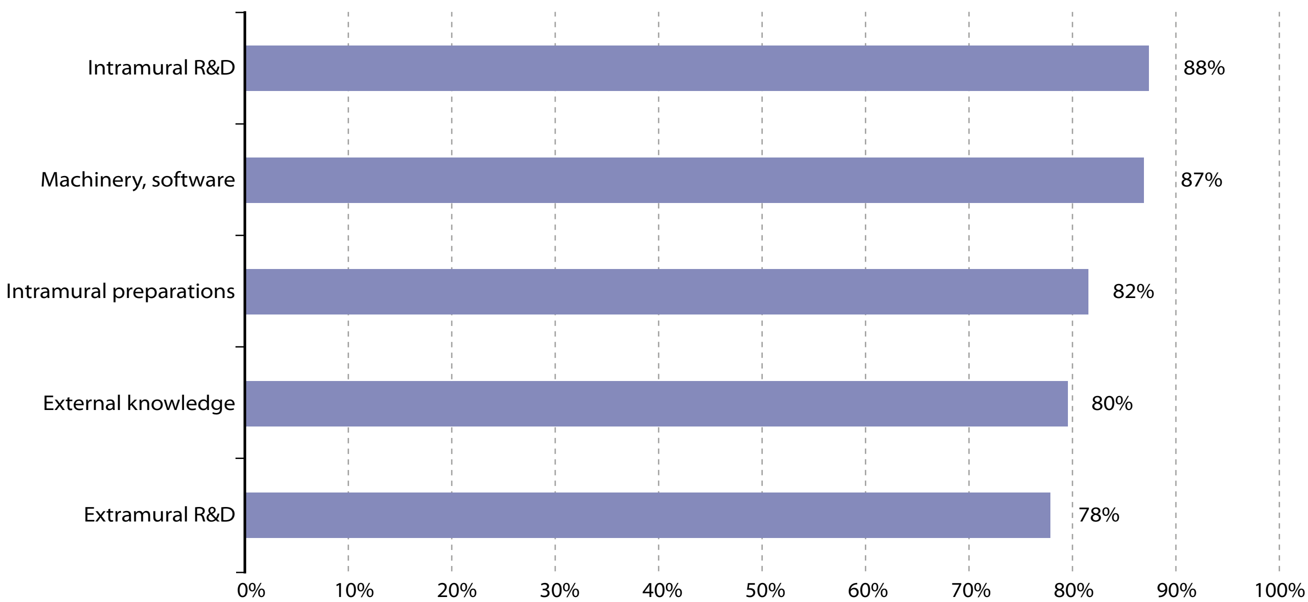
"Local/regional markets within your [country], but not in all of [the country]"

to ensure the multiple exclusiveness. Also, one should consider dropping the *No*-boxes.

When designing the CIS4-questionnaire it was decided to split the questions on **innovation activities** from the questions on **innovation expenditure**. There were more reasons for that: the activities refer to a three year period (2002-04), but the expenditure to one year (2004); many enterprises have problems making up some of the expenditure; it became possible to drop 3 of the expenditure questions. By splitting these questions there could, however, be a risk that too many respondents would declare an activity during 2002-04, but not report any corresponding expenditure in 2004.

A calculation from the Danish CIS4 dataset of the share of enterprises with an activity in 2002-04 having corresponding expenditure in 2004 shows that there seems not to be any problem of that kind. This finding is valid for all 5 activities asked for in the Danish CIS4, see Figure 5.2.

Figure 5.2: Share of enterprises with activities in 2002-04 having expenditure in 2004, Denmark, CIS4

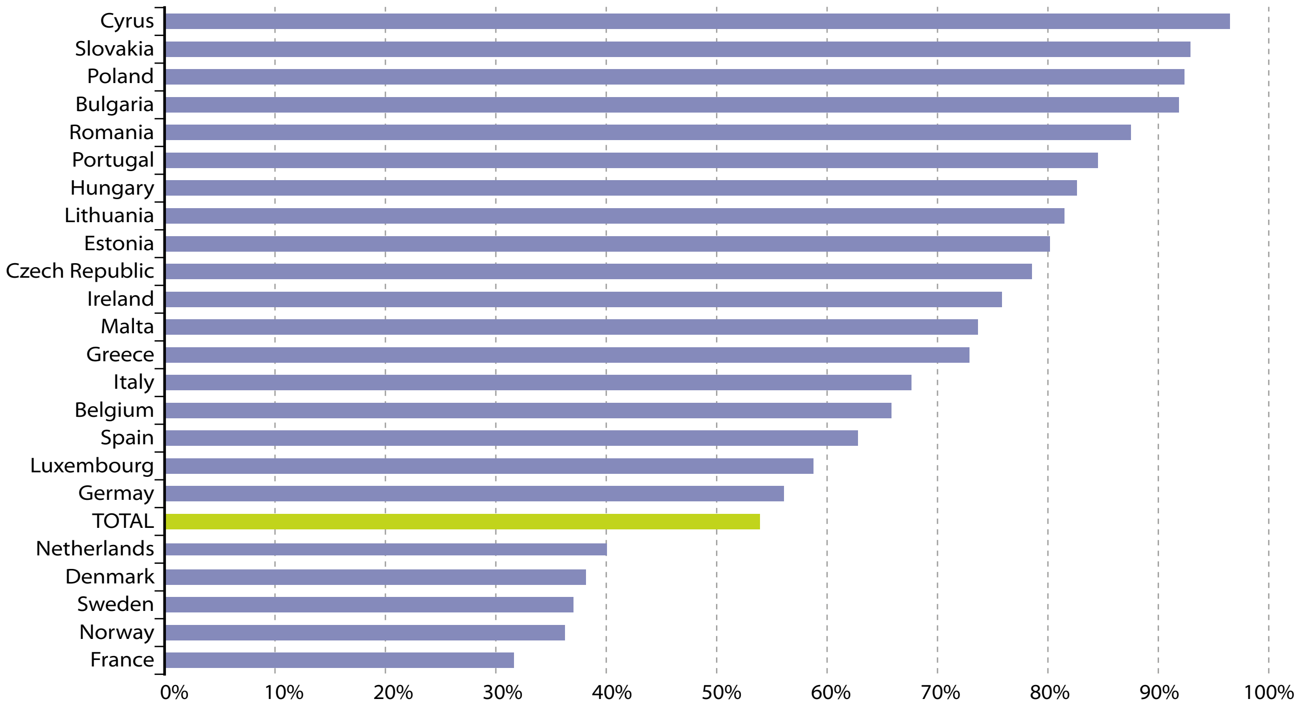


When making international comparisons it is important that all respondents in all countries understand the questions in the same way. Once again, there is a special problem with the expenditure. Do the respondents understand the concept of intramural R&D in the same Frascati-like way (see the next part) and are all **acquisitions** connected to the innovation activities? The latter question can be investigated by calculating the percentage of the total innovation expenditure that is acquisition expenditure, see Figure 5.3. The differences between countries are remarkable. The ranking may, perhaps, be close to what one might expect, but it seems that in some countries the reported acquisitions are much too high and/or the reported intramural R&D too low and vice versa in other countries.

There are three questions on **co-operation** in the CIS4-questionnaire. Product innovators are asked if the innovation(s) are *developed together with other enterprises or institutions*; process innovators are asked the same; and all enterprises with innovation activities are asked if they have *co-operated on any of their innovation activities*.

A certain consistency in the responses to these questions would be expected. This is partly true, as 80% of the product innovators with co-operation on their product innovation(s) also report having co-operation on innovation activities, while it is 55 % for other product innovators. For the process innovators the difference is not significant, being 59 and 57 %. 100 % congruence (instead of 80 and 59 %) cannot be expected, due to wording (*together* vs. *co-operation*) and to different action (*introduction of innovations* vs. *innovation activities*), but the level of the process innovators is rather low, so there is some reason to question the consistency of the responses. A placement of the questions on co-operation on innovation activities closer to the other questions on co-operation could reduce the inconsistency, but this may cause other problems in the rhythm of the questionnaire.

Figure 5.3: Acquisitions in % of total innovation expenditure, CIS4, 2004



As mentioned earlier the question on **co-operation** is split into 7 kinds of co-operation partners. The same 7 kinds are used when asking for **sources of information** for innovation activities. One would expect that close to all enterprises co-operating with a partner also would report that partner as a source of information. There are, however, from 2 to 14 % not reporting so – the 14 % being *Government or public research institutes* as partners. There does not seem to be much to do about this. The questions are standing next to each other and an integration of the questions would make them too complicated, as also the geographical dimension is asked in the question on co-operation.

There are a number of questions on the effects of the innovations. The first one is on the percentage of total **turnover from innovated products**, broken down in *new to your market* and *only new to your firm*. In the same block there are also two questions on the novelty of the product innovations: whether they were *new to your market* and whether they were *only new to your firm*. These two sets of questions may be answered in an inconsistent way, either by declaring *Yes* to the novelty question and declare *no turnover* or vice versa. Another form of inconsistency is, when one of the questions are answered, but the other one not. From the Danish micro data the amount of inconsistency has been calculated, and it varies according to novelty:

Novelty	Inconsistency	Partial item non-response
Only new to your firm	9%	6%
New to your market	5%	9%

Most of the inconsistency and item non-response comes from among respondents with *Yes* in the novelty-part and 0% or non-response in the estimate of the turnover. This is what was expected when the novelty-questions were added to the questionnaire from CIS3 to CIS4. However, the item-non response of the turnover-questions is not significantly higher, when the novelty-question is not asked. This can be seen by comparing the responses in the Danish short-form questionnaires, where the novelty-questions are not included (5.6 %), with the ordinary questionnaire (4.6-5.0 %). Also, a comparison of the smaller, non-innovating enterprises shows no significant difference in the distribution of novelty with and without the novelty-question. These results raise the issue of whether to include the novelty-questions in the CIS-questionnaire in the future.

Halfway through the questionnaire a question on the **effects** of *your product and process innovations introduced during the three years 2002 to 2004* is asked. The question refers to the PP-innovations reported in the first part of the questionnaire, but in spite of that 55 % of the group of respondents that did conduct some innovation activities, but did not introduce any PP-innovation during 2002-04, are reporting some effects, see Figure 5.4. These respondents have obviously misunderstood the question and they are either reporting on innovations introduced earlier on or reporting on their expectations of the innovations that hopefully will be the result of their ongoing innovation activities.

Figure 5.4: Any effect of PP-innovation, CIS4

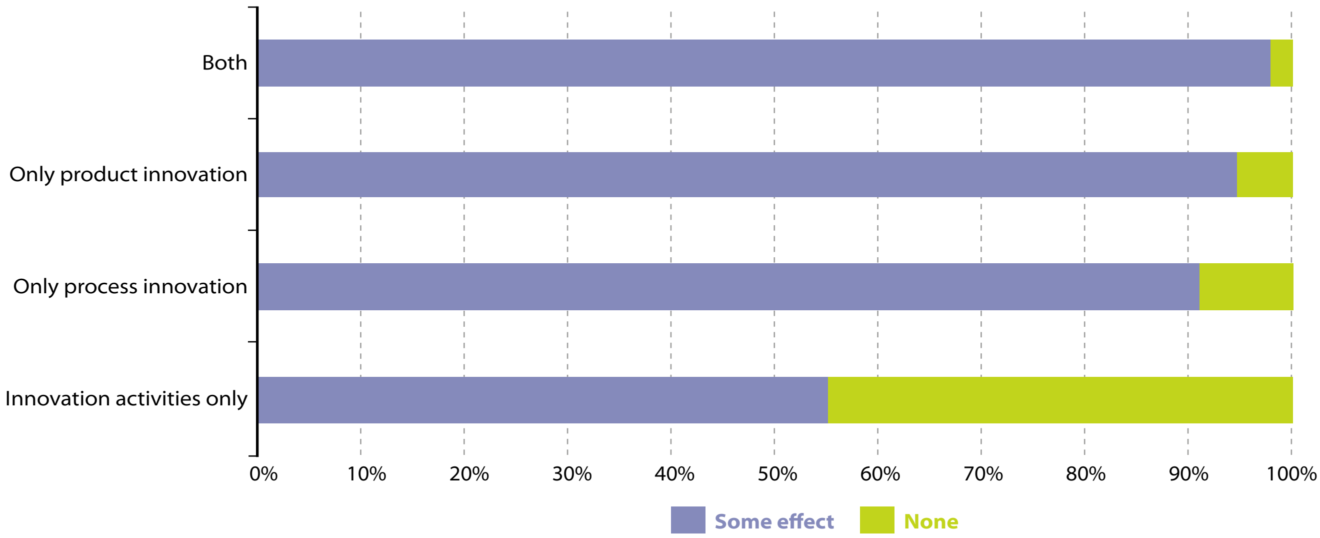
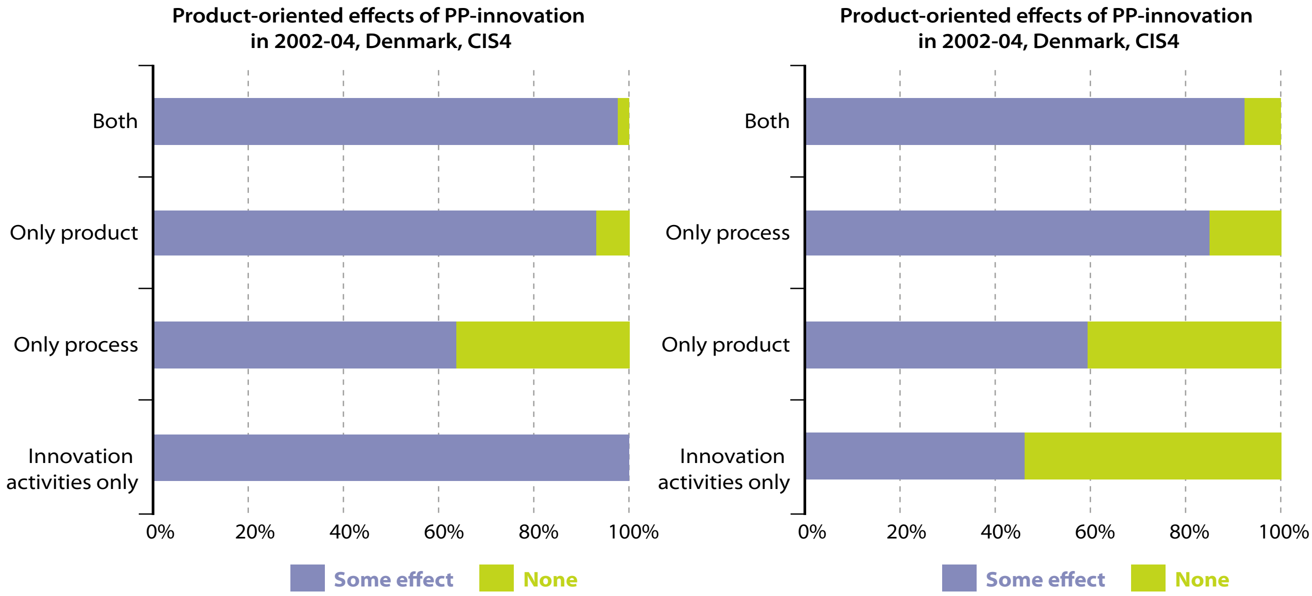


Figure 5.5: Effects of PP-innovation in 2002-04, Denmark, CIS4

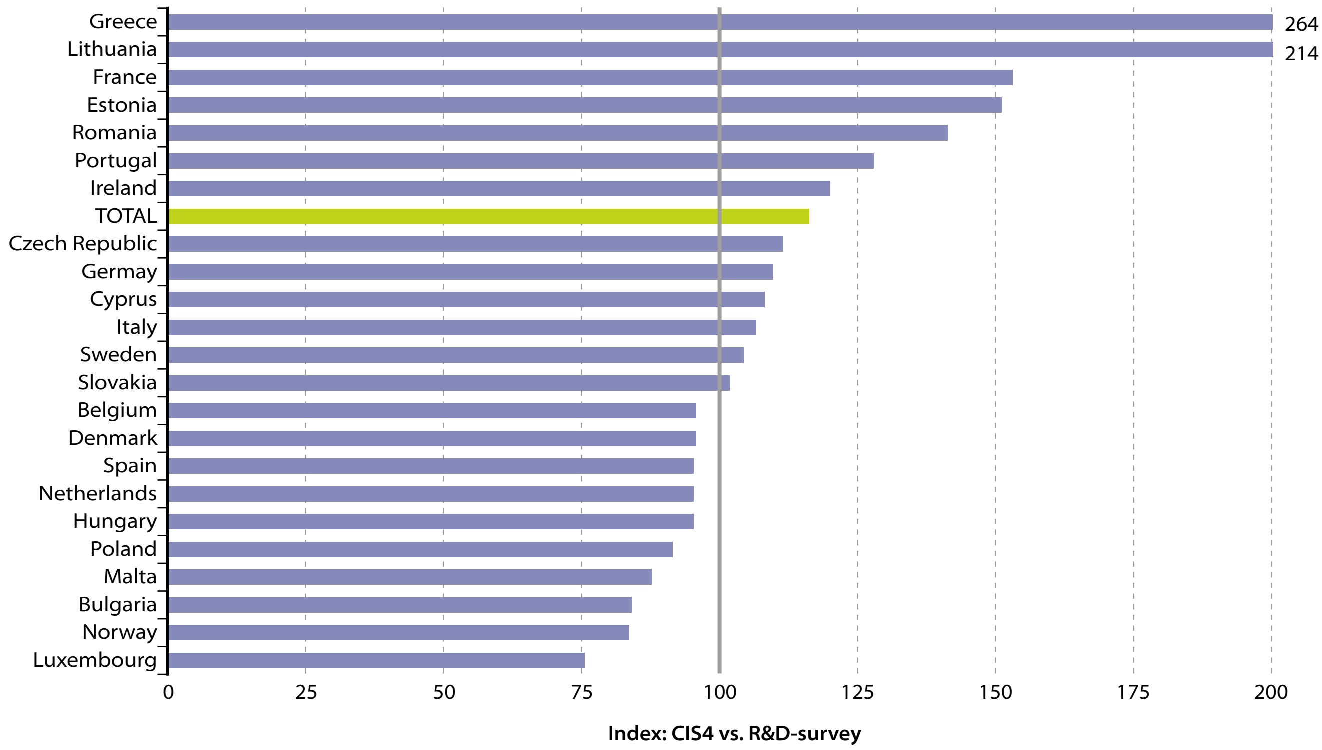


The 9 effects are presented in three groups in the questionnaire: *Product oriented*, *process oriented* and *other* effects. A similar counting of the respondents reporting at least one effect in each of the groups show that an even higher percentage of the only process-innovators report product-oriented effects (64 %) and a similar high percentage of the only product-innovators report process-oriented effects (60 %). For some "only-one-type-innovators" the reason might be secondary effects oriented towards the other type, but probably not that many. Most of these crossing effects probably have the same reasons as for the none-innovators above – previous innovations and expectations.

As a consequence of these findings the question on effects will be split into two and moved to the questions on product and process innovation in the coming Danish CIS2006-survey. Another consequence would be to ask about the objectives of the innovation activities, re. the discussion in the Oslo Manual, §386-91.

6. Inconsistencies with the Business R&D survey

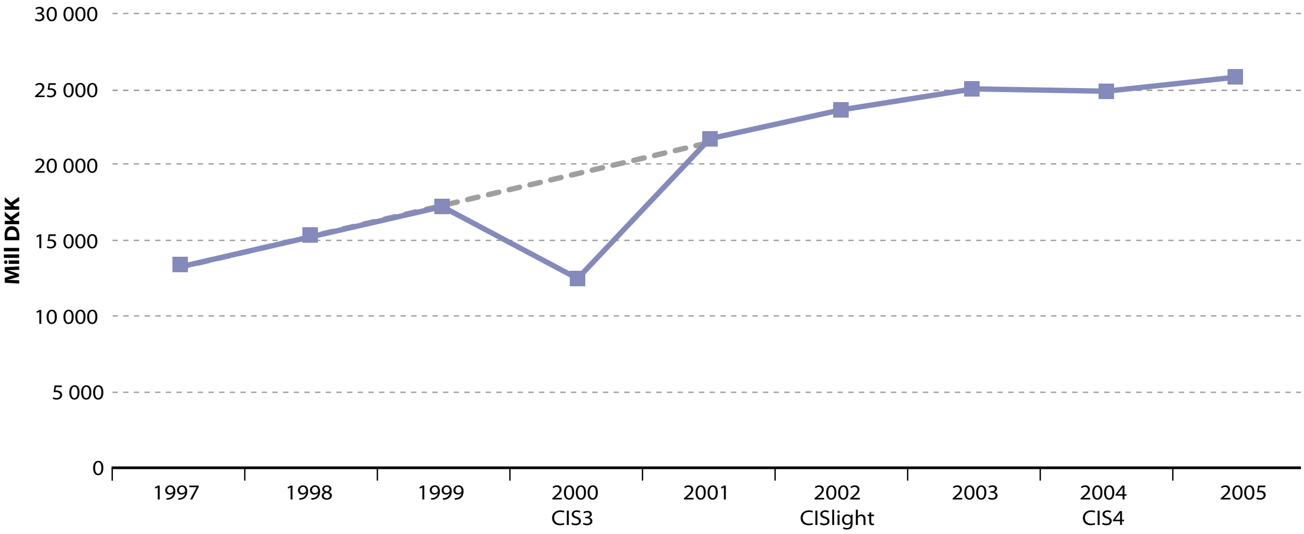
Figure 6.1: R&D expenditure in CIS4-survey and R&D-survey, 2004



One of the elements of innovation expenditure is the intramural R&D-expenditure. In most countries these expenditures are also estimated in a National R&D-survey for the same reference year. In some countries, the two estimates from the CIS- and the R&D-survey of the intramural R&D-expenditure differ significantly, see Figure 6.1. The CIS4-estimate is much higher than the estimate of the R&D-survey in 5-7 countries, while the opposite is the case for 3-5 countries. One explanation of these differences is for some countries a different coverage in the two surveys, but another explanation probably is the different contexts in which the question on R&D-expenditure is asked in the two surveys.

The Danish experience of the effect of the context of the R&D-question in the CIS3-survey was rather bad, cf. the graph that was presented at the last CEIES-seminar on innovation surveys, see Figure 6.2. In Denmark we thus decided to integrate the CIS- and the R&D-survey every two year, the latter in a shortened form. The effect of this has been very good, also by lessening the response burden for the enterprises.

Figure 6.2: Business R&D expenditure, Denmark



7. Conclusions

This paper has documented that a number of the questions in the CIS-questionnaire are complex and difficult to respond to for enterprises. A number of possible improvements have been suggested, and they will hopefully be part of the process of designing the next full CIS. The detailed findings shall not be repeated, but 4 main questions will be stated:

- Do we need to measure the expenditure of acquired machinery, software and know how?
- Can replacements of some of the questions improve the quality of the responses?
- Can some of the qualitative questions be asked in every second CIS-survey only?
- Can register data substitute some of the questions (industry, employees, turnover, part of a group and headquarters, markets, public financial support, patents)?

Appendix 4.1: Item non-response, CIS4

Country	Q.1.2	Q.5.2 - expenditure					Q.6.4	Q.7		
	Geographic markets	Intramural R&D	Acquisition R&D	Acquisition machinery	Acquisition know how	Total inno.exp.	Valuable co-partner	Product effects	Process effects	Other effects
dk **Denmark**	19%	4%	5%	9%	8%	not asked	11%	5%	5%	5%
de **Germany**	1%	17%	11%	17%	8%	23%	11%	22%	4%	19%
ee **Estonia**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
fr **France**	17%	5%	9%	11%	18%	4%	7%	6%	6%	8%
cy **Cyprus**	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
lt **Lithuania**	0%	0%	0%	0%	0%	0%	0%	30%	37%	52%
at **Austria**	optional	optional	optional	optional	optional	optional	-	1%	1%	1%
pt **Portugal**	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
si **Slovenia**	15%	0.5%	0.5%	0.3%	0.5%	0.3%	0.3%	0%	0%	0%
sk **Slovakia**	27%	0%	0%	0%	0%	0%	0%	0%	0%	0%
fi **Finland**	not asked	not reported	not reported	not reported	not reported	not asked	not asked	8%	8%	8%
uk **UK**	4%	no nil	no nil	no nil	no nil	no nil	not asked	0.3%	0.3%	0.3%
ro **Romania**	0%	27%	11%	9%	33%	7%	0%	4.0%	1.3%	1.6%

Country	Q.8.2				Q.11.1
	Cost factors	Knowledge factors	Market factors	Reasons not to innovate	Turnover 2002/04
dk **Denmark**	2%	2%	2%	2%	4%
de **Germany**	11%	11%	11%	11%	6%
ee **Estonia**	0%	0%	0%	0%	0%
fr **France**	7%	7%	7%	7%	From register
cy **Cyprus**	0%	0%	0%	0%	7%
lt **Lithuania**	50%	56%	51%	60%	2%
at **Austria**	3%	3%	3%	3%	18%
pt **Portugal**	3%	3%	5%	5%	?
si **Slovenia**	15%	15%	15%	15%	-
sk **Slovakia**	27%	27%	27%	27%	27%
fi **Finland**	5%	5%	5%	7%	0%
uk **UK**	4%	4%	4%	57%	14%
ro **Romania**	0.4%	0.4%	0.7%	0.7%	0.2%

Appendix 5.1. Geographic markets, where goods or services are sold

No. of item non-responses, all postal responses

Number of item non-response	Respondents	Item non-response and Yes-tick(s)	
All 4[1]	631		
3 of 4	129		
2 of 4	78	430	40%
1 of 4	223		
None	653	653	60%
Total	1714	1083	100%

1) Of which 612 short-form questionnaires

Item non-responses and ticking of No's:

Market	Item non-response	Ticks in No	Index: Item non-response/ticks in No	
Local/regional[1]	337	108	312	312
National	63	132	48	
Other European	140	320	44	49
All other	226	424	53	
Total	766	984	78	78

1) Of the 337 item non-response, 326 ticked Yes in National market

Local/regional vs. National:

Markets ticked	Responses	
	No.	Pct.
Only local/regional[1]	151	14%
Only national	401	37%
Both loc/reg. & nat.	487	45%
Only international	44	4%
Total	1083	100%

1) 18 (weighted: 143) also operated on international markets

Markets ticked	Weighted responses		Index: loc/reg. vs. national	
	No.	Pct.	Accepting the ticks	Nat-tick => Loc/reg.-tick
Only local/regional	1394	18%		
Only national	2853	37%	76	123
Both loc/reg. & nat.	3195	42%		
Only international	214	3%		
Total	7656	100%		

Comparative analyses based on CIS–data

INNOVATION IN LOW-TECH INDUSTRIES – CONCLUSIONS FROM THE PILOT PROJECT

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Abstract

A background for the PILOT project was the conjecture that the dominant discourse on industrial and technical innovation and development is inadequate for an understanding of the mechanisms behind competitiveness and change. In particular the assumption was that the OECD-based R&D dominated system of S&T indicators is too narrow in its scope and – in order to become useful for policy analyses – must be expanded to include other indicators.

Many policy makers and researchers tend to turn back to the easy concepts in their analyses, accepting R&D intensities (as measured) as good proxies for knowledge production and a policy parameter for the road to the knowledge society. One intention behind the PILOT project was to provide empirical and theoretical grounds for departing the conventional wisdom in favour of a more nuanced view on knowledge formation in economic activity.

The critique against the conventional wisdom may be summarized as follows:

- *The irrelevance of the linear model:* In short, this is the old question of the relationship between science and technology, between natural science and engineering science - is the knowledge formation process linear or more complex?
- *The rise of service activities.* Approximately 70 percent of economic activity in the most advanced industrialised countries now takes place in the service sector out of which significant parts are highly qualified. This is evident in those firms labelled Knowledge Intensive Business Services (KIBS); but also in manufacturing is creative problem solving for clients increasingly a normal activity and a means to create competitiveness. Although advanced this is not innovation proper, neither is it R&D or science; neither is it standardised routine work only. In fact qualified and situation specific application of professional skills fall outside the innovation concept as we normally use it.
- *The new production of knowledge.* Recent development in knowledge theory suggests that the increased specialization of academic work necessitates more of integrative skills and synthesizing competencies – although often advanced much of this is not innovation proper or is it carried out in R&D departments only.
- *Complexity.* The conventional view on what constitutes complexity is far from verified. In short: it is not necessarily so that systems oriented engineering activities – although not identified as innovative – are less complex and thus more open for competition than more science based activities. The rapid expansion of high-tech activities in catching up countries may illustrate that phenomenon.
- *Network character – distributed knowledge base.* Today´s industries are to a large extent network based with a distributed knowledge base, i.e. sometimes so called high-tech activities or science based activities are directly linked to so called low-tech industries thus forming symbiotic value chains.

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There are also – integrated to the phenomena mentioned above – processes of *diffusion* – often related to local, adaptive and incremental innovations which are very important but often fall outside the analytical net of innovation analysts. Many fast growing industries in the world are in fact importing/acquiring/learning/transforming technologies rather than innovating proper – and they often do that outside the R&D departments.

A means to depart from the conventional wisdom is to turn back to basics, i.e. the original Schumpeterian innovation concept. In the presentation the innovation concept is related to the wide capability concept rather than to R&D and science. *The dynamic capabilities approach* (the modern theory of the firm) is here developed to be useful for understanding of innovation and creativity. The "non-high-tech" firms studied in the PILOT project are analyzed using an enlarged capability approach introducing the concepts *transformative and configurational capabilities,* the latter of which includes *synthesizing* competence as well as *design* competence. Although the enormous cost differences between new and old industrial countries should not be underestimated the PILOT project revealed a significant amount of cases of competitive firms showing capabilities as discussed here.

Based on the PILOT project the presentation suggests a (family) of six new indicators which may solve the inadequacy of the old science based and biased indicators. These are:

- R&D intensity
- Design intensity
- Technological intensity
- Skill intensity (Human capital orientation)
- Innovation intensity
- Organizational innovativeness

This system of indicators is not a typology – or taxonomy - forming a conceptual world which is exhaustive and/or exclusive. The basic assumption is that these indicators together will capture the bulk of creativity explaining successful firms and industries and showing the *variety* in all economic sectors. The six entries above are not even necessarily exclusively defined. Some data collected for the formulation of "design intensity" may – depending on our definitions - be similar or identical to those needed for specifying "technology intensity". And parts of R&D activities may, depending on how innovation intensity is defined, be included also in the innovation intensity indicator.

Whether the new CIS round will capture these dimensions remains to be seen.

1. Introduction

A background for the PILOT project was the conjecture that the dominant discourse on industrial and technical innovation and development is inadequate for an understanding of the mechanisms behind competitiveness and change. In particular the assumption was that the OECD-based R&D dominated system of S&T indicators is too narrow in its scope and – in order to become useful for policy analyses – must be expanded to include other indicators

Many policy makers and researchers tend to turn back to the easy concepts in their analyses, accepting R&D intensities (as measured) as good proxies for knowledge production and a policy parameter for the road to the knowledge society. One intention behind the PILOT project was to provide empirical and theoretical grounds for departing from the conventional wisdom in favour of a more nuanced view on knowledge formation in economic activity.

2. Identifying the problem – a survey on the limitations of our concepts and tools

The strong Science & Technology focus in the international competitive race – within the OECD area, between OECD countries and Third World countries and (until one and a half decade ago) between the capitalist and communist world - has contributed to a more or less explicit conventional wisdom on what kind of industrial behaviour favours growth and what kind of structural change is necessary to secure the competitiveness of the leading OECD countries. The origin of this conventional wisdom is analyzed more in detail in this section.

This process has also been connected to a growing interest in data collection. With start in the 1970s OECD began to regularly publish statistics related to science, technology and industry. This statistics has increased in quality over the years; collection routines and classifications have been normalized (OECD, 1997; OECD, 2002a). During this process taxonomies were also constructed on how to classify industrial activities according to their estimated “technology levels”; as low-tech, as high-tech or somewhere in between.

The high-tech/low-tech taxonomy was – and still is – already from the beginning basically connected to R&D-intensity, i.e. R&D expenditures related to either total turnover or value added. Although the OECD statistics in this area includes a lot of different items this very simple taxonomy has become widely known: roughly we all know what low-tech is and we want to move away from it.

The conventional wisdom on technology levels based on R&D intensity - and the taxonomy related to it may be criticized from several perspectives. So has also been done; in fact there is a wide spread dissatisfaction on the ways innovations and knowledge formation processes are identified and presented (cf. eg van Hulst and Olds, 1993). Many analysts argue – and have done so for a long time - that neither R&D intensity data nor patent data do tell the whole truth on knowledge formation, on innovations and on growth potentials in industry (cf. e.g. Kleinknecht & Reijnen, 1990; Mowery & Rosenberg, 1989; Patel & Pavitt, 1994; Archibugi & Pianta, 1996; Brouwer & Kleinknecht, 1996; Laestadius, 1998a & 1998b; Baldwin & Gellatly, 1998; Arundel et al, 1998; Kleinknecht & Mohnen, 2002; Smith, 2004). This need to develop the innovation and S&T indicators is also acknowledged in several OECD publications (cf. e.g. OECD, 1996; OECD 1997; OECD 2001b & 2002a). In fact both the OECD/Eurostat initiated “Oslo Manual” (OECD, 1997) and the “Community Innovation Surveys” organized by Eurostat reveal an intention to both change focus from R%D to innovations and, at the same time, release the innovation concept from the S&T fetters, a release process which was influenced by Kline & Rosenberg (1986) (cf. Smith, 2004).

Nevertheless, in practice, many policy makers and researchers – sometimes by conviction but probably also due to lack of better alternatives - tend to turn back to the easy concepts in their analyses, accepting R&D intensities (as measured) as good proxies for knowledge production and a policy parameter for the road to the knowledge society (EC, 2002; cf. also Sheehan & Wyckoff, 2003). The intention behind this paper, based on the PILOT project, is to provide a theoretical ground for departing the conventional wisdom in favour of a more nuanced view on knowledge formation in economic activity.

Classifying the shortcomings of the conventional view

As indicated above, there is by now a vast theoretical literature on the shortcomings of the dominant concepts developed to describe and analyse industrial and technical change on the one hand and to use these as tools for promoting policy targets as regards employment, growth and competitiveness on the other (cf. also Laestadius, 2005b). These shortcomings may roughly be classified into one or more of the following families of arguments which, in addition, to some degree also are related to each other:

The irrelevance of the linear model

In short, this is the old question of the relationship between science and technology, between natural and engineering science. The fact that this is far from a simple linear unidirectional causal relation has been known and discussed during more than a century (cf. eg. Rankine, 1859; Whitehead, 1925; Merton, 1938/70; Schmookler, 1950; Musson & Robinson, 1969/89 and Landes, 1969/77 for different approaches). Many of these writers were clear in the view that the links between scientific discoveries and the world of artefacts were – and are - far from simple. There is also a modern discourse with roots in engineering studies as well as in science studies which reveal a relative independence as well as two-directed influences between science on the one hand and engineering/technology on the other (cf. eg. Price, 1965; Gibbons & Johnston, 1974; Price in Barnes & Edge, 1982; Gibbons & Johnson, 1982; Kline & Rosenberg, 1986; Vincenti, 1991; Brooks, 1994; Faulkner, 1994; Downey & Lucena, 1995) although e.g. Narin & Noma (1985) find that science and technology are more linked together within biotechnology than is the case in other fields.

In spite of all stylized facts and academic reports challenging the dominant view, the linear model of science and technology – with roots in the Bush Report (*Science, the Endless Frontier,* 1945) - maintains a strong position in policy circles and also in significant segments of academia (cf. Stokes, 1997).The linear model became the model for science policy in the USA and a means for the cold war competition with the Soviet Union. When the Soviets launched their Sputnik in 1957 the model was put in focus and the role of science and technology was emphasized in the high-tech race which followed (cf. Nelson in NBER, 1962 and Brooks, 1996). Motivated by the cold war - but also by the intensified competition between USA, Europe and Japan - the science and technology perspective became a core subject for analytical work within the OECD (cf. OECD, 1971 & OECD, 1981).

The OECD has since then been the motor for analyses of science, innovations and technology (cf. Elkana, 1974; Godin, 2003; Laestadius, 2003). It has provided analysts with data and with research tasks. In addition it has – as mentioned - provided a vocabulary and taxonomy on how to codify various activities into the science & technology analytical framework (OECD, 1997; OECD, 2002). As innovation researchers we all are - although in various degree - stakeholders in this development.

It may, in addition, be argued that the scientification of innovations – and of our understanding of them – also gained momentum of the development of corporate and managerial capitalism (observed by Berle & Means (1932) and Burnham (1941) already). The influence of this process on the writings of Schumpeter is well known: in Schumpeter (1943) the R&D department is substituted for the heroic entrepreneur from Schumpeter (1911). Innovations simultaneously became science based and institutionalised in R&D departments; a process which probably started in German chemical industry in the late 19th century and diffused to American firms during the first half of the 20th century (Schmookler, 1957; Freeman, 1974; Mowery & Rosenberg, 1998). Around 1960 innovations were something that had to be managed in the R&D units (cf. Burns & Stalker, 1959/61). This connection between industrial corporate capitalism and R&D-based innovation has become an influential background notion in our time and contributed to the ”scientification” of the understanding of innovative activity among analysts as well as among S&T policy makers.

Over the years there has been a lot of critical reflections over this paradigm of linearity (cf. eg. Barnes & Edge, 1982; Nelson, 1993; Rosenberg, 1976; Rosenberg, 1982; Kline & Rosenberg in Landau & Rosenberg, 1986 and Stokes, 1997). The critique follows several paths: (a) Although all technical change by necessity has to be in line with what natural laws allow us to do, it must not necessarily be based on scientific activity or even on established scientific knowledge; (b) and even if it is based on scientific activities, it is not necessarily based on recent ones – innovations, i.e. creative combinations, from the *stock* of knowledge may be more important for our wellbeing than creating *new* scientific knowledge. This was in fact what Schumpeter (1911) already told us. (c) The relationship may, in addition, be the other way around, i.e. technology creating the foundation for scientific knowledge (cf. e.g. Kline & Rosenberg, 1986). (d) Science and engineering may be relatively independent from each other (cf. e.g. Barnes & Edge, 1982; Brooks, 1994; de Solla Price, 1984; Rip, 1992). In particular it may be argued that there are many potential and widespread engineering solutions – of which some are better than others – related to the same science/knowledge base (cf. Rosenberg, 1969); and finally (e) non-science (and non-technology) based factors like institutions and organisational structures may be much more important than scientific advances. This argument may also include the simple fact that it is far from self evident that people in advanced countries will focus their demand on products and services that draw their immediate knowledge base from advanced (natural) science rather than from professional creativity (e.g. design or life style oriented activities) in a broader sense.

The rise of the service sector

This last statement above may be a very profane way of introducing the coming of the post-industrial society into the argument. Approximately 70 percent of economic activity in the most advanced industrialised countries now consists of services out of which significant parts are highly qualified (Wölfl, 2003). The service part of total value added increases all over the mature industrialised world. The innovation discourse, has to a large extent co-developed with hardware producing industries like manufacturing (cf. Laestadius, 2005). It is far from obvious that the innovation concept inherited from manufacturing – although transformed – is the best way to capture the dynamics of the service sectors (Tether, 2004). The magnitude of this problem will increase with the rising share of services in the economy as well as with the rising share of knowledge intensive services relative to the service sector as a whole.

The rise of the service sector is in itself a complex phenomenon containing relocation of traditional service activities (although maybe modernised) from manufacturing to service sectors (like outsourcing of cleaning and computer services) as well as the growth of traditional service sectors (like restaurants and lawyers) and the emergence of new service sectors (like mobile service providers). In addition the activities within manufacturing firms may become more indirect (i.e. service like). Manufacturers may as well transform their business concept towards more of integrated solutions, i.e. offer function or performance instead of selling hardware products (cf. Davies in Prencipe et al, 2003). Or they may – as in the case of contract manufacturing (cf. Bromberg, 2004) – even sell manufacturing itself as a service. In most of these cases there is an element of customisation connected to the service activity challenging the traditional innovation concept. This creation of "unique" solutions for the customers is directly related to the discourse on mode II knowledge production:

The new production of knowledge

There seems to be a general agreement among analysts that the character of knowledge production/formation is changing and has been so during recent decades. This is a transformation in many dimensions of which at least the following seem to be of interest: (a) The Gibbons et al (1994) argued that the increased specialisation of academic knowledge formation necessitates more of integrative skills and synthesising competencies (which probably fall outside what we normally identify as science);[1] (b) Due to organisational change, higher educational levels and decline of traditional manufacturing activities a larger share of employees get opportunities – as well as demand – to work with their brains rather than their hands. In short: activities aiming at innovations are not necessarily discriminated from normal "production" in what we label knowledge based firms. This is probably most evident in those firms labelled Knowledge Intensive Business Services (KIBS); but also in manufacturing is creative problem solving for clients increasingly a normal activity and a means to create competitiveness. Although advanced this is not innovation proper, neither is it R&D nor science (although there may be a scientific foundation for the knowledge base); still less is it standardised routine work. In fact qualified and situation specific application of professional skills fall outside the innovation concept as we normally use it.

The conventional wisdom on the characteristics of complexity

The traditional division of labour between industrialised and less industrialised countries as well as the historical processes of industrialisation may have contributed to a neglect of what constitutes complexity in industrial and technical activity and knowledge formation. Assuming that those firms and countries that can manage complex processes may develop competitive advantages in niches on all technology levels makes complexity phenomenon a core issue. In short: when colonial heritages are thrown away and the fetters of hierarchical structures are loosened what makes us assume that the catching up countries will face competitive disadvantages in science based activities - which to a large extent are labour (humans resources intensive) - rather than in traditional engineering, crafts and manufacturing? Although the details of

[1] It may be argued that what Gibbons et al (1994) have noticed has to a large extent been there all the time in scientific practice (Rip, 1997; Weingart, 1997; Bender, 2001) and particularly in traditional engineering.

this need a paper of its own it may be looked upon as a stylised fact indicating that latecomers may catch up starting in the assumed most complex end as well; and that challenges our conventional wisdom on innovative behaviour.

The network character of the economy and the distributed knowledge base

Although globalisation is far from new, and advanced global production processes have been organised for almost half a century by now, we may follow Castells (2000) in arguing that the network character of the world economy has dramatically increased during recent years influencing also innovation processes as well as our means to understand them: if value is added in a configuration of distributed actors rather than within a single organisation ”the unit of reference is no longer the firm, the research centre or the consumer. It is the system of co-ordinated links that exist between these different actors” (Bell & Callon, 1994:67*).* Then it is much more difficult to identify the relative importance of the different parts of the network as regards innovativeness: synergies may be created from the links between low-tech units and high-tech units in an economy and from diverse relations along the value chains (cf. Garibaldo et al, 2003). The importance of this argument should not be underestimated. The capabilities to identify and creatively combine relevant distributed assets (knowledge and others) may be the key to innovativeness, and ”low-tech” firms may be the nexus through which a lot of advanced competencies are integrated or synthesised.

A distributed knowledge base (cf. Smith, 2003) is a systemically coherent set of knowledges, maintained across an economically and socially integrated set of agents and institutions. The problem is not so much definition as empirical analysis of content. How can the content of these knowledges across particular industries be described, and how are they integrated? The main issue is the forms of knowledge involved in an industry, the articulation of this knowledge and its flow across industries. These inter-agent or inter-industry flows conventionally take two basic forms: ‘embodied' and ‘disembodied'. The former involve knowledge incorporated into machinery and equipment. Disembodied flows involve the use of knowledge transmitted through literature, consultancy, education systems, movement of personnel and so on.

The basis of embodied flows is the fact that most research-intensive industries (such as the advanced materials sector, the chemicals sector, or the ICT complex) develop products that are used within other industries. Such products enter as capital or intermediate inputs into the production processes of other firms and industries: that is, as machines and equipment, or as components and materials. When this happens, performance improvements generated in one firm or industry therefore show up as productivity or quality improvements in another. The point here is that technological competition leads rather directly to the inter-industry diffusion of technologies, and therefore to the inter-industry use of the knowledge which is “embodied” in these technologies. The receiving industry must of course develop the skills and competences to use these advanced knowledge-based technologies. Competitiveness within ‘receiving' industries depends heavily on the ability to access and use such technologies.

Fishing and fish farming may illustrate the phenomenon. Examples of embodied flows in fishing include use of new materials and design concepts in ships, satellite communications, global positioning systems, safety systems, sonar technologies, optical technologies for sorting fish, computer systems for real-time monitoring and weighing of catches, and so on. Within fish farming, these high-technology inputs include pond technologies, computer imaging and pattern recognition technologies for monitoring, nutrition technologies (often based on biotechnology and genetic research), sonars, robotics, and so on. These examples are not untypical of ‘low-technology' sectors – on the contrary, most such sectors can not only be characterised by such advanced inputs, but are also arguably drivers of change in the sectors that produce such inputs.

The disembodied flows and spillovers are also significant. Underlying the technologies for fishing and fish farming mentioned above are advanced research-based knowledges. Ship development and management relies on fluid mechanics, hydrodynamics, cybernetic systems, and so on. Sonar systems rely on complex acoustic research. Computer systems and the wide range of IT applications in fisheries rest on computer architectures, programming research and development, and ultimately on research in solid-state physics. Even fishponds rest on wave analysis, CAD/CAM design systems, etc. Within fish-farming the fish themselves can potentially be transgenic (due to research in genetics and molecular biology), and feeding and health systems have complex biotechnology and pharmaceutical inputs. It is clear that a wide range of background knowledges, often developed in the university sector, flows into fishing.

In short the discussion above opens for a large set of hypotheses as regards the character of knowledge formation as well as its location in space and in various actors in the system. Basically the argument is that any sensible analysis of the place of innovation and technological change in developed economies must examine all sectors because, with few exceptions, radical technological change has broad impacts that cut across economic activities. Not only do many innovations eventually diffuse to multiple sectors, but low and medium technology sectors (LMT) are often the best customers of high-tech producers. Furthermore, R&D activities are rarely confined to high-tech sectors. As a result, analysis has to look not only at how technological change is generated but also at its use because it is clear that the amounts invested in R&D depend on the size of the markets that will subsequently evolve and that dominant shares of these markets will frequently be outside high-tech areas.

The diffusion and catching up phenomenon

In the extension there is a connection between the network phenomenon discussed above and the diffusion mechanisms often discussed in relation to technical development and growth. Not the least Rosenberg has focused on the importance of the neglected dimensions of learning, of fine tuning, of small innovations which is what diffusion basically is about although much of it – not being "new to the world" - falls outside the conventional understanding of innovative activity.

Because established sectors constitute by far the largest part of an economy at any time, technological updating in these industries has played an important role in overall economic growth from the Industrial Revolution (Bruland, 2004) to the present.

Transformed to a global scale and changing the unit of analysis from industries to countries illustrates the importance of this phenomenon. It may be argued that the largest growth process hitherto in the world – the 9% yearly growth which China has had for a quarter of a century by now – has very little to do with innovations new to the world.

Summing up we cannot expect to find strong and reliable connections between localised scientific advances – or R&D-advances – on the one hand and growth of employment, production or competitiveness in the same locality, system, industry or firm on the other. And there is no clear reason to a priori assume that the innovative flow is unidirectional starting with basic science. Innovation surveys thus face problems although they use more elaborated innovation concepts intending to handle at least some of the limitations discussed above. In short: there are lot of ”innovation paradoxes” within the EU.

3. Introducing capabilities to broaden the understanding of creative and innovative behaviour of firms within industries

One difference between economists and other social scientists is that the former, due to their research interests, tend to underestimate differences between firms (cf. Nelson, 1991). Firms differ and they do it due to internal mechanisms – not only as a consequence of the competitive conditions in which they are embedded (cf. Porter, 1980). This difference between firms was present already in the original writings of Schumpeter (1911), it was revealed in important studies in both industrial and organisational sociology (among others Woodward, 1965 and 1970, Burns & Stalker, 1961) and economics (Chandler, 1966, Cyert & March, 1963, and Penrose, 1959). Since about two decades this has developed into a discourse on ”the resource based theory of the firm"; in its later varieties developed into a ”dynamic capabilities approach".

Firm differences is a core point in evolutionary economic theory (cf. Nelson & Winter, 1982). Much of the recent research in this area originates in contributions by Kogut & Zander (1992) and by Teece & Pisano (1994). The core results in this discourse is that these differences may be analysed in terms of capabilities orchestrating and mobilising resources available for firms as regards knowledge formation and productive activities (e.g. Dosi, Teece & Chytry, 1998; Foss & Robertson, 2000; Dosi, Nelson & Winter, 2000; Zollo & Winter, 2002). The capabilities of one firm cannot instantly be transferred to another; there are transaction costs. Capabilities are characterised by complexity having developed through learning processes, which may contain elements of tacitness. The cumulative character of these learning processes contribute to path dependence, i.e. firms tend to follow certain trajectories in their development.

It may be argued that the most critical point in the knowledge society is not knowledge as such but knowing and in particular the capability to cope with different forms (codified, embodied, tacit etc) of recurrent new knowledge. If these capabilities are potentially significant in magnitude – and if their transferability is limited in the short run – compared to, say, the costs of labour and standard machinery, the result of the competitive struggle between firms facing different competitive environments is far from evident. In short, the potential of the dynamic processes may be more important than ordinary factor cost differences. There is thus a window of opportunity also for innovative and creative firms in mature industries in high cost countries to compete on the world market.

The coupling of innovation to capability rather than to R&D opens for a much wider understanding of innovativeness and knowledge formation processes than what has normally been the case (although there are tendencies in that direction in the present reformulation of the Oslo Manual). There are of course many firms which develop significant parts or even most of their capabilities in the R&D department. With our approach, however, the relative importance of the R&D units becomes an empirical question rather than something postulated or assumed a priori. This is fully in line with ideas already proposed by Kline & Rosenberg (1986) and by Faulkner (1994). It is also fully in line with much of the recent discourse in knowledge management (cf. e.g. Nonaka & Teece).

Capabilities are created in organisational structures on all levels. Although our primary unit of analysis in this paper is the firm, we may imagine that capabilities are created in individual plants, in departments and sections of plants, as well as in various networks, alliances etc. It may be argued that the capability concept, as it is used here, does not significantly deviate from the original Schumpeterian innovation concept from 1911. For Schumpeter innovations were those creative combinations which made firms take off from their road towards equilibrium, which made them capable of creating what we usually label monopolistic competition where the competitive struggle is fought not with prices but with better performance, higher qualities etc. This innovative behaviour is (following Schumpeter) explicitly not restricted to technology, and still less to science labs.[1]

The fact that innovations over time so strongly have become associated with technology is one reason for our adoption of the capability approach: as we have argued above, firms do not necessarily need advanced technology to become profitable. Another reason is the strong connection which has developed between innovations and new knowledge – and primarily "new to the world". The capability approach opens for the fact that it is not necessarily the uniqueness which matters but the variety created by difficulties to imitate or to follow the paths tread upon by the leading performers (and by the variety of preferences on the demand side). The successful knowledge based service firm may be successful not because it is innovative in the conventional connotation of the term, but due to the fact that their staff have learned the professional skills and have developed a capability to perform better – at least from some aspects – than their competitors as regards customisation of professional routines. In short: the capability approach leaves us with a much wider concept for understanding the performance of firms which do not reveal high records in R&D or innovations as we normally define them.

Going further in our analysis we may develop the capability concept somewhat. Dosi, Nelson & Winter (2000:3) argue ”the term 'capabilities' floats in the literature like an iceberg in the Arctic sea … not easily recognized as different from several icebergs nearby"; neither is it in itself unambiguously distinctive. That is to say, we understand capabilities not as a pattern of activities but rather use the term to address specific preconditions for specific activities: a particular configuration of enabling cognitive, financial and material resources which characterises an organisation and which constitutes potentiality for this organisation.

Following Dosi et al (2000) we save that concept for a fairly large scale unit of analysis containing intentionality and conscious decision making as well as routines as building blocs. Capability is related to a recognisable purpose expressed in terms of significant outcomes it is supposed to enable. This also means that capability building can be a strategic aim (cf. Tidd, Bessant & Pavitt, 2001) whereat both the actual process of capability building and the definition of specific aims is affected by the capabilities already present at any point in time. The latter direction of impact has been labelled with the term absorptive capacity or absorptive capabilities (Cohen & Levinthal, 1990; Laestadius, 1995).

We may identify two analytical dimensions of "innovation enabling capabilities" which are tightly interwoven empirically.

[1] We may support our arguments with some illustrative examples. The Swedish firms Ikea and Hennes & Mauritz (H&M) have during the 1990ies established themselves as fast growing firms on a global scale. None of them has any R&D worth to mention, neither are they known as world leaders in what we traditionally identify as high-tech (cf. e.g. HM, 2004). Leaving their successful market strategies aside for a moment – assuming that these strategies basically mirror their underlying capabilities – we may identify that these firms have excellence in design and logistics. Going deeper into that we may argue that the design competencies of these firms include excellence in design for the use of the products as well as design for production, manufacturing, assembly, transport etc (and with "use" we – of course – include the aesthetic qualities and cultural values connected to the product, not only a narrow "function" perspective).

Transformative capabilities

constitute enduring ability to transform available general knowledge and competence into plant, firm or task specific knowledge and competence. This is a core competence particularly in LMT industries: the general knowledge on traditional industrial techniques like welding etc. is spread all over the world. The ability to transform it into specialised and economically competitive "high class zero defect" competence separates the profitable firms from the rest.

One may describe the underlying processes as a shift between levels which has to be mastered by an organisation: globally available knowledge is being accommodated and transformed locally for local use. Rip (1997) for instance provides a convincing elaboration of the relevance of this distinction. He argues that local knowledge refers to, and is embedded in, a certain local situation whereas global knowledge is in principle generally available. These two types of knowledge differ as regards the claimed validity – universality in the one case vs. adequacy in the other. And they differ in form as well. Global knowledge is always codified as it refers to a paradigm[1] whereas local knowledge, though having codified elements (instruction handbooks, formal organisational rules, technical process protocol etc.), is characterised by some degree of tacitness.

This difference has considerable practical consequences. The change from the global level to the local is not just a transposition of the same but always implies transformations. The phrase "application of generally available knowledge" (i.e. global knowledge) tend to shroud both the complex processes of transformation and adaptation and their individual and organisational preconditions. The ability to render global, e.g. technological knowledge useful in and for specific local circumstances *always* presupposes not only professional "literacy" as for the respective technological discipline but also contextual experience and practical knowledge – that is, knowledge and know-how concerning the local (cultural, technological, financial, etc) possibilities and needs.[2] This competence is fundamental for an organisation's transformative capabilities.

Transformation of global knowledge in local settings proceeds as contextualisation, that is, the global knowledge is not simply replicated locally (cf. Zollo & Winter, 2002) but it has to be translated according to local conditions which may include both (re-) codification and practical adoption "by using".[3] And this in turn may necessitate transforming and orchestrating of competencies and resources available in the firms capital – human as well as material.

Configurational capabilities

constitute enduring ability to synthesise novelty by creating new configurations of knowledge, artefacts and actors. There are at least three aspects of configurational capabilities.

(a) For once, integrating over dispersed knowledge bases and areas: Success in innovation is in principle to a large extent based on the "*synthesising competence*" (Bender, 2005) of actors, that is, on their ability to tap distributed knowledge and know-how from totally different areas and to recombine them creatively. This may include knowledge embodied in hard- and software, it may be scientific knowledge, design competence, or expertise in logistics, it may be codified knowledge or tacit knowledge incorporated in individuals or teams. This may also include mixes of science based knowledge with tacitness and crafts as well as mixing different scientific disciplines as is discussed in Gibbons et al (1994).

Although most of the technologies used in industry are well known in general as well as in most of their details since years or decades – what counts is often the precision and speed of a new architecture perhaps only marginally different from another one. This may be illustrated from pulp & paper industry where since long well known different technologies are integrated into large scale systems (Laestadius, 1998b). This configuration out of different technologies or systems – although unique in its details – may normally be too small in technological terms to be identified as "innovation". For those who master the system, however, these details may constitute the difference between high profitability and average performance. It may be argued that to a large extent this synthesising activity across different technologies and knowledge fields is what qualified

[1] This is what makes global knowledge – different from local knowledge – easily transferable in principle; global knowledge is by definition mobile.

[2] This is why an attempt would not make very much sense to characterise LMT industries as being dominated by practical knowledge as opposed to high-tech industries which are allegedly dominated by codified knowledge. The latter might be a useful starting point for a description of Science as a specifically organized societal system; but not to explain acts of doing science, that is research, and even less so to explain industrial R&D processes. To contrast practices of innovation in LMT companies with such a stylised picture of Science would be similar to an attempt to compare apples and oranges (strictly speaking apples and a particular picture of oranges).

[3] Cf. for instance the analysis by Collins (1985) on replication of scientific practice.

engineering is about.[1] We may here identify a dichotomy between analytical competence on the one hand – that is, being able to identify technological concepts or equipment that are potentially relevant to one's own business – and synthetic competence – being able to transform and rearrange them creatively – on the other (cf. Laestadius, 1998b).

(b) The other dimension of configurational capabilities – empirically interwoven with the first – is an *organisational* one: the enduring ability not only to combine pieces of knowledge and technology but also to link actors together who possess relevant knowledge, technology and competence. That is, configurational capabilities include an organisation's aptitude to efficiently provide for access to and use of distributed sources of relevant knowledge and competence; this may involve the ability to cooperate with external R&D facilities or design labs as well as an organisation's competence to timely and flexibly manage logistics.

(c) The third dimension of configurational capabilities is *design*. The design discourse spans over a wide domain including narrow as well as broad interpretations of concepts like function and form and their interrelationships. It also spans over professions from artists to engineers and over activities from styling to the configuration of complex systems. There is, for the purpose of our research, no need to analyse this design discourse in depth (cf. eg. Alexander, 1964; Julien, 2000; Simon, 1996). Of importance is that the act of creation performed by designers and by engineers to a large extent belong to the same realm. The aim of their activities is the creation of a new physical order, or organisation – what Alexander (1964) labels form – in response to function. The basic idea, thus, is to achieve fitness between two entities: the form and its context (e.g. between the car and the consumers or traffic regulation authorities). This act of creativity, i.e. configuring and modifying artefacts to meet certain needs and expectations, with no necessary relation to recent scientific advances is an important activity all over the innovation process (cf. Kline & Rosenberg, 1986). In fact it is, again, very close to what we may include in the original Schumpeterian (1911) innovation concept although we have no indications that Schumpeter himself was aware of that aspect.

The basic reason for including design as a discrete analytical dimension of configurational capability is simple: it seems that the variety of the design concept can be captured within the notion of configuration, thus eliminating problems of drawing strong analytical borders between design, engineering, logistics etc. Our notion configurational capabilities has in addition family resemblance with "combinative capability" introduced by Kogut & Zander (1992) which they explain as generating new applications from existing knowledge.[2]

We may conclude this discussion with a pointed reformulation of the basic practical problem for innovators: The major task is not necessarily to develop and/or apply latest technological knowledge but innovation always entails the creation and management of sustainable new configurations of various types of knowledge, actors and artefacts. And an organisational precondition of this is the creation and reproduction of appropriate innovation enabling capabilities in the sense just explicated.

Our discussion here has a clear connection to the problems described by Henderson & Clark (1990) related to architectural innovations. They show how certain ways of doing things tend to crystallise into organisational structures, information filters, and communication channels which, on the whole, shape an organisation's capabilities. They also highlight the problems incumbent firms face when confronted with architectural innovations. We argue that what they describe is not a specific threat when you take into account that innovation to a large extent is about reconfiguring existing knowledge, components and actors.

4. Solving the accountancy problem - towards a new set of indicators

As shown by Faulkner (1994) knowledge formation related to industrial innovation is far wider than what is normally included in R&D: the distinction between knowledge, related to design practice, and knowledge related to experimental R&D is of special interest. Design in different forms is the core activity also in the innovation model introduced by Kline & Rosenberg (1986).

[1] This also provides an engineering perspective on the mode 2 concept developed by Gibbons et al (1994). Engineers have for a long time developed their industrial innovations – whether product or process related – across the disciplines of natural sciences and parts of engineering sciences as well. It may be the case that the scientific division of labour has increased the specialisation of disciplines – although Gibbons et al do not provide much empirical evidence on this – but the mode 2 phenomenon as such is far from new on the planet, neither is its consequences for engineering.

[2] This is also very close to what innovative entrepreneurs do in Schumpeter (1911).

Explicitly including *a design concept* into the analysis of innovative activities does not immediately simplify analytical work. In short the discourse includes definitions focusing on aesthetics (adding aesthetic measures – or even functions - to objects) as well as focusing on the creation of the object itself (roughly "engineering"). The aim of the design process is to create *fitness*. From this perspective the design process may be looked upon as a *synthesizing activity*, a creative problem solving act, where different fields of knowledge and sub systems are modified and integrated into a new entity – a physical or virtual artefact. (cf. Simon, 1996).

A broad design concept, spanning from "adding aesthetics to the object" to "creating the object itself", complicates the dominant definition of innovations in general and of R&D in particular. An independent definition of a design concept will include parts of what hitherto has been included in the "D" part of "R&D". It may even be argued that most of the intentional creation of artifacts that characterizes engineering should be included in the design concept rather than in the (experimental) "R&D" concept.

Explicitly adding design as a category in innovation related typologies may necessitate a redefinition of R&D as it is presently identified in the Frascati Manual (OECD, 2002a). In that manual, "D" stands for "experimental development". The relation of that concept to design (which is not explicitly defined) is discussed on several places and it is concluded that the bulk of industrial design activities should be excluded from "R&D". It may, however be argued that good design to a large extent is experimental in its character. We may thus argue that some experimental activities may be classified as design as well as R&D in a revised typology. As a by-product we may obtain a somewhat more precise – and narrow - R&D concept.

Introducing design will also impact on the presently used innovation concept in the Oslo Manual (OECD, 1997). The implication of the intentional focus in the Oslo Manual on technological product and process innovations new (at least) to the firm is that much of design activity is excluded. "Technological" in the vocabulary of the Oslo Manual relates to the "objective" performance of products or processes thus locating "subjective" performance related activities to the non-innovation realm. In short: adding a "design category" to "R&D" and "innovation" will significantly increase our abilities to capture industrial creativity although parts of what will be captured in the "design net" will be reallocated from what is already captured in the "R&D (or Frascati) net" or in the "innovation (or Oslo) net". Design data may well be collected in the same way as R&D and CIS data are collected today.

This simple widening of the innovation concept and redefinition of "D" in R&D may impact on the classification of firms as well as of some industries. The impact on industry level should, however, not be overemphasized. As is discussed below, there is strong variety within industries.

Based on our discussion above and inspired by Baldwin and Gellatly (1998 & 1999) among others the PILOT project suggested a system with several indicators rather than one. B&G introduced a set of three: *innovation competencies*, *technological competencies* and *skills* respectively. Each indicator is based on a set of 5 – 10 criteria (variables) which may be collected using a five point Likert scale. The details of the variables in their approach is of less importance than their approach as a whole. In short only the first indicator (innovation competence) is similar to the traditional innovation concept. The second one – technological competence – has no explicit connection to innovation at all but may be looked upon as related to a capability approach. This indicator identifies competencies in developing, importing, acquiring, purchasing and integrating new technologies in their processes. The third indicator in the Baldwin & Gellatly system is focussing on human capital development, on the creation of skills etc. It may be argued that an indicator like this, if well developed, may catch the professionalism and skill based customized activities which may make KIBS firms successful even if they do not innovate in traditional sense.[1]

Integrating the B&G approach with the PILOT framework opens for a system with six indicators. Firms may be classified according to their:

- R&D intensity
- Design intensity
- Technological intensity
- Skill intensity (Human capital orientation)

[1] This searching for a skills related indicator is fully in line with ambitions within the European Trend Chart on Innovation work (cf. Lorenz, no date)

- Innovation intensity
- Organizational innovativeness

The sixth indicator is maybe somewhat less obvious than the other. The empirical results from the PILOT cases, however, indicate that many of the successful low-tech firms have developed advanced logistical capabilities; capabilities which sometimes seem to be part of their core competencies. There may thus be a strong case for including organizational skills/creativity as a sixth indicator rather than including it in the innovation intensity indicator.

These indicators may together make up a profile for the individual firm and/or for an aggregate of firms, e.g. an industry or a "sector" aggregate of different industries (e.g. the "ICT-sector" or the "technological system for pulp and paper"). They may require different sets of questions or data. The R&D intensity indicator is probably the most obvious: we may here stick to a revised – and a more narrow version of the Frascati manual. As regards design intensity we may include a broad design concept including parts of what hitherto has been included in the D of R&D. As a result of that reallocation of design activities, R&D intensity will, ceteris paribus, decline in the statistics. In addition the broadening of the design concept may have consequences for what aspects should be included in the new innovation intensity and thus have some impact on the further revisions of the Oslo Manual (OECD, 1997).[1]

This system of indicators is not a typology – or taxonomy - of the classical kind (cf. Bailey, 1994) forming a conceptual world which is exhaustive and/or exclusive. We do not have to assume that these indicators are the only valid ones. Neither do we have to assume that firms/industries are either "R&D intensive" or "Design intensive"; individual firms may score high/low in all or one of the indicators above. The basic assumption is that these indicators together will capture the bulk of creativity explaining successful firms and industries and showing the *variety* in all economic sectors.

The six entries above are not even necessarily exclusively defined. Some data collected for the formulation of "design intensity" may – depending on our definitions - be similar or identical to those needed for specifying "technology intensity". Purchasing e.g. a design solution to a process from a consultant may be reported as acquisition of design as well as captured as integrating foreign technology to own processes. And parts of R&D activities may, depending on how innovation intensity is defined, be included also in the innovation intensity indicator.[2]

Obviously there are two main paths two follow in the practical work on these indicators: either a) accepting this as a *family of indicators* telling different stories on the same phenomenon but not possible or reasonable to aggregate or b) to make them totally exclusive – i.e. locating all relevant activities to one and only one of the indices above - thus making it possible to aggregate them also to one single *composite indicator*. If overlaps are small, these may be neglected in the aggregating exercises.

The primary arguments for the construction of composite indicators – of which the already existing European Innovation Scoreboard, the Summary Innovation Index (SII) and Innovation Sector Index (ISI) are good illustrations (see ETCI, 2004b; EC, 2004 & ETCI, 2004a) – are the strive for simplicity and maybe also for *community creation* (cf. Laestadius, 2005b). As regards simplicity, one-dimensional indicators like the OECD high-tech/low-tech indicator have obvious pedagogical advantages: people remember them, react on them and (at least believe that) they can identify the meaning of them. As regards community creation it may be argued that a simple one dimensional indicator with related typology/taxonomy can be identified as a focal point for orchestrated political action: we can all unite on transforming Europe to a high-tech knowledge based economy.

There are, however, strong arguments favouring a family of related indicators rather than focusing on a composite solution. From a data acquisition point of view the problem is probably non-existent. The basic argument is related to *the need to capture the variety as regards creativity* which may exist between firms within different industries and countries. Just adding one or two variables on design to an aggregate innovation index will not capture the variety which exists within and between industries.

1 It may be argued that still another indicator is necessary, i.e. an indicator catching core data on sustainability issues. Such an indicator was not explicitly dealt with in the PILOT project. A sustainability indicator may reveal if firms/industries, which score high on "normal" indices also may be sustainable in the long run.

2 This phenomenon is, by the way, not new for innovation surveyors. The European Innovation Sector Index (ISI) eg. contains a variable on innovation expenditures as a percentage of total turnover (based on CIS 3 data) which partly overlaps with the indicators on investments in machinery and equipment and R&D expenditures (ETCI, 2004a)

A set of, say, six different indicators which aim to capture different aspects of industrial creativity must in addition not necessarily consist of totally exclusive indicators. In addition it may be argued that composite indexes, depending on how they are constructed, may not only provide different pictures but also hide real problems (cf. Grupp & Mogee, 2004).

Some of these indicators – like R&D intensity, design intensity and technological intensity - will include activities which can be measured in cost terms and related to sales, production or value added. We may here include data not only on activities performed within firms but also on acquisitions and sales between organisational entities. R&D intensity may thus be measured with the amount of R&D performed in the firm as well as the amount purchased by e.g. a KIBS firm. Sales of R&D work should be treated similarly. Design intensity may, likewise, be defined not only based on activities performed within the firm but also on the design services bought from, or sold to, external actors. One implication of this is that firms may be asked to classify parts of their knowledge related transactions and make them available for future innovation surveys or other means of data acquisition. This in line with the arguments once put forward by Cohen & Levinthal (1990). Firms which buy/acquire design solutions and R&D may indicate an absorptive capacity to transform knowledge into profitable activities as well as it may indicate networking in knowledge formation.

Indicators like these may, under certain circumstances, show problems of aggregation as some data may appear in several firms and industries. (Two firms may, e.g. acquire the same technology from a third firm.) Those problems have to be considered but are probably not severe. The suggested system of indicators may potentially capture the innovativeness of networks and inter-firm relations; a problem which for a long time has been identified by innovation researchers (e.g. Scherer, 1982 & Coombs, et al, 2001).

The present industrial classification system is not well equipped to catch the fundamental phenomena of the modern knowledge based economy. Especially service sectors are poorly developed and bluntly identified which is problematic in an epoch when much of creative activities are outsourced to KIBS firms or – which is the mirror image of this process – when manufacturing firms outsource their manufacturing activities thus transforming themselves into service firms. The broadening of the innovation/creativity concept as suggested here will make innovation analyses more relevant for more firms and industries than hitherto.

Testing the suggested family of indicators

The suggested family of indicators has been tentatively tested on Norwegian data. Especially if the ambition is to introduce a new system of indicators as a substitute for an older and much criticized system it is important to analyze the usefulness and limitations of the new system. Our test was only partly possible as available data were collected according to existing standards and thus not fully captured the new dimensions suggested in the PILOT approach. This is not a big problem, however. The aim of PILOT was not to provide new data series but to illustrate that there are alternatives which may provide different information compared to the dominating indicators even when using existing data.

Within PILOT the "fitness" of Norwegian data – most of them from the CIS-3 round - into the suggested system was analyzed. The reason for using data from Norway (with its a-typical oil industry) only was simple: recent European data were not available on the same level of aggregation as the data necessary for the detailed analysis.

The test methodology was simple. For each of the six indicators in the model, as developed above, we chose a few reasonably close variables among those that are available from primarily the CIS-3 round. We did not aggregate them to a composite R&D or design indicator. The intention was to show the variety – and similarities – within and between industries using this approach. It should be reminded that the use of existing data limits the opportunities to draw in depth conclusion on industry (and firm) behaviour. The results were clear however (cf. Laestadius, Pedersen & Sandven, 2005): although some indices may show similarities to the established ones others provided totally different and challenging results; identifying other signs of creativity and innovativeness. The next logical step – beyond the PILOT project - should be to define the detailed content of each of the six indicators; and we are sure they would deviate from the preliminary exercise – with limited data availability – performed in PILOT.

5. Concluding reflections on the suggested indicators

Basically the work of PILOT is in line with much of recent attempts from innovation researchers in their striving to reduce the high-tech and manufacturing bias in data acquisition and policy documents. On one important point there is a difference, however. Returning to the original Schumpeterian thought world the PILOT explicitly accept that innovative capabilities – we may as well label them dynamic – is what firms reveal as long as they are profitable. The implications from that is that the PILOT approach gives no a priori priority to science based creativity before non-science based, no priority to technological creativity before non-technological, no priority to global uniqueness before local uniqueness. What counts in this world is that firms can create a profitable diversified niche of reasonable duration. And that is what should be captured by analysts!

This creates a new starting point for innovation researchers. Several – not all – of the paradoxes as regards bad fitness between innovation input (as hitherto recorded) and output (and growth) disappear. The many discussions on what constitutes an innovation, on what we mean with technological height or technological innovation or how to discriminate industrial/technical design from other design categories can be reduced.

The PILOT approach assumes – in line with modern evolutionary theory – that there is, or may be, significant variety between firms and thus within as well as between industries. We argue that to understand the mechanisms of industrial creativity it is necessary to capture that variety. As is argued in the PILOT project, the variety within the non-high-technological sectors of the European economy is much more important than what is recognized using the traditional OECD technology-intensity indices or even the CIS-based composite indices hitherto produced within the European Union.

PILOT has shown that an indicator family of six indicators on industrial creativity and innovativeness based on already available data reveals significant aspects of the kind of variety that is important to understand when transforming Europe into a knowledge-based society. If left to European statisticians for further refinement in coming community innovation studies this family of indicators may be significantly improved. As we have shown, it is our conjecture that reducing the indicators to one composite innovation indicator – which is the present tradition within Europe - will reduce its value as analytic instrument and foundation for policy making. Such a behaviour will also preserve the outdated view on what is an innovation, and what kind of activity that is high-tech or low-tech and – not the least – what kind of creativity and which sectors do contribute to growth.

The innovation concept has obtained a free floating position in the discourses of analysts as well as policy makers; the original meaning of the concept is more or less forgotten and "innovation" is nowadays a "Denknotwendigkeit" which conditions our thinking and analytical work. Now, when we face that Asian firms compete with European firms in high-tech industries as well as in low-tech, is the time to analyze our concepts in detail and to evaluate whether the innovation concept could be widened to include those neglected aspects of professional and organizational skills, knowledge formation, design and creativity which – in addition to R&D – create the foundation for a profitable economy.

6. References

This paper is to a large extent based on the collective work of PILOT colleagues and primarily on the following sources:

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All references in this paper refer to the reference list in the third paper listed above.

SECTOR STUDIES

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Abstract

The presentation will address the experiences gathered while producing and using CIS data for academic studies and policy consulting. This will be done with particular reference to the "Innovation Watch - Systematic" project which runs under the Europe-Innova Initiative and which will analyse different dimensions of sectoral innovation systems. Access to CIS3 and CIS4 data is crucial for the research questions to be tackled in this project. The presentation outlines the planned use and the already encountered challenges and problems of CIS data users.

CROSS-COUNTRY ECONOMETRIC ANALYSIS USING CIS-DATA

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Abstract

The presentation reports cross-country econometric analysis using CIS-data in two steps. The ideas presented here are derived from a number of cross country studies using CIS-data carried out by the author[1].

Step 1 – An Example

The first step illustrates an example of cross-country analysis using CIS-data.

In the recent years foreign ownership issues have sparked both academic and policy attention. Foreign ownership of domestic companies is an issue on the global scale.

This step investigates whether foreign owned companies in small (open) economies reveal a different pattern of innovation activities and performance. The discussion bases on a number of cross-country comparisons[2] and individual country analysis[3] also summarized in Ebersberger, Dachs and Lööf (2007). The analysis compiled here covers Austria, Denmark, Finland, Iceland, Norway and Sweden and bases on CIS 3 data.

The analysis investigates whether foreign owned companies differ systematically in their innovation input, their innovation output, their innovation behaviour (collaboration and search for new ideas) and their productivity. The econometric techniques applied on each of the national CIS data sets are Heckman-selection models, multi-equation models following Crepon, Duguet and Mairesse (1998) and microeconometric matching techniques.

The general pattern in the Heckman-selection models of the analyzed countries is that foreign ownership has no (robust) effect on innovation input. After controlling for various firm level characteristics, foreign owned companies show a higher innovation output and higher (labor-) productivity. The results from the (more complex) multi-equation models are not that clear.

Step 2 – General observations

The second step discusses the ideas and targets, advantages, problems, short-comings of cross-country econometric analysis. The second step also suggests a direction for further research and methodological extensions of the common approaches to cross-country comparisons.

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1 Ebersberger and Lööf (2004, 2005), Ebersberger, Johansson and Lööf (2007), Ebersberger, Dachs and Lööf (2007), Ebersberger, Marsili, Reichstein, Salter (2006), Czarnitzki, Ebersberger and Fier (2004, 2007), Ebersberger, Dachs and Pyka (2004)

2 Ebersberger and Lööf (2004, 2005), Ebersberger, Johansson and Lööf (2007)

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ORGANISATIONAL INNOVATION – THE CHALLENGE OF MEASURING NON-TECHNICAL INNOVATION IN LARGE SCALE SURVEYS

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Executive Summary

In the current scientific debate the term "innovation" is predominantly linked to research and development (R&D) in order to create new products. There are many studies on innovation revealing that increased R&D activities lead to innovative products which enable companies to achieve competitive advantages and to gain market shares (e.g. Freeman and Soete, 1997). As a consequence, an increasing number of economies started to invest in an R&D-based innovation policy. In regard to R&D investment, particularly some fast developing countries have gained on the traditional European countries, the US and Japan, who lost their competitive advantages in some fields of product innovation.

Hence, during the last decades companies, policy-makers and researchers in Europe, the US and Japan have been searching more thoroughly for accompanying measures to flank their R&D-based strategy by innovation activities in additional fields to maintain and respectively regain their lead in innovation. This search has been reviving the Schumpeterian definition of innovation. Following Schumpeter (1934) at least four types of innovation can be identified. He differentiates between product and process innovations and technical and non-technical innovations (see also Anderson and King, 1993; Damanpour and Evan, 1984; Totterdell et al., 2002): (1) technical *product innovations*, (2) technical *process innovations*, (3) non-technical *service innovations*, and (4) non-technical process innovations, understood as *organisational innovations*.

The measurement of technical *product innovations* is based on a commonly agreed definition which is described in the Frascati Manual (OECD, 2002) and has come to a methodological standardisation and harmonisation when officially surveying and comparing enterprises at European or international level (OECD, 2005; OECD, 2002; European Innovation Scoreboard; Community Innovation Survey; Grupp and Mogee, 2004). Meanwhile, the scientific debate has intensified in two further fields of innovation. In this context, the Oslo Manual (OECD, 2005) as well as Battisti and Stoneman (2005) have made valuable contributions to the field of measuring technical *process innovations*. Further, there is an ongoing discussion about first approaches of methodological considerations to monitor non-technical service innovations (Drejer, 2004; Hipp and Grupp, 2005; Miles, 2005).

However, there have been little conceptual and methodological contributions to the monitoring of *organisational innovations* so far. Organisational innovations in this definition comprise changes in structure and processes of an organisation by implementing new managerial and working concepts and practices, such as the implementation of team work in production, performance-based wage systems or just-in-time concepts (OECD, 2005; Damanpour, 1987; Damanpour and Evan, 1984).

The importance of organisational innovation for competitiveness has been proven by several studies analysing the impact of organisational innovations on business performance (Caroli and van Reenen, 2001; Damanpour et al. 1989; Greenan, 2003; Piva and Vivarelli, 2002). These studies point to two different results. First, organisational innovations act as prerequisites and facilitators of an efficient use of technical product and process innovations as their success depends on the degree to which the organisational structures and processes respond to the use of these new technologies. Second, organisational innovations present an immediate source of competitive advantage since they themselves have an important impact on business performance in regard to productivity, lead times, quality and flexibility (e.g. Womack et al., 1990; Hammer and Champy, 1993; Goldman et al., 1995).

Although these studies have evidenced the importance of organisational innovations for business performance, the defining and measuring of organisational innovation still lags behind. Different interpretations are associated with the term "organisational innovation" and the lack of a generally accepted definition causes difficulties in designing and implementing measures and indicators that sustain validity on wide coverage (Lam, 2005).

This paper aims to undertake first steps to fill such a gap by tackling both issues, the definition and the measurement of organisational innovation. Based on an item-oriented typology of organisational innovations, serving as precondition for a common understanding, we describe and compare how organisational innovation has been measured in several existing surveys in Europe. Using a large-scale survey comprising data of 1 450 German manufacturing companies, we show how these different approaches lead to significantly different results regarding the organisational innovativeness of companies within one and the same sample. We derive four implications for the future measurement and monitoring of organisational innovations. Our findings contribute to the further development of an adequate methodology for an organisational innovation monitoring system. Parts of the results of this study have been developed in the EU project PORCH (Patterns of Organisational Change) issued by the DG Enterprise and Industry.

1. Definition of organizational innovation

The existing literature on organizational innovation is diverse and scattered. There is no consensus on a definition of the term "organizational innovation", which remains ambiguous (Lam, 2005). Different areas of research are developing their own approaches to understand the complex phenomenon of organizational innovation.

A first literature strand focuses on the identification of the structural characteristics of an innovative organization and its effects on product and technical process innovations (Burns and Stalker, 1961; Mintzberg, 1979; Teece, 1998).

A second literature strand, theories of organizational change and development, aims to analyze and understand how organizations change. This field of research covers models of different stages of how organizational change may occur (e.g. Greiner, 1967; Hannan and Freeman, 1977; 1984) as well as classifications of different types of organizational changes from evolutionary to revolutionary (e.g. Levy and Merry, 1986). It aims at understanding the resistance to organizational change and how to overcome the inertia of organizations enabling them to adapt to changing environments and technologies (e.g. Lewin, 1958; Lawrence, 1954).

A third strand of literature focuses on how organizational innovations are emerging, developing and enhancing at the micro level, within the organization. Theories of organizational cognition and learning (e.g. Argyris and Schön, 1978; Duncan and Weiss, 1978) as well as of organizational creativity (e.g. Amabile, 1988) are in the focus of this strand.

All these research approaches understand organizational innovation either as a necessary adaptation to the introduction of new technologies or as a precondition for successful product or technical process innovations. They try to understand how and under which circumstances organizations change. Thereto they analyze triggers and the paths companies then take to achieve a structure increasingly capable of continuous problem solving and innovation. However, the resulting status of the so converted organization as well as the concrete new elements of managerial and work practice are not in the focus of theses approaches, making it difficult to compare and measure the results of organizational innovations.

The independent contribution of organizational innovations to a superior performance and competitiveness of an organization is, at least partially, neglected. However, in the late 1980s MIT's study of the automobile industries in Japan, USA and Germany turned the attention of researchers and managers to organizational innovations as a driving factor for companies' competitiveness (Womack et al., 1990). Under the label "lean production", Womack et al. subsumed an integrated variety of new organizational concepts such as team work, job enrichment and enlargement, decentralization of planning, operating and controlling functions, manufacturing cells, quality circles, continuous improvement processes, zero buffer principles (kanban), simultaneous engineering and just in time delivery, which they discovered to be the main cause for the superiority of the Japanese car industry at this time.

In the following, a field of related managerial approaches like "business reengineering" (Hammer and Champy, 1993), "total quality management" (Ishikawa, 1985), the "fractal factory" (Warnecke, 1992), the "modular factory" (Wildemann, 1992), the "intelligent organization" (Pinchot and Pinchot, 1993), the "agile enterprise" (Goldman et al., 1995), "cellular forms" (Miles and Snow, 1997) or the "N-form corporation" (Hedlund, 1994) were introduced or became broadly known, promising to guide the reorganization of companies to achieve significantly better performance indicators regarding productivity, quality and flexibility.

Most of the concrete organizational concepts like manufacturing cells or team work can be found in almost all of these integrated managerial approaches. The labels of the latter were used to highlight the one and most important key factor of business success. Sometimes this led to a misinterpretation of these approaches as simple remedies for deeper and more intractable problems. Consequently, the labels, used to characterize the organizational innovations, became fashion fads with hardly separable contents and ever shorter shelf life (Kieser, 1996). On the other hand, labels, such as "lean production" or "agile enterprise", can be useful to lend new energy to the collective enterprise's attempt to adopt organizational innovations, if not revolutionary then at least evolutionary (Eccles and Nohria, 1992).

Regardless of the interpretation of managerial approaches' labels as fashions or enablers of reorganization, it is widely proven that the adoption of concrete organizational concepts has a paramount impact on the ability of a company to improve its performance (e.g. Caroli and van Reenen, 2001; Damanpour et al. 1989; Greenan, 2003; Piva and Vivarelli, 2002). For the measuring and monitoring of adoption and performance impact of organizational innovations it is therefore necessary to understand them on a conceptual level, as implementation of new and concrete organizational concepts. Thus, we define organizational innovation as the use of new managerial and working concepts and practices (Damanpour, 1987; Damanpour and Evan, 1984). With this definition it is possible to measure not only whether companies have changed their organization (structure and processes) within a defined time period. Also analysis of adoption ratios of concrete organizational concepts in different companies and company types (sector, firm size, etc.) and the extent of use within the company can be provided. They serve as an indicator for the intrafirm diffusion of different organizational practices.

Yet, some attempts have been made to cluster and classify different types of organizational concepts under certain categories (e.g. Coriat, 2001; Wengel et al., 2000; Whittington et al., 1999). Based on these approaches, organizational innovation can be differentiated into *structural* organizational innovations and *procedural* organizational innovations.

Structural organizational innovations influence, change and improve responsibilities, accountability, command lines and information flows as well as the number of hierarchical levels, the divisional structure of functions (research and development, production, human resources, financing etc.), or the separation between line and support functions. Such structural organizational innovations are for instance the implementation of (cross-functional) teams or the change from an organizational structure of functions (product development, production, human resources etc.) into one of product- or customer-oriented lines, segments, divisions or business units.

On the other hand, *procedural organizational innovations* affect the routines, processes and operations of a company. Thus, these innovations change or implement new procedures and processes within the company, such as simultaneous engineering or zero-buffer-rules. They may influence the speed and flexibility of production (e.g. just-in-time concepts) or the quality of production (e.g. continuous improvement process, quality circles).

Organizational innovation can be further differentiated into an *intra-organizational* and *inter-organizational* dimension. While intra-organizational innovations occur within an organization or company, *inter-organizational innovations* include new organizational structures or procedures beyond a company's border. This comprises new organizational structures in an organization's environment, such as R&D cooperation with customers or other forms, just-in-time processes with suppliers or customers or supply chain management practices with suppliers.

Intra-organizational innovations may concern particular departments respectively functions or may effect the overall structure and strategy of the company as a whole. Examples for intra-organizational innovations are the implementation of team work, quality circles, continuous improvement processes or the certification of a company according to ISO 9000.

It is obvious that there is a vast variety of organizational innovations differing in terms of type and focus of these concepts. Based on the examples provided in figure 1 it becomes clear that the proposed categorization is of analytical nature. In reality, most innovative organizational concepts address different aspects of business performance at the same time. They may contribute to several business strategies, requiring the use of specific performance indicators to analyze their impacts (see section 4.1).

Figure 1: An item-oriented typology of organizational innovations

Type of Organisational Innovation	Focus of Organisational Innovation: Intra-Organisational	Focus of Organisational Innovation: Inter-Organisational
Structural Innov.	• Team work in production • Cross -functional teams • Decentralisation of planning, operating and controlling functions • Manufacturing cells or segments • Reduction of hierarchical levels • ...	• Cooperation/networks alliances (R&D, production, service, sales, etc.) • Make or buy/Outsourcing • Offshoring/relocation • ...
Procedural Innov.	• Job enrichment/job enlargement • Simultaneous engineering/concurrent engineering • Continuous Improvement Process/Kaizen • Quality circles • Quality audits/certification (ISO) • Environmental audits (ISO) • Zero -buffer -principles (KANBAN) • Preventative maintenance • ...	• Just in time (to customers, with suppliers) • Single/dual sourcing • Supply chain management • Customer quality audits • ...

2. Surveying organizational innovations

Hand in hand with the emerging awareness of the importance of organizational innovation for industrial competitiveness, several efforts have been made to include this topic in innovation surveys during the past ten years. In the following chapter some of these attempts will be presented. This overview aims to introduce the objectives and the different methodological approaches which were chosen to cover organizational innovation in large scale inquiries. Against this background some key questions for designing a monitoring and measurement concept of organizational innovations can be derived.

2.1 NUTEK Survey "Towards Flexible Organizations"

In the framework of the OECD study "Technological and Organizational Change and Labour Demand: Flexible Enterprises – Human Resource Implications" the Swedish National Board for Industrial and Technical Development (NUTEK) decided to analyze the situation in the Swedish economy in the mid 1990s. The aim of this study was to increase awareness towards the importance of modern work organization, so-called flexible work organizations, and to contribute to their diffusion throughout Swedish economy (NUTEK, 1996).

To provide the data for this study a survey was launched covering more than 700 establishments with at least 50 employees in Sweden. They included companies out of the NACE sections Mining and Manufacturing, Construction, Retail, Wholesale, Hotels and Restaurants, Transport and Communication and other business activities including finance and real estate. The survey was conducted in 1995 by sending a written questionnaire to "the executive in charge".

The survey questionnaire was divided into three main sections and collected information as follows. In the first part the questionnaire asked for a *description of the present organization* in terms of staff and qualification, work organization, technology and product/service development as well as external relations. Within the subsection concerning work organization, the relative importance of continuous improvement, total quality management, ISO 9000, just-in-time and other concepts was to be evaluated as "not", "slightly" or "very important".

The second section had *organizational changes in the 1990's* as its topic, gathering information about important changes in the organization of the work place on a generic level without specifying any typology ("Has there been an important change of the organization of the work place during the 1990's" with possible responses "yes/is being implemented/no", for each of the five years 1990-1994. However, the survey went deeper into the subject when asking about the inspiration to implement the changes, computers as a contributory reason, lack of financial resources, influencing factors, employees affected, training and institutional support).

The last part of the survey aimed to gather data on *financial results for the year 1994* differentiating between revenues and expenditures, employee costs, fixed capital, and other related topics.

2.2 DRUID Project "DISCO"

Influenced by the NUTEK questionnaire, the **D**anish **R**esearch **U**nit for **I**ndustrial **D**ynamics (DRUID) developed its own survey within the Project **D**anish **I**nnovation **S**ystem in a **CO**mparative Perspective (DISCO), focusing mainly on flexibility understood as the ability of firm to react to a turbulent environment by developing new products and new technological processes on the basis of integrative organizational forms and a culture oriented towards renewal and learning (Lund, 1998). Technological innovations and human resources represent the pillar of this methodology.

The questionnaire, sent out in 1996, addressed Danish private enterprises with 10 and more employees within manufacturing, service and construction. 1 900 firms participated in this survey.

Regarding organizational innovations the survey wanted to know "Has the firm carried through important organizational changes during the period 1993-1995?" with affirmative and negative response possibility. With a further question "Has the firm extended its use of the following organizational traits during the period 1993-1995?" more detailed information was collected about delegation of responsibility, cross occupational working groups, quality circles, integration of functions, wages, job rotation and systems on how to collect proposals from employees (Lundvall and Kristensen, 1997). This design and phrasing of the questions enabled the DISCO survey to specify the share of the industry that changed specific organizational practices (e.g. delegating responsibility, implementing cross occupational working groups, installing quality circles).

2.3 EPOC Survey

At the same time as the DISCO survey, the EPOC inquiry was initiated as part of a project commissioned by the European Foundation for the Improvement of Living and Working Conditions (European Foundation, 1997). This project aimed to investigate direct **e**mployee **p**articipation in **organizational c**hange (EPOC). The EPOC survey was meant to provide empirical data on the extent of diffusion of direct employee participation in European economy.

In 1996 the EPOC questionnaire was sent out to enterprises in 10 European countries (DK, DE, FR, UK, IE, IT, NL, PT, ES and SW). 5 786 responding firms sent back a filled in questionnaire.

The survey focused on gathering information on the diffusion of main forms of participation. These main forms of participation are closely interlinked with specific organizational practices: individual consultation "face-to-face", as a first form of direct participation, has its organizational background in the implementation of regular discussions between employee and manager. Individual consultation "at arm's length", for example, refers to the organizational form of suggestion schemes. Group consultation with temporary groups signifies the introduction of project groups or task forces. Group consultations with permanent groups can be organizationally realized as quality circles. Group delegation organizationally means the implementation of team work.

The managers were to declare if they had put these forms of direct participation into practice or not. If so, they were to give information on how many years they had been utilizing them, which specific characteristics were involved, which reasons they had for introducing these practices and what consequences these concepts had on qualification and remuneration of employees. Additionally, the respondents were asked if they saw any impact of direct participation on cost reduction, reduction of throughput times, improvement of quality and other impact categories.

By the methodological approach summarized above the EPOC inquiry did not ask for the existence of different forms of work organization by using "labels", but concluded from asking for forms of direct participation to the existence of specific work organization concepts. On the other hand the survey did not ask for changes in the last years, but tried to get information about the existence of direct participation irrespectively to the year of realization.

2.4 The INNFORM survey

In 1997, as part of the so called "INNFORM project", another international survey dealing with organizational innovation was launched. The INNFORM project was funded by the Economic and Social Research Council in the UK and comprised research activities in Europe, Japan and the US (Whittington et al., 1999). The objective of the INNFORM project was to map the contours of contemporary organizational innovation, to examine the management practices and to test for the performance benefits of these changes. In order to tackle these issues the researchers developed a survey instrument, which was deployed in the UK and western European countries. About 500 firms participated in this survey.

The questionnaire addressed organizational and managerial innovation on three levels: unit, organizational and inter organizational level (Stoneman, 1999). The survey methodology was to serve as a standardized measuring instrument for all regions with no attempt of imposing a generally applicable methodology, even less in the actual landscape of theoretical diversity and empirical incompleteness (Pettigrew et al., 2003).

The survey includes a large number of questions exploring organizational innovations. These are split into several categories. First company structure is explored i.e. the number of senior managers reporting to the chief executive, the number of organizational levels between the manager with the lowest level of profit responsibility and the chief executive and the number of profit centers. Second, sub unit autonomy is addressed, i.e. the degree of discretion given to sub unit managers with regard to operating activities. Third, corporate controls are inquired i.e. the degree to which strategic decisions are in the responsibility of corporate HQ, the use of business performance indicators as targets and linkages between sub units and HQ. Fourth, systems in place are examined, in particular the extent to which the company has a common strategy for IT and its acquisition, user training, common IT systems and in house journals and newsletters. Finally human resource practices are looked at, especially, whether there has been any change in internal labor markets, managerial development events, mission building, team working, inter functional conferences and internal networks.

Against this background, in terms of methodology the survey is interesting for the following reasons: (i) Retrospective the questionnaire looks at the situation in 1992 and 1996 and thus can measure the existing organizational practice as well as organizational change. (ii) Contrary to the EPOC survey, the INNFORM questionnaire again asks for organizational innovations as particular labels and in this respect is similar to the NUTEK and DISCO inquiries.

2.5 Survey "Changements Organisationnels et l'Informatisation (COI)"

One year after the Europe-wide INNFORM survey a national inquiry was launched in France (Enquête sur les COI, 1998). This survey attempted to describe the changes that had occurred between 1994 and 1997 in work organization (company functional structure, devices to manage task and work time-sharing, relations with other firms) and the use of information technologies (equipment, organization of the computer function, data transfers). The survey was conducted by a consortium of French research units in collaboration with the Service des Statistiques Industrielles (SESSI).

The questionnaire was sent out by mail to a representative sample of industrial firms employing more than 20 people. In total more than 400 firms were questioned.

The questionnaire asked for details about computer use and firm organization in 1997, as well as about relating changes between 1994 and 1997. Organization related matters and topics linked to Information and Communication Technologies (ICT) were also part of the questionnaire. It further included questions like "Which of the following constraints affected your company with regard to organization and computerization between 1994 and 1997?", "Does your company use the following organizational systems" referring to certification, value analysis, profit centers and just-in-time just to mention a few. Another question read: "If the following problems curbed or handicapped the implementation of organizational changes between 1994 and 1997, how important were they?"

The methodological approach of this survey is characterized by an inquiry for ICT innovations in combination with organizational change. Most questions allow for a yes or no response, respectively ticking a box. When examining the use of certain concepts, an assessment of the change (+, =, -) in the share of employees affected since 1994 is required. Some questions give ranges in percentage of employees affected.

2.6 Community Innovation Survey – CIS

The Community Innovation Survey (CIS) is the main statistical instrument of the European Union that allows the monitoring of Europe's progress in the area of innovation (CORDIS). The methodological basis of CIS is provided by the Oslo Manual. Hence the definition of innovation comprises the development of new or significantly improved products, or the introduction of new or significantly improved processes within an enterprise.

For the first time a question was implemented in the CIS survey of 2001 (CIS III) that asked for innovative management techniques and new organizational structures. This "add-on" was to contribute to a better understanding of the "non-technological" aspects of innovation (EUROSTAT, 2005). The question was as follows: "Did your enterprise during the period 1998-2000 undertake any of the following activities: implementation of advanced management techniques within your enterprise, implementation of new or significantly changed organizational structures. Possible answers for both aspects were "yes" or "no" (European Community, 2004).

The results collected by this question show great variations at cross country comparison. The share of enterprises which had implemented advanced management techniques during the period 1998-2000 ranged from 7 or 8 % (Denmark and Sweden) up to 31 % (UK and Austria), 36 % (Germany) and even 57 % (Luxemburg). The share of enterprises which had implemented changes in their organizational structures during the same time-frame were at minimum 7 % (France) and at maximum 49 % (Germany) respectively 57 % (Luxemburg) (EU Innovation Scoreboard, 2004).

In the CIS IV questionnaire (2004) the wording of the non-technical aspects of innovation was slightly changed. The question for innovative management concepts was as follows: "Did your enterprise during the three years 2002 – 2004 implement new or significantly improved management systems to better use or exchange information, knowledge and skills within your enterprise?" The organizational question reads as follows: "Did your enterprise during the three years 2002 – 2004 make a major change to the organization of work within your enterprise, such as changes in the management structure or integrating different departments or activities?" Additionally the questionnaire asked: "Did your enterprise during the three years 2002 – 2004 introduce new or significant changes in your relations with other firms, such as alliances, partnerships, outsourcing and sub-contracting?" These modifications intended to specify the questions by explanatory amendments and to give the innovations in inter-firm relations an independent role in the questionnaire. Yet, the results of the newly phrased questions are not available.

Summarizing, the CIS survey was basically designed to cover technical aspects of product and process innovation as defined by the Oslo Manual. Organizational and managerial innovations are an amendment being approached in general terms. This approach provides limited options for response and asks for change, not for the share of establishments that use an innovation.

2.7 Summary

To conclude: we presented these surveys in order to demonstrate how different the first attempts in monitoring organizational innovations by large scale surveys are. Main differences can be contoured in regard to four aspects:

- Aggregation level: organizational innovation is partially treated on a high level of aggregation (e.g. CIS), while other surveys go more in-depth gathering information on different concepts related to organizational innovation (e.g. NUTEK, DISKO, EPOC, INNFORM, COI).
- Use or Change: Methodologically, organizational innovation is partially treated as change process and partially as the result of the adoption. This means that surveys asking for the adoption of new organizational concepts allow for a classification of the respondents into adopters and non-adopters of specific concepts (e.g. EPOC, INNFORM, COI). Other surveys (e.g. NUTEK, DISKO, CIS) are asking for changes in a time period

and can only distinguish between firms with and without change processes in the field of organizational innovation within the covered time-frame.

- Use or extent of use: Surveys asking for the adoption of organizational innovations can differentiate between adopters and non-adopters (e.g. INNFORM, EPOC). In case of adopters at times (COI) the share of affected employees is monitored additionally, which allows for controlling intra-firm diffusion.

- Labels vs. features: Inquiries in the field of organizational innovation can be designed by asking for their adoption using labels of new organizational concepts like team work or continuous improvement (e.g. NUTEK, DISKO, INNFORM, COI). In an alternative approach an inquiry can ask for the realization of specific features and then draw a conclusion to the existence of innovative concepts (e.g. EPOC). With this methodological concept the analysis does not depend on the judgment of the respondent and his understanding of a label.

In the following chapter we analyze the implications of measuring organizational innovation using the different concepts introduced above. Here we rely on data derived from a survey conducted in Germany that deals with organizational innovations and applies the methodological alternatives, as mentioned above, in parallel.

3. Challenges for measuring organizational innovation

Based on these four categories of different ways to measure organizational innovation, which have been outlined in the previous chapter, we now analyze how different indicators and ways of asking for organizational innovation lead to different conclusions concerning a company's organizational innovativeness. We compare the different approaches of measuring organizational innovation as utilized by the formerly described surveys by using the *German Manufacturing Survey 2003* which was conducted by the Fraunhofer Institute for Systems and Innovation Research (ISI). The objective of this questionnaire-based, mailed survey is to gather data on the implementation of innovative technical production concepts, on performance indicators, product innovations, service innovations, inter-firm cooperation, relocation of parts of the company, as well as general data on the company and data on the implementation of innovative organizational concepts, thus organizational innovations. In 2003, we asked 13,259 companies to fill in the questionnaire whereupon 1,450 companies returned a utilizable questionnaire, which makes a response rate of 11 percent. These companies constitute a representative sample of the investment goods industry, chemical industry and rubber and plastic industry. The survey was first launched in 1993 and is conducted every two years (Lay and Maloca, 2004).

3.1 Aggregation level: Complexity of organizational innovations

As previously illustrated, the term organizational innovation may include many different concepts of how to change traditional organizational structures. Organizational innovations can affect business processes (e.g. continuous improvement processes) as well as organizational structures (e.g. team work). Organizational innovations may occur in an enterprise itself (intra-organizational perspective, e.g. simultaneous engineering), but may also concern relationships to other companies (inter-organizational perspective, e.g. R&D cooperation).

The diversity of organizational innovations implies that they may be an element of many different business strategies:

- Implementing decentralized product- or customer-oriented organizational structures to replace traditional centralized tayloristic-type of organizational structures aims at improving companies' flexibility.

- Implementing quality circles, total quality management or continuous improvement processes contributes to improved quality.

- Implementing simultaneous engineering or cross-functional teams is to shorten the product development processes in the companies.

- Implementing concepts of just-in-time and supply chain management aims at increasing productivity by minimizing storage costs.

Figure 2: Results of a multiple regression analysis using a composite index for organizational innovation

	Productivity	
	Coeff.	t
Outsourcing ratio (1 – [turnover minus inputs per turnover])	-.274	-6.91***
Firm size (number of employees)	.008	0.18
East Germany (establishment located in East Germany, yes = 1 / no = 0)	-.309	-7.12***
Manufacture and assembling staff (staff occupied with manufacture or assembly as a share of all employees)	-.196	-3.86***
Index of IT application	.149	3.10**
Qualification of workforce (share of employees with university or college degrees, masters or technicians on all employees)	.131	2.59**
Rate of export	.097	2.03**
Share of turnover with new products	-.090	-2.14**
Degree of capacity utilization	.097	2,37**
Product quality (share of products re-worked or scrapped)	-.038	-0.95
Supplier to automotive sector (establishment predominantly supplies to automotive industry, yes = 1 / no = 0)	.029	0.66
Index of implementation of innovative organizational concepts	.038	0.83
Constant	1.958	23.42***
8 Sector dummies and production structure	yes	
Observations	417	
corr. R^2	.38	
F-test	13.360***	

*** Significance level <.001 ** Significance level <.05 * Significance level <.10.

The various business strategies are fostered and triggered by different innovative organizational concepts. Therefore, an indicator that merely states whether a company has implemented organizational innovation or not while disregarding the kind of organizational innovation may only have limited explanatory effect. An overall indicator of organizational innovation may merge various business activities in the field of organizational innovation which are targeted towards different objectives like flexibility, productivity, etc. and thus might not be able to explain specific performance differences.

An analysis using such an overall indicator of organizational innovation supports this assumption. In a regression model which aimed to identify variables that had an influence on productivity an overall indicator of organizational innovation was introduced. This indicator was composed of 13 organizational concepts covered in the *German Manufacturing Survey 2003*. This index covered the implementation of team work, simultaneous engineering, continuous improvement processes, decentralization, quality circles, kanban and other innovative organizational practices in a similar way.

Apart from the overall index on organizational innovation, a multiple regression analysis (see figure 2) tested various other independent variables. The R^2 value indicates that the model explains 38 percent of the variance of the dependent variable "productivity". The coefficient of the variable "index of implementation of innovative organizational concepts", however, was not statistically significant (coeff. .038). Thus, we can not conclude that there are significant differences in productivity based on the extent of implementation of organizational innovation in general represented in one index.

An in depth analysis with single organizational innovations instead of an overall indicator introduced in the regression model depicted a different picture: some organizational concepts proved to be significantly positively correlated showing a better performance in terms of productivity while others had no significant influence on the dependent variable. Figure 3 gives an overview over the results.

These first results yet clearly point out the necessity to explore the impact of different organizational innovations on company performance separately. As assumed in the introduction to this chapter some organizational innovations might have an impact on performance in terms of flexibility, while others entail improved quality and others again account for better productivity.

In order to explain and perhaps to predict a superior performance in specific fields like flexibility, quality or productivity it is crucial to not only inquire whether companies implemented organizational concepts at all, but to ask which particular kind of organizational innovation was implemented. It is probable that the effects of overall organizational innovations concerning productivity, flexibility and quality on performance indicators overlap and indicate no significant impact on performance.

Figure 3: Results of 13 multiple regression analyses each with one organizational innovation (1-13) and control variables outsourcing ratio, firm size, East Germany, manufacturing and assembling staff, index of IT application, qualification of workforce, rate of export, share of turnover with new products, degree of capacity utilization, product quality and supplier to automotive sector (see figure 2)

	Productivity			
	Coeff.	Sign.	F-test	corr. R^2
1 Customer or product-line-oriented segmentation of central departments	.029	n.s.	14.164***	.054
2 Decentralization of planning, operating and controlling functions	.069	*	14.547***	.361
3 Balanced scorecard	.046	n.s.	14.094***	.363
4 Regular individual consultation	.069	*	14.454***	.358
5 Quality Circle	.048	n.s.	14.127***	.354
6 CIP Continuous Improvement Process	.050	n.s.	14.556***	.361
7 Quality management according to EFQM	.033	n.s.	13.854***	.360
8 Simultaneous Engineering	.018	n.s.	14.052***	.352
9 Cross-departmental temporary development teams	.023	n.s.	13.636***	.345
10 Segmentation of production	- .021	n.s.	14.190***	.352
11 Integration of tasks	- .016	n.s.	14.162***	.353
12 Internal zero-buffer-principle (kanban)	.071	*	14.834***	.365
13 Team work in production	.024	n.s.	14.046***	.350

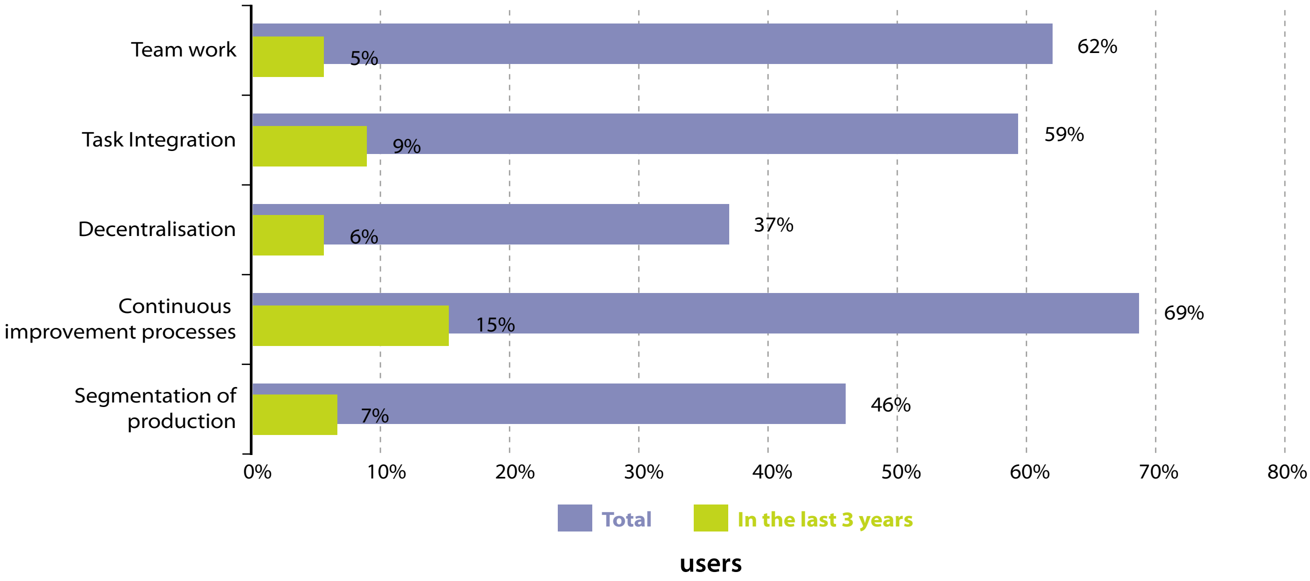
*** Significance level <.001 ** Significance level <.05 * Significance level <.10.

3.2 Use or change: Life-cycle of organizational innovations

As outlined previously in this paper, organizational innovations are changes to the structure and processes of enterprises that result from a new understanding of the adequate organization for the current market situation. In former times stable markets and homogenous customer demands required organizational structures that benefited from the advantages of specialization, labor division and centralization ("economies of scale"). However, this has changed. Turbulent and dynamic markets as well as heterogeneous customer demands together with greater market power of the customers require more flexible structures and less hierarchy levels in enterprises in order to promote more decision power in places where the relevant information is directly available.

The implemented organizational innovations as a response on the changes in the organizational environment (particularly the market situation) give the companies the ability to increase their performance as long as the market situation does not change. This implies that organizational innovations, as opposed to products, are not subject to an aging process per se. For example, enterprises will gain advantages from concepts like total quality management, supply chain management or just-in-time for more than 3 years after their first implementation. The concept of the "innovative firm" is to be questioned with respect to organizational innovation. At least, other reference periods or "life-cycles" may be considered.

Figure 4: Implementation of organizational concepts in total vs. within the last three years, Source: German Manufacturing Survey 2003, Fraunhofer ISI



Therefore, in order to empirically measure organizational innovations, it seems necessary to apply a different approach than with measuring product innovations. Product innovations age because of the fast technological progress, therefore the return on these innovations is earned during the first three years after their introduction. In the case of organizational innovations, however, the fact of the innovation being implemented at all rather than the point of time when the innovation is introduced is important.

The following example illustrates this through a comparison between the implementation of organizational innovations in total versus the implementation of organizational innovations within the last three years. The data are taken from the *German Manufacturing Survey 2003* (see Figure 4). The survey showed that 42% of all firms implemented just-in-time, 62% team work, 46% a product or customer-oriented organizational structure (segmentation of production) and 59% task integration.

Since the year of introduction of the particular organizational innovation was recorded as well, the results to the possible question "Have you implemented team work, task integration, decentralization, continuous improvement process, or product- or customer-oriented structures in the last three years?" can be reconstructed. This would have led to the following results:

- In the case of team work, 5% of all firms would have stated that they introduced this organizational innovation during the last three years. 57% of all firms that introduced team work would have been considered as not innovative even though they use team work, a concept still regarded as innovative. In a comparison between innovative and non-innovative enterprises, the previously named 5% where team work has been introduced in the last 3 years would have been compared to a group consisting of 57% that have used team work for a long time already and to a group of 38% without any implementation of team work so far.

- Considering task integration, 9% of all companies would have been regarded as innovative, although this innovation has actually been implemented by 59% of all companies.

- 6% of all firms would have introduced decentralization, even though already 39% of all firms have already launched this process

- Instead of 69% in reality, only 15% would have introduced continuous improvement process

- As to the introduction of product and customer-oriented structures (segmentation of production), with the 3-year-rule only 7% of the companies would have been registered in comparison to 39%

The percentages above illustrate that the group of non-innovative firms is not described correctly at all when asking for the innovations of the last three years. A comparison of the performance of firms characterized as innovative and non-innovative (based on the three years question) might expect the following: The group of non-innovative firms might perform better because of the high amount of enterprises that have already used the innovations on a long term (more than three years).

To conclude, when measuring organizational innovations, all firms that use organizational innovations have to be included in the set of innovative firms. This is only guaranteed when all firms that implemented organizational innovations at all are included. A limitation to the companies that introduced innovations in the last three years incorrectly characterizes the latecomers (who are the least innovative of the group of the innovative firms) as innovative.

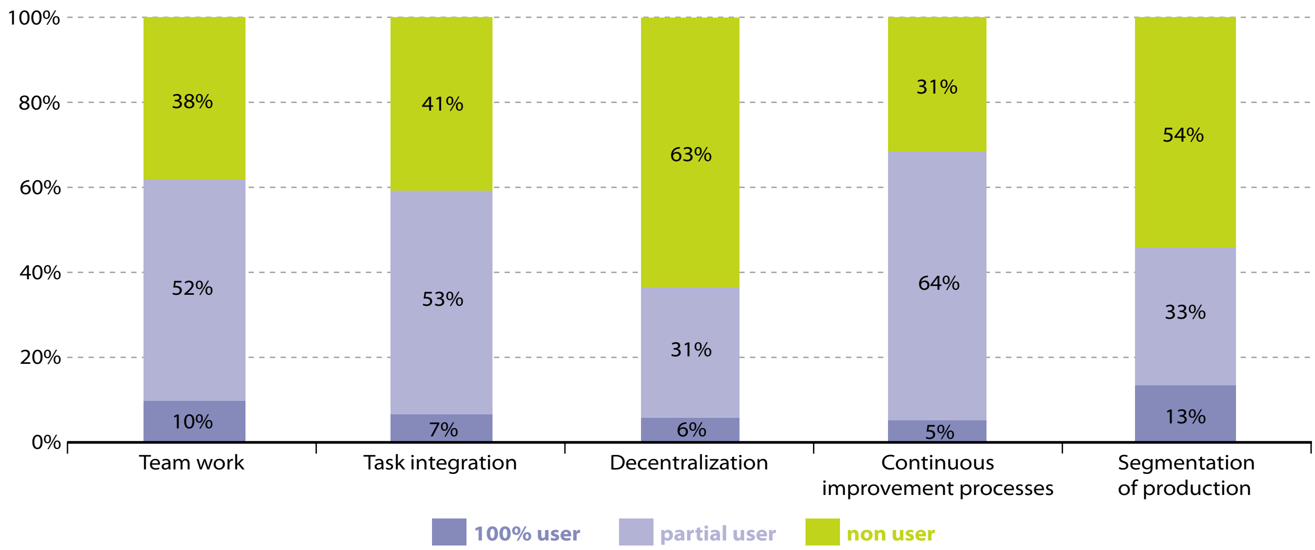
3.3 Use or extent of use: Scope of organizational innovations

The extent to which innovation characterizes a company is crucial. When product innovations are offered on the market most of the innovation process and effort is accomplished. Insofar, there is no interim solution between market offering and non-offering. Therefore, to capture the proportion of innovative firms in regard to product innovations, it is appropriate to examine a firm on whether it has launched a product innovation on the market or not. Such a question will identify innovative firms and give hints for policy-makers. Nevertheless it has to be recognized that economic success is only achieved through significant sales.

However, this is not valid in the case of organizational innovations. For example, if an organizational innovation is put into practice as a pilot project in a very small area of the enterprise, only a small part of the work is done and there might not be any impact on the performance of the business at all. Yet, if the organizational innovation is realized in highly relevant departments of the business, but an overall implementation is still missing, limited effects might occur. Ultimately, an organizational innovation can be implemented throughout all departments of the firm, so the impact on the performance of the business is maximal and no unutilized potential remains.

This shows that asking for the extent of use in a firm is crucial when investigating and measuring organizational innovation. Only with this knowledge it is possible to estimate the effects of organizational innovation and furthermore to quantify the unutilized potential for non-users and part-users of these organizational innovations.

Figure 5: Diffusion of organizational innovations between 'use' and 'non-use', Source: German Manufacturing Survey 2003, Fraunhofer ISI



The analysis of the *German Manufacturing Survey 2003* shows that only a small proportion of the companies that make use of a certain organizational innovation have fully implemented this organizational innovation in all business areas (see Figure 5):

- More than 60% of all firms claim to have implemented team work; however, only 10% say that they have fully exploited the potential of this organizational innovation.
- Task integration has been realized by more than 60%, but only 7% have implemented this innovation throughout the whole corporation.
- 37% of all enterprises use decentralization, yet only 6% indicate that they have completed the process of decentralization.
- Almost 70% of the companies stated that they use continuous improvement processes, but only 5% indicate that they have completely implemented this organizational concept.
- A total of 46% have begun with the segmentation of production, however just 13% state that the potential of this innovation has been fully exploited.

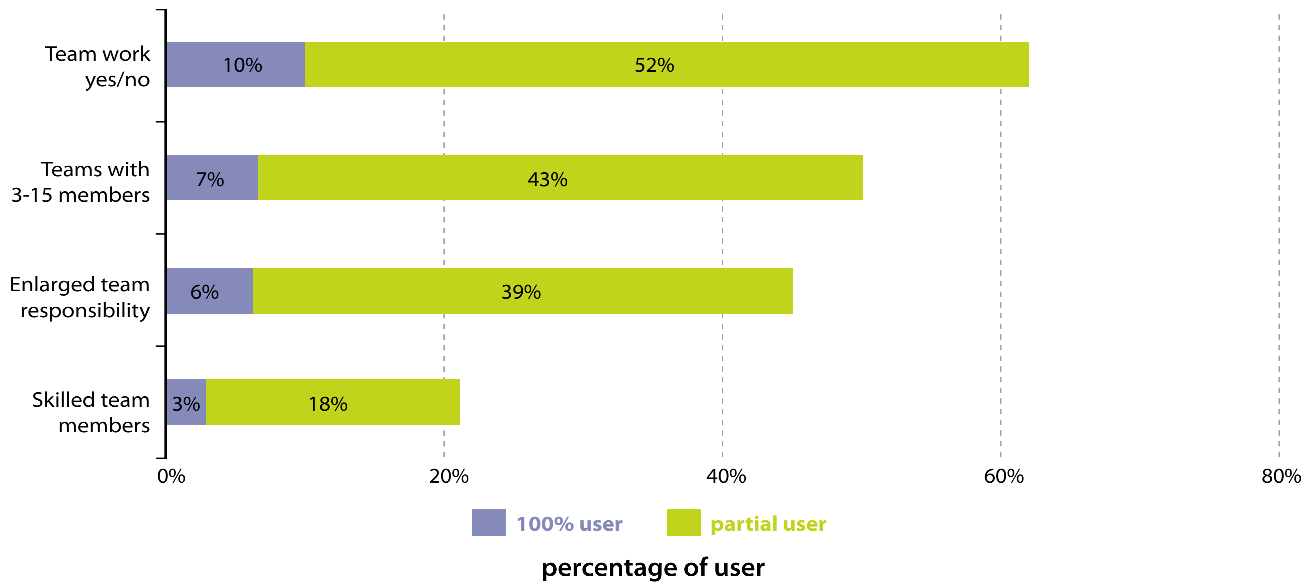
Considering a comparison between innovative and non-innovative firms where the extent of use of an organizational innovation is not regarded, it would be difficult to estimate the impact of this organizational innovation on performance indicators. As for instance, if the group of innovative firms contains a high percentage of businesses that have only partially implemented various organizational innovations without having increased their performance so far, this group of organizationally innovative firms will not stand out with a superior performance.

3.4 Labels or features: Quality of organizational innovation

Most organizational innovations are not linked to clearly defined measures for changing organizational structures and processes. They are rather basic concepts and their actual implementation depends on the company's management. Except for ISO 9000 (quality assurance) and ISO 14000 (environment protection), there are no standards for these organizational innovations.

Particularly when organizational innovations are very new and are yet not to be assessed as established concepts, companies tend to label their small realization efforts as a successful implementation of the organizational innovation. An example on team work which is integrated in the *German Manufacturing Survey 2003* (see Figure 6) proves this thesis.

Figure 6: Diffusion of 'team work', Source: German Manufacturing Survey 2003, Fraunhofer ISI



62% of the firms answered with "yes" when asked if they had realized team work (10% are users with fully exploited potential and 52% partial users). This result suggests that team work is used by a relevant part of the economy. However, when asking if team work was realized with a team size of 3 to 15 members the share decreased to 50% (of which 43% are partial users). This indicates that 12% of the enterprises realize team work with a group size of 1 to 2 or more than 15 members which does not comply with the basic idea of team work and therefore will not lead to the positive effects that are intended.

When restricting team work to those models that have teams consisting of 3 to 15 members and that assign an enlarged responsibility to the team, the share drops to 45% (of which 39% are partial users). Moreover, when adding the requirement that all team members are qualified for all up-coming tasks within the team, only 21% of all firms comply with these requirements (of which 18% are partial users).

As depicted above, the measurement of organizational innovations by using no more than a term like "team work" will lead to results that are highly questionable. The quoted example, leads to the assumption that two thirds of all firms are profiting from all possible advantages of team work. In fact, this is only true for less than a quarter of the firms, since only this proportion has yet realized the concept of team work in a proper sense. Moreover, the percentage of all firms that are utilizing the entire potential of team work in all parts of the business is only 3%.

This accentuates the need for additionally characterizing organizational innovations in such a way that –beyond the term - their characteristic features within companies can be recorded.

4. Implications, limitations and future research

Although the use of innovative organizational concepts is evidenced to have a positive impact on a company's competitiveness, research lags behind in defining and measuring organizational innovation. This paper attempts to more deeply enlighten the definition and measurement of organizational innovations by providing a typology of organizational innovations and contrasting different approaches of measuring organizational innovations.

Comparing approaches of measuring organizational innovations in existing surveys by modeling these organizational innovation indicators in the *German Manufacturing Survey 2003* leads to four main implications for measuring organizational innovation:

- *Complexity of organizational innovation:* It is not sufficient to only ask for "organizational innovation" in general. It is necessary to enquire for different types of organizational innovations separately. This is important because different organizational innovations have different effects on performance indicators. An index based on the summation of various organizational innovations that neglects the different types of organizational innovation might have only limited explanatory power.

- *Life-cycle of organizational innovation*: It is not sufficient to simply ask whether organizational concepts have been changed over the past years. In contrast it is important to determine the proportion of firms that has generally implemented an organizational innovation at all. This is crucial because organizational innovations do not age as fast as product innovations do. Thus, applying the "three years question" incorrectly only classifies latecomers as innovative.

- *Extent of use of organizational innovations:* It is not sufficient to only ask for "use" or "non-use" of organizational innovations. It is, however, necessary to identify the extent to which organizational innovations have been implemented into business processes. Only this additional information gives indication of the utilized and non-utilized potentials within the company. In order to generate viable estimations on the performance effects of organizational concepts, the extent of use of organizational innovations has to be taken into consideration.

- *Quality of organizational innovation:* It is not sufficient to only ask for labels of organizational innovations like "team work" or "task integration" as in every company organizational concepts are defined and shaped differently and answers of the respondents vary according to their own definition. It is crucial to know how terms like "team work" or "TQM" are used in the respective company. Merely using labels when inquiring about organizational innovations biases the diffusion of organizational innovations across companies.

Our analysis provides evidence that these four points should be taken into consideration when measuring organizational innovation in order to adequately survey companies' and countries' innovativeness as regards the adoption of organizational concepts.

However, there are several limitations to our findings. First, it is obvious that surveying complete definitions of organizational innovations instead of solely labels will increase the complexity of a questionnaire. To include items that monitor the different forms and definitions of organizational innovations within companies may sometimes hardly be realizable, depending on how many elements of organizational innovation are surveyed. Second, adding the extent of use of organizational innovations usually leads to sometimes rough assessments on the part of the respondents instead of gathering facts. But still these estimations allow a better understanding of the "internal adaptation" of an organizational innovation than just asking for "yes" or "no". Finally, the interpretation and presentation of the results that are based on a survey having included the above implications is rather complex and not straightforward. It is not recommended to score companies or countries according to one composite index indicating the most or least innovative in using innovative organizational concepts. On the contrary, with this type of analysis the innovativeness of companies or countries is rather based on a number of single organizational innovations and not on an index. We are aware that these results are more difficult to interpret, but are convinced that they are more useful than simply integrating all organizational innovations into one index. One possibility to display multi-task based results for organizational innovations are multi-dimensional charts such as the spider graph (Grupp and Mogee, 2004).

This paper is not devoted to design universally applicable, "one size fits all" methodologies, but simply to bring some light into the black box of measuring organizational innovation in large scale surveys. More research is needed in the field of theoretical conceptualization of organizational innovations when assuming that a better understanding of the compounding concepts will be helpful in order to develop an adequate monitoring system. For instance, it might be interesting to investigate the importance of organizational innovations across different industry sectors since we only discuss organizational innovations relevant for the manufacturing sector in this paper. These organizational innovations might be less relevant for other sectors. Further research is needed to resolve the question for which organizational innovations a common understanding across different companies is yet existent. An interesting task for research might also be to investigate the life-cycle of an organizational innovation. Getting insights into the question after what time of use an organizational innovation is more or less effective in terms of positively influencing performance indicators might help to develop future indicators. Research might tackle this issue by analyzing the influence of different organizational innovations on different performance indicators in longitudinal studies.

There is still plenty of research to do before organizational innovation surveys achieve the degree of homogeneity and standardization most R&D and technical innovation surveys possess. However, the need for constructing an organizational innovation monitoring system is becoming increasingly important as the first attempts of the European Commission to integrate indicators for organizational innovations in the European Innovation Scoreboard demonstrate.

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The revised Oslo Manual – and the implementation into CIS

THE NEW TYPES OF INNOVATION

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Summary

The last version of the manual has updated and extended the definition of innovation to a wide concept used in business and industry today. Due to this extension the definitions in the revised manual are more open and vague and not very clear on what is outside the innovation concept. One may get the impression that in general all activities in an enterprise with a positive contribution to the bottom line should be defined as innovation activity.

In the manual, four types of innovation are specified: product, process, organizational and marketing innovation. Specific definitions and explanations of the borderlines between the different types are given in the manual. But this is quite complicated and one feels rather confused after reading this text; what does it really say and is it reasonable.

One particular change in the revised manual is that the term "technological" has been removed from the definition of product and process innovation. The effect of this change is however hard to measure. In the former manual, a product whose "*intended uses* differed significantly from previously produced products" was included among a technological new product.

The most important changes are obviously the inclusion of organizational innovation and marketing innovation in the broad definition. In the former manual, organizational innovation was definitely specified as beyond the TPP definition of innovation (§ 155-159). But in the old manual, examples were given of borderline cases where organizational innovation, specifically in services, could be regarded as process innovation.

On innovation activities in general, the specifications in the old and new manual are more or less the same. The activities specified are R&D, acquisition of external knowledge, acquisition of capital goods and other preparation activities. The R&D activity shall be reported as a total for all types of innovation in the new manual, while the other activities shall be specified separately for product and process innovations, marketing innovations and organizational innovations. In principle, this means that R&D based on the new version will include R&D in marketing innovations and organizational innovations, while this was left out in the former version. In practice this difference is probably quite small. Innovation expenditure based on the new version should be higher than based on the old version due to the expanded definition of innovation. On the other hand, innovation expenditure based on the new version can be split to make it comparable with the old version. The difficulties and uncertainties in measuring innovation expenditure probably represent a more serious problem than deviations due to changes in the manual.

What are the effects of these changes on the innovation surveys and on the results of the innovation statistics?

The results show high degree of stability in the time series of product and process innovations and it seems that changes in definitions/wordings have had small effects, particularly in manufacturing industries. But the extended definition, including organizational and marketing innovation, has had real effects on the results.

There are a high number of enterprises with organizational and marketing innovations, in fact higher numbers than for process innovation and more or less the same as for product innovation. This means of course that one has to take the extended definition into account when presenting the results. On the other hand there is a fairly high degree of correlation between the different types of innovation. One type of innovation is normally accompanied by at least another type. Only a limited number of enterprises only have one type of innovation.

Conclusions

- Important to update the manual and revise the definition in line with developments in business and industry, particularly for the producers of innovation statistics.
- Changes in wording have little effect on the results. The enterprises use their own understanding of the innovation concept without reading the nitty-gritty definitions.
- Do not expand the definition to all activities having effect on a firm's performance. Keep the distinction between innovation and non-innovation activities.

The new version of the Oslo manual has been rewritten in its entirety and it is quite difficult to compare the two last editions and identify what are the main changes. In the revised manual itself, in ch.1 Introduction, three aspects are highlighted:

- greater emphasis on the role of linkages with other firms and institutions
- importance of innovation in less R&D intensive industries
- the expanded definition of innovation to include organizational and marketing innovation.

The main changes in the revised Oslo manual are also described in a paper for the Eurostat conference "Knowledge Economy - Challenges for Measurement" in Luxembourg 8 - 9 December 2005[1]. In this paper, more or less the same changes are underlined as the most central:

- the broader definition of innovation, including marketing innovations and organizational innovations in the concept of innovation.
- novelty concept
- greater emphasis and coverage of knowledge transfers and linkages
- innovation activities due to the extended definition of innovation.

This paper will focus on the change in the definition of innovation.

The last version of the manual has updated and extended the definition of innovation to a wide concept used in business and industry today. Due to this extension the definitions in the revised manual are more open and vague and not very clear on what is outside the innovation concept. One may get the impression that in general all activities in an enterprise with a positive contribution to the bottom line should be defined as innovation activity.

In the manual, four types of innovation are specified: product, process, organizational and marketing innovation. Specific definitions and explanations of the borderlines between the different types are given in the manual. But this is quite complicated and one feels rather confused after reading this text; what does it really say and is it reasonable? I will not go into detail on this in this presentation in order to clear this up.

One particular change in the revised manual is that the term "technological" has been removed from the definition of product and process innovation. The effect of this change is however hard to measure. In the former manual, a product whose "*intended uses* differed significantly from previously produced products" was included among a technological new product.

In the old manual it was also stated that minor changes or changes in aesthetic or other subjective qualities are excluded from product innovation. The new manual is less specific on what is excluded from product innovation, but has a footnote on routine upgrades. In addition, §162 contains a discussion on the borderline between product and marketing innovation regarding design.

The most important changes are obviously the inclusion of organizational innovation and marketing innovation in the broad definition. In the former manual, organizational innovation was definitely specified as beyond the TPP definition of innovation (§ 155-159). But in the old manual, examples were given of borderline cases where organizational innovation, specifically in services, could be regarded as process innovation.

What was defined as organizational innovation in the old manual is, in practice, quite close to the definition in new manual, even though the wording is different. But there is an important difference. In the old manual "organizational change is innovation only if there is a measurable change in output (productivity, sales)". In the definition in the new manual this is not a criteria for organizational innovation; implementation of organizational activities is itself sufficient, regardless of any effects. The manual only says what the intention of organizational innovation could be. This is in principle the same as for process innovation, and partly product innovation. But in the last case the product has to be introduced on the market.

[1] "Innovation measurement: present and future challenges" by Carter Bloch (CFA)

Marketing innovation, as defined as the implementation of a new marketing method, is completely new compared to the old definition. This does not mean that the concept "marketing" was totally absent in the old manual. It was clearly stated that marketing for new or improved products was part of the innovation activities. Opening up new markets and maintaining/increasing market shares were also among the objectives of innovation in the former manual, but then in principle only relating to new or improved products.

On innovation activities in general, the specifications in the old and new manual are more or less the same. The activities specified are R&D, acquisition of external knowledge, acquisition of capital goods and other preparation activities. The R&D activity shall be reported as a total for all types of innovation in the new manual, while the other activities shall be specified separately for product and process innovations, marketing innovations and organizational innovations. In principle, this means that R&D based on the new version will include R&D in marketing innovations and organizational innovations, while this was left out in the former version. In practice this difference is probably quite small. Innovation expenditure based on the new version should be higher than based on the old version due to the expanded definition of innovation. On the other hand, innovation expenditure based on the new version can be split to make it comparable with the old version. The difficulties and uncertainties in measuring innovation expenditure probably represent a more serious problem than deviations due to changes in the manual.

The definition of an innovative firm has not changed from the old to the new manual, adjusted for the expanded innovation concept. But a difference in concept of innovation activities and innovative firms is expressed in the new manual. Smaller continuous incremental changes are defined as innovation activities (§ 151), but within the survey's reference period such firms will not be defined as innovative.

What are the effects of these changes on the innovation surveys and on the results of the innovation statistics?

Until now, four large scale Community Innovation Surveys have been performed (1990-1992, 1994-1996, 1998-2000, 2002-2004). From the first survey the subsequent ones have been developed gradually based on experiences from the former. The two first surveys were fully based on the existing Oslo manual regarding definitions. Also, the first two editions of the Oslo manual were only marginally changed regarding definitions.

However, CIS3 deviated from CIS2 with regard to definitions and also from the second edition of the Oslo manual. The word "technologically" was removed from the definition of product innovation and at least the wording of process innovation was extended; including methods of supplying services and ways of delivering products.

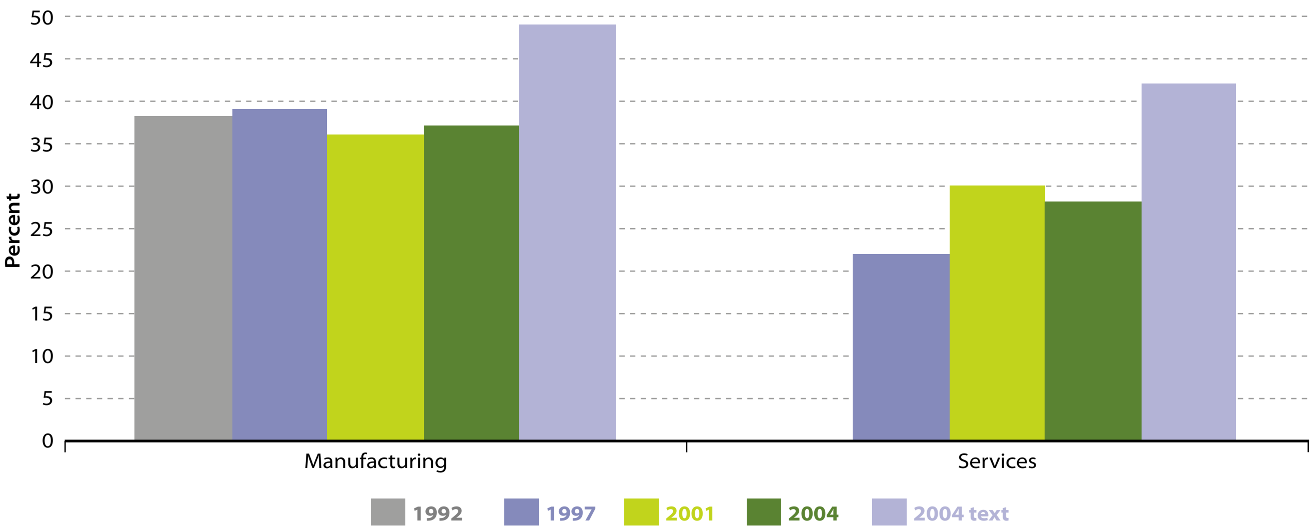
In CIS4 the product definition was the same as in CIS3. The wording of process innovation was more specific, but without changing the definition. In addition, questions on organizational and marketing innovations were included on a voluntary basis.

The last revision of the Oslo manual was done alongside the planning and execution of CIS4. By and large, the last edition of the manual is in line with CIS3 and particularly CIS4. The wording in the new Oslo manual is for some reason different from the wording in CIS4, but in substance the differences are small, and mostly of academic nature.

One may say that the first two surveys followed the definitions in the Oslo manual, as should be the normal case, while the last two surveys did not follow the existing manual. But the manual has now caught up with the survey experience, and probably the next CIS will follow the existing manual. Due to this time lag the effects of the new manual have partly been observed already. And what are the effects?

I will show some examples of experiences from the four Norwegian surveys; they are in harmony with the CIS. Due to lack of time and quite different ways of publishing the CIS in Eurostat, it is not possible to present results for all EU/EFTA countries.

Figure 1: Enterprises wih product- or processinnovation



The results in figure 1 show high degree of stability in the time series of product and process innovations and it seems that changes in definitions/wordings have had small effects, particularly in manufacturing industries. But the extended definition, including organizational and marketing innovation, has had real effects on the results.

Figure 2: Enterprises with innovation. Manufacturing. CIS4

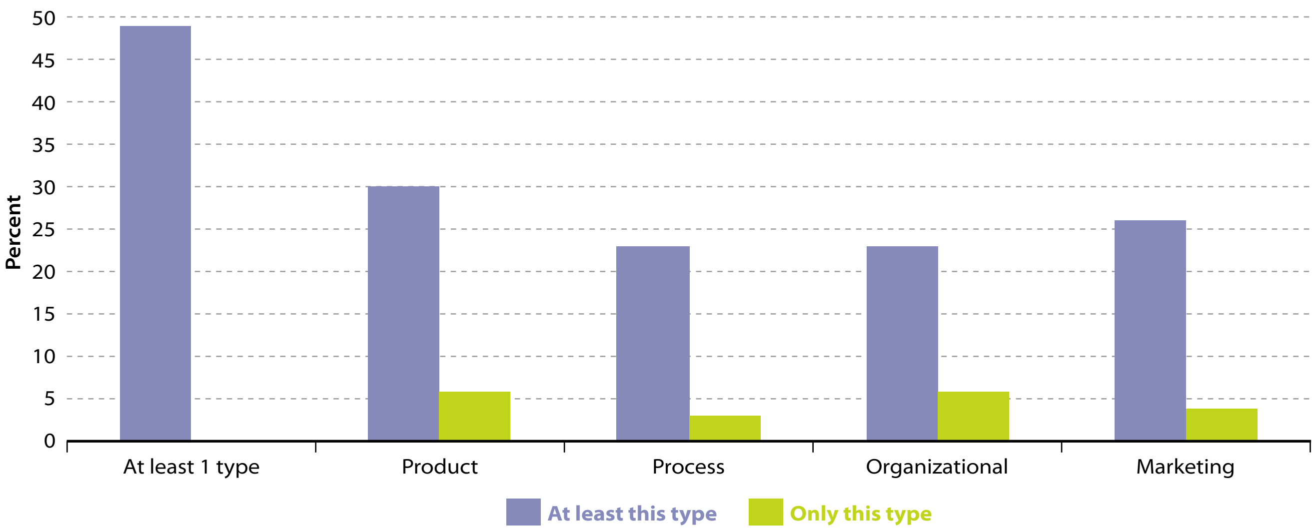


Figure 3: Enterprises with innovation. Services. CIS4

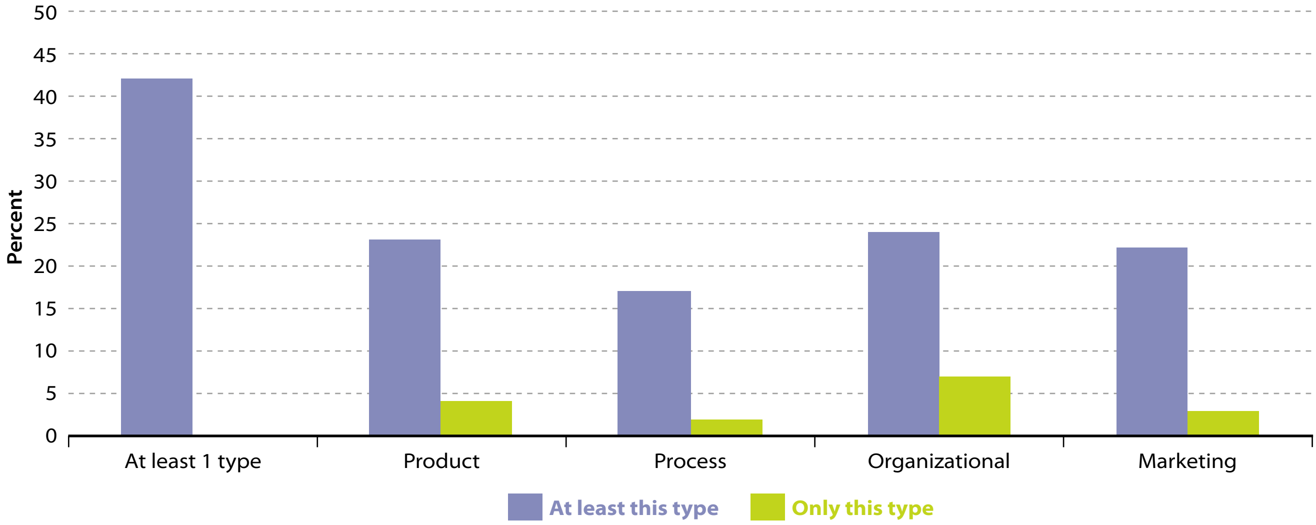


Figure 2 and 3 show a high number of enterprises with organizational and marketing innovations, in fact higher numbers than for process innovation and more or less the same as for product innovation. This means of course that one has to take the extended definition into account when presenting the results. On the other hand there is a fairly high degree of correlation between the different types of innovation. One type of innovation is normally accompanied by at least another type. Only a limited number of enterprises only have one type of innovation.

Summary

- Important to update the manual and revise the definition in line with developments in business and industry, particularly for the producers of innovation statistics.
- Changes in wording have little effect on the results. The enterprises use their own understanding of the innovation concept without reading the nitty-gritty definitions.
- Do not expand the definition to all activities having effect on a firm's performance. Keep the distinction between innovation and non-innovation activities.

ANNEX

Definitions in CIS

In CIS1 the basic question was:

- Has the enterprise developed or introduced any technologically changed or new products during 1990-1992.
- Has the enterprise developed or introduced any technologically changed or new processes during 1990-1992.

The survey distinguished between two types of product innovation: significant and incremental.

Significant innovation: newly-marked product whose intended use, performance, characteristics, technical construction, design, or use of materials and components is new or substantially changed. Such innovations can involve radically new technologies, or can be combined on existing technology in new uses.

Incremental innovation: existing product whose technical characteristics have been enhanced or upgraded. This can take two basic forms. A simple product may be improved in terms of better performance or lower cost, through use of new components or materials. A complex product, consisting of a number of integrated technical sub-systems, may be improved by partial changes to one or more of the sub-systems.

In CIS2 the basic question was:

- Between 1994-1996 has your enterprise introduced onto the market any technologically new or improved products?
- Between 1994-1996 has your enterprise introduced onto the market any technologically new or improved processes?

Technologically new product: product whose technological characteristics or intended uses differ significantly from those of previous products. Such innovation can involve radically new technologies, can be based on combining existing technologies in new uses or can be derived from the use of new knowledge.

Technologically improved product: existing product whose performance has been significantly enhanced or upgraded. Either a simple product may be improved, or complex product may be improved by partial changes.

In CIS3 the basic question was:

- During the period 1998-2000, did your enterprise introduce onto the market any new or significantly improved products (goods or services) for your enterprise?
- During the period 1999-2001, has your enterprise introduced any new or significantly improved production processes including methods of supplying services and ways of delivering products?

An innovation is defined as a new or significantly improved product (good or service) introduced to the market or the introduction within your enterprise of a new or significantly improved process. The innovation is based on the results of new technological developments, new combinations of existing technology or utilisation of other knowledge acquired by your enterprise.

Product innovation is a good or service, which is either new or significantly improved with respect to its fundamental characteristics, technical specifications, incorporated software or other immaterial components, intended uses, or user friendliness.

In CIS4 the basic question was:

- During the period 2002-2004, did your enterprise introduce onto the market any new or significantly improved products (goods or services) for your enterprise?
  - Product innovation is a good or service, which is either new or significantly improved with respect to its fundamental characteristics, technical specifications, incorporated software or other immaterial components or user friendliness.
- During the period 2002-2004, did your enterprise introduce:
  - New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services
  - New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing
  - New or significantly improved methods of manufacturing or producing goods or services

Organisational innovations

An organisational innovation is the implementation of new or significant changes in firm structure or management methods that are intended to improve your firm's use of knowledge, the quality of your goods and services, or the efficiency of work flows.

During the period 2002-2004, did your enterprise introduce:

- New or significantly improved knowledge management systems to better use or exchange information, knowledge and skills within your enterprise
- A major change to the organisation of work within your enterprise, such as changes in the management structure or integrating different departments or activities
- New or significant changes in your relations with other firms or public institutions, such as through alliances, partnerships, outsourcing or sub-contracting

Marketing innovations

A marketing innovation is the implementation of new or significantly improved designs or sales methods to increase the appeal of your goods and services or to enter new markets.

During the period 2002-2004, did your enterprise introduce:

- Significant changes to the design or packaging of a good or service (Exclude routine/ seasonal changes such as clothing fashions)
- New or significantly changed sales or distribution methods, such as internet sales, franchising, direct sales or distribution licenses
- Orientation and sales towards new customer groups or market segments

Definitions in the Oslo manual

Basic definition of innovation in Oslo manual (**1992**): Technological innovations comprise new products or processes and significant technological changes of products and processes. An innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation). Innovations therefore involve a series of scientific, technological, organizational, financial and commercial activities.

Basic definition of innovation in Oslo manual (**1997**): **Technological product and process (TPP) innovations** comprise implemented technologically new products and processes and significant technological improvements in products and processes. A TPP innovation has been **implemented** if it has been introduced on the market (product innovation) or used within a production process (process innovation). TPP innovations involve a series of scientific, technological, organizational, financial and commercial **activities**.

A technologically new product is a product whose technological characteristics or intended uses differ significantly from those of previously produced products. Such innovation can involve radically new technologies, can be based on combining existing technologies in new uses or can be derived from the use of new knowledge.

A technologically improved product is an existing product whose technical characteristics have been enhanced or upgraded. A simple product may be improved (in terms of better performance or lower cost) through use of higher-performance components or materials, or a complex product which consists of a number of integrated technical sub-systems may be improved by partial changes to one or more of the sub-systems.

Basic definition of innovation in Oslo manual (**2005**): An **innovation** is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations.

A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.

MEASURING LINKAGES IN THE INNOVATION PROCESS

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Executive summary

It has long been recognized that firms do not innovate in isolation. The importance of linkages and knowledge flows has taken on increasing weight in subsequent research and policy discussions, placing corresponding demands on the coverage of linkages in innovation surveys. This is also reflected in recent innovation surveys and in the recent revision of the Oslo Manual, where linkages in the innovation process are given a more central role in its measurement framework. However, the development of measures of linkages in the innovation process is in many ways an ongoing process in itself.

This paper examines the measurement of linkages in the innovation process. We will discuss the new chapter on linkages in the revised Oslo Manual and how linkages are covered in practice in the CIS4 and upcoming CIS2006 questionnaires. We also illustrate some examples of how CIS4 data on linkages can be used, drawing on data from Denmark.

A separate chapter in the new Oslo Manual is devoted to linkages, which presents a coherent framework in which linkages are characterized by their source, cost and level of interaction. Three types of external linkages are identified: *open information sources*, *acquisition of knowledge and technology*, and *innovation cooperation*.

While the full implementation of the new Oslo Manual guidelines is planned for CIS2008, a large number of aspects will have been introduced or pilot-tested in CIS4 and CIS2006. Linkage related questions in CIS4 were very similar to those in CIS3. There is a question on information sources and on innovation cooperation. In order to reduce potential overlap, respondents are asked to give the importance of each information source, while the innovation cooperation question is in terms of geographic location. Finally, questions on innovation activities provide information on acquisitions of technology.

We also explore some possibilities for creating new indicators or simply presenting the data in a different light, drawing on Danish CIS4 data. One example is the combination of different questions on linkages to provide greater information on linkages with different types of sources (such as suppliers, customers, and public research institutions). The three types of linkages can also be used jointly to create indicators of diffusion.

The recently finalized CIS 2006 questionnaire includes a number of optional pilot modules. The main aim of these modules is to pilot questions on marketing and organizational innovation towards the full implementation of new Oslo Manual guidelines in CIS 2008. These pilot modules are, however, also related to linkages in a number of ways.

The pilot modules on marketing and organizational innovations include questions on whether these new types are integrated or linked with product or process innovations. This type of data can potentially add a number of insights on how innovation activities (and thus also knowledge transfer) is linked across firms and to what extent innovation projects span more than one 'area'.

An additional pilot module for CIS 2006 concerns knowledge management practices. These questions deal with practices to gather external knowledge, organize the firm's knowledge base and to promote knowledge transfer. Responses to the

question on knowledge management practices provide an indication of whether knowledge management is part of firms' organizational strategy and whether firms make explicit efforts to promote knowledge exchange.

An additional pilot module that will be tested in the Danish CIS 2006 questionnaire is on the drivers of innovation. The question draws on the Carnegie-Mellon R&D survey and is also related to the earlier classification of sources for innovation in the first edition of the Oslo Manual. Firms may draw on different sources at different stages of product development, and information on this may be very useful for understanding linkages. The pilot question contains a number of market based sources: customers, competitors, firms' own marketing departments and marketing research.

Finally, the paper assesses these recent developments in coverage of linkages, and briefly discusses additional possibilities for measuring internal and external linkages in future innovation surveys. Among the topics considered are whether additional questions are needed on firm's existing practices (and not just innovations) in order to gain a full understanding of the role of linkages, and measuring the role of demand in firm innovation.

1. Introduction

It has long been recognized that firms do not innovate in isolation[1]. Influential works such as Nelson and Winter (1982) and Kline and Rosenberg (1986) highlighted the role of interaction among actors in the development of knowledge and technology. Systems approaches (Lundvall, 1992; Nelson, 1993) emphasize that, in addition to these interactions, innovation is influenced by institutions and the social, political and cultural environment that firms operate in.

These ideas have taken on increasing weight in subsequent research and policy discussions, placing corresponding demands on the coverage of linkages in innovation surveys. This is also reflected in recent innovation surveys and in the recent revision of the Oslo Manual[2], where linkages in the innovation process are given a more central role in its measurement framework. However, the development of measures of linkages in the innovation process is in many ways an ongoing process in itself.

Linkages involve the flow and subsequent use of knowledge. They can be links to sources outside of the firm or interaction within the firm itself. Both the existence of linkages and their characteristics are important to the innovation process in a number of ways.

For example, Pavitt (2005) identifies three innovation processes for firms: the production of new knowledge, the utilization of knowledge to implement new products and processes, and the matching of products, processes and organizational practices with market demand. Linkages are important to or a part of all three of these processes. Both external and internal linkages are potential sources for the creation of new knowledge and also for the development of new ideas into products and processes. Firms may actively collaborate with other actors for their innovation projects. Finally, matching products, processes and organizational practices with market demand involves external linkages with customers and markets as well as internal linkages among different activities in the firm (such as marketing and product development activities). Note also that linkages here involve not only types of information and sources, but also the (external and internal) channels by which the interaction is made.

This paper examines the measurement of linkages in the innovation process. We will discuss the new chapter on linkages in the revised Oslo Manual and how linkages are covered in practice in the CIS4 and upcoming CIS2006 questionnaires. We also illustrate some examples of how CIS4 data on linkages can be used, drawing on data from Denmark. Finally, the paper will briefly discuss additional possibilities for measuring internal and external linkages in future innovation surveys.

[1] Parts of this paper draw on Bloch (2007).

[2] OECD/Eurostat (2005)

2. Linkages and the Oslo Manual revision

Both the first and second editions of the Oslo Manual[1] recognized the importance of linkages for innovation. The first edition lists a number of different sources, including internal sources, commonly available sources of codified knowledge, acquisition of embodied and disembodied technology, and cooperation with a number of external actors. These sources could be examined as "sources of innovative ideas" that contribute to the initiation of innovation projects, or as "factors contributing to the success of innovative projects". The first edition also discussed outbound diffusion of technology through the sale of products to user sectors, and R&D cooperation.

These same topics were included in the second edition, though with a number of modifications. The two lists of factors were consolidated to a single set of "sources of information for innovation", where no specification is made on how the information is obtained. For example, firms and public institutions can be information sources either through passive (one-way) transfer of knowledge or through active cooperation.

In the years following the publication of the second edition of the Oslo Manual, innovation surveys[2] built on this framework and included separate questions on information sources and on 'innovation cooperation'[3], a topic that was not formally discussed in the second edition. These developments, combined with an increasing awareness of the importance of linkages, motivated a deeper and more extensive discussion of linkages in the third edition of the Oslo Manual.

A separate chapter in the new Manual is devoted to linkages, which presents a coherent framework in which linkages are characterized by their source, cost and level of interaction. Three types of external linkages are identified: open information sources, acquisition of knowledge and technology, and innovation cooperation.

Open information sources provide access to knowledge without the need to pay for the knowledge itself, although there may be marginal fees for access (membership in trade associations, attendance at conferences, subscriptions to journals). This type of linkage involves the transfer of codified knowledge, though some open sources, such as attendance at fairs or exhibitions, can give access to some tacit knowledge through personal interaction with other participants.

Acquisition of technology and knowledge involves the purchase of external knowledge and technology without active co-operation with the source. External knowledge can be embodied in machinery or equipment, in new employees, or in the use of contract research and consulting services. Disembodied technology or knowledge also includes other know-how, patents, licenses, trademarks and software.

Innovation co-operation involves active participation in joint innovation projects with other organizations. Innovation co-operation allows enterprises to access knowledge and technology that they would be unable to utilize on their own. Innovation co-operation can take place along supply chains, involving customers and suppliers in the joint development of new products, processes or other innovations, or it can involve horizontal collaboration, with enterprises working jointly with other enterprises or public research institutions.

The framework allows both for an examination of which types of linkages are used by firms in their innovation activities and a comparison of the relative importance of different types of linkages and sources. Sources include:

- Market and commercial sources, such as competitors, clients, suppliers and consultants
- Public sector sources such as universities, public research institutes and public support services
- General information sources, such as patent disclosures, conferences, scientific journals, informal networks and standards.

This framework, which forms the core of the chapter on linkages, mainly deals with external linkages and primarily with inbound diffusion, with the exception that cooperation involves the two-way flow of knowledge. The third edition also discusses outbound diffusion, though this is more difficult to measure as firms will generally be much less able to assess the impact of knowledge flows outside of the firm. One possible option in this area is to collect information on the users of a firm's innovations. The new Oslo Manual suggests the following classification:

1 OECD (1992), OECD/Eurostat (1997).

2 Such as CIS3 and the 1999 and 2001 Canada Innovation Surveys.

3 Earlier surveys, such as CIS2, also covered cooperation, though only for R&D activities.

- Consumer markets
- Domestic
- Foreign
- Inputs to other firms
- Domestic (inside/outside enterprise group)
- Foreign (inside/outside enterprise group)

In general, the Oslo Manual devotes less attention to internal linkages. One exception is knowledge management practices, which involve activities relating to the capture, use and sharing of knowledge by organizations. It thus encompasses the management of both external and internal linkages, including methods and procedures for seeking external knowledge and for managing relationships with suppliers, customers and research institutions. A number of surveys on knowledge management practices have been conducted in recent years, most notably in Canada (Foray and Gault, 2003). In addition, questions on knowledge management have been included in innovation surveys, for example the Japanese NIS 2003 Survey, the French CIS3 and the Australian Innovation Survey 2003.

Also discussed in the new Manual are linkages among different types of innovations. Relations between different types of innovations can provide useful information on internal linkages in innovation activities, for example whether the successful implementation of a process innovation requires organizational innovation or if the introduction of a new product requires the implementation of new marketing methods. Data on linkages between innovations provides information on how firms organize their innovation activities and on internal knowledge flows.

Overall, the new Oslo Manual provides a greater motivation for data collection on linkages and offers a number of options for expanding the examination of linkages. However, in terms of actual survey implementation, the new Manual is mainly keeping up to date with recent surveys. For example, CIS3 and CIS4 essentially already follow new Manual guidelines. One exception to this is in distinguishing different types of linkages. The new Oslo Manual encourages a clear distinction between types of linkages to facilitate later analysis of their relative importance. In contrast, information sources as defined in CIS3 and CIS4 can in principle include all three types of linkages.

3. Implementing linkages questions in innovation surveys

While the full implementation of the new Oslo Manual guidelines is planned for CIS2008, a large number of aspects will have been introduced or pilot-tested in CIS4 and CIS2006. This section will discuss the coverage of linkages in both these surveys.

Linkage related questions in CIS4 are very similar to those in CIS3. There is a question on information sources and on innovation cooperation. In order to reduce potential overlap, respondents are asked to give the importance of each information source, while the innovation cooperation question is in terms of geographic location. Finally, questions on innovation activities provide information on acquisitions of (embodied and disembodied) technology.

Basic tabulations of the results of these questions provide valuable information on patterns of knowledge flows, etc. However, there are a number of other uses of the data that can make important additions to the basic results. An examination of how this data can be used to create new indicators is also useful for future questionnaire design, since it allows a more complete assessment of these questions. Here, we will explore some possibilities for creating new indicators or simply presenting the data in a different light, exemplified Danish CIS4 data. An additional, important step would be to examine how linkages indicators can be used with other innovation indicators, though this paper will only look at linkages on their own.

The new Oslo Manual suggests defining information sources and innovation cooperation so that they are mutually exclusive (see the definitions above). This is however, not the case for CIS4 (or CIS 2006): in principle all cooperation partners should also be sources of information. The formulations used in CIS4, however, open up another possibility, that the two questions (information sources and cooperation) can be considered jointly, in terms of types of sources. For example, we may be able to examine whether suppliers function only as a passive information source (with corresponding importance) or whether they are also active cooperation partners, where a combination of the two questions gives the cooperation partners' importance (as a source of information) and their geographic location.

3.1 Linkages data – Examples based on the Danish CIS4

Table 1 shows some exploratory results for the six main external sources. To avoid any potential effects generated by estimated responses, only actual item responses are included here[1]. In principle, there should not be any responses where a source given as a cooperation partner is cited as 'none/not used' as an information source. From table 1, we can see that this logical relation does not always hold. The share of enterprises in this category (cooperation, but 'none/not used' as information source) is very small for some sources, and higher for others such as 'government and public research institutions' and 'consultants, commercial labs or private R&D institutes'. Interestingly, a large share of enterprises in the category for 'consultants, etc.' and 'competitors, etc.' name these sources both as 'not used' and as the 'most valuable cooperation partner' (results not shown). These inconsistencies between responses to information source and cooperation questions, and potential ways to minimize them, should be investigated in more detail.

Table 1. Linkages by type of source and importance (in % innovation active enterprises)

	Importance as information source	Suppliers	Customers	Competitors	Consultant and Private R&D inst.	Universities	Government research
Innovation active firms							
As info source only	None	16.4	13.7	24.8	53.5	63.5	70.2
	Low	16.9	10.3	26.6	17.5	14.3	17.2
	Medium	26.2	25.2	25.5	10.2	4.4	6.1
	High	11.4	16.1	4.0	2.6	0.5	*
As cooperation partner	None	2.0	0.5	1.6	2.6	1.0	0.9
	Low	6.0	3.4	4.6	4.2	5.9	2.1
	Medium	11.0	13.0	9.9	6.0	6.5	3.1
	High	10.0	17.8	3.0	3.5	3.9	0.5
Developed product and process innovations mainly by themselves							
As info source only	None	17.3	11.7	17.1	55.9	58.5	72.4
	Low	19.8	10.0	28.0	18.2	17.0	16.2
	Medium	32.2	24.7	31.1	12.9	6.6	7.1
	High	5.8	20.5	5.2	0.5	*	*
As cooperation partner	None	1.1	*	2.5	1.5	*	0.8
	Low	6.6	4.3	3.7	5.0	8.4	1.3
	Medium	8.6	10.4	8.5	4.6	6.5	1.7
	High	8.5	18.4	3.9	1.4	1.7	*
PP innovations have been developed by others or in cooperation with others							
As info source only	None	13.7	15.8	37.7	50.8	72.2	67.7
	Low	10.0	9.7	18.2	13.7	5.8	15.5
	Medium	16.4	20.1	17.6	7.6	1.4	5.0
	High	16.4	9.0	2.6	7.0	*	*
As cooperation partner	None	*	*	*	*	*	*
	Low	5.3	2.3	6.5	3.5	3.0	3.5
	Medium	18.3	20.7	15.6	8.3	8.4	6.3
	High	16.1	21.7	1.4	7.8	8.1	*

Source: Danish CIS4 data, CFA, based on own calculations. *: Not shown due to confidentiality restrictions. Percentages calculated using actual item responses only. No estimated responses included. Results weighted using weights calculated for full sample (ie including both actual and estimated responses), and thus not fully representative.

[1] Results are weighted, though given that these weights are based on all responses, these results are not fully representative.

Examining the results of table 1, suppliers and customers are the most common information source, used by around 85 percent of enterprises, though only a third of these also engage in active cooperation with these sources. A high percentage also cites competitors as an information source, but less often as a cooperation partner, and the source is seldom cited as 'highly important'. A much lower percentage cites universities as information sources, though among those that do, around half have active cooperation with the source. An additional point is that for a large share of cooperation partners, the source is given low importance. This is particularly the case for research based institutions, though less the case for suppliers and customers. It also suggests that active cooperation partners are not always highly important to innovation activities.

As noted in Arundel (2006) and Eurostat (2006), the questions on 'who developed product/process innovations' provide information on the degree to which firms rely on diffused knowledge in their innovation activities. Product-process (PP) innovators are divided into those that have developed product and process innovations mainly by themselves and those where PP innovations have been developed by others or in cooperation with others.

Table 1 also shows results for these two groups of PP innovators separately. For all six types of sources, the shares of firms citing a source both as a cooperation partner and as a medium or highly important information source are higher for firms that have developed PP innovations with others. This implies, as would be expected, that linkages are more important for firms that have developed in cooperation with others compared to those that develop innovations primarily on their own.

Table 2. Linkages by type of source and sector (in % innovation active enterprises)

	High tech manufacturing	Low tech manufacturing	Wholesale trade	Financial services	Knowledge intensive services
Supplier, info only	29.8	65.6	33.8	19.4	31.0
Supplier, cooperation	39.7	20.9	39.3	22.0	31.4
Market, info only	46.8	48.3	32.1	67.9	38.4
Market, cooperation	43.1	21.5	38.2	22.8	53.7
Research, info only	7.6	14.4	19.6	51.1	15.7
Research, cooperation	34.2	15.5	12.9	18.9	34.3
No acquisitions	23.3	32.9	47.6	52.3	27.9
Machinery only	23.8	37.6	23.4	20.4	45.6
External knowledge only	5.8	2.1	*	*	5.4
Machinery and ext. knowledge	47.2	27.4	27.1	25.8	21.1
PP innovations developed by mainly by firm itself (in % PP innovators)	75.8	62.9	38.3	86.7	84.5
PP innovation developed by or in cooperation with others (in % PP innovators)	24.2	37.1	61.7	13.3	15.5
PP innovation developed with other enterprises: % with no cooperation	30.0	61.2	32.1	*	53.9

Source: Danish CIS4 data, CFA, based on own calculations. *: Not shown due to confidentiality restrictions. Percentages calculated using actual item responses only. No estimated responses included. Results weighted using weights calculated for full sample (ie including both actual and estimated responses), and thus are not fully representative.

However, as can be seen at the bottom of table 2, a (very) high percentage of firms that have developed PP innovations in cooperation with others (ie. inpdtw=2 or inpcsw=2) cite no innovation cooperation what so ever (ie. Co=0). One would generally expect that all firms that respond that they have developed a product or process innovation with others should cite at least one cooperation partner. The result that a fairly large share of firms does not do this seems problematic and merits further investigation. It is, however, possible that some innovative firms may have had cooperation on product or process innovation development *prior* to the CIS4 reference period, and had no cooperation during the reference period. However, this possibility does not seem likely for such a large share of these firms.

As noted by the new Oslo Manual, we have data on three types of linkages, open information sources, acquisitions of knowledge and technology, and innovation cooperation. These may be analyzed together as 3 different types of diffusion. Table 2 divides these different types into:

- 3 types of sources:
  - Suppliers
  - Market (customers and competitors)
  - Research (consultants, commercial labs and private R&D institutes; universities; government or public research institutes)
- Information sources or active cooperation
- Acquisitions of embodied (machinery and equipment) and disembodied (extramural R&D, other external knowledge) technology.

High tech manufacturing has generally the highest shares utilizing linkages, in particular concerning R&D based sources. For low tech manufacturing, suppliers are the most prevalent linkage, though mainly as a passive source. Wholesale trade has a relatively high use of linkages, while knowledge intensive services do not seem to have a greater use of linkages than other sectors. Financial services have a very high use of market and R&D based sources, though predominantly as passive information sources. There is very little variation in terms of acquisitions, though one could likely gain more information by examining expenditures on these items.

3.2 CIS2006 pilot modules

The recently finalized CIS 2006 questionnaire includes a number of optional pilot modules. The main aim of these modules is to pilot questions on marketing and organizational innovation towards the full implementation of new Oslo Manual guidelines in CIS 2008. These pilot modules are, however, also related to linkages in a number of ways.

Organizational innovation

An organisational innovation is the implementation of a new organisational method in your enterprise's business practices (including knowledge management), workplace organisation or external relations that has not been previously used by your enterprise. It must be the result of strategic decisions taken by management. *Exclude mergers or acquisitions, even if for the first time.*

1. During the three years 2004 to 2006, did your enterprise introduce:

	Yes	No
New **business practices** for organising work or procedures *(i.e. supply chain management, business re-engineering, lean production, quality management, education/ training systems, etc)*	☐	☐
New **knowledge management systems** to better use or exchange information, knowledge and skills within your enterprise or to collect and interpret information from outside your enterprise	☐	☐
New methods of **workplace organisation** for distributing responsibilities and decision making *(i.e. first use of a new system of employee responsibilities, team work, decentralisation, integration or de-integration of departments, etc)*	☐	☐
New methods of organising **external relations** with other firms or public institutions *(i.e. first use of alliances, partnerships, outsourcing or sub-contracting, etc.)*	☐	☐

3. Were any of these organisational innovations integrated with or linked to other innovations that were introduced during the three years 2004 to 2006?

Tick 'not relevant' if your enterprise did not introduce one of the following	Yes	No	Not relevant
Product innovations for a new or improved good	☐	☐	☐
Product innovations for a new or improved service	☐	☐	☐
Process innovations	☐	☐	☐

Source: Eurostat (2006)

The two main modules on organizational and marketing innovation consist of five questions on: the implementation of innovations, who developed these innovations, whether these innovations were linked to other types of innovations, the effects of innovations and barriers to their implementation. Organizational innovations are divided into four subtypes, innovations in business practices, knowledge management systems, workplace organization and external relations. The question on marketing innovation contains six sub questions, on design changes, changes to packaging, product promotion, entering new markets, product placement and pricing methods. A split ballot approach will also be tested in some countries (such as Denmark), where firms can respond whether they have introduced or changed methods before 2004. This split ballot approach is shown in the box on knowledge management below.

Marketing innovation

A marketing innovation is the implementation of a new marketing concept or strategy that differs significantly from your enterprise's existing marketing methods and which has not been used before. It requires significant changes in product design or packaging, product placement, product promotion or pricing. *Exclude seasonal, regular and other routine changes in marketing methods.*

1. During the three years 2004 to 2006, did your enterprise introduce the following marketing innovations:

	Yes	No
Significant changes to **product design** or the packaging of goods or services (*exclude changes that only alter the product's functional or user characteristics*)	☐	☐
New media or techniques for **product promotion** *(i.e. the first time use of a new advertising media, fundamentally new brand to target new markets, introduction of loyalty cards, etc)*	☐	☐
New methods for **product placement** or sales channels *(i.e. first time use of franchising or distribution licenses, direct selling, exclusive retailing, new concepts for product presentation, etc)*	☐	☐
New methods of **pricing** goods or services *i.e. first time use of variable pricing by demand, discount systems, etc)*	☐	☐

3. Were any of these marketing innovations integrated with or linked to other innovations that were introduced during the three years 2004 to 2006?

Tick 'not relevant' if your enterprise did not introduce one of the following	Yes	No	Not relevant
Product innovations for a new or improved good	☐	☐	☐
Product innovations for a new or improved service	☐	☐	☐
Process innovations	☐	☐	☐

Source: Eurostat (2006)

These linkages questions are motivated by a number of issues. For example, are (technological) product innovations often connected with significant changes in design, or does the implementation of new products require the development of new marketing methods? In addition, new marketing methods may be closely linked with new logistics or distributional methods, indicating broad innovations that span from the firm's internal processes to its contacts with clients.

A number of studies have documented the importance of organizational change for the successful implementation of process innovations, in particular those that are IT-related[1]. Questions on innovation linkages provide some information on whether process and organizational innovations are linked. Also, it is commonly argued that service innovation (PP innovation in services) often has a substantial organizational component. This question will allow us to examine how often service innovations are linked to organizational innovations.

One limitation to this question is that it does not specify which types of organizational or marketing innovations are linked to product or process innovations (unless only one type is chosen). Both organizational and marketing innovations are fairly broad, complicating the interpretation of these linkages.

Another limitation is that these questions only look at links to marketing, organizational innovations, and not also to practices. It has been argued that, depending on other factors, certain types of organizational practices may be more effective in promoting learning, knowledge exchange and the use of knowledge to innovation[2].

The role of organizational practices in influencing knowledge flows and the implication of innovations is an important element in understanding the innovation process. Details on firms' existing organizational practices, in addition to questions on their organizational innovation activity, would be very useful in examining this topic. The split ballot approach, by asking for introductions/changes before the reference period may be useful in gaining information on 'existing' practices.

Knowledge Management

1. Is your firm currently using each of the following knowledge management practices? [1]

If yes, please indicate if your firm first introduced or made a significant change to each practice between 2004 and 2006 inclusive

	No	***Yes*** *(tick both if relevant)*
1.1 A written knowledge management policy	☐	☐ Introduced/changed 2004-2006
		☐ Introduced/changed **before** 2004
1.2 Incentives for employees to share knowledge within your enterprise	☐	☐ Introduced/changed 2004-2006
		☐ Introduced/changed **before** 2004
1.3 Dedicated resources to monitor and obtain knowledge from outside your enterprise	☐	☐ Introduced/changed 2004-2006
		☐ Introduced/changed **before** 2004
1.4 A policy to bring in external experts from universities, research institutes, or other firms to participate in project teams, as needed[2]	☐	☐ Introduced/changed 2004-2006
		☐ Introduced/changed **before** 2004
1.5 Regular updates of internal databases or manuals of good work practices, lessons learned, or expert advice	☐	☐ Introduced/changed 2004-2006
		☐ Introduced/changed **before** 2004

Source: Eurostat (2006)

[1] E.g. Brynjolfsson and Hitt (2000), Gera and Gu (2004) and Murphy (2002).

[2] E.g. Lam (2005). See also the analysis of the relation between workplace organisation and innovativeness in Arundel et al (2006).

This same point is also relevant for marketing practices, both in terms of what practices are used to collect information on user needs, an in linking marketing activities with other functions in the firm that are active in product or process development.

One exception to the above is the pilot module of knowledge management practices. These questions deal with practices to gather external knowledge, organize the firm's knowledge base and to promote knowledge transfer. Responses to the question on knowledge management practices provide an indication of whether knowledge management is part of firms' organizational strategy and whether firms make explicit efforts to promote knowledge exchange.

Drivers of innovation

1.1. How important are the following sources in providing new ideas for product development (for the period 2004 to 2006)?

SOURCES FOR PROVIDING NEW IDEAS	Degree of importance for product development: High	Medium	Low	None/ Not used
1. Technical departments (such as R&D, production, engineering) within your enterprise	☐	☐	☐	☐
2. Marketing or sales departments within your enterprise	☐	☐	☐	☐
3. Public research (universities, government or public research institutes) or commercial R&D labs in Country	☐	☐	☐	☐
4. Public research (universities, govt or public research institutes) or commercial R&D labs outside of Country	☐	☐	☐	☐
5. Clients or customers	☐	☐	☐	☐
6. Systematic market analysis (such as focus groups, panels, trend analysis)	☐	☐	☐	☐
7. Competitors and other enterprises	☐	☐	☐	☐

1.2. How important are the following sources in contributing to the completion of product development projects (for the period 2004 to 2006)?

SOURCES FOR CONTRIBUTING TO PRODUCT DEVELOPMENT	Degree of importance for product development: High	Medium	Low	None/ Not used
1. Technical departments (such as R&D, production, engineering) within your enterprise	☐	☐	☐	☐
2. Marketing or sales departments within your enterprise	☐	☐	☐	☐
3. Public research (universities, government or public research institutes) or commercial R&D labs in Country	☐	☐	☐	☐
4. Public research (universities, govt or public research institutes) or commercial R&D labs outside of Country	☐	☐	☐	☐
5. Clients or customers	☐	☐	☐	☐
6. Systematic market analysis (such as focus groups, panels, trend analysis)	☐	☐	☐	☐
7. Competitors and other enterprises	☐	☐	☐	☐

Source: Danish version of CIS2006 questionnaire

An additional pilot module that will be tested in the Danish CIS 2006 questionnaire is on the drivers of innovation. The question draws on the Carnegie-Mellon R&D survey (see Cohen et al., 2002) and is also related to the earlier classification of sources for innovation in the first edition of the Oslo Manual. Firms may rely on a variety of internal and external sources for ideas on new products and in contributing towards the actual development and implementation of product innovation. Firms may draw on different sources at different stages of product development, and information on this may be very useful for understanding linkages. The question on innovation drivers functions as an alternative to the standard question on information sources.

An example is Industry-Science relations (see Polt et al, 2001). Public research institutions can potentially contribute to firm innovation as a supplier of new research results, or they may be actively involved in the development and testing of new products. Information on which stages of the innovation process public research contributes to can aid in targeting research policy.

An additional example concerns user driven innovation and the role of market interaction. Of interest here is the role of demand in the innovation process, for example the extent to which product innovations are initiated by user needs as opposed to technological developments and also how relatively important demand sources are for the development process and subsequent market introduction.

4. Future directions

Recent surveys provide a wealth of information that can be utilized in a number of ways, a few of which have been explored here. Further evaluation is needed in order to assess these indicators, how they can be used, and whether they could be improved upon. This final section considers a few directions that future surveys could consider.

Survey coverage of diffusion is generally limited to inbound diffusion[1]. Questions on outbound flows, while likely difficult to measure in a specific way, could very feasibly be included in a general sense as suggested by the new Oslo Manual (see above). This type of information would allow the identification of the structure of demand for firms' innovations. Innovation processes may differ significantly between firms that primarily sell products to private consumers and those that have other firms as their main customers. It may for example be much more straightforward for firms to assess the user needs of other firms than those of private consumers, and firm clients are more likely to be closely involved in product development.

While there is a great deal of coverage of linkages with other actors in recent surveys, less attention is given to linkages with institutional organizations. The question on public innovation support organizations in the Canadian Innovation Survey 2003 offers a feasible method that could be used in other surveys, and where a number of country-specific organizations or programs could also be included.

In considering regional factors, there are in particular three areas of relevance for innovation surveys: linkages to regional actors and to regional institutions (and their importance) and the importance of regional markets for innovation activity. Compiling innovation statistics at the regional level poses also additional requirements on sampling procedures and the need to identify actual location(s) of innovation activities for enterprises with operations in more than one region (or collecting data at the establishment level, as for example has been done in Canada and Italy).

Demand plays an important role in innovation and has been the subject of increased policy interest[2]. However, demand is a broad concept that may influence or play a role in firm innovation in a variety of ways, many of them central to the issue of linkages. Here we will consider what might be meant by demand, drawing both on marketing and innovation literature. We can identify four main aspects of how demand may affect innovation: the role of the user in innovation; the impact of market demand and market structure; understanding user needs; and utilizing market knowledge in the firm's innovation activities.

'User driven innovation' involves the use of knowledge of customer needs in the firm's innovation activities. To some degree, demand influences all innovations, as was clearly pointed out by Mowery and Rosenberg (1977) in their critique

[1] An exception is the Canadian Survey of Innovation 2003, which examines outbound diffusion to two specific industries, Mining and Forestry.

[2] See eg. The Aho group report (2006), Nordic Council of Ministers (2006) and Commision of European Communities (2006).

of a number of earlier studies of demand and supply influences. User driven innovation should thus imply that user needs are a driving force in generating new ideas for product development.

Literature on user driven innovation, in particular by Eric von Hippel[1], emphasizes the role of users in the innovation process. 'Lead-user innovation' involves the participation of lead users in the actual development of new products (e.g. Lilien et al., 2002). In the lead-user process, interaction with customers not only concerns identifying user needs, but also in seeking solutions for the development of new products. This assigns users a greater role as a linkage source, potentially also as a source of new technological knowledge.

'User innovation' concerns the development of innovation for own use, either as final products or as intermediate inputs. Von Hippel (2005) argues that users are a very important source of innovation and the creation of new knowledge. Among the implications of this view are that policy should not focus on a few individuals, as it is hard or impossible to predict where new ideas will originate. In addition, the benefits of 'open innovation' increase when one takes into account that many new ideas may come from users.

Another aspect concerns how firms collect and utilize information on demand in their internal innovation processes, i.e. methods used by firms to analyze market demand and the flows of this information within the firm.

Griffin and Hauser (1996) analyze and review work on R&D-marketing interaction, examining both barriers to communication and cooperation across functions and organizational approaches used to enhance integration of marketing and R&D. Among these approaches are: relocation and physical facilities (i.e. keeping marketing and R&D activities physically close to one another), personnel movement (such as job rotation), informal social systems, organizational structures (such as coordinating groups and project teams), incentives and rewards, and integrative management processes.

While it will likely not be used in CIS2006, a short pilot question was developed that attempts to capture aspects of R&D-marketing integration and market analysis:

How important were the following market-related activities for your enterprise's product and process innovation projects between 2004 and 2006?

	High	Medium	Low	Not relevant
Maintaining close links between your marketing department and other divisions or teams involved in developing or implementing product and process innovations	☐	☐	☐	☐
Systematic analysis of your customer's needs by your marketing division	☐	☐	☐	☐
Systematic analysis of the effectiveness of your marketing techniques	☐	☐	☐	☐

Source: Eurostat (2006)

Market analysis can range from traditional techniques that examine identified needs to newer research methods that involve identifying customers' 'latent needs'. An example of newer techniques is ethnographic design research (Gilmore, 2002), which involves deeper research into potential customer needs through observation of their habits, routines, views and preferences. As opposed to examining average user preferences or needs, its aim is to uncover idiosyncrasies and new perspectives. The focus of this type of research is on customer experience as opposed to simply product functions (Suri, 2003).

This type of design method can have important implications for innovation processes. They place a clear focus on the user (and research conducted on the user) as the source of new ideas, charting the direction for product development and potentially also the direction of general research on new technologies. The use of these methods may also imply in some cases that (part of) 'market research' activities falls under the formal definition of R&D, as it involves the creation of new knowledge.

1 Eg. von Hippel (1988, 2001, 2005).

More general characteristics of market demand and market structure are important aspects of innovation systems, both through their influence on incentives to innovate and for knowledge flows. Hauser et al (2006) refer to the concept 'consumer innovativeness' as the propensity of consumers to adopt new products. 'Consumer innovativeness' is an important determinant for the rate of diffusion, how quickly new products are adopted in the economy. It will also be an important factor for firms' propensity to innovate, as the more responsive customers are to new products, the greater the incentives and return to innovation. Consumer innovativeness in home markets may also be important for development and testing. Even in cases where domestic markets are relatively unimportant in terms of share of turnover, they may be essential for the development and testing (market and otherwise) of new products. Innovation surveys provide some information on general demand factors through questions on hampering factors (uncertain demand for new products and lack of demand for new products).

'Network externalities' (Hauser et al, 2006) refer to demand that is affected by the number of users with similar products or the availability of related products. Hence, for new product areas innovation may be very dependent on the existence of a 'market' for the product. Standards, platforms and regulations may also play an important role in establishing demand for certain product groups.

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REFERENCE PERIOD FOR THE CIS: TWO OR THREE YEARS

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Executive summary

This paper analyses the effect of the length of the reference period on the results provided by a Community Innovation Survey (CIS). Since the first CIS survey (CIS1) to the last one (CIS4) a three year reference period has been used so as to identify innovative firms. Only for the CIS light survey (carried out between CIS3 and CIS4) a small number of countries, including Luxembourg, have collected innovation data based on a two year reference period. The inclusion of our CIS light national results in that analysis gives insights on the impact of a two year reference period on the CIS results. To do so, we compare some CIS light results to some CIS3 and CIS4 results. In doing so, it has to be pointed out that comparison between results from different survey has to be made with care. Indeed, some modifications in the concepts, methodology and definitions used may have a significant impact on the results provided and as a consequence lead to difficulties in the comparison process. More economic environment, which changes over time, is also likely to significantly impact firms' innovation activities.

In order to circumvent these difficulties and to have additional insight, additional data on innovation activities launched in 2005 or planned to be launched in 2006 were collected through our CIS4 survey (the field of the survey took place in the beginning of 2006). Based on these data we build a second two year reference period (2005-2006) in line with the methodology and definitions used in three year reference period (2002-2004).

As an introduction to this paper, we present advantages and disadvantages of respectively a three year reference period and a two year reference period. We also put our attention on a first insight regarding the persistence of innovation. To our opinion, this persistence and its impacts are key points in the resolution of two issues related to the length of the reference period that next CIS surveys will have to face: (1) should we alternate full CIS survey based on a three year reference period and light one based on a two year reference period, (2) should we rather opt for a specific reference period for all the next surveys (full or light) and in that case which one?

A first part is dedicated to present the methodological aspects. More precisely, we present, over the last CIS data collections, some changes in the methods used for collecting and producing the datasets and variation in firm's environment. Indeed these aspects are likely to affect the results and as a consequence have to take into account in order to make reliable comparisons over the CIS results. A second part aims to the examination of the impact of the length of the reference period on the propensity to innovate by size and sector (manufacturing industry / service). A third part is dedicated to the profile of the innovative and non innovative firm through different lengths of the reference period: with a shorter reference period are the innovative firms, in comparison to the non innovative ones, more often involved in international markets, do they more often belong to a group, do they more often belong to specific sectors? In a last part we compare innovative firms' behaviour between CIS3, CIS light and CIS4. In order to do so, we put our attention on the following themes related to innovation process: sources of information, innovation activities and effects of innovation.

Introduction

The Community innovation survey aims to provide, at the firm level, harmonised and comparable information on innovation activities in the European countries. In order to do so, clear methodological guidelines defined in the Oslo Manuel and in the task forces dedicated to CIS preparation are submitted to national statistical institutes and other centres in charge of the survey. Through the different rounds of the survey these guidelines were modified and improved leading to progress related to data quality and comparability across countries. However, an important aspect remains stable along that process: the length of the reference period used for identifying innovating firms.

This stability does not mean that this aspect is not questionable. As an illustration, the Oslo Manual stipulates that "it is recommended that the length of the reference period for innovation surveys should not exceed three years or be less than one year" (p. 61) and that "the length of the reference period is a compromise between different requirements" (p. 129). Indeed, on the one hand a short reference period should increase the accuracy of the results (respondent's memory decreases over time). On the other hand, a longer period would allow covering long life phenomena (e.g. innovation effects) or infrequent phenomena.

Moreover, two important aspects have to be considered regarding the length of the reference period: (1) the consistence of descriptive results with those of previous rounds, which should allow comparison over time, (2) the stakeholders' experience, including firms surveyed, with the current reference period. These two criteria speak in favour of the current three year reference period.

In other side, the request from different stakeholders of more frequent innovation data (i.e. every two years) brings to the fore this stability. Indeed, collecting innovation data every two years and based on a three year reference period should create overlaps between the rounds of the survey. Due to that, it would be difficult to attribute to a specific round the innovation that will explicitly take place in the overlapping year (OSLO Manual p. 130). A two year reference period solves that issue.

Nevertheless, it has also to be remained what type of data are collected: (1) the propensity to innovate over the reference period, (2) some information relating to innovative and non innovative firms, (3) some characteristics of the innovation process over the reference period, (4) the different innovation expenditures for the last year of the reference period and (5) measures of product innovation output for the last year of the reference period. As a consequence, a decrease of the length of the reference period (from three years to two years or one year) should impact the main results of the survey to the extent that the persistence of innovating activities differs by firms' types.

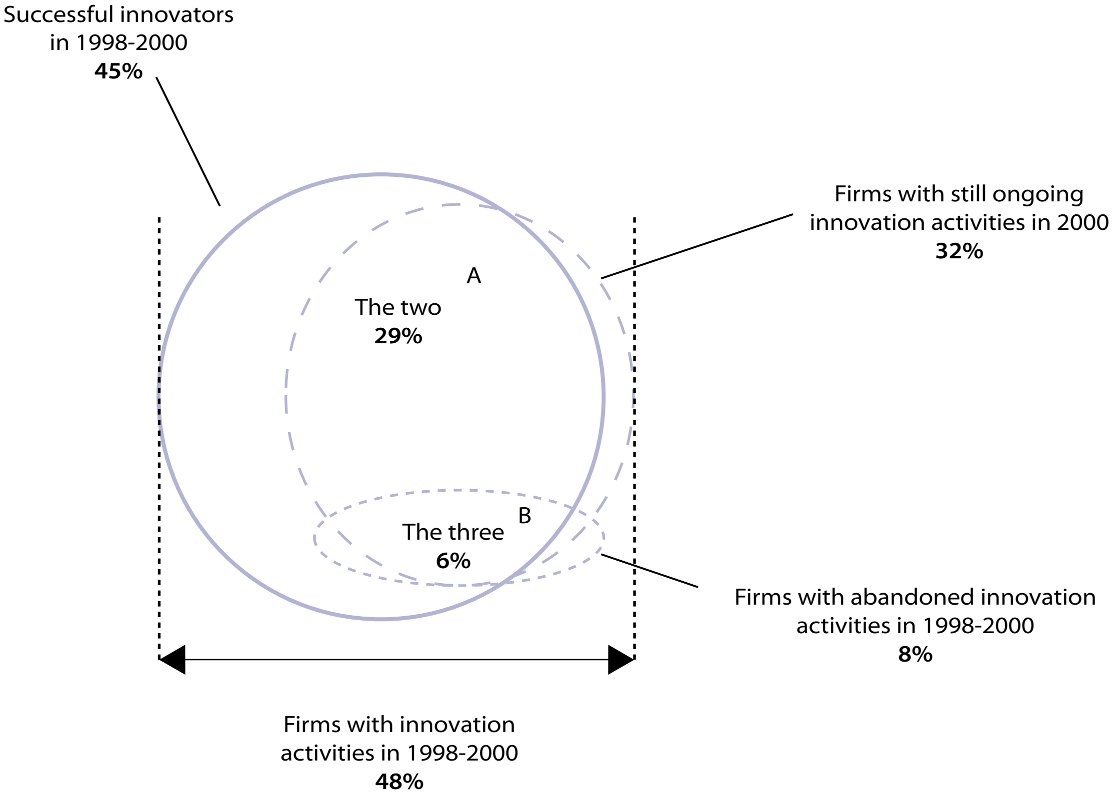
The main objective of this paper will be to give insights on the extent of this persistence and its impacts. To our opinion these aspects are key points in the resolution of two issues related to the length of the reference period that next CIS surveys will have to face: (1) should we alternate full CIS survey based on a three year reference period and light one based on a two year reference period, (2) should we rather opt for a specific reference period for all the next surveys (full or light) and in that case which one?

In order to have a first insight about this persistence, one can point out his attention to CIS3 national datasets. Indeed, those make the distinction between innovation success, ongoing innovation and abandoned innovation (i.e. in CIS4 the distinction between ongoing and abandoned was dropped).

As we do not have access to results from other countries, we have pointed out our attention to our national CIS3 dataset (figure 1). This one shows that most of innovating firm in 1998-2000 (two-third of them) point out that they have at least one other innovation project still ongoing at the end of the reference period. Due to that, one can expect that many of these firms will be again innovative in the next round of the survey. More, one can hypothesize that most of these firms would be innovative with a shorter reference period. But to what extend? The question remains.

In order to fine-tuned these first insights, we use and compare over time our national CIS datasets. Those offer the opportunity to compare, in our national context, the effect of the length of the reference period on the CIS results. Indeed, as a small number of countries, we have collected, through our CIS light survey, innovation data, based on a two year reference period. For the purpose of that comparison, we will also consider our CIS3 and CIS4 results. In doing so, it has to be pointed out that comparison between results from different rounds of the survey has to be made with care. Indeed, some modifications in the concepts, methodologies and definitions are likely to affect the results provided and as a consequence to lead to difficulties in the comparison process. More economic environment, which changes over time, is also likely to significantly impact firms' innovation activities. These two aspects have to be considered in order to make reliable comparisons.

Figure 1: To what extent are firms innovating parsimoniously: a first insight.



A: successful innovators in 1998-2000 with ongoing innovation activities in 2000.
B: successful innovators in 1998-2000 with ongoing innovation activities in 2000 and abandoned innovation activities in 1998-2000.

Source: CIS3; dataset from Luxembourg.

In order to circumvent these difficulties and to increase the validity of our first results, we have collected additional data, through our CIS4 survey, on innovation activities finalized in 2005 or planned to be finalized in 2006 (the field of the survey took place in the beginning of 2006). Based on these data, we built a second two year reference period 2005-2006 in line with the methodology and definitions used in three year reference period 2002-2004.

A first part of this paper is dedicated to present, over the last CIS data collections, some changes in the methods used for collecting and producing the datasets and variation in firms' environment. Indeed, these aspects are likely to affect the results. A second part is aimed to the examination of the impact of the length of the reference period on the propensity to innovate by size and sector (manufacturing industry / service). A third part is dedicated to shed light on the profile of the innovative and non innovating firms through different length of the reference period: with a shorter reference period are the innovative firms, in comparison to the non innovating ones, more often involved in international markets, do they belong more often to a group, do they belong more often to a specific sector, are they more often engaged in R&D activities? In a last part we will compare innovative firms. In order to do so, we put our attention on the following themes related to innovation process: sources of information, innovation activities and effects of innovation. Therefore it has to be pointed out that some of questions on innovation process have been modified/improved through the different rounds of the survey. We have to retain those that will appear as enough comparable.

1. Testing the impact of the length of the reference periods: the methodological guidelines

The results that we provide in the next sections have to be regards as experimental. Indeed, our tests and comparisons are contingent upon the methodological guidelines used in the different rounds of the survey. The two first paragraphs are dedicated to present (in comparison to CIS3) the guidelines used for our CIS light and CIS4. In a third paragraph, we present our additional CIS4 question dealing with innovation activities in 2005 and 2006. In a last paragraph, we give some insights on firms' environment along the last CIS data collection.

It has also to be noticed that for two sectors (i.e. the whole sale trade sector, the transport and communication sector) large discrepancies were found in the results over the rounds of the CIS. In order that these inconsistencies will not impact the comparison process, decreasing the reliability of our exam, these two sectors will be excluded to the analysis.

1.1 CIS light survey

As previously stated, our CIS light was conducted on a two year reference period (i.e. 2002-2003). As a consequence, firms were required to point out whether or not they were innovative in product or process in 2002 and/or 2003, and if so, to provide information on their innovation practices.

In order to collect those data, a questionnaire based on the CIS3 one was prepared. Most of the questions and definitions used are from CIS3. Nevertheless, some modification, relating to methods for protecting innovation and other important changes, were introduced (i.e. strategy, management, organisation, marketing and aesthetic change) and the question relating to hampering factors for innovation were not included in the questionnaire.

It has also to be noticed that some changes were made in the methods used for collecting the data. Indeed, for CIS3 (and also CIS4) data were collected via face to face interviews. This method was not fully applied in our CIS light. Indeed, in order to decrease response burden data were collected in two phases. A first one was dedicated to identify innovative firms (introduction of product or process innovation, innovation activity still ongoing and abandoned innovation) and non innovating ones, R&D performers and firms that have had registered a patent. This first phase was carried out by phone calls of our experienced CIS interviewers. A second phase collected information on innovation activities (innovation process) and R&D performers. This second phase was conducted via face to face interviews. In this second phase the following traditional CIS themes were included: innovation activities, sources of innovation, innovation co-operation, effects of innovation. Some additional questions, not from the CIS3 questionnaire, were also added.

1.2 CIS4 survey

For CIS4, the questionnaire developed by Eurostat and a task-force dedicated to that preparation was used. In addition to these questions, Luxembourg's firms were also surveyed on their R&D activities. To do so, we have attached to the end of the CIS4 questionnaire, a distinct small R&D questionnaire. This practise aims that R&D questions do not affect respondents' perception of innovation. As for CIS3, CIS4 data were collected via face to face interviews.

More, it has to be noticed that we have introduced some additional questions in the CIS part. Indeed, firms were surveyed on the introduction of product or process innovations in 2005 and in 2006 (see 1.3) and on acquisition and transfer of knowledge. Therefore, in order to stay fully in line with the reference CIS4 questionnaire, we not have modified any items related to the reference CIS4 questions. More, we not have changed the questions order.

Nevertheless, it has to be remembered that the CIS questionnaires have been changed/improved over time. Some variable items were modified in CIS4 in comparison to CIS3. Some sub-questions were introduced. For example, a distinction between product innovation in goods and service was inserted in CIS4. Other distinctions, relating to process innovation, were also included in the CIS4 questionnaire. Those aim to improve the notification of product and process innovation in the service sector. These improvements are, however, likely to affect our ability to compare innovation rates over CIS3 and CIS4.

1.3 The inclusion of an additional question in CIS4: (1) to have innovated (i.e. in product or process) in 2005, (2) or to have planned to do so in 2006

The field of our CIS4 took place in the beginning of 2006 (January to mid-March). Due to that, respondents were fully informed of whether or not an innovation has occurred in the firm in 2005. More, we expect that respondents had adequate insights on innovation projects that would be finalized for 2006.

In practise, we included the following question in CIS4: "did your firm introduce in 2005 or plan to do so in 2006 an innovative product or process". For 2005, the three following responses were offered:

- "Yes, an innovative product"
- "Yes, an innovative process"
- "No, neither an innovative product nor an innovative process"

For 2006, an additional response was offered:

- "Do not know".

This question, drawn from the German innovation survey (Mannheim innovation panel), was address to all firms covered by the survey (i.e. the innovative and non innovative ones). In order to compute innovate rate in 2006, firms pointing out that they do not know whether or not a innovation will occur in 2006 were reported as non innovative for 2006 (3% of the firms provided that response).

These responses are used for the establishment of the following reference period: 2005-2006, 2005, 2006. Pointing out our attention to this building, based on the CIS4 results, it has to be remembered that respondent's memory decreases over time, and as a consequence, recent innovation successes (in 2005 or 2006) are more likely to be reported than previous ones. More, some innovations planed for 2006 can have been delayed or been unsuccessful. If this occurs, responses provided by respondents overestimate innovation successes in 2006. In other way, some innovations not planned at the beginning of 2006 could have taken place in 2006.

1.4 Firms' environment along the last years

Firms' environment may have a significant impact of firm's decision to undertake innovation activities. Indeed, innovation is function among other of legal environment, technological opportunities, and demand (national and international). On the latter factor, some variations have occurred along the last years. In fact and until 2000, the growth was high (around 5% per year in Luxembourg), whereas growth was low (around 1% in Luxembourg) in the period 2001-2003, and still high since 2004 (around 4% per year in Luxembourg). As a consequence, less innovation activities are expected in the period 2001-2003.

One can expect that the decision to undertake R&D activities depend less on these factors. Indeed, R&D activities develop firms' absorptive capacities (Cohen and Levinthal, 1989 and 1990). To profit of them, firms have to be involved in R&D along a medium-term or a long-term period. More, due to this absorptive capacity hypothesis, propensity to undertake R&D activities are expected to depend less on the length of the reference period (i.e. firms have advantage to undertake R&D activities along a medium-term period) than the propensity to innovate.

Firstly, due to these changes in firms' environment and the reduction of the length of the reference period, less innovation activities are expected in CIS light. Secondly, the CIS light innovators are expected to be more often engaged in R&D.

2. Length of the reference period and propensity to innovate

The following paragraphs are dedicated to the exam of the propensity to innovate. To do so, we make the distinction between the following reference periods: 1998-2000 (CIS3), 2002-2003 (CIS light), 2002-2004 (CIS4), 2005-2006, 2005 and 2006. In a first paragraph this exam is carried out across three size classes (10-49 employees, 50-249 employees, 250 employees and more). In a second one, it is realized across two economic sectors (manufacturing sector, service sector).

2.1 Length of the reference period and propensity to innovate by size

Looking at the two standard results, innovating in 1998-2000 (CIS3) and innovating in 2002-2004 (CIS4), it appears that small and medium size firms have tended more often to innovate in 2002-2004 (table 1). At the opposite, big size firms have tended to innovate more often in 1998-2000, than in 2002-2004, therefore this discrepancy is small and it has to be noticed that due to the small size of our sample large differences are needed to be statistically significant.

Looking at CIS light (2002-2003) results, and for every size classes, firms are less innovative in that two year reference period than in CIS3. The same holds if we compare innovation in the two years 2005-2006 to innovation in 2002-2004, expect for the big size firms. The length of the reference period appears to reduce the propensity to innovate in small and medium size firms.

Nevertheless, this discrepancy between, a two year reference period and a three year, does not appear as so large. Comparing 2002-2004 results to 2005-2006 results based on an identical selection of firm (CIS4 sample) and similar economic environment, a ten percentage point gap is observed between medium size firm and a four percentage point gap between small size firms.

Table 1. Propensity to innovate by size through CIS3, CIS light and CIS4 datasets (%)

	2002-2004	2002-2003	1998-2000	2005-2006	2005	2006
10 to 49 employees	50	33	42	46	39	42
50 to 249 employees	68	43	58	58	55	55
250 or more employees	84	77	92	86	77	84

Source: CIS3, CIS light and CIS4; datasets from Luxembourg; based on own calculation; 'whole sale trade', and 'transport and communication' sectors excluded.

2.2 Length of the reference period and propensity to innovate by sector

Pointing our attention at the propensity to innovate by sector, we observe that the propensity to innovate across the different periods is more fluctuating in the service sector than in the manufacturing one (table 2). In the manufacturing sector, 47% of the firms have pointed out to have innovative in 1998-2000, 47% in 2002-2004, 36% in 2002-2003, 40% in 2005-2006 and finally 35% in 2005. For the service sector gaps are deeper. More precisely, firms are more often innovative, in the service sector, through CIS4 (2002-2004, 2005-2006, 2005), than through CIS3 (1998-2000) and CIS light (2002-2003). It has to be remembered that CIS light questionnaire has been based on the CIS3 one, and that in CIS4 some change has been managed on the questions dedicated to the identification of product and process innovations.

Table 2. Propensity to innovate by sector through CIS3, CIS light and CIS4 datasets (%)

	1998-2000	2002-2003	2002-2004	2005-2006	2005	2006
Manufacturing sector	47	36	47	40	35	36
Service sector	51	41	64	60	53	56

Source: CIS3, CIS light and CIS4; dataset from Luxembourg; based on own calculation; 'whole sale trade' and' transport and communication' sectors excluded.

3. Length of the reference period and profile of the innovative and non innovative firms

In order to have a look at the profile of the innovative firms along different reference periods we consider available data relating to these firms. Among the few variables, we put our attention to firm market (mainly international or not), group belonging, economic activity and R&D activity.

For the latter variable we do not possess, over all the rounds, information regarding R&D activities carried out by non innovative firms. Nevertheless this information is available in our CIS4 dataset. Indeed, one additional question was dedicated to that purpose. Among the firms that have declared, in one hand, to not have succeeded to innovate in 2002-2004 and, in other hand, to not have any ongoing or abandoned innovation activities, only around 1% of them point out that they were engaged in R&D activities (table 3). Due to that result, one would conclude that no significant bias would be included, in the analysis on R&D activities, by pointing our attention only to innovating firms.

Table 3. In-house R&D activity and innovation in product or process in CIS4 (%)

	In-house R&D activity	No in-house R&D activity	Sum
No innovation activities	1	46	47
Ongoing or abandonned innovation	1	1	2
Innovation in product or process	23	28	51
Sum	25	75	100

Source: CIS4; dataset from Luxembourg; based on own calculation.

3.1 Market type and propensity to innovate across the reference periods

It has to be noticed that due to some modifications in the questionnaires, it is not possible to compare the propensities to innovate by main firms' market over all the reference periods. Due to that, we only point our attention to CIS4 results. For that survey, we classify firms by main market (international or not international) and reference period (2002-2004, 2005-2006, 2005, 2006) and point our attention to the firms' propensity to innovate. The resulting cross-tabulation (table 4) shows a significant interaction (at the 5% level) between those variables: a shorter reference period decreases the propensity to innovate for firms mainly active on national markets; at the opposite the propensity remains stable for firms mainly active on international market.

Table 4. Propensity to innovate for those that are mainly active on international markets and those that are not (%)

	2002-2004	2005-2006	2005	2006
Mainly active on international market	63	64	58	62
Not mainly active on international market	52	42	36	35

Source: CIS4; dataset from Luxembourg; based on own calculation; 'whole sale trade' and 'transport and communication' sectors excluded.

3.2 Belonging to a group and propensity to innovate across the reference periods

In order to complete this first result, we make a second distinction between firms belonging or not belonging to a group and measure for these two groups the propensity to innovate over the different reference periods. In that case, calculations are based on CIS3, CIS light and CIS4 datasets. This cross-tabulation shows a significant interaction (at the 10% level): a shorter reference period decreases the propensity to innovate for firms not belonging to a group whereas this propensity remains more stable for firms belonging to a group (table 5). Nevertheless, the exclusion of CIS light results in the test process leads to non significant interactions (p=0.2).

Table 5. Propensity to innovate for those that belongs to a group and those that does not (%)

	1998-2000	2002-2003	2002-2004	2005-2006	2005	2006
Belongs to a group	56	51	66	63	58	58
Does not belong to a group	40	21	45	35	29	34

Source: CIS3, CIS light and CIS4; dataset from Luxembourg; based on own calculation; 'whole sale trade' and 'transport and communication' sectors excluded.

3.3 Economic activity and propensity to innovate across the reference periods

As a third exam we consider the interaction between economic activity, length of the reference period and propensity to innovate (table 6). This cross-tabulation shows a significant interaction (at the 5% level). These interactions are due to the low-tech manufacturing sector and the following R&D- architecture and engineering - control and analysis activities (the sectors have been put together due to the application of the confidentiality rules) and to a less extent financial services and computer and related activities.

Table 6. Propensity to innovate by economic activity (%)

	1998-2000	2002-2003	2002-2004	2005-2006	2005	2006
High and medium high-tech manufacturing industry	52	67	71	70	64	63
Medium low-tech manufacturing industry	35	26	32	31	28	29
Low- tech manufacturing industry	55	31	49	34	28	31
Electricity, gas and water supply'	35	25	21	11	11	11
Financial intermediation	46	42	65	64	58	60
Computer and related activities	74	46	65	62	57	55
R&D – Engineering activities and consultancy - Technical testing and analysis	44	30	61	42	30	39

Source: CIS3, CIS light and CIS4; dataset from Luxembourg; based on own calculation; 'whole sale trade' and 'transport and communication' sectors excluded.

3.4 Innovation activities based or not based on R&D across the reference periods

Following the previous impacts on the length of the reference period, one may expect that, with a shorter reference period, firms identified as innovative would be more often engaged in R&D activities. In order to give some insights into this question, we have draw our attention to the proportion of innovating firms that, either provide a positive R&D

expenditure, or declare a positive R&D personal, for the last year of the reference period. Based on those criteria, we compare innovative firms in CIS3, CIS light, CIS4 and 2005. As expected, we observe that, with a shorter reference period, innovative activities tend more often to be carried out with some R&D activities (table 7). Firstly, 44% of innovative firms were engaged in R&D activities in CIS3, compared with 55% in CIS light. Secondly, 49% of innovative firms were engaged in R&D in CIS4, compared with 55% in 2005.

Table 7. Proportion of innovative firms that are engaged in R&D activity (%)

	1998-2000	2002-2003	2002-2004	2005
Proportion of innovative firms with in-house R&D activity the last year of the reference period	44	55	49	54

Source: CIS4; dataset from Luxembourg; based on own calculation; 'whole sale trade and 'transport and communication' sectors excluded.

4. Length of the reference period and behaviour of the innovative firms: comparison of the innovation process over CIS3, CIS light and CIS4

Numerous information describing the innovation process are collected via CIS3 and CIS4. More, the main themes covered by these rounds are stable. Those are about source of information used for innovating, cooperation engaged, innovation activities and innovation expenditures, innovation effects, methods for protecting innovation activities, factors hampering innovation activities.

Most of those themes were also included in our CIS light questionnaire. However, two CIS light exceptions have to be noticed: (1) questions on hampering factors for innovation were excluded, (2) substantial modifications were made on methods for protecting innovation activities in our CIS light. As a consequence those two themes will be excluded to the comparison that will follow.

As some modifications were made on questions or items, all available results do not appear as enough comparable through the different rounds. Due to that, some have been excluded to the comparison.

By comparing innovation process of the innovating firms through CIS3, CIS light and CIS4, it appears that the result do not differ so much across the rounds (table 8). More specifically, no clear differences regarding 'innovation effects' are observed. Pointing our attention to 'sources of information' and 'innovation activities', the main discrepancies arise from CIS3 innovation process in comparison to CIS light and CIS4 ones.

As expected, more firms, among the innovative ones, are involved in R&D activities in the two year reference period 2002-2003 (55%) than in the three year reference period 1998-2000 (44%). As firms engaged in R&D should differ in their innovation process, one would expect that some overall results, relating to the innovation process, would differ between CIS light and CIS3. On this point, Cassiman and Veugelers (2002) have provided evidence, based on Belgium CIS data, of complementarities between in-house R&D and some other innovation activities. Some results follow that expectation. More precisely, source of information from 'government and public research institutes' and 'universities and other higher education institutions' appeared as more important through CIS light innovative firms than through CIS3 ones. The same holds for acquisition of 'other external knowledge' and 'extramural R&D'.

Comparing the CIS light innovation process to the CIS4 one, we observe that among the innovative ones, neither the proportion of firms engaged in R&D activities, nor the main other results, differ significantly. Indeed, only two main discrepancies seem to appear in the results: innovative firms in CIS light tend to point out as more important than in CIS4 information from 'competitors or other enterprise in the sector' and from 'clients and customers'.

Table 8. Innovation process

Source of information for innovation activities	CIS3	CIS light	CIS4
		(min=0; max=3)[1]	
Government or public research institutes	**0.4**	0.7	0.8
Universities or other higher education institutions	**0.3**	0.7	0.6
Competitors or other enterprises in your sector	1.3	**1.9**	1.6
Clients or customers	1.6	**2.2**	1.9
Innovation effects	CIS3	CIS light	CIS4
		(min=0; max=3)[2]	
Met regulatory requirements	1.2	1.6	1.5
Reduced environmental impacts or improved health and safety	0.5	0.7	0.8
Reduced materials and energy per produced unit	0.6	0.5	0.6
Reduced labour costs per unit output	1.0	1.0	1.3
Improved quality in goods or services	2.2	2.2	2.4
Entered new markets or increased market share	1.8	1.9	1.9
Increased range of goods or services	2.0	2.0	2.1
Innovation activities	CIS3	CIS light	CIS4
		(Percentage)	
Market introduction of innovations	31	52	59
Training	73	90	82
Acquisition of other external knowledge	**40**	55	28
Extramural R&D	**24**	31	27
Intramural (in-house) R&D	**44**	**55**	**53**
Percentage of innovative firms	50	39	57
Length of the reference period	3 years	2 years	3 years

Source: CIS3, CIS light and CIS4; dataset from Luxembourg; based on own calculation; 'whole sale trade and 'transport and communication' sectors excluded.

Concluding remarks and implications

Through the comparison of CIS results over different reference periods some conclusions have emerged. Firstly, it appeared that reducing the length of the reference period should decrease the rate of innovators, especially in some service sectors or low-tech manufacturing sectors and in small and medium size firms. Secondly, we have found that this reduction will impact the profile of the innovative firms in comparison to the non innovative ones. Thirdly, it appeared that a short reference period could modify some results related to the innovation process.

As a consequence, and first implication, only one reference period should be used for the next CIS survey, whatever their type (i.e. full CIS surveys, light ones). Indeed, with more frequent surveys, the comparison over the rounds should appear as more and more requested by the users. In order to make these comparisons, a unique reference period is needed.

The second implication is related to the reference period that should be used. As stipulated in the introduction, a two year reference would solve the overlap issue. Nevertheless, with such a reference period overall results would turn toward high-tech and knowledge intensive services and results should be less informative about small and medium size activities leading to a decrease in the usefulness of the data collection. Indeed some parsimonious innovation will be lost through a two year

[1] Mean of the score measured on a 4-point scale (from not relevant (0) to high (3)).

reference period. More, as the next CIS will aim at covering other types of innovation, this drawback will increase. As a consequence, it seems that the second issue overtake the first one relating to the overlap. Therefore, additional insights, from other countries, would be needed to complete this picture.

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THE UNIVERSE OF UNDERSTANDINGS — WHICH ONE IS OBSERVED?

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Executive summary

This paper reflects the thoughts and experience accumulated by the author during data processing and analysis of the results of the Third and Fourth Community Innovation Surveys (CIS3 and CIS4). The preparatory phase for the 2006 CIS was even more demanding, as a large number of aspects connected with non-technological innovations (NTI) will be pilot tested.

First we compare the results of CIS4 for NTI and for technological product and process (TPP) innovations and show that the capability of firms to implement NTI is closely interlinked with TPP innovation activities. Even at country level NTI and TPP innovation intensities are fully correlated.

Then we reflect on the differences in how innovation is perceived by the various persons, ranging from researchers to accountants, filling in the CIS questionnaires. In our opinion, measurement errors in the CIS very much depend on such differences, which vary even more with a firm's position in the survey population.

Finally, we look at the concepts, instructions and recommendations of the Oslo Manual and their use in CIS 2006 pilot modules in respect of NTIs to see how clear they are to statisticians and CIS respondents, and find that some improvements are needed.

Introduction

It is widely accepted that nowadays innovation is a central driving force behind the growth in output and productivity. A good illustration to this can be found in the McKinsey surveys. In 2005,[1] business executives were asked what was the most important capability for growth. The most popular answer (43%) was the ability to innovate, all other answers being under the 25% borderline. Last year,[2] the question was what single factor contributes most to the accelerating pace of change in the global business environment today. And again executives' prime response was innovation. Innovative products, services and business models accounted for 24% of answers, clearly ahead of greater ease in obtaining information and developing knowledge (17%). Other possible answers pooled less then 12% of support.

However, our understanding of innovation activities and their economic impacts is still inadequate. In a survey[3] run by the Estonian Centre of Policy Studies Praxis it transpired that even the term "innovation" is not understandable enough for Estonian opinion leaders or the Estonian public. Thus, two processes are needed to measure innovation: a clear and concise definition of the concepts connected with innovation, and greater public awareness of innovation. In terms of the former, the measurement instrument in the form of a questionnaire only performs well when the respondent (enterprise) understands its content.

[1] http://www.mckinseyquarterly.com/article_page.aspx?L2=21&L3=34&ar=1653&pagenum=2

[2] http://www.mckinseyquarterly.com/article_page.aspx?ar=1754&l2=21&l3=114&srid=8&gp=1

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Non-technological innovations versus technological ones

The OECD (Organisation for Economic Cooperation and Development) started to arouse interest in measuring innovation at the end of the 1970, but the corresponding member of the Frascati family of manuals — the Oslo Manual (OM) — was only published in 1992. The first two versions of the Oslo Manual focused on the measurement of technological innovation, whereas the latest version —the third edition[1] — describes two non-technological innovations in detail: organisational innovation and marketing innovation. Organisational innovations were already discussed in the second edition, but marketing innovations were new to the Manual. First of all, definition of non-technological innovations stemmed from the need to describe and measure innovation processes in the services sector, although they also play an important role in industry. Thus, the Oslo Manual defines non-technological innovations as follows:

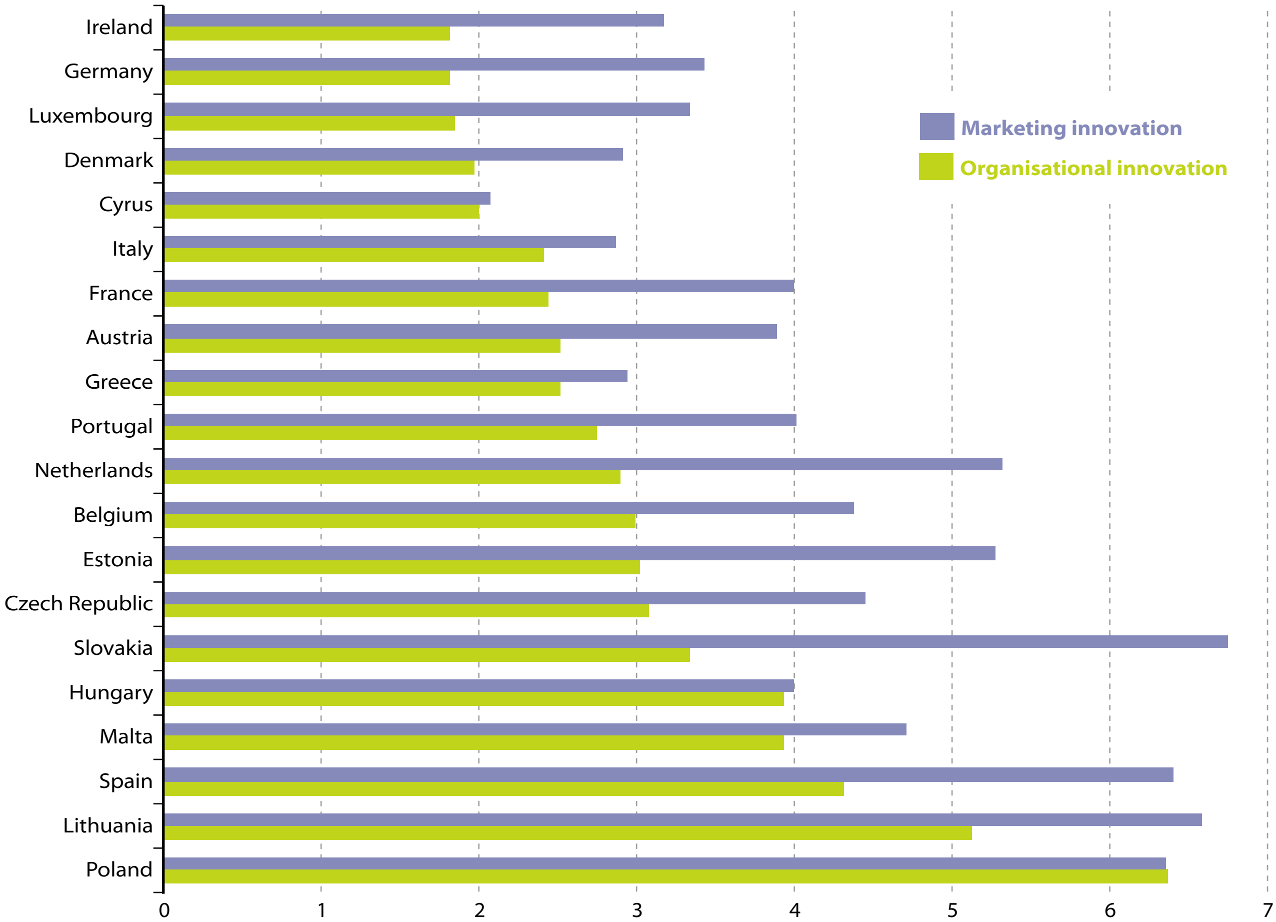
- An **organisational innovation** is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.

- A **marketing innovation** is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.

TPP innovations and NTIs are not distinct phenomena, they are closely linked, often parallel processes. A new product often means changes in marketing, and a new technological process some restructuring of workplaces. Conversely, reorganisation of the knowledge management system improves the innovation capacity of the enterprise and will probably be followed by technological innovations. While the Third and Fourth Community Innovation Surveys (CIS3 and CIS4) did not include organisational and marketing innovations in the definition of the innovativeness of firms, a number of specific questions on the issue were nevertheless added to the questionnaire. This allows us to compare non-technologically innovative firms with technologically innovative ones. The results of the Fourth Community Innovation Survey (CIS4) show that, on average, enterprises without technological innovation activities implement organisational innovations three times and marketing innovations four times less frequently than firms with technological innovation activities (Figure 1).

[1] The Measurement of Scientific and Technological Activities, Proposed guidelines for collecting and interpreting innovation data. Oslo Manual, third edition. OECD, 2005.

Figure 1: Relative incidence of non-technological innovations in technologically innovative enterprises compared with non-innovative ones, 2004



Source: Eurostat, CIS4.

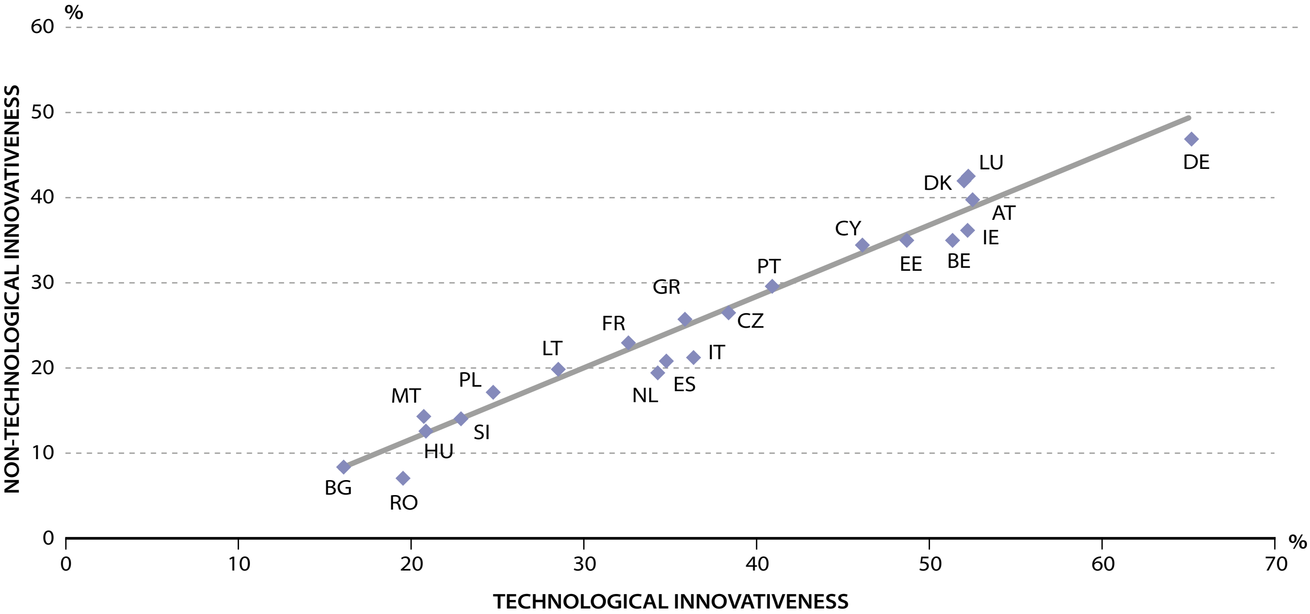
The new and old EU Member States are recognisably divided (Spain being the exception) into two groups, with Estonia at the frontier between the two. There are more non-technological innovations in technologically non-innovative enterprises in old Member States then in new ones. This could also be interpreted to mean that non-technological innovations in new Member States are more closely linked to technological ones. Table 1 gives exact figures for Estonian industry and services enterprises, showing that an organisational innovation takes place only in every fifth and a marketing innovation less then in every tenth technologically non-innovative enterprise.

Table 1. Share of enterprises with non-technological innovations in Estonia (%), 2004

	Industry			Services		
	Total	Technologically innovative	Technologically non-innovative	Total	Technologically innovative	Technologically non-innovative
Organisational innovation	38.2	59.8	19.0	43.2	63.6	22.2
Marketing innovation	21.3	37.5	6.8	28.8	47.4	9.6

A comparison of the two main indicators (Figure 2) — the share of non-technologically innovative and technologically innovative enterprises — for 20 EU Member States and 2 Candidate Countries (Bulgaria and Romania are now already full members) produces an amazing picture: the figures for certain economic indicators are such a linear fit. But is this a real pattern or just some peculiarity connected with the specific properties of the statistical instrument (CIS)? It has to be said, nonetheless, that there is some logic in the picture: Europe's locomotive — Germany — out in front and the candidate country carriages bringing up the rear. There is hardly any clustering except in one of the first class carriages, which includes Estonia.

Figure 2: Innovation intensity in EU, 2004



Source: Eurostat, CIS4.

Universe of understandings

Even if it can be assumed that some sort of understanding exists about innovation or innovativeness as an actual phenomenon, it must be recognised nevertheless that such understandings differ appreciably according to the types of persons involved. Policy-makers are eager to have measurements of the phenomenon and thus be praised for their wise innovation polities that have led to prosperity and growth. Their vision is limited to only a few indicators and they rarely delve into the real content of the assembled figures. Researchers, including those involved in the compilation of the Oslo Manual (OM), care more about theoretical models, universal definitions and linkages, and are usually more inclined towards high-tech and large companies. And then come the statisticians — the only people besides the authors who have studied the OM from cover to cover. They turn the content of the OM into a measurement instrument that will reach the last and the main group of interests — the respondents. All four groups definitely have their own somewhat different understanding of what innovation activities are, but statisticians — creators of statistical instruments and performers of actual measurements — are probably closest to what is really meant in terms of interpretation of measurements.

As regards the sub-universe of respondents, it has to be understood first of all that the CIS questionnaire often moves around within an enterprise, but it does not take an ideal path. In the worst case scenario, it goes no further than the accountant's office, whereas, ideally, it should land on the desks of quite a number of different managers. All these people have one virtue in common — they have never opened the OM — but the viewpoint of the marketing director will certainly differ from that of the production manager or the chief accountant, thus creating certain biases. During the processing of CIS4 data, the author had the opportunity to have phone contacts with about 700 respondents either for non-response, illogicality or, in numerous cases, to establish that a firm really is as innovative as it describes itself on its website, when the accountant filling in the questionnaire had declared the opposite. To avoid measurement errors of this kind, the Estonian CIS 2006 questionnaire includes precise instructions as to who should be responsible for completing the questionnaire.

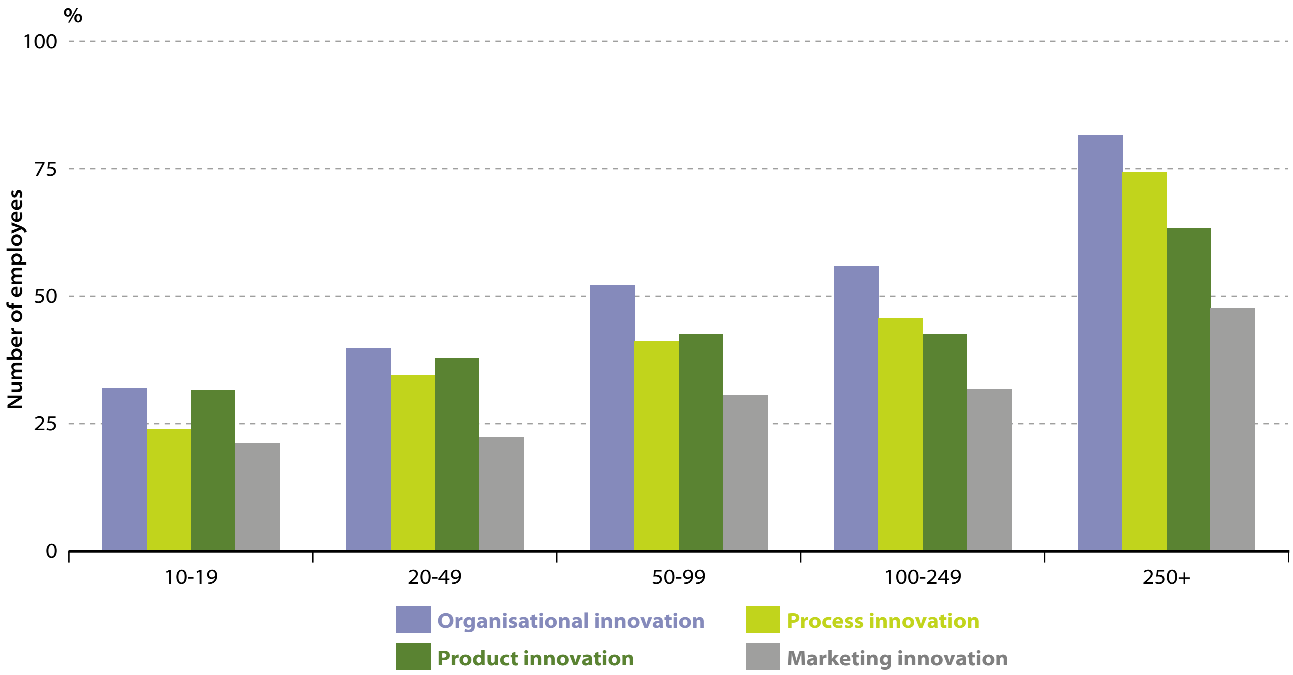
Even where respondents do their best to complete the questionnaire correctly, there are enormous differences between enterprises themselves, and no common understanding. It has to be acknowledged that actual innovation activities and how they are perceived differ appreciably according to an enterprise's:

- size (small versus large)
- technological intensity (low-tech versus high-tech)
- type of the economic activity (industry versus services)
- position in the group (head of group versus subsidiary)
- geographical, cultural and legal environment.

Looking at the list of examples added to the OM and CIS questionnaires, it is impossible to overlook the fact that they are biased towards innovations in large, knowledge-intensive firms. Actual contacts with respondents confirm that the variety must be increased, as otherwise the list can be misleading. A number of specific situations should also be considered, there being a number of firms (subsidiaries, subcontractors) with closed markets. How must they interpret certain concepts?

It should be said at this juncture that all our efforts to measure innovativeness would be cheaper if instead of counting enterprises their relative weight by turnover or number of employees were taken into account. 10% of enterprises with the largest turnover from the CIS4 frame accounted for 68% of total turnover and 44% of employment in Estonia. A change of this kind would mean smaller samples and — better still — higher values for innovation indicators.

Figure 3: Estonian enterprises with innovations by size class, 2004



Source: Statistics Estonia, CIS4.

In the case of TPP innovation, the innovativeness of a firm is correlated with a number of features, such as share of foreign equity, belonging to a group, share of exports, knowledge intensiveness of activity, etc. As a result of close linkages between two types of innovations, this also holds true for NTIs; at least this is what the CIS4 showed for Estonia. Similarly, the size of the enterprise determines its capacity to innovate (Figure 3), and organisational innovation happens to be the most frequent kind of innovation of the four defined in the OM. By contrast, marketing innovation is the least common, significantly less so than even product innovation. In other words, not all product innovations need marketing innovation to support them.

Nevertheless, looking at the pattern in Figure 3, measurement errors connected with the facts need to be considered:

- The smaller the enterprise the more likely it is to put NO answers in the innovation survey questionnaire to minimise the burden of response or even not to answer at all.
- For a small enterprise the questionnaire is more likely to go no further than the accountant's office.
- A small enterprise will not consider a change in the responsibilities of just a few people to be an organisational innovation, although the change is on the same scale as the reorganisation of several units in a large enterprise.

This last point illustrates the problem of different understandings. Another example could be a highly innovative small IT firm that sees its everyday efforts as being just routine.

Clarity of OM and CIS 2006 modules in respect to NTIs

There are several dangers lurking in the form of ambiguous or unclear questions when completing CIS questionnaires. Some may be due to the attachment of the properties of the technological innovations to NTIs, others to the impossibility for respondents to separate certain features of linked innovations.

The term "new to the firm" is quite clear for TPP innovations, but not so clear in the case of NTIs. Take the following simple example. The structure of a firm was reorganised but after a year and a half the old structure was restored. The process of restoring the structure is new but the result of the process is not. Was innovation involved? Another example. A firm was advertising its services on TV using commercials, but then began sponsoring certain TV programmes with its name shown regularly during the programmes. The medium is the same but the type of advertisement new. The explanation in the pilot module "… the first time use of a new advertising medium …" is therefore too strict or even misleading.

It seems quite improper to ask firms about their NTI developers. Both organisational and marketing innovations are based in most cases on existing ideas, models and examples and a firm simply implements them as and when it can. This kind of implementing process clearly includes some aspects of development. The answer will thus depend somewhat on the respondent's interpretation. NTI and TPP innovations are certainly different in terms of the diffusion of innovation.

As far as linkages are concerned, TPP innovations seem to be given a certain priority. One question included in the organisational pilot module asks:

- Were any of these organisational innovations integrated with or linked to other innovations that were introduced during the three years 2004 to 2006?

Very often organisational innovation is a precondition for TPP innovation, and thus there is no need for TPP innovation already to be introduced for a linkage to exist. TPP innovative activities coming on stream or even planned are of the same importance as TPP innovations already introduced.

As regards the effects of innovations listed in the core questionnaire and in both the pilot modules, some shown on several lists are more universal (improved quality of goods and services, reduced costs). In the case of a complex innovation activity, e.g. process innovation interlinked with organisational innovation, it is not so simple for respondents to evaluate the importance of effects in respect of different innovations. To improve the quality of answers it would be useful to combine questions about specific effects with the type of innovation and separate them from questions about more universal effects.

So far the pilot modules do not include activities for NTIs in same way as the core questionnaire does for TPP innovations. Looking ahead to CIS 2008, when all kinds of innovations, innovative activities and expenditure for those activities will have equal significance, it is imperative to test the new structure of the questionnaire to find out how respondents will interpret activities for NTIs. Unfortunately, the OM is somewhat short and imprecise in its explanations.

Conclusions

The remarkable shift made in the new version of the OM towards NTI and further refinement of definitions and concepts of TPP innovation must be adequately reflected in the redesign of innovation measurement instruments. Regrettably, a conceptual and methodological basis for the measurement of organisational and marketing innovations has not yet been developed to the level of TPP innovations. It can bring along the credulous attachment of properties of TPP innovations to the non-technological ones. Even if NTI has a certain property it can be much harder for the respondent to evaluate it (expenditure, for instance) compared to TPP innovations. The dividing lines between innovative and non-innovative activities are particularly blurred, as are the lines between different types of innovation.

To make the OM operational, the guidelines and recommendations must be made clearer. Implementation difficulties impose certain limitations on questionnaire content and structure. Ambiguous questions or questions to which respondents cannot find a straight answer must be avoided in CIS or similar questionnaires. Examples and instructions must be meaningful to all kind of respondents, not only respondents from high-tech or large firms.

User needs for new indicators – As well as the existing

MEASURING INNOVATION PROCESSES

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Abstract

Is it possible to be a surviving firm and non-innovative (if not a monopolist)? It can be – and is - argued that all surviving firms should be considered innovative to some degree, but in different ways. Current designs of questionnaires (CIS) use filter questions that in effect extensively limit the amount of information obtained from firms that don't consider themselves "innovative" according to the definitions and filter questions. It represents a lost opportunity at low costs as long as the firms already have received the questionnaire. This reduces our ability to study the performance of firms with different ways of innovating and renewing themselves. The problem affects both product innovation and in particular changes to the different aspects of process innovation. An alternative is to leave out definitional questions in the form of filters and pose all questions to all firms. Labels that characterize the type of behaviour can then be adapted subsequently by the analysts – preferably in a more nuanced fashion than the rough process/product innovative/not innovative categories, for instance like the innovation modes used in Trend Chart.

The current CIS 4 and (to a lesser extent) the Oslo Manual are biased towards product innovation. There are in particular no indicators for outputs of process innovation. It can also be argued that there is a bias towards R&D based knowledge or even high-tech innovation (even if the opposite is the intention) whereas low-tech and/or new combinations of existing solutions or utilization of external and embedded knowledge is underrepresented – at least in practical data collection.

Particularly important components of innovation inputs are designs of different kinds – aesthetical, functional, and industrial - and these kinds of inputs are not satisfactorily treated in CIS 4/ OM. This affects both product and process innovation. The current treatment in particular mixes design with marketing innovation. Even if it introduces a whole new set of indicators to define and collect it can potentially be of significant help in differentiating the innovation modes. Another example concerns access to external knowledge of different kinds where the current CIS don't distinguish sufficiently the different types of relationships between the innovator and the external knowledge source or –supplier.

Information on process innovations is mainly limited to the input side, since indicators to quantify results or outcomes of process innovations are limited to an evaluation of the importance of effects on a likert scale. This applies for the original definition of process innovation - for the broader supplementary categories of organisational change and marketing innovation there are even less information. The introduction of the new types rightly broadens the scope but at the same time delimitation of process innovation from marketing and organizational innovation is not sufficiently clear. Thereby uncertainty concerning both the input and output sides of process innovations are created.

As mentioned above there do exist indicators on effects of innovation that include effects of process innovation, as evaluations of "degree of importance" on a likert scale from 1-4. No similar measures exist for marketing and organizational innovation, but such measures can easily be included if they are considered valuable. It is also possible to construct quantitative measures for process innovation and it should be investigated how this can be accomplished. Among other things that can help overcome the product innovation bias of the survey resulting from having quantitative measures of output only on the product side. One should also try to clarify the different components of innovation costs so that process costs are more visible and costs related to organizational innovation and marketing innovation are included.

To construct measures for results of process innovation, including for organizational change and marketing, one can work along two lines:

1. Ask for share of turnover affected by the innovation, parallel to the indicator for product innovation, and if desirable distinguish between new and significantly changed processes.
2. Ask explicitly for economic results of process innovation, such as effect on unit cost of production, percentage change in labour productivity, change in production time, change in market share, and change in overall profitability.

New indicators like this have to be tested properly before implementation. However some experiences do exist for instance in the Norwegian survey, and these experiences should be better utilised.

A final point relates to periodisation of inputs and outputs which are problematic in the current survey design. It can be enhanced by having annual surveys. Annual information will also improve the possibility to construct panels for time series analysis. Time series analysis of panel data can help tracking the effects of different kinds of innovation over time. Annual surveys will also improve the overall quality of the information for two reasons:

1. It is easier to remember more precisely what went on in the last year than in the last three years.
2. An education effect of more frequent surveying will improve the responses.

Introduction

It is generally challenging to identify and delimitate the starting and ending points of innovation processes since these are dynamic activities evolving over time. When do one process end and another begin? What is the significance of cumulative learning, market positions, networks, and investments? Of this reason it is difficult to obtain clearly defined measures for such activities. What kinds of preparations, generation of ideas, physical- or knowledge investments are relevant? And when can we say that an innovation is "finalised", so that we can measure its total value, effects and inputs? Clearly this can hardly be done but in very special cases. Otherwise we are constrained to collecting information about a series of activities which we define to constitute innovation activities and resulting innovations, but without identifying each single innovation. This is the general approach in the Oslo Manual and the CIS surveys. Yet it is an open question where to draw the border between innovations and other activities. One can ask if it is conceivable at all to be a surviving firm and totally non-innovative (if not a monopolist). In this paper it is argued that all surviving firms should be considered innovative to some degree, but in different ways. To investigate the case one need adequate information on all firms surveyed. Current designs of questionnaires (CIS) truncate the information in several ways:

1. Filter questions filter which firms that should reply to the majority of questions and which should not.
2. Only innovations considered by the respondents to be "significant" changes are included.
3. It is a reward for declaring oneself non-innovative in terms of not having to answer a number of difficult questions.

In effect this extensively limits the amount of information obtained from firms that don't consider themselves "innovative" according to the definitions and filter questions. In this respect it represents a lost opportunity to achieve additional information at low costs since the firms already have received the questionnaires. The limitations in available information reduce our possibilities to study the performance of firms with different ways of innovating and renewing themselves. The problem affects both product innovation and the different aspects of process innovation. An option is to leave out definitional questions in the form of filters and pose all questions to all firms. Labels that characterize the type of behaviour and degree of involvement can then be adapted subsequently by the analysts in a more nuanced fashion than the rough process/product innovative/not innovative categories, as illustrated by the innovation modes used in the recent Trend Chart reports.

The following paragraphs first briefly discuss what a reasonable delimitation of innovation can be, problematising in particular the use of "significant change" as a delimiter for innovation. Next the usefulness of distinguishing types and degrees of innovation is brought up, as an alternative to the innovation/non-innovation dichotomies. To elaborate on the information needs to make such distinctions a brief discussion is included to highlight some of the shortcomings in the current coverage of indicators. This includes innovation inputs and related linkages, innovation outputs and periodisation problems of the current indicators. Lastly the function of the filter questions in CIS is revisited with a suggestion to remove the filter function from the definitional questions. This is coupled with a proposal to alter the sequence of questions so that activities (yes/no) are addressed initially as an introduction to defining what is meant by innovation. The quantitative information about activities (innovation costs) is suggested as a separate question in the latter part of the questionnaire. Lastly some concluding remarks are added.

What to include as innovations

To be a surviving firm over time it is in most cases necessary to renew and change operations to some degree. In particular for large firms it is unconceivable that they exist over time without any changes in operations or some activities to supervise and prepare changes. Only in rare cases and for limited periods operations can by and large be unchanged due to circumstances such as monopolistic market power, full control over natural resources, or extremely conservative demand. But even in such cases some adjustments will usually occur, and it will be possible for the firm to make production or distribution more effective in order to improve profitability. In light of reasoning like this it is fair to consider all, or at least the vast majority, of surviving firms as innovators to some degree.

Nevertheless CIS results show that considerable shares of even large firms are identified as non-innovators according to the present survey design (on average around 20-30 percent). Among smaller firms the shares of non-innovators make up a large majority. It is difficult to accept that this really signifies that the firms are truly non-innovators. One option is that innovations do occur, but that they affect only minor parts of production relative to a larger turnover of basically unchanged products, as may be the case in for instance oil companies. Another option is that the changes in technology or production processes are considered to be relatively modest or incremental, and therefore does not reach the threshold level of a significant change. It is also possible that firms don't consider themselves innovative if the sources or development work of the new technology is mainly external to the firm. Yet another possibility is that there are other types of innovation going on than those defined by the survey instrument. This kind of reasoning resulted in the increased scope in the 3rd edition of the Oslo Manual covering also organisational and marketing innovation, which is also partially implemented in CIS 4.

I would argue that the cases listed above should be covered by innovation surveys, but that there are reasons to believe that many of them are ruled out in the current practice. In particular we should remember that the Oslo Manual initially tempted to collect information going beyond the usual focus on R&D as the sole input with "high-tech" sectors emerging as the most progressive parts of the economies. The current threshold defined by the requirement to introduce significant news is suspected to contribute to under representing many of the cases we are actually trying to capture.

The question then is if it is not only desirable but also possible to expand the scope to cover also such "low key" innovations that have so far fallen outside the filtering definitions. In the following it is argued that a more clear focus on innovation activities rather than filtering by means of innovation results can contribute to this. It is also suggested to consider an additional category of low-key innovativeness to cover "modifications and minor changes to existing products" and "modifications and minor changes to existing production processes" to cover the cases between the "new or significant change" and "basically unchanged" categories. Such a change will necessitate modifications in how innovations are defined in the core definitions.

Distinguishing types and degrees of innovativeness

The main advantage of having more information about more firms is that it becomes possible to create more nuanced classifications to describe how firms behave and innovate. A good example is found in the Trend Chart reports that distinguish different innovation modes on the basis of combinations of several variables. This is a valuable improvement in the analysis of innovators, and allows for instance to identify the innovation modes that are most affected by innovation system linkages and through this affected by policy actions. Such modes can be constructed to highlight a series of topics of interest and can in particular help in doing meaningful comparisons of countries.

Current use of innovation modes has been hampered by relatively high frequencies of missing values and ad hoc solutions to dealing with them to a large degree affect the results. For the so-called non-innovators there is also too little information available to make useful distinctions between them. The current situation has left us with plus/minus 50 percent of firms solely characterised as non-innovators with very limited additional information. A series of suggestions to expand the number of indicators are included in the 2006 Trend Chart Methodological Report by better utilising the information contained in CIS, and by utilising supplementary data. It is important to consider what is not available from other sources and therefore must be included in the innovation survey. In many countries there are big opportunities to utilise available micro level register based information that can supplement CIS. However, such additional information will lack the definitional references to the particular types of activities targeted in innovation surveys.

Indicators for innovation inputs and external linkages

Inputs can be measured in the form of a yes/no to indicate whether an activity takes place, and in the form of some measure for the volume of the activity. The latter is the most useful information for economic analyses, but at the same time the most difficult to obtain. It is also an option to indicate if an activity is considered important or valuable for the firm.

It is suggested here to introduce the list of innovation activities early in the questionnaire and ask all firms to complete it in the yes/no form. This helps defining for the firms what kinds of activities that should be considered as part of their innovation activity, if any. On this list the new types of organisational and marketing innovations should be added. In this way all firms are introduced immediately to the description of activities considered to be innovation activities. The more difficult quantitative information about the costs for these activities should be posed as a separate question, again including organisational and marketing innovation.

It can also be argued that there is a bias towards R&D based knowledge or even high-tech innovation (even if the opposite is the intention) whereas low-tech and/or new combinations of existing solutions or utilization of external and embedded knowledge is underrepresented – at least in practical data collection.

Particularly important components of innovation inputs are design of different kinds – aesthetical, functional, and industrial - and these kinds of inputs are not satisfactorily treated in the current CIS/OM framework. It affects both product and process innovation. The current treatment in particular mixes design with marketing innovation. Even if it introduces a whole new set of indicators to define and collect it can potentially be of significant help in differentiating innovation modes.

Another challenge concerns access to external knowledge of different kinds where the current CIS don't distinguish sufficiently the different types of relationships between the innovator and the external knowledge source or –supplier. There are different strengths in the degree of involvement with external partners, and this information can be used to characterise different modes of innovation. In particular, as suggested in the 3rd edition of the Oslo Manual, one can distinguish between open information sources, technology that is purchased, and knowledge/technology that is developed in co-operation with partners.

Indicators for innovation outputs

The current CIS 4, and (to a lesser extent) the Oslo Manual, are biased towards product innovation. Information on process innovations is mainly limited to the input side. There do exist indicators to quantify results or effects of different kinds including process innovations. The measurement is in the form of an evaluation of the importance of effects on a Likert scale. This applies for the original definition of process innovation - for the broader supplementary categories of organisational change and marketing innovation there are even less information. Similar measures for organisation and marketing can easily be included if they are considered valuable.

It is possible to construct quantitative measures for process innovation and it should be investigated how this can be accomplished, in line with the recommendations in the Oslo Manual. To construct measures for results of process innovation, including for organizational change and marketing, one can work along two lines:

3. Ask for share of turnover affected by the innovation, parallel to the indicator for product innovation, and if desirable distinguish between new and significantly changed processes.
4. Ask explicitly for economic results of process innovation, such as effect on unit cost of production, percentage change in labour productivity, change in production time, change in market share, and change in overall profitability.

New indicators like this have to be tested properly before implementation. However some experiences do exist for instance in the Norwegian survey, and these experiences should be better utilised.

As introduced above, there are reasons to consider introducing an additional category of innovativeness to capture moderate changes to existing products or operations (process, organisation, and marketing). The reason for this is to have additional information for a broader group of firms characterised by "less significant" innovations. To do this an additional output category should be included to cover "modifications and minor changes to existing products" and "modifications and minor changes to existing production processes". The current category of goods and services that were "unchanged or only marginally modified" should be changed accordingly to read something like "basically unchanged".

Filtering and the sequence of questions

In practical terms it is suggested to split the question on innovation activities/costs into two parts; One Yes/No question in the very beginning of the questionnaire, and one question on resources towards the end of the questionnaire. The advantage of this is to contribute at the very beginning to defining what is meant by innovation activities, without posing the difficult question on use of resources. All firms will have to consider these activities. Next, the questions that further characterise the innovation processes in terms of linkages and hampering factors should follow on. The current questions on achieved innovations should be next in line. These questions should not be used as filters for the other parts of the questionnaire. Results should both include the outcome of the activities; innovations (product, process, organisation, marketing) yes/no, who did contribute, and share of production being new or significantly changed products, being new or significantly changed processes.

Concluding remarks

The paper argues for being inclusive when it comes to defining innovativeness. In particular it is argued that firms surviving over time must be expected to adjust their products and ways of operation to some degree. The current filtering out of respondents not considered significant innovators limits more than necessary the amount of information that is gathered. In order to obtain better information about the types and degrees of innovativeness it is suggested to pose all questions to all firms. In this way it is the actual activities the firms report that defines what types of innovators we will consider them. It also assures that we get the maximum amount of information in return after having invested in distributing the questionnaire.

The requirement for innovations to be at least "new or significantly changed" is suspected to contribute significantly to the relatively low shares of innovators recorded. With the limited information obtained about non-innovators this contributes to limiting the amount of information collected. Therefore it is suggested to consider including an additional category to cover low-key innovators, in the form of modifications and minor changes to existing products and processes. Even if such a new type could be kept separately in the questionnaire it would affect how the core definitions of innovation are formulated.

In practical terms it is suggested to split the question on innovation activities/costs into two parts; One Yes/No question in the very beginning of the questionnaire, and one question on resources towards the end of the questionnaire. The advantage of this is to contribute at the very beginning to defining what is meant by innovation activities without posing the difficult question on use of resources. All firms will have to consider these activities. Next, the questions characterising the innovation processes further can be put, on linkages and hampering factors. The current questions on achieved innovations should be next in line. These questions should not be used as filters for the other parts of the questionnaire. Results should both include the outcome of the activities; innovations (product, process, organisation, marketing) yes/no, who did contribute, and share of production being new or significantly changed products, being new or significantly changed processes.

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THE PROS AND CONS OF DIFFERENT FORMS OF MICRO-DATA ACCESS

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Summary

Among a number of scientific and social factors influencing the production and use of statistical indicators on innovation at international level, the growing request for accessing enterprise-level statistical micro-data in order to perform econometric analyses is probably the most challenging for data producers.

In general, the access to economic micro-data for research purposes is by far less developed than the access to social statistics micro-data. Furthermore, R&D and innovation data at enterprise level have been long regarded as very confidential data and the access to these data has been severely restricted in most countries.

Technical and institutional developments are now setting a new scene for accessing innovation micro-data. On the one hand, the increasing convergence of a number of EU and non-EU countries towards a common model for innovation surveys largely based on the European CIS is opening the way to a higher level of comparability between analyses performed in different countries. On the other hand, the users are becoming more demanding and even international institutions, like the OECD, are developing large scale research projects including statistical micro-data analysis.

The results of a survey on the procedures for accessing CIS micro-data in 14 EU countries will be presented in order to provide some evidence about micro-data access strategies, at national level, in the EU.

In this framework, the implementation by Eurostat of the European Commission Regulation no. 831/2002 - granting European researchers the access to innovation micro-data - is going to strongly affect the relationship between producers and users of innovation statistics in the EU.

This environment will offer new and important chances for the advancement of research but also will pose new challenges to the European statistical system. Some issues related to this evolution – mainly with reference to innovation statistics - will be described in the paper, including:

- asymmetries in accessing statistical micro-data as a result of a lack of coordination between national and EC strategies;
- consequences on the users of different national attitudes towards the access to micro-data for research purposes;
- potential barriers to entry in the field of studies on innovation economics.

Finally, some guidelines to be taken into consideration for future actions will be discussed.

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1. The demand for accessing the innovation micro-data

The development of innovation surveys as an innovative source to collect statistical information on the innovation activities undertaken by enterprises has been, undoubtedly, one of the major achievements of the statistical institutions which are closely co-operating in the framework of the OECD on one hand, and of the European Statistical System (ESS) on the other hand.

After two revisions of the original "Oslo Manual" and four editions of the European Community Innovation Survey (CIS), the innovation surveys are currently based on robust statistical methodologies while sharing a coherent set of concepts and definitions about what is "innovation" in manufacturing and service enterprises and how it can be measured.

Not affected by changes has been the main objective of innovation surveys: to provide the policy-makers with reliable statistical information on the main features of innovation. The use of statistics made available by innovation surveys is currently widespread at all levels of policy-making: local (as far as territorial data can be produced), national and supra-national, at least in the EU context.

The sectoral and territorial breakdown of the innovation indicators currently available, though acceptable for policy-makers, is regarded as largely unsatisfactory by academic researchers and analysts. Since the beginning of the process to develop a European model for innovation surveys, several research projects were designed in order to extract as much information as possible from innovation data, mainly performing statistical and micro-economic analysis on survey micro-data. Among the first experiences of micro-data analysis using the innovation micro-data, it can be mentioned the use by selected institutions involved in research projects funded by the European Commission of a "micro-aggregated" file of the CIS1 results (1990-92) from seven EU countries. In the following years the use of innovation micro-data in research projects has become widespread but it is common opinion that the fully potential of innovation surveys is still far to be exploited[1].

The advantages analysts find in accessing the micro-data are multiple. For instance, causality links between a range of innovation phenomena can be explored by performing micro-econometric analyses. Relevant experiences can also be found of testing simple or complex econometric models ranging from those aimed at investigating the relationship between R&D and innovation to those estimating different production function models or the impact of innovation on productivity[2]. Innovation micro-data have also provided fresh evidence for testing some evolutionary theories of innovation and technological change by focusing on the analysis of determinants of the heterogeneity which can be observed at firm level and exploring diversities in the innovative behaviour of enterprises belonging to the same industry or located in the same region.

All these research experiences have been made possible by allowing researchers to access innovation surveys micro-data. The access to micro-data is usually allowed by single data producers on their national data. In a few cases, the pooling of anonymised or perturbated micro-data[3] from two or more countries has been tested[4], as well as performing comparative and parallel analyses on data-sets from two or more countries.

Strategies, procedures and rules for accessing enterprise micro-data in general, and innovation micro-data as a specific case, may also differ significantly among the EU countries. Differences in institutional settings and regulations between countries have obviously affected the ability of researchers to exploit the potential of innovation micro-data for economic research. In practice, some countries allow for an easier access to micro-data with the result of giving national researchers a comparative advantage in comparison to their academic colleagues from countries where innovation data are either not available, or not accessible. To provide an example about these effects, it could be argued that the possibility to access the UK innovation micro-data by researchers working in the UK under a contract with a British academic institution has

[1] According to UNU-Merit, 162 academic papers based on microeconomic analyses of CIS data have been produced until June 2006, with a remarkable increase in the most recent years (Arundel, 2006).

[2] Mohnen (2006) and Colecchia *et alii* (2006) provides a quite detailed and updated information on studies which have used innovation micro-data.

[3] For the purposes of this paper, by "anonymised micro-data" is meant a statistical dataset of enterprises level information where all identification variables have been dropped but the indirect disclosure of confidential data can not be totally excluded; by "perturbated micro-data" is meant a statistical dataset of enterprises level information where all variables have been treated to avoid both direct and indirect disclosure of confidential data.

[4] Some experiences are mentioned in Mohnen (2006) including the pooling of German and Swedish non perturbated innovation data by Janz, Lööf and Peters (2004) and the use of micro-aggregated data for seven EU countries by Mohnen, Mairesse and Dagenais (2006) and by Mohnen and Röller (2005).

led, over the last ten years, to a "migration" of innovation experts from several European countries to Britain in order to conduct research on innovation.

In the next paragraphs, some evidence on the differences between the national approaches to the access to CIS micro-data will be discussed by presenting the results of a survey carried out by ISTAT on fourteen EU countries. To complete the description of the currently available options for accessing the CIS micro-data, a short description of the procedures implemented at Eurostat will be given. Finally, an evaluation of the opportunities for innovation micro-data access in the European context will be provided with reference to:

- asymmetries in accessing statistical micro-data as a result of a lack of coordination between national and EC strategies;
- consequences on the users of different national attitudes towards the access to micro-data for research purposes;
- potential barriers to entry in the field of studies on innovation economics as a consequence of the above mentioned asymmetries.

2. Different models of micro-data access in the EU

In December 2006, a short questionnaire has been circulated by ISTAT among CIS data producers in European countries to collect information about innovation micro-data management at national level[1]. Fourteen national CIS managers have filled in the ISTAT questionnaire[2]. For France and the UK only general information have been made available.

Information have been collected on four main subjects:

- Basic information about the national legislation on statistical confidentiality and its influence on CIS data management.
- Procedures for accessing the CIS micro-data.
- Technical aspects of micro-data access.
- Co-operation with Eurostat on micro-data access.

2.1 The national legislations on confidentiality and access to micro-data

Almost all surveyed countries have legislation on statistical confidentiality which is influencing the access and use of CIS micro-data. In some cases, statistical confidentiality rules are included in the general statistical legislation (as it is the case in Slovenia[3], in the UK[4] and other countries) since the borders between laws regulating official statistical activities and laws on the protection of personal (including enterprises) data are often blurred. An interesting point is that most surveyed countries seem have revised their legislations quite recently (in very few cases the current legislation has been approved before 1995), probably in order to keep pace with the increasing need for the protection of personal data emerging at EU

[1] Additional information has been found from two surveys which have been recently carried out at international level. In 2005-2006, the OECD Statistical Directorate carried out a survey on NSIs of OECD member countries to investigate the possibility to access statistical micro-data available at national level. Several information about micro-data management strategies in OECD member countries were asked. A synthesis of the results of the survey was presented by Nadim Ahmad to the meeting of the OECD Working Party on Statistics held in Paris on 13-14 November 2006. The Eurostat sponsored, Centre of Excellence for Statistical Disclosure Control (CENEX SDC) has launched in 2006 a EU-wide survey on the implementation of statistical disclosure control activities by NSIs. The results of the survey have been used to establish a European inventory of statistical disclosure control initiatives and practices (neon.vb.cbs.nl/**cenex**/).

[2] The countries which have provided the requested information are: Austria, Czech Republic, Denmark, Estonia, Germany, Hungary, Italy, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden.

[3] In Slovenia the relevant legal source is the "National Statistics Act" (1995, amended in 2001).

[4] British business statistics are currently conducted under the Statistics of Trade Act dating back to 1947 and amended in 1990.

level. It is worth reminding that the framework EU legislation on European statistics entered into force in 1997[1] and the Regulation on the access to statistical micro-data in 2002[2].

As to the institutional settings of statistical data production and management, two main models came out from the survey:

1. Micro-data access and management responsibility rests totally with the data producers (usually, the National Statistical Institute).
2. A network of public institutions shares the responsibility for data production and/or management.

Institutions belonging to such networks are selected according to a range of criteria:

- In Spain and Austria, for instance, the "regional" statistical offices share with the NSI the responsibility for data collection.
- In countries like Poland or Estonia, government institutions dealing with economic policy co-operate with the NSI in statistical data collection.
- In Sweden and Norway, a number of public institutions (mainly dealing with research) can be involved in data production, as it is in Italy for the statistical offices of public institutions belonging to the National Statistical System (SISTAN).

These models of institutional co-operation do not necessarily imply neither the management of micro-data, nor the right to access them[3]. Nevertheless, in Italy, SISTAN institutions can access statistical micro-data for research and statistical purposes. Similar rules exist in Sweden where transmission of (identifiable) statistical micro-data to other public institution (including government agencies) is allowed but only for research and statistical purposes. Netherlands is a special case, since only data on individuals can be transferred from the NSI to other public bodies (thus excluding CIS and other enterprise micro-data). Micro-data transfer to other public institutions is not allowed in Portugal, Spain, Slovenia, Austria, Hungary, Norway and Estonia.

In some countries, an official body is dealing with the protection of individual data, including statistical data. Some examples of such bodies are shown in table 1. The national experiences in this field are quite different, ranging from the Hungarian Ombudsman, to the French Committee of Statistical Confidentiality and similar administrative bodies, to the Italian 'Authority' which is totally independent from the Government. According to the results of the ISTAT survey, only in two countries, Portugal and Slovenia, these bodies have been involved in questions related to the confidentiality of CIS data. In both cases, they were requested to take a decision about whether allowing national researchers the access to CIS data. In the case of Slovenia, the Data Confidentiality Committee is also in charge of approving the requests submitted to Eurostat for accessing the Slovenian CIS micro-data stored in the Eurostat data-warehouse.

[1] Council Regulation No.322/97 of 17 February 1997 on Community Statistics.

[2] Commission Regulation No.831/2002 of 17 May 2002 implementing Council Regulation No 322/97 concerning access to confidential data for scientific purposes.

[3] In particular for those institutions not directly involved in data collection activities.

Table 1. Official bodies dealing with statistical confidentiality issues in selected EU countries

Estonia	Data Protection Inspectorate (1999)	The Chief Inspector is appointed by the Government for a term of five years.
France	Committee of Statistical Confidentiality (1984)	Members are eleven public officials.
Hungary	Ombudsman responsible for data confidentiality (1990)	
Italy	Supervisory Authority for the protection of personal data (2003)	Members are four experts elected for a term of four years by the Italian Parliament.
Poland	Commission on statistical data confidentiality (1996)	Members of the Commission are officials from the Central Statistical Office and Regional Statistical Offices.
Portugal	Statistical Council (1989)	Members of the Council are representatives from national government bodies, regional governments, municipal associations, the Portuguese Central Bank, trade unions, employers' associations and universities.
Slovak Republic	Office for Personal Data Protection of the Slovak Republic (2002)	It is a government office. It was established according to the Act No. 428/2002 of 3 July 2002 on Protection of Personal Data.
Slovenia	Data Confidentiality Committee (2003)	Members of the Committee are appointed by the Director-General of SORS.

On the basis of the information collected, only a few requests by public institutions for accessing the CIS micro-data, at least in the surveyed countries, have been found. Public, mainly government, institutions seem not having interest in accessing the CIS micro-data (it has to be stressed that, in some cases, they neither have the right to access them). In general, the issue of using the CIS data to support the definition of public policies has to be restricted to a few countries where public authorities – either at national, or regional level – have an internal capacity of performing economic research. In this perspective, access to micro-data by academic researchers and analysts becomes increasingly relevant, being aimed at filling both scientific and policy needs at a time.

2.2 Procedures for accessing the CIS micro-data

Only three – Hungary, Poland and Slovak Republic - out of fourteen surveyed countries have not had experience of access to their CIS micro-data for research purposes. The status of these three countries is not indeed the same. In fact, while access to enterprise micro-data for research is forbidden in Hungary and Poland, in the Slovak Republic micro-economic analysis on individual statistical data is allowed to "legal entities whose basic mission is to carry out scientific research if conditions for data protection are ensured by such legal entities". At least in this case, only requests by potential users are still lacking.

Evidence about the access to CIS micro-data by researchers has been provided by twelve countries (including the UK). In table 2, the survey datasets actually accessible in each responding country are listed. Even in this case, the availability of data is quite different across country. In countries like Germany and Norway all innovation surveys are used to perform micro-analyses (including innovation surveys not harmonised with the CIS). In a few countries the CIS1 is not available mainly because the survey was not carried out in the country. In general, CIS2 and CIS3 data are largely accessible and good prospects can be foreseen for the CIS4 (with the exception of Austria, unfortunately).

Table 2. Surveys available to researchers for statistical analysis in selected EU countries

Austria	CIS3. Since CIS4 interpretation of "confidential" has become stricter. No access to micro-data will be allowed for future surveys
Denmark	CIS3 and CIS4
Estonia	CIS3 and CIS4
Germany	All innovation surveys
Italy	CIS2 and CIS3
Netherlands	CIS2, CIS2.5, CIS3, CIS3.5 CIS4. Also CIS1, which was conducted by the University of Amsterdam
Norway	All innovation surveys
Portugal	CIS2 and CIS3
Slovenia	CIS2 and CIS3
Spain	CIS3 and CIS4
Sweden	CIS2, CIS2.5, CIS3 and CIS4
United Kingdom	CIS1, CIS2, CIS3 and CIS4

In order to identify who is actually accessing the available CIS datasets in the surveyed countries, the data producers have been asked about the people who actually access the micro-data. As a first step, information about the "internal" access for research purposes has been requested. This activity is relevant for those producers which have research among their institutional duties and are employing a staff of researchers with experience in micro-economic analysis.

Data producers in Hungary, Poland, Portugal, Slovenia and Spain do not have the need to perform economic research on innovation micro-data and do not have an internal staff dealing with economic research. In other institutions, like in the Slovak and Dutch NSIs, internal analyses on CIS data are mainly performed in order to improve statistical production. Other European NSIs (Italy, Sweden) have a staff of economists who access the CIS micro-data mainly to contribute to international co-operative research projects. Finally, in countries where the CIS is conducted by research institutions (or by research branches of government institutions) - like Denmark, France, Germany and UK – the data producers play also a key role in the use of CIS results. The objectives of the research carried out in these institutions are multiple: from academic research, to policy consultancy and support to policy-making.

As to the access to CIS micro-data by external researchers, only two countries do not allow it: Hungary and Poland. In these countries the national legislations do not include provisions for the use of statistical micro-data for "academic" research purposes.

In Austria and Spain, the distinction between "academic" (i.e. "curiosity driven") and "institutional" research seems relevant since research projects including the analysis of statistical micro-data have to be consistent with the scientific and institutional needs of the national NSIs.

As a result of the ISTAT data collection, four main models for micro-data access have been identified (table 3), ranging from the unavailability of micro-data for research to an increasingly open policy of micro-data exploitation.

Among the countries which allow for external access to micro-data, a main distinction is proposed according to the admission procedure: either on the basis of a simple application (even though subject to some screening by data managers), or by signing an agreement (a contract, a joint-project, etc.) between the data producing institution and the accessing researchers. The rationale for this distinction is the evaluation of the degree of control data producers intend to have on external researchers about their purposes, methods and use of the results. For instance, Statistics Austria reports that " … access to micro-data by third parties is only possible [in Austria] under a legal contract between Statistics Austria and a research institution. Statistics Austria mandates/orders the third party to carry out specific analyses." A similar contract is mentioned by the UK's Department of Trade and Industry (DTI): … [the access is allowed] through the Business Data Laboratory, operated by the ONS, where researchers, subject to a contractual arrangement between ONS and their institutions can access a number of data sets for analytical purposes…". Finally, in Spain, a contract including the commitment to produce a research report has to be signed between INE and the researchers who access micro-data.

No similar agreements are requested in other countries, where researchers (who apparently need to be affiliated to a research institution only in Estonia, Netherlands and Slovak Republic) can ask to use micro-data for academic purposes by just forwarding the proposal for a research project. In general, statistical analysis for economic research is the only purpose accepted by data producers to allow for the access to micro-data.

Three countries give access to data only in laboratories, or safe centres, or secure places: they are Denmark, Italy and the Netherlands. On the other hand, most of the surveyed countries seem to have a micro-data access policy aimed at establishing a trustful relationship with users, mainly university professors and researchers working in public institutions, who have some experience with micro-data analysis. These users are allowed to access even anonymised (i.e. non perturbated) datasets under their personal responsibility. This kind of relationship has some obvious advantages both for producers and users: costs related to data access are very low, as well as the burden related to data management and analysis, not to mention the advantage to access "raw" anonymised micro-data rather than micro-data modified or aggregated.

Table 3. Models of CIS micro-data access for external researchers

Description		Countries
1.	Institutions which do not allow external researchers/analysts to access the CIS micro-data	Hungary, Poland
2.	Institutions which allow external researchers/analysts to access the CIS micro-data only in the framework of an agreement/joint project with the institutions.	Austria, Spain, UK
3a.	Institutions which allow external researchers/analysts to access the CIS micro-data for scientific purposes (only in a safe place)	Denmark, Italy, Netherlands
3b.	Institutions which allow external researchers/analysts to access the CIS micro-data for scientific purposes (also by releasing anonymised datasets)	Estonia, Norway, Portugal, Slovak Republic, Slovenia, Sweden
4.	Institutions which allow external researchers/analysts to access the CIS micro-data for scientific purposes but giving priority to internal researchers	France, Germany

France and Germany do not show special features in general, compared to other countries, but the procedures external researchers have to go through in order to get the access to data in France and the three-years lag before they can access the data in Germany are significantly limiting the chances for micro-data access in these countries. In France, the applications for accessing enterprises micro-data are subject to the scrutiny of the Committee of Statistical Confidentiality (CSC). The CSC is a large administrative body meeting two or three times per year to take decisions about the protection of the confidentiality of data collected by French official statistical surveys on enterprises[1]. Even though the rate of success of applications to CSC from 1984 to 2002 is quite high (73%), the procedure seems quite complex, including a pre-evaluation performed by the Secretariat of the CSC which prevent a number of applications to be even taken into consideration by the CSC. On the other hand, the French CIS is carried out by the Service for Industrial Studies and Statistics (SESSI – Service des etudes et des statistiques industrielles) of the Ministry of Industry which supports its statistical activities with a relevant research capacity based on a large staff of researchers (mainly economists) and experts. As a result, the informative contents of the French CIS micro-data is largely exploited by the SESSI researchers, as well as by consultants working for the Ministry of Industry. In general, the role of external researchers seems quite limited in this context. In Germany, the picture is different since the CIS data producer is a research institution: the ZEW of Mannheim (Zentrum für Europäische Wirtschaftsforschung – Centre for European Economic Research). In principle, all researchers working at the ZEW have access to the CIS micro-data: actually, six economists are directly dealing with research on innovation data. According to the ZEW regulations, external researchers can apply for using the CIS micro-data only three years after the end of the reference period, which means 18 months or more since micro-data are make available to the ZEW internal researchers. A safe centre is available at the ZEW but also anonymised datasets can be delivered for either scientific purposes (academic research, project sponsored by the German Research Foundation, etc.), or educational purposes.

As a general comment, the models of CIS micro-data access in EU countries seem still quite heterogeneous across EU countries with reference to legislations, institutions and procedures.

As to the ability of users to influence micro-data access strategies, it could have been negligible so far mainly because – excluding the quite impressive figures from ZEW, where around 130 external researchers have accessed the CIS micro-data in about 15 years – very few researchers have been working on CIS data in 2006: 2 in Denmark, 5 in Estonia, 3 in

[1] See, Lang (2003) and the last annual report available on the Internet (2005) of the French CNIS (Conseil Nationale de l'Information Statistique) about the activities of the Comité du secret statistique.

Italy, 20 in the Netherlands, 5 in Norway and a few in Sweden. Also the scientific productivity of these researchers does not seem very high – at least according to information available from the data producers – reinforcing the hypothesis that most of the scientific papers published in recent years and based on CIS micro-data analyses have been published by data producers and partner institutions, rather than by external researchers. It could be explained by the restrictions to CIS micro-data access which is really open to external researchers only in some countries, while in most EU countries data producers either still keep a strong internal research capacity, or retain some rights to "select" the users by associating partner institutions in undertaking ad hoc research projects.

2.3 Technical aspects of micro-data access

Some technical information on data access may complement the description of the "data access policies". In table 4, the methods to give access to CIS micro-data are presented: access by safe centres and anonymised data sets is widely spread throughout Europe.

The access to safe centres is free for the users in all countries but Spain (a fee of 2,000 Euros per project is due) and the Netherlands (100 Euros as a fixed fee plus 35/43 Euros for any half-day spent at the centre; data preparation costs have also to be covered, 82 Euros per hour). Statistical software packages like SAS, STATA and SPSS are usually available on request in all countries, even though some national preferences as to the use of specific software packages emerged from the survey. The efforts for diffusing best practices in micro-data access have also led the EU countries to use similar procedures in the management of safe centres, as well as for the control of users' activities and the checking of the results to protect data confidentiality[1].

Table 4. Methods to give access to external researchers to CIS micro-data

Countries	Access to micro-data in a safe place	Access to anonymised datasets	Remote access
Denmark	✓		
Estonia		✓	
Germany	✓	✓	
Italy	✓		
Netherlands	✓		✓
Norway		✓	
Portugal		✓	
Slovak Republic		✓	
Slovenia	✓	✓	✓
Spain	✓		
Sweden		✓	✓
UK	✓	✓	

In general, foreign researchers (at least from the EU) seem to have the same rights to access the CIS micro-data as the nationals in several countries. Foreign researchers are not admitted to perform micro-data analysis in Estonia and Spain. In the UK, foreign researcher can have access to micro-data only if working for UK-based institutions. Access to anonymised data sets is limited to nationals in Denmark, in the Netherlands and in Norway. Some more restrictions for foreigners are reported in Sweden[2].

[1] These information are confirmed by the CENEX SDC 2006 Inventory which reports 13 EU NSIs running a safe centre; 8 safe centres have between 2 and 10 users per year, only 2 safe centres have more than 25 users per year. These data refer to access to all statistical surveys whose micro-data are made available to researchers, not just the CIS.

[2] As reported by Statistics Sweden: "Regarding the release of CIS micro-data to foreign researchers/institutions, other than Eurostat, the decisions outlined in the Secrecy Act do not convey any obligation to release data. They simply establish under what conditions confidential data can be released to foreign authorities and international organisations. A Swedish authority does not have any obligation to assist foreign authorities or international organisations with data, confidential or otherwise. This is the case as long as an obligation to supply data is not specifically prescribed. When releasing data to a foreign private party, for example a university, it must be shown that the data can be protected by the recipient, either through the country's internal regulations or through a specific confidentiality agreement. Furthermore, it must be taken into consideration that it is forbidden to release personal information to a third country, meaning a country outside the EU, which does not have a level of protection equivalent to that within the EU.".

Countries which allow the access to CIS anonymised datasets have not reported the use of specific data disclosure control methodologies. The general rule is dropping all identification variables and, for smaller countries, excluding the largest, and most easily spotted, enterprises from the dataset. Spain is testing the application at national level of data perturbation methods similar to those implemented by Eurostat.

Quite surprisingly for non-experts, experiences of remote access to CIS micro-data already exists in three EU countries: the Netherlands, Slovenia and Sweden. Statistics Netherlands can probably claim to have the longest experience in the field. Dutch CIS files are regularly accessed from "on-site" desks mainly based in Dutch universities and connected to CBS. Biometric authentication (fingerprinting) is used as ordinary user's recognition technology. In Sweden, a large project called MONA (Microdata ON-line Access) is being implemented to allow the access from research institutions to statistical micro-data. A similar project is under development in Slovenia as a result of an agreement signed in 2005 between the NSI and the Ministry of Higher Education, Science and Technology.

2.4 Co-operation with Eurostat on micro-data access

A few questions of the ISTAT survey dealt with access to national CIS micro-data stored at Eurostat, according to the provisions of the EU Regulation no.831/2002. CIS3 micro-data are currently available at Eurostat for all EU countries and, as it will be discussed later, can be made available to European researchers by:

1. the access to "micro-aggregated" CIS datasets;
2. the access to raw CIS micro-data at the Eurostat premises in Luxembourg.

In the first case, EU countries which have transmitted – either on a mandatory, or on a voluntary basis – their CIS3 micro-data to Eurostat have to agree on the method used by Eurostat for perturbating their micro-data (Eurostat is currently using "micro-aggregation" by individual ranking[1]). If a country agrees, in principle, on the Eurostat methodology, it will be asked also to agree on each single request to access their micro-aggregated data. The countries retain the right to deny the access to their micro-data if they do not agree with the proposed projects. In the second case (raw data), the countries are only requested to agree with the projects proposed for micro-data analysis.

Since the Eurostat safe-centre in Luxembourg has become operational (late 2006) only few requests of access to raw micro-data have been made. Nevertheless, the attitudes by countries are still polarised between those which have constantly accepted the projects proposed, and those which are constantly denying – mainly for legal concerns – the access to their own CIS micro-data. For instance, Estonia, Germany, Hungary, Italy, the Netherlands, Norway, Poland, Slovak Republic and Spain have never refused to allow for the access to their micro-data, while Austria and Denmark have always refused it.

In parallel with the opening of the new safe centre, Eurostat has managed to make available a CD-ROM containing CIS3 micro-data for as much countries as possible. While Eurostat has achieved the goal of producing a micro-aggregated dataset including data from 15 countries (Belgium, Bulgaria, the Czech Republic, Estonia, Germany, Greece, Hungary, Iceland, Latvia, Lithuania, Norway, Portugal, Romania, the Slovak Republic and Spain) several EU countries are still sceptical about the adoption of the "micro-aggregation" methodology for protecting the confidentiality of CIS micro-data.

According to the ISTAT survey, the micro-aggregation method is "a good method" only for Spain. Most countries - including Estonia, Germany, Hungary, Portugal and Slovak republic which have agreed on using it – recognise that this method "could be improved". As pointed out by the German ZEW, improvement should focus on improving the "quality" of the data in reducing the biases in the analytical results due to data perturbation. Finally, it can be stressed that four countries are considering the method "not acceptable", at least with reference to their specific national conditions: Austria, Italy, the Netherlands and Sweden. As an example, ISTAT is concerned both about the poor "quality" of the micro-aggregated data with reference to the researchers' needs, and about the low level of protection of confidential data provided through the use of the method proposed by Eurostat.

[1] For a technical description of this methodology, see Eurostat, (2005).

Table 5. Access to national CIS micro-data at Eurostat

Countries	Micro-data sets transmitted to Eurostat	Refuses to allow access to national CIS micro-data stored at Eurostat	Overall about the perturbation methodology adopted by Eurostat to produce the anonymised CIS datasets
Austria	CIS 2 (not conducted by Statistics Austria); CIS 3; CIS 4.	Access never allowed.	It is not acceptable
Denmark	CIS3; CIS4 (to be transmitted)	Access never allowed.	It is acceptable, but could be improved
Estonia	CIS3; CIS4.	No refuses.	It is acceptable, but could be improved
Germany	CIS3	No refuses.	Too much focus on confidentiality and to little on analytical potential
Hungary	CIS3; CIS4.	No refuses.	It is acceptable, but could be improved
Italy	CIS1; CIS2; CIS3.	No refuses (but requests for more information).	It is not acceptable
Netherlands	CIS3.	No refuses.	For small countries like the Netherlands it is not acceptable.
Norway	CIS1; CIS2; CIS3; CIS4.	No refuses (but requests for more information)	The method is acceptable even though data for some units may be highly perturbated. Improving the method may not increase the quality of the data essentially.
Poland	CIS3.	No refuses	It is acceptable, but could be improved.
Portugal	CIS3; CIS4.	Access not allowed for several projects	It is acceptable, but could be improved
Slovak Republic	CIS3; CIS4.	No refuses	It is acceptable, but could be improved.
Slovenia	CIS3; CIS4.	No refuses	It is totally unacceptable.
Spain	CIS3; CIS4.	No refuses	It is a good method.
Sweden	CIS2; CIS3; CIS4 (to be transmitted).	Access not allowed for one project.	It is totally unacceptable

3. Micro-data access at European level: access asymmetries and potential barriers

As mentioned in the previous paragraph, the full implementation of the provisions of the EU Regulation no.831/2002 – at least with reference to the access to CIS micro-data – has opened a totally new perspective for European researchers who need to use such data.

In fact, the researchers who need to access the CIS micro-data have now two new chances: to apply to Eurostat for receiving a CIS3 (in the next future, CIS4) micro-aggregated dataset with data from around 15 countries and/or to apply for requesting the access to up to 24 countries raw micro-data at the Eurostat premises in Luxembourg[1].

For instance, an Italian researcher interested in undertaking a comparative research on some features of enterprise innovation in Europe by analysing CIS3 micro-data, would have now the following options:

- access the Italian CIS3 raw micro-data at the safe-centre of ISTAT in Rome;
- access CIS3 micro-data of few other countries – like Denmark, the Netherlands and Slovenia - but only in their safe centres (it has to be stressed that no pooling of national datasets will be allowed);
- apply to Eurostat for accessing either the micro-aggregated file on 15 countries or the Eurostat-based raw micro-data for about 18 countries.

[1] According to a note delivered by Eurostat in November 2006, Austria, Denmark, France, Luxembourg, the Netherlands and Sweden had not yet agreed on allowing researchers to access their raw CIS3 micro-data.

The trade-off between the three options is clearly in favour of the access to the Eurostat safe-centre but such an increasing request for access may cause some inconveniences because of an evident lack of coordination between the actors involved in the system.

Assuming that the access to Eurostat-based micro-data will be in the next years the option most requested by users, this should be evaluated in terms of effects on the other actors, mainly national producers of CIS data. On the one hand, a relevant number of users may move from the national access points to Eurostat where they will be able to perform analyses on multi-national data sets. On the other hand, since Eurostat will not be able to accommodate all applicants and the requests for accessing the CIS micro-data will probably increase in the next future, a large number of researchers will still have only the chance to apply for accessing CIS micro-data at national level (if allowed in their countries[1]).

The issue here is how to select the applicants at both national and Eurostat level. Several alternative criteria could be taken into consideration to rank individual researchers or research institutions in order to give priority to some of them in accessing the micro-data: scientific reputation, previous experience with micro-economic analysis, seniority, nationality, "first come, first served", etc.. What should be stressed is that any criterion will be ineffective if not aimed at allowing as many researchers as possible to access the data according to their needs. This would need a strong coordination in the framework of the ESS, providing an easy access to national data for researchers who do not really need to access multi-national data sets. At the same time, options for pooling data from a number of countries could be explored. Finally, Eurostat should commit itself to provide a proper accommodation in its safe centre for all European researchers who really need to access EU-wide CIS datasets (not excluding to encourage partnerships among researchers from different institutions working on the same subjects).

Without any positive action, the current lack of coordination between Eurostat and EU countries may have several negative effects in terms of asymmetries in accessing the micro-data, as well as in barriers to entry in the domain of research on innovation-related phenomena by performing micro-economic and econometric analyses.

Obviously, national data producers have also a role in influencing the Eurostat access strategies by, more or less systematically, denying the authorisation to access their own national micro-data stored at Eurostat. In fact, some EU countries – either for methodological or legal concerns – are actually preventing Eurostat to give access to researchers to their CIS micro-data. This attitude by some EU countries should turn from being only "negative" to "positive", opening the way to bilateral agreements with Eurostat to allow a wider access to national micro-data.

From the users' perspective will be crucial to have a set of options available, as well as preventing any distortion in the selection process, for accessing Eurostat-based CIS micro-data. It is quite evident that a restricted access to these data will lead to some monopolistic positions in the competition for international fund raising by research institutions (including funding from the EU Framework Programme).

In this complex environment, the role of other relevant actors should not be forgotten. In particular, the OECD seems reluctant to give up its leading role in promoting statistics and studies on innovation and it is launching an ambitious project of innovation micro-data analyses (considering also non CIS-based innovation surveys) which is only partially co-ordinated with the options for accessing CIS micro-data at Eurostat. This project, which can be seen as "strategic" for the OECD, is going to be developed on two different levels:

- a proposal for increasing – even though on a voluntary basis – the transmission from member states to the OECD Statistical Directorate of enterprise statistical micro-data in general (but also to develop new technologies for remote access to national micro-data by OECD analysts);
- the setting up of a network of international experts aimed at developing some key areas of economic research[2] by using innovation micro-data; according to the OECD, national research teams (more than 15 countries could contribute to the project) should work in a common research framework in order to get comparable results by running the same, or at least similar routines, on their national innovation datasets, although without pooling the data.

[1] Some researchers may actually find easier to access their own national micro-data at Eurostat than at home because of the strict regulations on micro-data access enforced in some EU countries. Hungary is a case in point.

[2] Five priority research areas have been identified during a kick-off meeting in Mid-November 2006 at the OECD: Innovation and productivity/employment; Innovation and foreign affiliates; Channels of international technology transfer; Technological and non-technological innovation; Innovation and IPRs.

The OECD is thus candidating itself to act as a "neutral" clearing room promoting the co-ordinated use of innovation micro-data from different countries and implicitly proposing a "bottom-up" approach to internationally comparable research on innovation, as an alternative to the centralisation of economic analysis on an international data-warehouse as currently pursued by Eurostat[1].

4. Guidelines for future actions

Suggesting proposals for implementing some changes in a complex environment where statistical and methodological issues are strictly related with the strategies of national and international institutions, as well as political and juridical constraints, is a difficult and risky task.

A good starting point could be to agree on some principles – deontological more than legal – to correctly manage the research access to innovation (including CIS) micro-data.

A basic principle to adopt should be avoiding every intentional or unintentional discrimination in the access to micro-data. Some actions could be implemented in this perspective:

- EU countries should cancel any restrictions to micro-data access for foreign EU researchers; some initiatives could be taken on bilateral/multilateral basis to allow access (including remote access[2]) to CIS micro-data produced by other countries, progressively extending the access rights through reciprocity agreements.
- Eurostat should reinforce the approach of granting the access to micro-data to "research projects" rather than to researchers or institutions. By encouraging the applications by multinational research teams co-operating on specific research projects, Eurostat may avoid that some key European institutions will overcome – by accessing the micro-data to perform several analyses at a time - potential competitors on the "market" for economic research.
- A key role could be played by the OECD exploring new options for comparative data analysis. As part of this effort, the OECD should encourage the national data producers to make available statistical micro-data to all potential users more than relying on "leading national users" to have a easier access to micro-data. The development of new technologies for remotely accessing statistical micro-data, opening the way to an alternative access to micro-data from different countries, could be another helpful contribution in this perspective.

A second objective which could be effectively pursued is improving the circulation of information and documentation. For instance, the scientific community – as well as the data producers themselves – would have a great advantage in being informed about the analyses carried out on the CIS micro-data released by Eurostat, as well as on the results of such analyses. Answering the ISTAT survey, several national data producers have admitted they have had a poor feedback from the users of CIS micro-data. This point should be definitely improved. On the other hand, data producers have to improve their methodological reporting (meta-data) associated with innovation surveys, even though this process is already on-going, at least at EU level.

Finally, it could be stressed that the whole system requires a strong commitment to co-operation.

- Co-operation has to be improved among EU countries which – under current or new legislations – may develop joint projects for mutual access to micro-data and data sharing for research and statistical production purposes[3].

[1] It has to be mentioned that the OECD is still awaiting for a decision by Eurostat about the admissibility of the OECD researchers to the Eurostat safe-centre which seems controversial according to the EU Regulation no.831/2002.

[2] An initiative is going to be launched by Eurostat to support remote access from national safe centres to micro-data sets stored at Eurostat or in other EU countries' data-warehouses.

[3] It can be reminded that the EU Regulation no.831/2002 does not allow European NSIs to access statistical micro-data produced by other EU countries and collected by Eurostat. A proposal is currently discussed at Eurostat about including the NSIs among the research institutions which can access the Eurostat micro-data. The pilot experience of circulating micro-data from the EU Labour Force Survey to other European NSIs is an interesting example of the potential of future co-operation.

- Co-operation could be improved between producers and users at national level, by extending the experiences of allowing the access to anonymised, but not perturbated, datasets for research purposes. As discussed above, several EU countries have very positive experiences in transferring anonymised datasets to users. Very encouraging are also the results of the OECD survey on micro-data access, since many countries reported to " …have been able to tackle business micro-data access difficulties by identifying and creating, a trusted, responsible, educated user network."[1]. An approach aimed at "screening" and "training" the users, associated with some penalties for confidential data disclosure, could help to diffuse the use of anonymised datasets.

- Even between Eurostat and the EU countries a stronger coordination of their access strategies would prevent the risk of asymmetries in micro-data access. The identification of the legal and methodological requirements needed by each EU country to agree on having their CIS micro-data accessed at Eurostat would be the first step to settle any dispute in order to offer the users an access to data sets containing micro-data from 27 countries, rather than just from 15 or 18 of them. Such an initiative would certainly be as much helpful as the "simplification and reduction of administrative burden" often requested by Eurostat for streamlining the process of authorisation, by national data producers, to micro-data access.

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CIS 2006, CIS 2008 and beyond

eurostat

HOW FAR AND FAST CAN WE GO?

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Executive Summary

Two OECD meetings in 2006 looked at new indicators and their use by the policy community. The first was the Global Science Forum Workshop in Helsinki in July on 'Science of Science Policy: Developing our Understanding of Public Investment in Science'. The second was the Blue Sky II Forum in Ottawa in September. Both looked at science, technology and innovation (STI) indicators, their evolution, and the interaction between the communities of practice that produce and use the indicators. A summary objective that was evident at both meetings was the need to 'provide science policy makers with the same kinds of analyses and advice that economists now provide for the makers of fiscal and monetary policy' (NSF 2006:10).

Another theme present in Helsinki, Ottawa and in Seoul in October at the OECD Workshop on Evaluation, was the need to understand the impact of public investment in science. However, attempts to address these and other themes required a clearer understanding of the complexity of the STI system than is now available. Suggestions were made to model the system, or systems, in order to improve that understanding and to explore the links between STI and economic and social outcomes. The Blue Sky II Forum brought much of this thinking together.

Participants in the Blue Sky II Forum identified five high-level issues to guide future indicator development at the OECD. They were: the capacity to tell the story (What happens when there is STI investment?); moving from 'activity' measures, such as R&D funding, to 'impact' measures, such as social changes resulting from the diffusion of mobile telephones; co-ordinating, focusing and synthesizing STI work at OECD and in other international organizations; moving from macro data to micro data analysis; and, developing the science of science policy. This last point was promoted by the science advisor to the U.S. President, Dr. John Marburger, who spoke in both Helsinki and Ottawa.

In addition to the high-level issues, there were a number of issues that were cross-cutting: human resources; classification and guidelines; firm characteristics; and, sustainability. The importance of human resources for STI was stressed repeatedly in view of the scarcity of the highly skilled, the shortfall in production of such people, problems associated with immigration and the absorption of highly skilled immigrants and, the need for greater commitment to lifelong learning. There was also a series of specific issues which are developed in the Statistics Canada Innovation Analysis Bulletin (Statistics Canada 2006).

Once the directions and goals arising from the deliberations of the last year are reviewed, the question of how rapidly the OECD and other international and supra national institutions can accommodate them is addressed. This moves the discussion to practices, and how these can change, and the extent to which such change is possible. For example, the development of a dialogue between the producers of indicators and the community of policy analysts requires the learning of a common language and the use of a shared set of tools. This and other objectives will be examined.

1. Introduction

There are two questions addressed in this paper. The first is, in the world of new indicators, how far can we go? The second question is how fast? The first is easier to address than the second.

Over the last year, speakers at international meetings have identified the need to 'provide science policy makers with the same kinds of analyses and advice that economists now provide for the makers of fiscal and monetary policy'. That particular quotation comes from the note on the Science of Science Policy in the Strategic Plan of the U.S. National Science Foundation, *Investing in America's Future* (NSF 2006:10). It illustrates that, in the U.S., this is now a strategic goal for the period 2006-2011.

How quickly such a goal can be achieved depends upon the institutions that are involved in producing the indicators, doing the analysis and disseminating the results. But, it also depends upon the policy analysts that are going to take the information and use it to effect change. Bridging the gap between the producers of indicators and the policy community requires investment in a common language and the use of shared tools. Investment takes time and to encourage it there must be a clear return. These issues where raised in the course of three OECD meetings in 2006.

At the OECD Blue Sky II Forum in Ottawa the focus was on the development of new indicators of science, technology and innovation (STI) and on what was required to support that process. It was accepted that all STI indicators had to be policy relevant and the measure of relevance was that they were being used by the policy community. Five high-level issues, four cross-cutting issues, and a number of more specific issues were identified to guide indicator development at the OECD. In almost every issue, there was a need for the OECD, and for the organizations in the member countries that provide the data, to shift the emphasis from what they are now doing to include new activities. While these were not proposals for radical change, they required a more integrative and collaborative approach to producing and disseminating indicators which would require organizational change. Time will be needed to make these changes.

The OECD Global Science Forum (GSF) in Helsinki brought together the policy analysts and the developers of indicators with a view to finding common ground and direction. It was evident that there was work to be done to find a common language with accepted concepts and definitions to facilitate the dialogue. Some of the work has been done, such as the publication and revision of the Frascati Family of manuals (OECD 2002:16) produced by the OECD or jointly with Eurostat. More needs to be done if the language in those manuals is to have the same currency as that found in the manuals supporting the System of National Accounts (SNA) which allow people to talk about gross domestic product (GDP), balance of payments, merchandise trade, and employment, with confidence that they will be understood. Conversations about innovation, or even research and development, are more difficult.

The GSF workshop was not just about language. As with Blue Sky II, there was discussion of the need to model the system, or systems, where STI happens. However, for there to be useful modeling, there have to be good data and outcomes which shed new light on economic and social problems. Economic and social problems and the impact of STI on the economy and the society were recurring themes in Helsinki and Ottawa, and at an OECD workshop in Seoul. The issue was the impact of public investment in science. More and more, governments are asking, and citizens are demanding to know, what the consequences are of making these investments. Measuring the outcomes and the impacts of public investment is one of the future directions to emerge from all of these meetings.

In what follows, selected outcomes of the OECD Blue Sky II Forum are reviewed[1], taking account of what has gone on at the other related OECD meetings, in order to examine what is needed to go forward and where the institutional barriers lie. The paper ends with a call to action.

[1] All of the papers submitted to the Forum are available on the OECD website. See OECD (2006).

2. Indicators and Policy

Indicators for telling the story

For indicators to be relevant, they must be used in the policy process. However, there are different uses for indicators. They are used for monitoring, benchmarking, as part of foresight exercises, and for research into the science of science policy. The growing interest in public accountability has also resulted in a demand for indicators to support evaluation of public spending programmes and of public institutions. An example of this interest is *The State of Science and Technology in Canada* (Council of Canadian Academies 2006) which reports on the state of Canadian science, but leaves to government the responsibility for judgment and priority setting. More specific examples can be found in Bernstein (2006) and Therrien (2006) and the European perspective in Veugelers (2006). Whatever the application, the indicators must be able support the telling of the story of what happens when STI activities are undertaken.

Moving from activity measures to impact measures

There are now many indicators of activities, such as R&D performance and funding, invention, innovation, diffusion of knowledge, technologies and practices, and the development of human resources for all of these. But, there are limited indicators of linkages among the actors (governments, institutions of education and research, hospitals, businesses, private non-profit institutions, and foreign institutions) which tell some of the story about the dynamics of the STI system. There are fewer indicators of outcomes (market share, change in profits, employment, skills, …) and fewer still on impacts of supporting and engaging in the activities and the linkages.

To tell a compelling story to the policy community, indicators of impact are necessary and this requires a shift in focus of indicator programmes. This does not mean producing fewer activity indicators. It does mean producing more impact indicators and integrating them into a system of indicators of activities, linkages and outcomes.

Co-ordinating, focusing and synthesizing

To produce a system of indicators to help tell the story requires co-ordination, focus and the capacity to synthesize. In international organizations, such as the OECD, this means working across committees and directorates to produce more integrated products. In governments, it means working across different departments and agencies to integrate human resource, financial, and other measures of STI activities, as all activities influence all others. Bringing the indicators together to tell the story requires considerable power of analysis and synthesis of information from different sources.

Moving from macro data analysis to micro data analysis

With increasing computing power it is now possible to add micro data analysis to the existing macro data analysis. This a more powerful way of testing hypotheses and gaining insights into how the system works, especially in a world where the system changes rapidly. As most micro data are confidential, making this move requires gaining access to micro data in countries that permit it and then, if international comparisons are to be made, using the same techniques in different countries to analyse comparable micro data. This is quite different from publishing macro data in the Main Science and Technology Indicators (OECD 2006a).

Developing the science of science policy

The science advisor to the U.S. President, John Marburger, spoke at both the GSF and the Blue Sky meetings and stressed the importance of developing the subject of the science of science policy within the social sciences, a subject 'complete with journals, annual conferences, academic degrees, and chaired professorships – that focus on the quantitative needs of science policy' (Marburger 2006). In support of this, the U.S. National Science Foundation has launched a programme in the 'Science of Science and Innovation Policy (SciSIP)' which is going forward.

Marburger argues that, after significant changes at the end of the last century, the 21st century preoccupation is with technology-based innovation and how to sustain it. This gives rise to a need to understand how science policy can improve economic effectiveness. With global change, old correlations lack predictive value, and focus has to move from the macro to the microeconomic domain. The growth of computing power makes possible large data bases, complex models for analysis of the large data bases and the visualization of the results. However, to make use of the data bases, models, visualization techniques and skills have to be developed.

While science policy research flourishes in many countries, the emphasis on the quantitative aspects of the subject has the potential to change the way in which policy analysts think and policy makers act. The growth of this subject, with its own 'intimidating models', moves the indicator and policy community closer to being able to provide the minister of industry, research or education with advice comparable to that now received by ministers of finance and central banks. It also supports public education in the areas of science and science policy.

3. Cross-cutting Issues in Indicator Development

Human Resource Measures

All STI activities depend upon human resources and that gives rise to the need to identify the education, training and learning facilitation that prepares people to contribute to STI, to engage in life-long learning, and to recover from learning failures. In addition, there are the immigration policies that guide the flow of skilled people across national borders and their assimilation into the society. Statistics are required to describe the characteristics of the institutions involved in education, training, learning and immigration.

In addition to the institutional statistics, some of which are quite well developed, there is a need for statistics on the characteristics of the individuals in the STI system, their age distribution, their stocks, and their flows among the actors in the system and across national borders. One of the characteristics of individuals noted was that of entrepreneurship, which is the subject of an existing OECD project. There is also the information gathered in the Programme for International Student Assessment (PISA) (OECD 2006b), the work on the Career Path of Doctorate Holders (CDH) by NESTI, and the programmes of the Global Science Forum, and the Ad Hoc Group on Steering and Funding of Research Institutions.

There were five papers at the Forum that addressed the human resource issues in STI (Auriol, 2006, Hansen 2006, Kim 2006, Moguerou, Da Costa, Paoli de Pietrogiacomo and Laget 2006, and Sandgren and Perez (2006)) and it was clear that there is a need to co-ordinate the work in order to provide the common concepts and definitions leading to comparable indicators that had once been the objective of the OECD / Eurostat Canberra Manual (OECD 1995). This is a role for the OECD and Eurostat in consultation with other international organizations.

Classification and Guidelines

Standard classifications of industry, occupation, education were not only necessary to the development of new indicators of economic activity, but they had to be revised in a way that reflected the needs of analysts who where trying to present STI indicators to the policy community in an accessible manner. This revision requires on-going liaison between the OECD and the international bodies, such as the UN Statistical Commission, that are responsible for the international standard classifications.

Firm Characteristics

While firm characteristics have always been important to STI analysis, globalization, interest in the urban economy, the importance of small and medium-sized enterprises (SMEs), as well as large firms and multi-nationals, highlighted the importance of common measures of firm size, geographical location, and the location and characteristics of the (foreign) affiliates of firms.

Sustainability

In a global economy, with competition for people, water, food, and fossil fuels, and concern for the impact of the results of STI activities, there is the question of whether the STI activity is sustainable, or even feasible in the short term. Indicators of sustainability are needed as part of the development of indicators for the next decade. (Bordt, Boivin and Rosa, 2006, Gault 2007).

4. Indicators of Activities, Linkages, Outcomes and Impacts

4.1 Activities

Actors (governments, businesses, education and research institutions, foreign institutions …) engage in STI activities. This section looks at R&D, invention, innovation and the diffusion of knowledge, technologies and practices, and highlights some findings. As noted in the introduction, these findings are not radical but suggest the need for oversight, co-ordination and communication.

R&D and Globalization

The formal creation of knowledge is an important input to the activity of innovation and it is being affected by globalization. The requirement is to go beyond the collection of data on the performance of R&D in countries to the adding of a global dimension (OECD 2005). This would include the classification of domestic industrial R&D by the country of control of the firm performing the R&D as well as the collection of information on the affiliates of that firm, especially those abroad, and the R&D performed by those affiliates. This then leads to questions on foreign direct investment (FDI) both incoming and outgoing.

Going beyond the firm and its affiliates, there are questions about the payments and receipts for technological services, including R&D services. This is covered in the OECD manual on the Technological Balance of Payments (OECD 1990) and it bears of the current issue of outsourcing of R&D, as well as other activities, and the information is needed for a complete picture of the R&D enterprise. There is also a need to distinguish between the purchase or the sale of a service, and a transfer payment, or company tax, to pay for a central R&D facility.

There is some work on globalization of R&D going on in NESTI (Åkerblom 2006, Perani and Cozza, 2006), but there is a need to recognize that this work is of immediate policy relevance and to support it. There is also work on the capitalization of R&D for national accounting purposes which, assuming the decision is taken to do this as part of the 2008 revision of the 1993 System of National Accounts (SNA), needs support.

Invention

Invention leads to intellectual property which may be protected by an intellectual property instrument such as a patent, copyright or a trademark, or by trade secrecy. Once an instrument of protection is chosen, indicators can be developed. The current OECD manual (OECD 1994) is being revised to take account of indicator development since the first Blue Sky Forum on 1996[1].

Innovation

Experience of surveying the activity of innovation has grown through the surveys in many countries, including the Community Innovation Survey (Eurostat 2004). The issue now is the making of this information more policy relevant and a number of proposals were raised (Arundel 2006). These included the qualifying of existing variables to make the

[1] A selection of papers relating to the first Blue Sky Forum can be found in the OECD STI Review, OECD (2001).

resulting measures more comparable and an example was moving from just presenting the revenue from new products, to revenue from new products sold abroad to get an indicator that was more internationally comparable. Another example was the qualifying of new products by their degree of novelty, which is already suggested by the 3rd edition of the Oslo Manual (OECD/Eurostat 2005). The use of panel data and longitudinal data bases were discussed.

New ways of doing innovation, and the related indicators, were considered which included open innovation (Chesbrough 2003) and the democratization of innovation resulting from user initiated innovation (von Hippel 2006). Both could be examined in case studies or pilot surveys, leading to new indicators.

Other aspects of innovation where discussed, such as the role of design (Gertler and Vinodrai 2006, and Lambert 2006). Design, as part of innovation, also linked to sustainability, (Douglas 2007) and is an area of growing interest for indicator development. With the expansion of the definition of innovation in the 3rd edition of the Oslo Manual to include industrial organization and practices, and market development, there was discussion of indicator development linked to organizational forms and innovative practice (Arundel and Lorenz 2006).

Diffusion of Knowledge, Technologies, and Practices

Knowledge is diffused in codified form through books and journals and through the more difficult transfer of tacit knowledge from person to person. Both cases presuppose an absorptive capacity so that the knowledge can be received and used.

The use and planned use of technologies was treated separately from innovation in the first and 2nd edition of the Oslo Manual. With the 3rd edition, they were incorporated into innovation that was in the lowest novelty class, new to the firm. However, if the technology was adopted earlier than the reference period, it did not qualify as an innovation, even at the lowest novelty level. While some technology use is captured in innovation surveys, there is still a place for the study of the diffusion of technologies.

The OECD pilot surveys of knowledge management practices in 2001 looked very like the 1980s surveys of technology use and demonstrated that there is no reason why 'practices' cannot be treated in the same way as technologies (Foray 2006). The expectation of the Forum was that business practices, including knowledge management, would continue to be measured and that attention should be given to practices in public organizations.

There was also an expectation that the diffusion of technologies would continue to be measured and the list of technologies expanded. Those mentioned where Information and Communication Technologies (ICTs) (OECD 2005a), Biotechnologies (OECD 2006c), Nanotechnologies (including ICT miniaturization, biotechnology applications, development of large (nano-scale) molecules, and new materials), Materials, Biofuels, Hydrogen Power, Grid Computing, and Health Technologies.

4.2 Linkages

The measuring of linkages is fundamental to the understanding of the dynamics of the STI system. However to monitor the linkages requires co-ordination across the OECD.

Linkages have been measured through the bibliometric analysis of publications with more than one author, representing different institutions. This kind of work shows the connections between the institutions in the system and their spatial distribution. Work has also been done on contracts for R&D performance. A contract is a linkage measure as it is a formal agreement between two organizations which can be classified by industry, geography, and field of science. Collaborations are more difficult to measure unless they are part of a contract and, there is commercialization of intellectual property.

Linkages do not have to be just between two people or institutions; they can include networks and how they are measured or visualized. Networks raise the question of network capital, the knowledge stored in the social network that goes beyond the human capital stored in the individual participants. Social networks and network capital are significant areas for network development.

Commercialization is an important linkage measure as it is the creation of market value from knowledge. It can result from the sale of intellectual property, or its licensing to the private sector, or the spinning off of a new firm to bring the new knowledge to market, or a combination of these.

Innovation surveys collect information on the sources of ideas for the activity of innovation but they do not focus on the money made by the source of the ideas, if it is a commercial transaction. There is a place for capturing more information on commercialization and the value chains in which the activity is embedded.

Linkages also involve people and machinery and equipment. Institutions hire people and they come from other institutions and carry knowledge with them, or, at the very least, the capacity to absorb knowledge. Machinery and equipment embodies knowledge which is transferred to the firm by the supplier. There is a link between the client and the supplier, especially if there is discussion about modifying the machinery and equipment to serve better the client needs.

Linkage measures should be reviewed by NESTI, and member countries encouraged to share information from case studies and surveys. The 3rd edition of the Oslo Manual provides a starting point for this work which should include the development of a conceptual framework for the understanding of commercialization.

4.3 Outcomes

The outcomes of an activity, such as R&D, innovation, or the diffusion of knowledge, technologies and practices provide direct evidence of the consequence of engaging in the activity, such as increased revenue, market share, or employment as a result of innovation.

The need is to share country experience of the measuring of outcomes through surveys.

4.4 Impacts

The impact of an activity is difficult to determine as the STI system is non linear. It is evident that wireless telephony, computing and broadband have had an impact on quality of life and business practices and organization. However, it would be difficult to tie this impact to the early research on wireless communication and surveys are not the ideal instrument as they cover a limited time period. Case studies and historical analysis are required.

Analysis of productivity and economic growth provide a means of getting at some of the causes, as do case studies. However, if the subject of the science of science policy is to develop, and if the policy community is to have a story to tell about government interventions in the economy and the society, more work has to be done on impacts (Ertl 2006).

5. Analysis

Analysis of STI data needed to populate statistics and to construct indicators requires concepts and definitions acceptable to the international community that govern both the measurement and the interpretation of the data. This is part of the on-going work of NESTI and its collaborators such as Eurostat and the UNESCO Institute of Statistics (UIS).

At present, depending upon the area being studied, there are not only data bases at the OECD but also at other international organizations such as the International Monatary Fund (IMF), the World Bank (WB) and the International Telecommunications Union (ITU). There is a need for a co-ordination role on the part of the OECD to facilitate the standardization and use of these data bases.

A recurring theme of the Forum was the importance of analyzing micro data in addition to doing more macro analysis using OECD data bases such as the Structural Analysis Statistics (STAN) data bases and the need to facilitate access to micro data holdings for institutions that hold such data.

There was also a question of analytical techniques. While much has been learned from the use of econometric modeling, there is also much that could be learned from micro analytic simulation models capable of supporting scenario analysis and engaging the policy community in a dynamic learning activity. This is one of the subjects of interest in the science of science policy.

There is also an analytical role for case studies in illuminating those relationships that are outside the capability of the models and which raise new research questions.

In summary, analysis is needed to create information from data and knowledge from information. The analytic activity requires international standards, co-ordination, micro and well as macro analysis, and a variety of techniques to tell the story about what is going on in the STI system. This is especially important in a rapidly changing world.

6. Moving Forward

The speed of introduction of new indicators and systems of indicators depends upon institutional factors and the willingness to adopt a common language and common tools. Bill Gates (2007) makes the point that for robotics to advance, in same way that personal computers took off thirty years ago, there have to be common standards and language. The same is true for the development and application of STI indicators.

A second issue governing the rate of progress is managing the transition from the indicators needed for policy development in the 20^{th} century to those needed in the 21^{st} century. Freeman and Soete (2006) make the point that indicators that served well in the past may be no longer as important as they were and they may even be misleading. This makes the choice of the trajectories along which indicators will develop both critical and urgent. Again, institutions, and their collaboration, will play a key role.

Institutions Producing Statistics

STI statistics in the OECD are produced by many different institutions including statistical offices, government departments, research institutes, central banks and industry associations. The model for the collection and dissemination of statistical data ranges from the centralized to the widely disbursed.

The economy is changing as a result of globalization, service industries are becoming even more dominant, and products and occupations are appearing, and disappearing, and making existing classification systems less relevant. This has led to suggestions that statistical data on firms be held in data bases that support analysis and different aggregations, with analysis driven by policy questions rather than being constrained by standard classifications.

In the shorter term is the need for micro data linkage of files that allow STI surveys, or administrative data bases to be linked to data from other surveys or administrative data bases to produce files for analysis without additional burden on respondents and more relevant variables for analytical work.

The OECD has a key role to play in the revision of international classifications and in working with statistical offices through the Statistics Committee of the Statistics Directorate. Additional co-ordination is required for the work of the many other organizations that produce STI statistics.

Institutions and Framework Conditions

Activities do not take place in isolation. They occur in a country which has a government that may or may not intervene in the economy and society, a culture, or cultures, a history, an education and research system that creates new knowledge and produces highly qualified people, a banking system, and an established legal system which ensures that consumers are protected, contracts are supported, and intellectual property is managed. These characteristics of the country are influenced by public and private institutions – governments, education and research organizations, and business.

Assuming a stable environment, surveys of STI activity can be conducted and compared over time. However, for there to be meaningful inter country comparisons, some account has to be taken of the framework conditions.

Development and Developing Countries

STI activities are part of economic development, but they need the support of public institutions to succeed. The knowledge developed by the OECD on how the STI system work can be shared with international organizations, such as those of the UN that deal with development and with those that represent developing countries such as the African Union and the S&T Secretariat of the New Programme for Africa's Development (NEPAD). Fostering a link between the NEPAD S&T group and the OECD committees engaged in STI policy and indicator development and use would promote knowledge exchange and capacity building as NEPAD develops its own set of STI indicators and guidelines for their use (NEPAD S&T 2006).

The Red Iberoamericana de indicadores de Ciencia y Technologia (RICYT) is planning a major conference, the Seventh Ibero-American Congress for Science and Technology Indicators, in Brazil, in May 2007 to address 'New Indicators for New Information Demands'. RICYT, NEPAD and other organizations are working on the development of indicators to take account of their special needs and this must be part of a collective and co-ordinated effort.

7. Conclusion

An answer to the question of how far we can go in developing indicators for science, technology and innovation is to reach the same level of presence and credibility as that of colleagues in working in the system of national accounts. This will ensure that science policy makers have the same kinds of analyses and advice that economists now provide to the makers of fiscal and monetary policy. How fast we can go depends on the will of the community of STI indicator developers, producers and users to collaborate across government departments and international organizations to accept and to achieve this as a common goal. The challenge to the community is to make it happen.

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COMMUNITY INNOVATION STATISTICS
Implementation of the new Oslo Manual, new indicators, constructing time series, micro-data access

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Abstract

The paper will deal with a number of different issues linked to the series of Community Innovation Surveys launched in recent years: the CIS 3 (reference year: 2000), the CIS 4 (reference year 2004), the CIS 2006 and the CIS 2008.

The new Eurostat/OECD Manual: "Guidelines for collecting and interpreting innovation data", edition 2005, emphasises the measurement of innovation by looking more closely at the measurement of non-technological types of innovation such as organisational and marketing innovation. A new chapter on "Linkages in the Innovation Process" has been added to the manual.

The revised guidelines laid down in the Oslo Manual 2005 need also to be taken into account and implemented within the Community Innovation Surveys. As this was not feasible for the CIS 2006, pilot modules on organisational and marketing innovation were drawn-up which are currently implemented in many EU countries. These modules were designed as self-standing modules or alternatively also integrated in the CIS 2006 questionnaire. The aim of these modules is to test them and to then integrate them into the CIS 2008. With regard to the measurement of linkages in the innovation process, some questions are already part of the CIS 4 and CIS 2006 questionnaires. However the question as to whether these are sufficient must be raised.

A further chapter of the paper will deal with the possibilities of constructing CIS time series. These options will be discussed with regard to the data produced on the basis of the CIS 3 (reference year 2000), the CIS 4 (reference year 2004) and the CIS 2006. The time series might then be continued with the CIS 2008.

The last chapter of the paper will deal with the CIS micro-data access for researchers and the micro-data linking of the CIS data to other micro-data sets. Greater progress was made with regard to the creation of an anonymisation method for the CIS micro-data. The anonymisation method - applied to the CIS 3 micro-data - was finally agreed on by 15 European countries and the data was disseminated to researchers accordingly. As a further option, researchers can also access the confidential CIS 3 micro-data at the Eurostat Safe Centre. The increased micro-data use by researchers will render the CIS much more visible. Also, the policy impact of the CIS should therefore increase. Finally, some future options for linking the CIS micro-data to other micro-data sets (such as the ICT micro-data) are laid down in the paper.

1. Introduction

With reference to the recent series of Community Innovation Surveys (CIS) this paper deals with a number of different issues. First of all the implementation of the new Oslo Manual 2005 will be discussed which will be challenging for the Community Innovation Statistics. Secondly the paper will look at the possibilities to construct CIS time series. And thirdly the access and further use of the CIS micro-data will be debated.

2. The implementation of the Oslo Manual 2005: some upcoming challenges for the Community Innovation Statistics

The new Eurostat/OECD Oslo Manual 2005 puts new challenges on the Community Innovation Statistics. The implementation of this new Manual will mainly happen for the CIS 2008 which is prepared from 2007 onwards. In the following some particular actions and user demands are outlined which will impact the future Community Innovation Statistics.

2.1 The pilot modules on organisational and marketing innovation as well as on knowledge flows

The Oslo Manual 2005 more broadly introduces two new types of innovation: organisational innovation and marketing innovation. The introduction of these two additional types of innovation already was prepared in drafting three pilot modules on organisational and marketing innovation as well as on knowledge flows. These pilot modules are tested and implemented at national level in many European countries in 2007.

The three modules are added to this paper in **annex 1**. They have the following characteristics:

- The **modules on organisational and marketing innovation** are structured in a similar way. They first ask if the enterprise introduced an organisational/marketing innovation in specifying a certain selection of subcategories for those two types of innovation. Then both modules ask who developed these innovations and on their links to other types of innovation. Finally the modules also ask on the innovation effects and on barriers when not introducing such an innovation.

- The **module on knowledge management** is somehow different as being shorter compared to the other two ones. It concentrates on a selected number of knowledge management practices and their introduction in the enterprise.

The three pilot modules can be tested in a self-standing manner, i.e. they can be used for a separate pilot survey hereon which also might cover face-to-face interviews. The modules are then used at national level aside the regular implementation of the CIS 2006 survey. On the other hand, the pilot modules can also be integrated into the CIS 2006 survey questionnaire. For this purpose an extended version of the CIS 2006 questionnaire is offered to countries that covers the pilot modules on organisational and marketing innovation as separate questions.

It will be interesting to see the results of the testing of the pilot modules in the various countries. Depending of these results, the modules on organizational innovation, marketing innovation and on knowledge flows might need to be revised when preparing the CIS 2008.

An additional question in this context is how to integrate the new modules into the CIS 2008 questionnaire. If they are listed after the questions on product and process innovations, all the subsequent questions on ongoing/abandoned innovation, innovation expenditure, etc. would also cover these additional types of innovation. This would affect the comparability of the CIS 2008 results to the CIS 4 (2004) and CIS 2006 results.

2.2 Linkages, throughput, technology transfer indicators

Beyond the traditional ‘input’ / ‘output’ indicators, a new category of indicators that has been emerging since the late nineties tries to describe the ‘process’ of knowledge creation and diffusion within the systems of innovation. Such indicators examine for instance the existence of networks of researchers/inventors, the extent at which enterprises make use of the results of the scientific work for its innovative activities etc.

Also the CIS is concerned by the request of producing more of these linkages indicators. The reference for these indicators is first of all the Oslo Manual 2005 which now contains an additional chapter 5: “Linkages in the innovation process”. The manual distinguishes three types if linkages:

- **Open information sources**
- **Acquisition of knowledge and technology and**
- **Innovation co-operation.**

The manual recommends the collection of all three types of linkages indicators. The questions hereon can refer to all innovation types combined, but also to individual types of innovation. Questions on linkages can either use the binary scale (yes/no) or an ordinal scale. Additional information could be obtained by asking for the geographical location of the co-operation partners. Also questions on the developer of the enterprises` innovation are recommended. Finally the manual speaks also of indicators of measuring the outbound diffusion of innovation (innovation impact on consumer and other markets) and on knowledge management indicators.

When looking to the CIS 2006 questionnaire, linkage indicators are already somehow present in the harmonised survey questionnaire. Question 5.1 deals e.g. with extramural R&D, the acquisition of external knowledge, etc. in also asking for the corresponding expenditures. Also the sources of information and the co-operation for innovation activities are covered in question 6 with many details, in also asking for prioritising the co-operation partners. Also question 10 touches upon the linkages aspects with regard to marketing and organisational innovation.

Under the assumption that the CIS 4 micro-data can be exploited better in also producing additional indicators going beyond the standard ones, the CIS seems to be prepared at a certain extent for producing such linkages, throughput or technological transfer indicators.

The question needs however to be asked if more needs to be done when preparing the CIS 2008 questionnaire. This should be thoroughly discussed when preparing this next CIS. In any case, the indicators on the outbound diffusion or the innovation impact on consumers and other enterprises are not really present in the current CIS 4 and CIS 2006 questionnaires.

2.3 Additional user needs expressed towards the CIS 2008

A number of additional user requests coming from various, often heterogeneous user groups were already brought forward to Eurostat. Some of these issues are:

- An open question carried forward since quite some time is the question whether the **observation period for the CIS** should be cut from three years to two years in the light of the fact that the frequency of the CIS has been increased to surveys being undertaken every two years from 2004 onwards. More discussions hereon need to take place in also taking into consideration some evidence coming from national surveying.
- An important question for the CIS 2008 will also be if **all CIS questions should cover all four types of innovation** (product, process, marketing and organisational innovation). If this is decided, then the CIS 4 and CIS 2006 data probably cannot be fully compared to the CIS 2008 data any more.
- A number of users (at the European Commission, the International Atomic Energy Agency or other users) want to keep better track of **eco-innovation**. As far as already understood from the users, the requests are two-fold: On the one hand the existing question 7.1 would need to be more detailed (in particular with regard to the materials and energy per unit output or the environmental impacts or improved health and safety criteria). On the other hand even more detailed information on eco-innovation seems to be necessary which possibly cannot be performed by an instrument such as the CIS any more. More detailed eco-innovation surveys would therefore be needed.
- **Innovation and public procurement** are also getting more importance on the EU policy agenda. At a certain stage the CIS should also be able to provide some answers hereto. A question could be added to the survey asking firms whether they sell to the government and, if so, to report on the relative influence of costs versus innovative characteristics on procurement decisions.
- **Open and user driven innovation** seems to gain in importance with the cheaper and better performing IT technology. Consumer and investment good are often improved by the users in an innovative manner.

So it seems that the closed in-house R&D and innovation environment is complemented by a more open innovation network also involving the users of the goods and services.

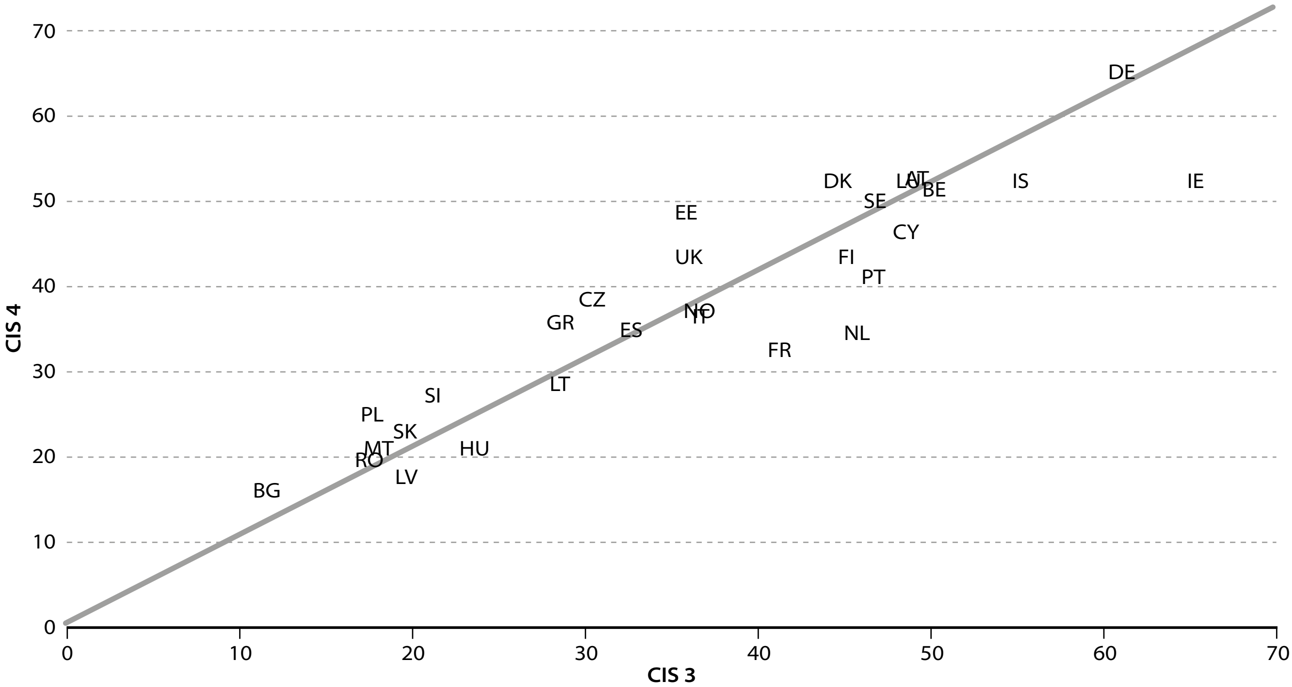
- **Design as an innovation input measure** needs better recording and observation with the Oslo Manual or Frascati Manual (in the OM design is recorded under product or marketing innovation depending on the functional changes of the product) as the design intensity of the economy increases. More design indicators should then be constructed. It seems however that the CIS as basic survey instrument can however not be overloaded with much more questions on design.
- Several users also asked for the CIS to be extended **to more economic activities**, in particular to public services, additional services activities or other non-market activities. The new Nace Rev. 2 classification to be used for the CIS 2008 will provide some answers in this respect.

All the preparatory work already launched and all the additional ideas and user requests will need to be treated when entering the preparation of the CIS 2008 harmonised questionnaire and methodology. All over it seems that the changes of the CIS 2008 compared to the CIS 2006 might be larger. This could affect the comparability of the CIS 2008 to the results of previous CIS.

3. Constructing time series with Community Innovation Statistics

Since long user requested the building-up of time series in using the results provided by the Community Innovation Surveys. When comparing the results provided by the CIS 3 and the CIS 4, these in general show a quite good level of stability as shown in the following graph.

Figure 1: Share of innovative enterprises CIS 3 vs CIS 4



The share of innovative enterprises often did not change too much when comparing the data provided by the CIS 3 to the data provided by the CIS 4. The authors of the European Innovation Scoreboard 2006 however observed that "for some of the CIS indicators the changes seem unrealistically high and may partly be due to changes in e.g. the sampling techniques in these countries. " Some more evidence is given to this statement when comparing some of the CIS indicators used for the European Innovation Scoreboard. For some of them the differences between the CIS 3 values and the CIS 4 values are more than 50 %.

Another input with regard to the comparability between CIS 3 and CIS 4 data comes from the CIS 4 quality reports which are more and more available for European countries. There chapter 7: "Comparability" can be exploited which deals with national deviations from the methodological recommendations set for the CIS 4 on the one hand. On the other hand the report also deals with the comparability between the CIS 3 and the CIS 4 results in illustrating the relative differences between the main indicators produced by both surveys (e.g. turnover, the share of innovative enterprises, etc.).

The following table shows two of these quality indicators for the countries for which this information is already available:

Table 1. Relative differences between the CIS 3 and the CIS 4 data (CIS 3 results /CIS 4 results in %)

Countries	Proportion of enterprises with innovation activity	Turnover from all new products as a % of total turnover (for enterprises with innovation activity)
BE		
BG	65,2	79,5
CZ		
DK	120,0	79,0
DE		
EE	73,0	100,0
EL		
ES		
FR		
IE		
IT		
CY	105,0	79,3
LV	93,2	58,7
LT	116,9	60,7
LU		
HU		
MT	129,0	114,0
NL		
AT	93,0	124,5
PL		
PT	107,5	244,1
RO	85,7	250,8
SI		
SK		
FI	101,1	129,0
SE		
UK		
IS		
NO	103,2	128,9
CH	102,7	100,0
HR		

More analysis of these quality indicators and more comparisons between both data sets are needed in the months to come in order to get a clearer view on the comparability of the results of both CIS surveys.

On the other hand the comparability of the CIS results should be assured when comparing the CIS 4 (2004) data to the CIS 2006 data as - in general - neither the survey questionnaire nor the survey methodology was changed.

Another issue coming up regularly in this context is the insertion of a **CIS indicator into the list of Structural Indicators** measuring the progress of the Lisbon agenda. Such an insertion would however require the following:

- This indicator would need to be produced (estimated) annually for all EU Member States and related countries.
- The underlying methodology would need to be kept rather stable in order to assure a maximum of comparability of this CIS indicator over time.
- A meaningful indicator would need to be chosen which could maybe also combine several CIS indicators to a composite indicator showing the innovation progress in Europe.

Further discussions hereon are needed in order to pave the way for finally arriving to a Structural Innovation Indicator for the EU. This would however be a great breakthrough for the better use of the CIS.

4. The access and further use of the CIS micro-data

The transmission of the CIS micro-data and its exploitation is seen as crucial for improving the cost/benefit ratio for this survey. In this context reference is also made to the "Commission Communication on reduction of the response burden, simplification and priority setting in the field of Community statistics" which also makes reference to the re-engineering of European business statistics in pointing to the better use of business related micro-data.

The CIS micro-data can be used two-fold. On the one hand, they can be made available for researchers under certain conditions. On the other hand, more CIS indicators can be centrally produced on the basis of this micro-data.

4.1 The access to the CIS micro-data by researchers

The CIS micro-data can be opened for researchers at national level and at Eurostat. In order to maximise the benefits at international level, as many national CIS micro-data sets as possible should be made accessible for researchers at Eurostat. Eurostat then open the CIS micro-data sets for researchers in accordance with the provisions laid down in the Commission Regulation No 831/2002. By today, many countries transmitted the CIS 4 micro-data to Eurostat. This means that much value added can be created through the CIS micro-data access and additional CIS micro-data use.

The access to the CIS micro-data by researchers is again organised two-fold: **as access to the anonymised CIS micro-data and as access to the confidential CIS micro-data.**

- In 2005/2006 Eurostat successfully created a **CIS micro-data anonymisation method** which was applied to the micro-data of the Third Community Innovation Survey (CIS 3). The method used for the anonymisation of the CIS 3 data is based on the micro-aggregation process (MAP) which modifies the individual data in such a way that an enterprise can no longer be identified as such. This means that the identification of the respondent (enterprise) with its exact values is not feasible. The method is structured in different work steps. Those steps are: Pre-work on the data, micro-aggregation, global recoding, evaluation of the disclosure risk, data suppression, release of the final data file. The method is available on the Eurostat CIRCA site.

  Based on written consultations with countries, 15 countries agreed to the CIS 3 anonymisation method proposed. These countries are: Belgium, Bulgaria, the Czech Republic, Estonia, Germany, Greece, Hungary, Iceland, Latvia, Lithuania, Norway, Portugal, Romania, the Slovak Republic and Spain. In the second step, Eurostat produced the corresponding 15 anonymised micro-data sets in applying the method agreed on and disseminated these micro- data sets on CD-ROM to researchers.

  At this stage, Eurostat received access requests from more than 25 research institutes for the CIS 3 anonymised micro-data. These institutes received the 15 national anonymised CIS 3 micro-data sets. No in depth feed-back on the data use was received yet. In the view of applying the method to the CIS 4 micro-data and in the view of getting higher acceptance of the method with countries, some improvements of the CIS 3 anonymisation method are proposed by Eurostat. Further work hereon will be done also in the course of 2007.

- In the course of 2006, Eurostat started to set up its Safe centre in-house where researchers can **access the confidential CIS micro-data** in accordance with the provisions of the Commission Regulation No 831/2002 and in accordance with the specific procedures laid down in the Manual "Protection of confidential data in Eurostat".

  This second CIS micro-data access option requires that Eurostat thoroughly checks the data output produced by researchers. These data checking routines are currently developed. These routines are determined by the following main characteristics: all Safe centre output is reviewed manually; the output has to be prepared that it is readable for the checkers; each single cell will be checked; a dominance rule will be defined and applied; small geographical areas tabulations should be avoided; the software for tabular data protection will be applied to the tabular output; all cells must have a frequency of at least 5 observations; etc.

  Until now several research institutes applied for the access to the CIS 3 confidential micro data at the Eurostat Safe centre. The first visit of a researcher at the Eurostat Safe centre took place on 13. October 2006. Based on the project descriptions submitted by the researchers, a number of countries however declined the access to their respective national data set.

4.2 The production of complex CIS indicators using the CIS micro-data

The creation of additional indicators using the CIS data will be tackled in 2007. Beyond maybe producing more simple CIS indicators, most of the additional indicators envisaged require constructing **complex indicators** based on the responses to more than one CIS-4 question. In contrast, almost all CIS indicators published by Eurostat are simple frequency indicators, such as the percentage of enterprises that applied for at least one patent or the percentage of firms in each of three size classes that reported a 'lack of information on markets' as a highly important hampering factor. These indicators are based on responses to a single survey question.

An exception to the simple frequency indicators is the complex indicator for the percentage of enterprises with innovative activity. This indicator is based on a positive response to at least one of six CIS-4 questions: two product innovation categories, three process innovation categories, and ongoing innovation activities. This indicator is constructed from a series of 'or' statements. A firm is defined as innovative if it responds positively to at least one of the six questions.

Many of the additional complex CIS indicators that will be tackled in the months to come will use the 'or' statements. When a value is missing for one of these questions, one can assume that the mostly likely answer was negative instead of missing. Indicators that require 'and' statements are limited to questions that should have low item non-response rates.

Two examples for complex innovation indicators are given:

1. Complex indicators on the innovation diffusion: Firms that primarily innovate 'with other enterprises or institutions' or firms that obtain their innovations 'mainly (from) other enterprises or institutions' rely on the diffusion of knowledge from other firms or sources. An indicator for firms that primarily innovate through knowledge diffusion can be constructed from the percentage of innovative firms (excluding innovative firms that only have ongoing or abandoned activities) that give a positive response to at least one of the following questions:

1. Product innovators that state that they developed innovations together with other enterprises or institutions' (Question 2.2, INPDTW = 2), *or*
2. Product innovators that state that their innovations were developed 'mainly (by) other enterprises or institutions' (Question 2.2, INPDTW = 3) *or*
3. Process innovators that state that they developed innovations together with other enterprises or institutions, (Question 3.2, INPCSW = 2) *or*
4. Process innovators that state that their innovations were developed 'mainly (by) other enterprises or institutions' (Question 3.2, INPCSW = 3).

The default is the percentage of firms that primarily develop product and process innovations in-house.

2. Successful technological adopters: The CIS can be used to identify firms that *only* innovate through the adoption of innovations developed outside their firm:

1. If a product innovator (question 2.1 = yes), the firm reports 'mainly other enterprises or institutions' as the developer of the innovation (INPDTW = 3), *and*
2. If a process innovator (question 3.1 = yes), the firm reports 'mainly other enterprises or institutions' as the developer of the innovation (INPCSW = 3), *and*
3. Question 6.2 or variable CO (any collaboration) = no.

These firms are largely technology adopters. Unfortunately, the results do not tell us anything about the success of the innovation to their firm – are they capable of efficiently using it, or does some collaboration or active diffusion greatly improve the probability of good implementation.

In close co-operation with Member states and users, Eurostat will tackle the production of additional, more sophisticated CIS indicators. The production of these additional CIS indicators – together with the new access possibilities of researchers to the CIS micro-data – should increase the use and usefulness of the CIS data considerably.

This should counterbalance the user interest and user needs - until now thoroughly directly to R & D statistics - more towards innovation statistics as a whole.

5. Conclusions

Larger progress has been made in terms of data quality, accessibility and data use of the CIS 4. Further progress is needed with regard to the CIS 2006 which is currently implemented in many Member states. The preparation of the CIS 2008 has already been started at a certain extent. More user requests are piling up for the next waves of the CIS.

All this should increase the use and usefulness of the CIS considerably. This will probably lead to a better counterbalancing of the traditional R & D statistics.

Annex 1

The three CIS 2006/2008 pilot modules

This annex includes the CIS pilot modules on organisational and marketing innovation and knowledge management. There are separate modules for organisational innovation, marketing innovation and knowledge management. Each module can be piloted separately.

Countries may also use split-ballot or other methods to examine the effect of alternative response categories. For example, a split-ballot technique could be used for question 1 on organisational innovations to test the following response options (as suggested by Denmark):

No

If yes, introduced/changed between 2004 and 2006

If yes, introduced/changed before 2004.

Module on organisational innovation
(for independent pilot testing not attached to the CIS 2006)

ORGANISATIONAL INNOVATION

An organisational innovation is the implementation of a new organisational method in your enterprise's business practices (including knowledge management), workplace organisation or external relations that has not been previously used by your enterprise. It must be the result of strategic decisions taken by management. *Exclude mergers or acquisitions, even if for the first time.*

1. During the three years 2004 to 2006, did your enterprise introduce:

	Yes	No
New **business practices** for organising work or procedures *(i.e. supply chain management, business re-engineering, lean production, quality management, education/training systems, etc)*	☐	☐
New **knowledge management systems** to better use or exchange information, knowledge and skills within your enterprise or to collect and interpret information from outside your enterprise	☐	☐
New methods of **workplace organisation** for distributing responsibilities and decision making *(i.e. first use of a new system of employee responsibilities, team work, decentralisation, integration or de-integration of departments, etc)*	☐	☐
New methods of organising **external relations** with other firms or public institutions *(i.e. first use of alliances, partnerships, outsourcing or sub-contracting, etc)*	☐	☐

If no to all four options, go to question 5. Otherwise go to question 2.

2. Who developed these organisational innovations?

	Select the most appropriate option only
Mainly your enterprise or enterprise group	☐
Both your enterprise and other enterprises or institutions (including consultants)	☐
Mainly other enterprises or institutions (including consultants)	☐

3. Were any of these organisational innovations integrated with or linked to other innovations that were introduced during the three years 2004 to 2006?

Tick 'not relevant' if your enterprise did not introduce one of the following	Yes	No	Not relevant
Product innovations for a new or improved good	☐	☐	☐
Product innovations for a new or improved service	☐	☐	☐
Process innovations	☐	☐	☐

4. How important were each of the following effects of your enterprise's organisational innovations introduced during the three years 2004 to 2006?

(If your enterprise introduced several organisational innovations, make an overall evaluation)

	High	Medium	Low	Not relevant
Reduced time to respond to customer or supplier needs	☐	☐	☐	☐
Improved ability to develop new products or processes	☐	☐	☐	☐
Improved quality of your goods or services	☐	☐	☐	☐
Reduced costs per unit output	☐	☐	☐	☐
Improved communication or information sharing within your enterprise	☐	☐	☐	☐
Improved communication or information sharing with **other** enterprises or institutions	☐	☐	☐	☐
Other (please describe) ____________________	☐	☐	☐	☐

Go to question *x*..

5. If your enterprise did not introduce an organisational innovation: How important were the following factors for not introducing an organisational innovation between 2004 and 2006?

	High	Medium	Low	Not relevant
Organisational innovations were introduced before 2004 and no need for further change	☐	☐	☐	☐
Lack of funds to implement an organisational innovation	☐	☐	☐	☐
Lack of knowledgeable or qualified staff to implement an organisational innovation	☐	☐	☐	☐
Resistance of staff or management to organisational change	☐	☐	☐	☐
No need for organisational change at this time	☐	☐	☐	☐
Other reason (please describe) ____________________	☐	☐	☐	☐

Module on marketing innovation
(for independent pilot testing not attached to the CIS 2006)

MARKETING INNOVATION

A marketing innovation is the implementation of a new marketing concept or strategy that differs significantly from your enterprise's existing marketing methods and which has not been used before. It requires significant changes in product design or packaging, product placement, product promotion or pricing. *Exclude seasonal, regular and other routine changes in marketing methods.*

1. During the three years 2004 to 2006, did your enterprise introduce the following marketing innovations:

	Yes	No
Significant changes to the **design** of a good or service (*exclude changes that only alter the product's functional or user characteristics*)	☐	☐
Significant changes to the **packaging** of a good	☐	☐
New media or techniques for **product promotion** *(i.e. the first time use of a new advertising media, a new brand image, introduction of loyalty cards, etc)*	☐	☐
New marketing strategy to **target new customer groups or market segments**	☐	☐
New methods for **product placement** or sales channels *(i.e. first time use of franchising or distribution licenses, direct selling, exclusive retailing, new concepts for product presentation, etc)*	☐	☐
New methods of **pricing** goods or services *(i.e. first time use of variable pricing by demand, discount systems, etc)*	☐	☐

If no to all four options, go to question 5. Otherwise go to question 2.

2. Who developed these marketing innovations?

	Select the most appropriate option only
Mainly your enterprise or enterprise group	☐
Your enterprise together with other enterprises or institutions (including consultants)	☐
Mainly other enterprises or institutions (including consultants)	☐

3. Were any of these marketing innovations integrated with or linked to other innovations that were introduced during the three years 2004 to 2006?

Tick 'not relevant' if your enterprise did not introduce one of the following	Yes	No	Not relevant
Product innovations for a new or improved good	☐	☐	☐
Product innovations for a new or improved service	☐	☐	☐
Process innovations	☐	☐	☐

4. How important were each of the following effects of your enterprise's marketing innovations introduced during the three years 2004 to 2006?

If your enterprise introduced several marketing innovations, make an overall evaluation

	High	Medium	Low	Not relevant
Increased or maintained market share	☐	☐	☐	☐
Introduced products to new markets or customer groups	☐	☐	☐	☐
Increased visibility of products or business	☐	☐	☐	☐
Improved ability to respond to customer needs	☐	☐	☐	☐
Improved customer satisfaction	☐	☐	☐	☐
Other (please describe) ________________________	☐	☐	☐	☐

Go to question x…

5. If your enterprise did not introduce a marketing innovation: How important were the following fact,ors for not introducing a marketing innovation between 2004 and 2006?

	High	Medium	Low	Not relevant
Marketing innovations were introduced before 2004 and no need for further change	☐	☐	☐	☐
Lack of funds to implement a marketing innovation	☐	☐	☐	☐
Lack of knowledgeable or qualified staff to implement a marketing innovation	☐	☐	☐	☐
Resistance of staff or management to marketing innovations	☐	☐	☐	☐
No need for marketing innovations at this time	☐	☐	☐	☐
Other reason (please describe) ________________________	☐	☐	☐	☐

Module for knowledge management
(for independent pilot testing not attached to CIS 2006)

KNOWLEDGE MANAGEMENT

1. Is your firm currently using each of the following knowledge management practices?

If yes, please indicate if your firm first introduced or made a significant change to each practice between 2004 and 2006 inclusive

	No	**Yes** *(tick both if relevant)*
1.1 A written knowledge management policy	☐	☐ Introduced/changed 2004-2006 ☐ Introduced/changed **before** 2004
1.2 Incentives for employees to share knowledge within your enterprise	☐	☐ Introduced/changed 2004-2006 ☐ Introduced/changed **before** 2004
1.3 Dedicated resources to monitor and obtain knowledge from outside your enterprise	☐	☐ Introduced/changed 2004-2006 ☐ Introduced/changed **before** 2004
1.4 A policy to bring in external experts from universities, research institutes, or other firms to participate in project teams, as needed	☐	☐ Introduced/changed 2004-2006 ☐ Introduced/changed **before** 2004
1.5 Regular updates of internal databases or manuals of good work practices, lessons learned, or expert advice	☐	☐ Introduced/changed 2004-2006 ☐ Introduced/changed **before** 2004

PROBLEMS WITH MICRO-DATA FROM SMALL COUNTRIES

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Executive summary

During the recent years there has been an increasing demand from the research community for access to micro-level enterprise data. This demand has been echoed by policy makers, who have also called for, among other things, more detailed insights into complex questions like the impacts of technological advances on business profitability.

National statistical institutes have responded to these needs by providing safeguarded data access channels. At Statistics Finland, for example, the Safe Centre has been operational since 2001. The first attempt of Eurostat was the delivery of anonymised CIS-3 data. Later also Eurostat opened a Safe Centre providing access to CIS-3 data. However, due to confidentiality reasons, the delivery of anonymised micro-data to researchers on cd-roms was rejected by a number of member countries, Finland among them.

The purpose of our paper is not to examine the micro-aggregation method itself, but to examine the protected data. This means that our main purpose is to test if it is possible to disclose any units, including all the information in those units, from the protected data. In February 2006 we received micro-aggregated data from EUROSTAT for checking. When examining these data, our first conclusion was that the grouped qualitative variables using anonymisation methodology together with 2-digit NACE codes did not prevent a potential disclosure of the individual enterprise. The major enterprises, which often dominate their NACE classes, remained fairly straightforwardly identifiable. Also, with the help of some auxiliary information, it seemed to be possible to rank the enterprises according to their size measures, for example turnover. Using possible external information it was then possible to identify enterprises with varying probabilities. Without any information the correct guessing of the order of units is nearly impossible if five units are grouped together and very improbable if three units are grouped together. This is a strength of the micro-aggregation method.

Two of the most identifiable variables, in addition to the NACE-codes, are the number of employees and turnover. Previously turnover was public information in the Business Register of Finland. At the present time it is suppressed at the unit level. However, there are other sources from where the ranking of enterprises according to turnover can be obtained. The data can be ranked according to turnover easily with the help of other variables and external information. The number of employees has been deleted from the anonymised data file. This is a positive thing because this is public information in the Business Register of Finland. However, it is again rather easy to identify a ranking according to the number of employees using the information and NACE-codes in the anonymised data. This comes from the fact that the turnover-employment ratios are rather near each other within the NACE 2 -classes.

In addition to the confidentiality issue, there is the question of the quality of micro-aggregated data for research use. One example is the cross-industry bias that comes as a combination of the respondents' turnover in the retail trade and other neighbouring service sectors. Turnover in the retail trade is usually higher as it includes the whole chain of value-added in the production. Therefore taking an average of the sales of the units from these different industries can create distorted figures.

As enterprise data is sensitive in varying degrees when designing the modes of data access for researchers, the potential existence of a malicious intruder - no matter how implausible it may be - has to be accounted for.

Evidently the safe centres are the way ahead as far as national data are concerned. It still remains to be seen, however, what the role of the centralised mode (Eurostat centre) will be, or if there will be more co-operation and networking between national safe centres in order to provide data for comparative analysis on the European level.

1. Access to enterprise-level data

During the recent years there has been an increasing demand from the research community for access to micro-level enterprise data. This demand and better accessibility to the enterprise micro-data were also among the main conclusions of the recent OECD Blue Sky conference 2006 on the science, technology and innovation policy and statistics issues for the next decade. In addition, the OECD has launched a new project on the analysis of the innovation micro-data in which a number of the member countries have volunteered to participate. The demand for more analytical results has been echoed by policy makers, who have also called for, among other things, more detailed insights into complex questions like the impacts of technological advances on business profitability.

However, national statistical institutes (NSIs) are collecting the enterprise-level data primarily for the production of aggregate statistics and not to provide databases for research. Often enterprises have an obligation to deliver data, but at the same time also the protection of the individual respondent's data is guaranteed by legislation. Thus, high quality databases of great research value are produced by public authorities but access to these data is restricted. There are basically three options to grant access to the confidential enterprise data while still respecting the legal requirements of data protection:

1. Direct employment of the researcher by the data producer. Obviously, this is an option only for large-scale projects in which the data producer and the research institute are likely to be sharing interests and resources. Also, if the data producer is an NSI this option may not be feasible, in particular if research is not included the institute's strategy.

2. Supervised access to non-anonymised enterprise data. Usually enterprise names have been deleted and the identification codes modified but the data remains original in other respects. Access can be in the data producer's premises (on-site) or remote by computer (on-line). This latter mode of access is usually accompanied by a signed agreement in which the user commits him/herself to the practices of data confidentiality. However, as some of the individual enterprises can be identified, trust and ethical co-operation of the users has to be expected. In practice this is enforced by the fact that users come from respected research institutions.

3. Delivery of the anonymised micro-data to researchers (off-site). This is the most challenging option as the data have to be modified to prevent disclosure, but on the other hand it should not be too distorted so that it retains good quality as research material.

Of the access modes listed above, Statistics Finland applies the second one as the 'on-site' variant (on-line access is foreseen in the coming years).

The demand for enterprise level micro-data is also recognised by the Commission. Articles 5 and 6 of Commission Regulation (EC) No 831/2002 define the principles of access to the confidential data which some of the member states have transmitted to Eurostat. Community Innovation Survey (CIS) data are specifically mentioned in the text along with three other datasets:

Access on the premises of the Community authority

1. The Community authority may grant access on its premises to confidential data obtained from the following surveys or statistical data sources:

- *European Community Household Panel,*
- *Labour Force Survey,*
- *Community Innovation Survey,*
- *continuing vocational training survey.*

However, on the request of the national authority which provided the data, access to data from that national authority shall not be granted for a specific research project

The same principles are repeated concerning the release of the sets of anonymised micro-data with a specification on the anonymisation methodology:

Prior to such release, the Community authority shall ensure in cooperation with the national authorities, that the methods of anonymisation applied to these micro-data sets minimise in accordance with current best practice the risk of identification of the statistical units concerned, in accordance with Regulation (EC) No 322/97.

So far Eurostat has produced CD-ROMs of the micro-aggregated CIS-3 data for the 15 countries which agreed on the anonymisation method. In addition Eurostat has opened a Safe Centre on the 13th of October 2006.

2. Statistics Finland's policy on data dissemination and access

The production of the official statistics is rather concentrated in Finland. Consequently, the most comprehensive databases have been accumulated at Statistics Finland. Concerning the access to these data, Statistics Finland complies with the confidentiality rules defined in the Statistics Act (280/2004). In essence, the law guarantees confidentiality of all the sensitive, identifiable individual information. Concerning data on enterprises and corporations, Section 18 of the Act specifies the following variables in the Register of Enterprises and Establishments as public:

In respect of employers and self-employed persons, corporations and foundations the data on the following shall be public:

1) *Business identity code and its validity period, legal form, name, industry, language code, municipality of domicile and public address, as well as other public contact information;*
2) *Type of owner;*
3) *Location and establishments of activity;*
4) *Size category of turnover;*
5) *Total number of personnel and number of personnel by municipality;*
6) *Engagement in foreign trade;*
7) *Liability to pay value added tax, activity as employer and registration in preliminary tax withholding register;*
8) *In respect of enterprise groups, group relationships.*

Obviously, these variables do not fulfil the needs of researchers as their analysis requires detailed data on topics such as financial accounts, R&D or innovation. The basic rule for dissemination for all other business data is that each - say NACE - class in the tabulations must contain at least three observations. In addition there are varying limits of dominance for numeric variables, in other words one unit can not exceed certain percentage of the total sum of the variable in a given class.

In addition to acknowledging the principles of data confidentiality, Statistics Finland is also committed to good customer service and data quality. Confidentiality rules permitting, unit level data have been delivered to the research community as in the case of the household panel data, for instance. As for the enterprise data, unit-level dissemination has not been an option. Thus, two main alternatives remain: joint research projects with the involvement of Statistics Finland's staff or properly administrated access for researchers to the micro-data on-site at Statistics Finland.

Research activities based on micro-data were underway at Statistics Finland already in the mid-1990s when some researchers employed by Statistics Finland were provided access to enterprise panel data, but the activities were consolidated in 2001 when the Research Laboratory (as the safe centre is called) was officially opened. At the Research Laboratory enterprise and establishment data can be used at the workstations reserved for visiting researchers. Since the beginning the aim has been to gather together all the relevant data available at Statistics Finland that could be useful for economic research. In particular, the comprehensive register-based data system provides wide opportunities for linking different data. All the main statistical units in the databases, i.e. enterprises, establishments and individual employees have an identification code by which the data can be linked to each other. The Finnish Longitudinal Employer-Employee Data is an example of this. The enterprise data in the Research Laboratory include, among others, the business register, financial statements data, R&D and innovation, ICT use in the enterprises, plant-level industrial data. As for the employees, a wide variety of demographic variables along with mobility can be analysed.

The experiences from the Research Laboratory have been positive. The data has been used actively by the research community and a number of scientific papers have been produced. The databases have also facilitated participation in lager-scale projects such as the EU-project studying the impact of ICT on enterprises. A further advantage of the co-operation is that research can provide useful feedback into statistical production. The challenge is the setting-up of an on-line service, which is already in operation for instance in Denmark and Sweden.

3. Community Innovation Survey - some confidentiality problems with major enterprises

As mentioned above, Eurostat produced micro-aggregated files of the CIS-3 data and transmitted the datasets to member countries for approval. Due to data confidentiality reasons, Statistics Finland declined permission to disseminate the Finnish CIS data. Nevertheless, we also examined the anonymised data and made some observations which are presented below. First we discuss briefly the possibility of direct identification of the major enterprises. More elaborate remarks on the anonymisation methodology are discussed later.

The Community Innovation Survey (the third wave, CIS-3) is a sample survey covering selected industries. There is no need to go into details of the survey methodology in this paper, but with regard to the disclosure problem it is essential to note that in the Finnish survey all the firms with more than 100 employees are included. In short, the confidentiality problem for a small economy like Finland is that in some industries there are dominating and well-known enterprises which are at high risk of direct identification. The only precondition is a basic knowledge of the Finnish business landscape. As for the information sources, the size-category of turnover is publicly available from Statistics Finland. More detailed information on turnover can be found from various sources such as professional journals or private databases monitoring business performance, and also directly from company reports. Obviously, micro-aggregation does smooth the distribution of turnover (tables 1 and 2). But still eight out of twelve cases are left in which a firm's proportion of the turnover in its NACE class is more than 50 per cent. Even though the turnover figure as such is modified and not the real value, recognizing the dominating enterprise in a given NACE class in the data sorted by 2-digit NACE class and turnover remains fairly simple on the basis of publicly available information.

Table 1. Finnish CIS-3 data, a firm's proportion of turnover in its NACE class

Original data

Proportion of turnover (%)	N	0-5	5-10	10-25	25-50	50-75	75+
All	1,617	1,493	57	41	14	8	4
Manufacturing	1,046	962	39	27	9	6	3
Services	571	531	18	14	5	2	1

Table 2. Finnish CIS-3 data, a firm's proportion of turnover in its NACE– class

Micro-aggregated data

Proportion of turnover (%)	N	0-5	5-10	10-25	25-50	50-75
All	1,474	1,362	55	36	13	8
Manufacturing	904	831	38	22	9	4
Services	570	531	17	14	4	4

We can conclude that at least in the Finnish CIS-3 data, the major enterprises are at considerable risk of being identified. This is problematic particularly since these firms are important players in the business life and there is a lot interest on their activities. Furthermore, this identification can be straightforward and does not require detailed technical knowledge of the anonymisation methodology.

4. Test of the Finnish CIS-3 micro-aggregated data

The purpose of our paper is not to scrutinize the micro-aggregation method itself, but to examine the protected data. In February 2006 we received micro-aggregated data from Eurostat for checking.

The moral obligation to obtain the cooperation of those who are selected in the survey sampling necessitates privacy protection. The International Statistical Institute formulated the issue in 1985 in the following manner:

Statisticians should take appropriate measures to prevent their data from being published or otherwise released in a form that would allow any subject's identity to be disclosed or inferred

Many such measures are included in the method of micro-aggregation. However, the method does not sufficiently take into account the auxiliary information that the possible intruder may have. For example, together with some auxiliary data the NACE code becomes a very identifiable variable.

There are two important concepts in the field of statistical disclosure control, namely re-identification and disclosure. Re-identification occurs when an attacker can deduce the value of a sensitive variable for the target individual after this individual has been re-identified. Prediction occurs if the data enable the attacker to predict the value of a sensitive variable for some target individual with some degree of confidence. Because the CIS data mainly includes the qualitative variables, we have concentrated on possibilities to re-identify units in the micro-aggregated data.

When examining the micro-aggregated CIS-data, our first conclusion was that the grouped quantitative variables using anonymisation methodology together with 2-digit NACE codes did not prevent a potential disclosure of the individual enterprise. The major enterprises, which often dominate their NACE classes, remained fairly straightforwardly identifiable. Also, with the help of some auxiliary information, it seemed to be possible to rank the enterprises according to their size measures, for example turnover. Using possible external information it was then possible to identify enterprises with varying probabilities. Without any information the correct guessing of the order of units is nearly impossible if five units are grouped together and very improbable if three units are grouped together. This is a strength of the micro-aggregation method.

Two of the most identifiable variables, in addition and together with the NACE codes, are the number of employees and turnover. Previously turnover was public information in the Business Register of Finland. At the present time it is globally re-coded at the unit level. However, there are other sources from where the ranking of enterprises according to turnover can be obtained. If then the data can be ranked according to turnover it is easy to re-identify units. So our first attempt was to rank the micro-aggregated data according to turnover.

Order the data according to the micro-aggregated turnover in decreasing order. Let T(1) be the average turnover in the first group of the micro-aggregation, N(21) the two digit NACE code, E(1) the average export in the first group, I(1) the average investment in the first group, P(1) the average number of employees with higher education in the first group. We can prepare the table 2. below.

Table 3. An attempt to rank the CIS-3 micro-aggregated data by turnover by using selected variables

Turnover	NACE	Exports	Investments in the tangible assets	Highly educated employees	Rankings
T(1)/1	N(21)	E(1)	I(2)	P(1)	3 (5)
T(1)/2	N(40)	0	I(1)	P(1)	2 (2)
T(1)/3	N(32)	E(1)	I(2)	P(1)	1 (1)
T(1)/4	N(51)	E(2)	I(4)	P(1)	5 (3)
T(1)/5	N(32)	E(1)	I(3)	P(2)	4 (4)
T(2)/1	N(25)	E(2)	I(2)	P(1)	2 (1)
T(2)/2	N(27)	E(1)	I(3)	P(1)	3 (2)
T(2)/3	N(21)	E(2)	I(1)	P(1)	1 (3)
T(3)/1	N(64)	E(2)	I(1)	P(1)	2 (3)
T(3)/2	N(21)	E(1)	I(1)	P(2)	1 (1)
T(3)/3	N(51)	E(3)	I(2)	P(3)	3 (2)

It is a well known fact that the greatest Finnish enterprise has the NACE code 32. The table contains two enterprises in this NACE group[1]. However the investments in the third row are greater than in the fifth. Therefore we can be certain that the third row has rank 1. Next it is possible to conclude that because row 2 has the greater investments we can assign it the rank 2. After this it is easy to rank the others.

In the second turnover group it is not easy to determine the rank. The best option seems to be the order in investments.

In the third turnover group it seems easy to rank row 2 as the first. The third row would then get rank 2.

The results show that the more information the greater the probability of guessing the right order. Sometimes the data gives much information for determining the order and sometimes not. The results also show that one strength of the micro-aggregation method is that one ranking mistake automatically results in mistakes in one or more other rankings. The last column shows our estimated ranking and the right ranking in parenthesis.

Even if correct ranking is not easy using the information in the data itself, it must be remembered that if the intruder has information of the greatest enterprises measured in turnover in different industries, it is the NACE code that reveals the rank. If you look at the table above, all the enterprises in the first turnover class belong to different industries, except N(32). The rank of these units is however easy to conclude using the rank of the investments or the number of employees with higher education.

The most important variable together with NACE code for the intruder is the number of employees because it is public information in the Business Register of Finland. This is a newly coded variable in the micro-aggregated data. However we can use the information that the turnover per employee is rather constant within the NACE classes. To see how well this works we have used the original CIS data as the auxiliary data. We can proceed as follows. Order a list of the greatest enterprises with their ID numbers according to the number of employees and NACE codes in the auxiliary data. Let E(1) be the number of employees with rank 1 and N(21) the two digit NACE code in the original CIS-3 data. We get the following table:

Table 4. CIS-3 micro-aggregated data identified by NACE, turnover and number of employees

Rank by the number of employees	NACE	Estimated rank in the micro-aggregated data by turnover
E(1)	N(64)	T(9)
E(2)	N(25)	T(6)
E(3)	N(21)	T(1)
E(4)	N(40)	T(2)
E(5)	N(27)	T(7)
E(6)	N(32)	T(3)
E(7)	N(51)	T(4)
E(8)	N(72)	T(21)
E(9)	N(60)	T(24)
E(10)	N(24)	T(18)
E(11)	N(32)	T(5)
E(12)	N(35)	T(22)
E(13)	N(21)	T(8)
E(14)	N(15)	T(84)
E(15)	N(20)	T(12)
E(16)	N(24)	T(30)
E(17)	N(21)	T(10)
E(18)	N(20)	T(14) ->42
E(19)	N(20)	T(33)
E(20)	N(64)	T(19)

[1] The analysis here is at the level of legal units: they may belong to the same parent company

The last column shows the estimated row where the unit E(x) is situated in the in the micro-aggregated CIS data. The arrow and number shows the right row when the estimated rank is wrong. It is worth noticing that there are many correct rankings and the errors in ranking cause errors only in subsequent units belonging to the same NACE-class.

Conclusion

There has been an increasing demand for micro-level enterprise data for research purposes. The most comprehensive databases are produced by national statistical institutes. For many producers of statistics the rules of data access are set out in the law. Also, it is essential for the enterprises providing the data that their responses are safeguarded and not disseminated publicly. As enterprise data is sensitive in varying degrees when designing the modes of data access for researchers, the potential existence of a malicious intruder - no matter how implausible it may be - has to be accounted for.

In spite of the confidentiality issue data producers have recognized the need to provide enterprise level data to researchers. National data producers have different solutions to this and many of them have opened safe centres for data users. Eurostat has prepared anonymised CIS-3 data by micro-aggregation to be delivered to the researchers as CD-ROMs. Unfortunately, the outcome has been complex as member states have been divided in the acceptance of the method. Based on the general principles of the data confidentiality policy as well as examination of the anonymisation methodology, Statistics Finland was among those who denied the dissemination of the CIS-3 micro-aggregated data. However, Statistics Finland has transmitted the CIS-3 micro-data to Eurostat and granted access to it in the Eurostat's recently opened Safe Centre. Evidently the safe centres are the way ahead as far as national data are concerned. It still remains to be seen, however, what the role of the centralised mode (Eurostat centre) will be, or if there will be more co-operation and networking between national safe centres in order to provide data for comparative analysis at the European level.

Summing Up

IV

SUMMING UP

Karen SIUNE
Director
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This CEIES seminar was about innovation and in particular about problems to do with innovation being more than just technology. The title of the seminar shows how the concept of innovation has changed, and flags up the challenges it raises for the producers of statistics on innovation.

New guidelines for measuring innovation have been discussed.

When we talk about innovation statistics we mean statistics on Innovation activities performed by innovation active firms. According to the 3rd edition of the Oslo Manual (OECD 2005, p. 47, §149): "*Innovation activities include all scientific, technological, organisational, financial and commercial steps which actually lead, or are intended to lead, to the implementation of innovations (...) Innovation activities also include R&D that is not directly related to the development of a specific innovation*".

As you have learned from the discussions at this seminar, there are plenty of demands and plenty of challenges in innovation statistics. **Hans Müller Pedersen** spoke in his opening speech about some of reasons why the importance of innovation statistics is on the increase. One of the reasons is because modern policies tend to be increasingly based on evidence and facts, and comparability is extremely important. The political and administrative demand for high quality innovation data based on the right indicators is growing and will continue to grow. The newer the data the better.

In his keynote speech, **Michel Glaude** gave us an overview of the situation regarding innovation statistics as seen from a Eurostat perspective, referring among other things to the revised Oslo Manual in which four types of innovation are now specified: product, process, organisational and marketing innovation.

The revised manual is intended to solve many of the problems we discussed at the 2003 innovation seminar, where the focus was on "Innovation statistics – more than R&D indicators", and the intention was to give definitions of most of the indicator concepts recommended in 2003.

Nevertheless, some of the problems highlighted in 2003 have still not been totally solved.

SESSION 1 on the agenda centred on PRODUCER ABILITY TO COLLECT DATA. The presentations in session 1 were based on the EXPERIENCES of European, Canadian, American and Japanese producers of statistics.

Peter Teirlinck presented **INNOVATION ACTIVITIES AND EXPENDITURES**.

Expenditure is traditionally one of the first issues to look at, and it was concluded at the 2003 seminar that more work had to be done on this indicator, since it is usually the first indicator asked for by users of statistics. In his presentation, Mr Teirlinck discussed the problem of obtaining information about the expenditure spent by companies on innovation activities and compared the different types of innovation activities both over time (2004 – CIS4 – versus 2000 – CIS3) and between countries. He also focused on the problem that aggregated results for R&D expenditures do not always turn out to be in line with results of the R&D survey! This is a big challenge, therefore, and this issue was touched upon several times in later presentations.

The regional aspect of innovation is of high political interest in many European countries. However, big companies often have establishments and thus also innovation activities in more than one region. **Guilio Perani** of Istat gave a short presentation of an issue that is of increasing interest, the issue of **regionalisation of CIS indicators,** and suggested ways of how to regionalise. Different methods were also presented and discussed by **Peter Mortensen** in his outline of the Danish way of measuring regionalisation.

Session 1 also included submissions from non–European countries, showing the global interest in innovation data.

Michael Bordt of Statistics Canada focused on the response unit (a problem also raised in the 2003 CEIES seminar) and looked at the interrelationships between **the response unit, the novelty of innovation (new to the firm, to the market or to the world) and knowledge management,** highlighting (among other aspects) the problem that responses "new to the market" vary according to the institutional level responding!

The question of "what is an enterprise?" has to be discussed. The OECD, Eurostat and all entities collecting data at national level must agree on the statistical unit; multinationals are a real challenge for the producers of statistics. Mr Bordt concluded that the two–tiered approach recommended in the revised Oslo Manual will produce better results and make them easier to interpret than the previous approach.

Tomohiro Ijichi opened the discussion about "innovation indicators – more than technology" with a paper on **Measuring Non–technological Innovation: Experience from the Japanese Innovation Survey.**

Mr Ijichi argued that survey results indicate that questions on non–technological innovation are informative and useful to understanding the innovation system. The Japanese results revealed that non–technological changes have been made not only by most (technological) innovators but also by a considerable number of (technological) non–innovators, whereas the major types of changes varied between innovators and non–innovators.

From Japan's experience, progress in measuring and analysing non–technological innovation is expected to lead to a better understanding of innovation systems and to help formulate and monitor innovation policy.

Lynda Carlson, from the US, gave an overview of the **plans to redesign US surveys of industrial research and development with Implications for Statistical Data on Innovation.**

She talked about the systematic redesign of a longstanding US survey and illustrated how, within the confines of the redesign, mechanisms may be developed to obtain much needed data on innovation in the US industrial sector. Her presentation was about the systematic redesign of the Survey of Industrial Research and Development, NOT about the development of a survey of innovation.

The new data needed is known, said Lynda Carlson, but we do not necessarily know how to collect that data or to phrase the questions!

SESSION 2 focused on DATA PROVIDERS' RESPONSE, ABILITY AND WILLINGNESS.

Patrick Corbel presented **EVIDENCE ABOUT THE CONCEPTS OF INNOVATION WITHIN ENTERPRISES** from A PILOT SURVEY CONDUCTED AMONG SEVENTY ENTERPRISES IN FIVE COUNTRIES – THE "*VIGNETTES*" PILOT SURVEY.

He concluded from his studies of respondents' reactions to the *vignettes* that two aspects emerge:

- The concept of "marketing innovation" ties in rather well with the expectations of enterprises.
- The concept of "organisational innovation" is harder to frame according to enterprises: where this type of innovation occurs it is in combination with other types of innovation.

Viggo Maegaard spoke in this session of his experience in a large Danish company Danfoss, which has activities in many different business units all over the world. Innovation at Danfoss, alongside other companies, is important, but what about **the ABILITY TO REPLY IN such A LARGE MANUFACTURING ENTERPRISE GROUP?**

R&D reporting in businesses is possible with a small central resource as there are a limited number of R&D departments and the definitions are understandable, he said.

Innovation reporting, on the other hand, if it has not been integrated into existing reporting and become part of a company reporting demands, is seen as being more difficult and there is no easy solution unless a company decides to invest significant time and money into responding. The internal value of this is hard to see at country–specific level.

Mr Maegaard argued that innovation based on country–specific cuts of the data has no meaning whatsoever – as the value chains are global.

Peter S. Mortensen presented **EVIDENCE OF DATA PROVIDERS' RESPONSE ABILITY AND WILLINGNESS** based on data from CIS studies.

Evidence of data providers' response willingness and their ability to answer the questionnaire on innovation performance can be found in the responses given by the enterprises in the survey – and in the responses **not** given.

Finally, external validation of one of the components of innovation expenditure, namely, intramural R&D expenditure, had been performed with the National R&D surveys for 2004. In a number of countries, the two estimates from the CIS and R&D surveys differ significantly. This had also been the case in Denmark in 2000, and thus the Danish CIS and R&D surveys have been integrated, the latter in shortened form. The effect of this has been very good; it has also lessened the response burden on enterprises.

The Danish paper documented that a number of the questions in the CIS questionnaire are complex and difficult for enterprises to answer. A number of possible improvements have been suggested, and these should ideally be part of the process of designing the next full CIS. 4 main questions have to be borne in mind:

- Do we need to measure expenditure on machinery, software and know–how?
- Can replacing some questions improve the quality of responses?
- Can certain qualitative questions be asked in every second CIS survey only?
- Can register data replace some of the questions (industry, employees, turnover, part of a group and headquarters, markets, public financial support, patents)?

The discussion that followed showed that very many producers and data providers felt that it was not necessary to repeat all the questions, although repetition every year makes the respondent acquainted with the questions, as described by Viggo Maegaard in his presentation. The issue of the need to measure expenditure was raised, but no clear conclusion came out of the discussion.

In **SESSION 3** the spotlight was on **COMPARATIVE ANALYSIS possible with CIS data**.

Staffan Laestadius presented **Innovation in low–tech industries – conclusions from the PILOT project**.

Taking the PILOT project as a basis, he suggested (a family of) six new indicators as a way of solving the inadequacy of the old science–based and biased indicators. These are:

- R&D intensity
- Design intensity
- Technological intensity
- Skill intensity (Human capital orientation)
- Innovation intensity
- Organisational innovativeness

These suggestions and other issues aired in Session 3 were discussed with the focus on strong, reliable indicators.

Heidi Ambruster's very detailed study of the innovation process, based on Fraunhofer surveys, cannot be applied to CIS surveys, although several found her points interesting and relevant.

Leo Hannes presented interesting ideas from a sector study, and **Bernd Ebersberger** presented results from comparative econometric analyses based on CIS data, both arguing for access to CIS data to be applied in their analyses.

In **SESSION 4**, **Aavo Heinlo** presented the very central problem of the **UNIVERSE OF UNDERSTANDINGS.**

The CIS questionnaire often moves around within an enterprise, not necessarily taking the ideal path. In the worst–case scenario it goes no further than the accountant's office whereas ideally it should land on the desks of quite a number of different managers. All those people have one virtue in common — they have never opened the Oslo Manual — but unfortunately the viewpoint of the marketing director will differ from that of production manager or chief accountant, thus creating certain biases.

Innovation activities and how they are perceived differ appreciably according to an enterprise's:

- size (small versus large);
- technological intensity (low–tech versus high–tech);
- type of activity (industry versus services);
- position in the group (head of group versus subsidiary);
- geographical, cultural and legal environment.

The shift in the new version of the Oslo Manual towards non–technological innovation (NTI) and further refinement of definitions and concepts of technological product and process (TPP) innovation must be adequately reflected in the redesign of innovation measurement instruments. Regrettably, a conceptual and methodological base for the measurement of organisational and marketing innovation has not yet been developed to the level of TPP innovation, and something has to be done.

The Oslo Manual, as mentioned several times, was revised in 2005 and now includes four **NEW TYPES OF INNOVATION**: product, process, organisational and marketing innovation (some of which were already discussed in earlier sessions).

"You might get the impression that in general all activities in an enterprise with a positive contribution to the bottom line should be defined as innovation activity," said **Frank Foyn,** who discussed the new challenges in his presentation, stating that, due to this extension of innovation, the definitions in the revised manual are more open and vague and not very clear on what is outside the concept of innovation. One particular change in the revised manual is that the term "technological" has been removed from the definition of product and process innovation. The effect of this change is hard to measure, however. (In the previous version of the manual, a product whose "*intended uses* differed significantly from previously produced products" was included as a technological new product.)

The most important changes are obviously the inclusion of organisational innovation and marketing innovation in the broad definition of innovation. In Frank Foyn's view:

- It is important to update the manual and revise the definition in line with developments in business and industry, particularly for the producers of innovation statistics.
- Changes in wording have little effect on results. Enterprises use their own understanding of the concept of innovation without reading the nitty gritty definitions.
- The definition should not be expanded to all activities that have an effect on a firm's performance. A distinction should be kept between innovation and non–innovation activities.

For the Oslo Manual to become operational, guidelines and recommendations must be made clearer. On that there was general agreement.

Measuring linkages in the innovation process was discussed by **Carter Bloch** in connection with the revised Oslo Manual, which, in his opinion, presents a coherent framework in which linkages are characterised by their source, cost and level of interaction. Three types of external linkages are identified: *open information sources*, *acquisition of knowledge and technology*, and *innovation cooperation*.

Ways of creating new indicators or simply presenting the data in a different light were explored by Carter Bloch. One example is the combination of different questions on linkages to provide greater information on linkages with different types of sources (such as suppliers, customers and public research institutions). The three types of linkages can also be used jointly to create "indicators of diffusion". Finally, linkage indicators can be used to examine the driving forces behind innovation activity.

Among the topics considered are whether additional questions are needed on firms' existing practices (and not just innovations) in order to gain a full understanding of the role of linkages, and the role of demand in a firm's innovation activities. While there has been a great deal of coverage of linkages with other stakeholders in recent surveys, less attention has been given to linkages with institutional organisations.

Demand plays an important role in innovation and has featured increasingly in policy. However, demand is a broad concept that can influence or play a role in a firm's innovation in a variety of ways, many of them central to the issue of linkages. Four main aspects of how demand may affect innovation were listed: the role of the user in innovation; the impact of market demand and market structure; understanding user needs; and utilising market knowledge in the firm's innovation activities.

User–driven innovation should thus imply that user needs are a driving force in generating new ideas for product development, and more and more researchers ask for data to help them meet these expectations.

Another issue in relation to data collection, and therefore to the manual guiding data collection, is the **Reference period for the CIS: two or three years**. The issue of the reference period was raised in several presentations. **Vincent Dautel** based his presentation on his studies of the effect of the length of the reference period on the results provided by a Community Innovation Survey (CIS). Between the first CIS survey (CIS1) and the last one (CIS4) a three–year reference period has been used to identify innovative firms. Only for the CIS light survey (carried out between CIS3 and CIS4) did a small number of countries, including Luxembourg, collect innovation data based on a two–year reference period.

The message put across by Mr Dautel is that not only is it very critical in theory what reference period is used, practice also bears this out.

Svein Olav Nås also raised the issue of reference period in his presentation. He argued in favour of a shorter period, maybe just a year. Annual information will also make it easier to construct panels for time series analysis. Time series analysis of panel data can help to track the effects of different kinds of innovation over time. In his opinion, annual surveys will also improve the overall quality of the information for two reasons:

1. It is easier to remember more precisely what went on last year than in the last three years.
2. The educational effect of more frequent surveying will improve responses.

The ensuing discussion supported the demand for clearer guidelines.

Some agreed with Frank Foyn, but there was nonetheless great interest in the possibility of splitting the different forms of innovation. More clarifying work therefore has to be done because users also have their demands, as illustrated in the opening session and in Session 5. The issue of the reference period, also raised by Heidi Armbruster, was discussed, but no clear conclusion came out of the discussion.

USER NEEDS FOR NEW INDICATORS – AS WELL AS EXISTING ONES was the item for discussion in **SESSION 5.**

There are many different users; this session started with policy–makers at European level, with **Reinhard Büscher** from the European Commission listing the needs within DG Enterprise. Input from CIS to European Scoreboard on Innovation was his main concern and he expressed satisfaction with the input because the CIS data produced so far could be used to give a picture of trends in innovation. Mr Büscher was less concerned about specific measuring problems. Keeping up with business innovation as a moving target is necessary, and organisational innovation and measures of diffusion together with measures of innovation demands are among the new indicators needed.

Anthony Arundel, from MERIT, representing another type of user, focused on the lack of synchronisation with policy needs. He emphasised that the main focus so far has been on R&D and R&D performing firms, and he recommended that more attention should be given to innovative firms not doing R&D. He concluded that the usefulness of CIS data for policy calls for more attention to be given to firms not performing R&D, what he called "neglected" innovators.

Svein Olav Nås represented researchers as users when speaking about the broad issue of measuring innovation **processes,** an issue also highlighted in Heidi Armbruster's presentation.

Different kinds of design – aesthetic, functional and industrial – are particularly important components of innovation and inputs of this kind are not satisfactorily covered in CIS 4/OM, he said. This affects both product and process innovation. The current coverage in particular mixes design with **marketing innovation.**

Information on **process innovation** is mainly limited to input, since indicators to quantify results or outcomes of process innovations are limited to an evaluation of effects. The introduction of new types rightly broadens the scope, but at the same time the line between process innovation and marketing and organisational innovation is not sufficiently clear. This creates uncertainty as to both the input and the output components of process innovations.

Svein Olav Nås argued in favour of clarifying the different components of innovation costs so as to make process costs more visible and include costs relating to organisational and marketing innovation.

According to Mr Nås, there are two ways of measuring the results of process innovation, including organisational change and marketing:

1. Ask for the share of turnover affected by innovation, in parallel with the indicator for product innovation, and, where appropriate, distinguish between new and significantly changed processes.
2. Ask explicitly for the economic results of process innovation, such as the effect on unit cost of production, percentage change in labour productivity, change in production time, change in market share, and change in overall profitability.

In **SESSION 6**, **Fred Gault** from Statistics Canada, Chairman of NESTI, the OECD network of national statistical experts, spoke on the subject of **How far and fast can we go?**

He mentioned that two OECD meetings in 2006 had looked at new indicators and their use by the policy community. Based on his experiences from the Blue Sky project, Fred Gault informed us that the Blue Sky II Forum had identified five high–level issues to guide future indicator development at the OECD. They were:

- the capacity to tell the story (What happens when there is STI investment?);
- moving from 'activity' measures, such as R&D funding, to 'impact' measures, such as social changes resulting from the diffusion of mobile telephones;
- coordinating, focusing and synthesising STI work within the OECD and in other international organisations;
- moving from macro–data to micro–data analysis; and
- developing science of science policy.

In addition to high–level issues, there were a number of issues that were cross–cutting: human resources; classification and guidelines; firm characteristics; and sustainability. The importance of human resources for STI is stressed repeatedly in view of the scarcity of the highly skilled, the shortfall in production of such people, problems associated with immigration and the absorption of highly skilled immigrants, and the need for greater commitment to lifelong learning.

The question is how rapidly the OECD and other international and supranational institutions can accommodate the recommendations, Fred Gault said. This moved the discussion on to practices, and how these can change, and the extent to which such change is possible. The development of a dialogue between the producers of indicators and the community of policy analysts requires the learning of a common language and the use of a shared set of tools; this issue was also stressed by Aavo Heinlo and others. This is the very essence of the CEIES.

COMMUNITY INNOVATION STATISTICS by **AUGUST GÖTZFRIED**

A number of additional user requests from various, often heterogenious user groups had already been flagged to Eurostat. Some of these issues brought up by August Götzfried from Eurostat have been mentioned in other presentations, but some had not been discussed before.

Innovation and public procurement are becoming increasingly prominent on the EU policy agenda. At a certain stage the CIS should also be capable of providing answers to these issues. A question could be added to the survey asking firms whether they sell to the government and, if so, to report on the relative influence of costs versus innovation on procurement decisions.

Open and user–driven innovation seems to gain in importance the cheaper and better the IT technology. Consumer and investment goods are often improved and innovated by users. The closed in–house R&D and innovation environment therefore seems to be complemented by a more open innovation network involving the users of the goods and services.

Several users have also asked for the CIS to be extended **to more economic activities**, in particular to public services, additional service activities or other non–market activities.

The preparatory work already undertaken and the additional ideas and user requests will all need to be incorporated in the CIS 2008 harmonised questionnaire and methodology. Overall, the changes to the 2008 CIS would seem to be bigger than to the 2006 CIS. This could affect the comparability of the CIS 2008 with the results of previous CIS.

Greater progress has been made in terms of data quality, accessibility and data use of the CIS 4. Further progress is needed with regard to the 2006 CIS, which is currently implemented in many Member States. This should increase the use and usefulness of the CIS considerably, and will probably lead to a better counterbalance of traditional R & D statistics.

THE PROS AND CONS OF DIFFERENT FORMS OF MICRO–DATA were discussed by **Guilio Perani**, who gave some guidelines for future measures. **Ari Leppälahti and Ismo Teikari** followed this up with a look at **PROBLEMS WITH MICRO–DATA FROM SMALL COUNTRIES.**

In recent years there has been an increasing demand from the research community for access to micro–level enterprise data. This demand, which was also raised by Guilio Perani, has been echoed by policy–makers.

National statistical institutes have responded to these demands by providing secure data access channels. At Statistics Finland, for example, the Safe Centre has been operational since 2001.

The first attempt by Eurostat was the delivery of anonymised CIS3 data. Later, Eurostat also opened a Safe Centre providing access to CIS3 data. However, for confidentiality reasons, the delivery of anonymised micro–data to researchers on CD–ROM was rejected by a number of member countries, Finland among them.

The purpose of the paper by **Ari Leppälahti and Ismo Teikari** was not to examine the micro–aggregation method itself, but to look at protected data.

In addition to the confidentiality issue, there is the question of the quality of micro–aggregated data for research use. Therefore, taking an average of the sales of units from these different industries can create distorted figures.

Safe centres are clearly the way forward as far as national data are concerned. It still remains to be seen, however, what the role of the centralised mode (Eurostat centre) will be, or whether there will be more cooperation and networking between national safe centres in an effort to provide data for comparative analysis at European level.

All in all

After this seminar we know more or less what we want to be able to say something about, and we know to a large extent what policy–makers want indicators on, but we do not always know how to get valid and reliable data on these indicators. The seminar showed that for some indicators there are still problems.

The purpose of CEIES seminars is to help producers to make users of statistics aware of what they can get and vice versa.

As Aavo Heinlo said, it is necessary to find a common language, so that users, producers and data providers know what they are talking about when they talk about innovation, and especially about innovation being more than R&D and more than technology. It is my hope that we have managed to take a few steps in that direction at this seminar.

On behalf of the CEIES subcommittee on innovation, I can conclude that this seminar has demonstrated the great value of CEIES seminars, and I therefore wish to thank all who have participated, the speakers, the chairs, the secretariat, Eurostat and, not least, all the participants who have shown by attending the seminar that the issue of innovation indicators is very much on the agenda.

Reaction from Eurostat

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REACTION FROM EUROSTAT

Michel GLAUDE
Director for Social Statistics and Information Society
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I would like to thank CEIES and all participants for what I think was a most useful and stimulating seminar. We addressed all key issues related to Community Innovation Statistics and beyond. They concerned data producers and data users, they looked back at what has already been achieved and ahead to the next waves of Community and other innovation surveys and innovation indicators to come.

There is no doubt: the measurement of innovation in Europe and in the world has improved considerably in recent years, but more progress is still needed. The Chair of the Sub–Committee presented an excellent summary of the sessions and the main conclusions. In the following, I would like to address the most important issues from Eurostat's point of view.

Statistical data quality has been one of the major issues during our challenging seminar. All the 7 dimensions of quality were touched upon, e.g. relevance, accuracy, timeliness, accessibility, comparability, etc. Furthermore, the weighting procedures, the identification of the enterprise, the statistical unit to be addressed, etc. were questioned. On some points it was said: "not good, needs to be improved". The quality of the "innovation expenditure" as the most critical variable seemed – to some of the participants – even too weak for dissemination. For some other variables, inconsistencies were identified.

From my point of view it is always a good signal when concrete statistical issues are raised and addressed. But "**Do not throw the baby out with the bathwater**". In all statistical areas which I know we faced the same process. Just think about our definitions of employment 60 years ago. So adjust and refine the concepts and definitions better to the user demands and data providers, improve the data production process, the questions and the questionnaire by analysing the results. We still have a long way to go. Let us go now into more details.

Looking at **data production**, it seems that the data quality of the CIS–4 has improved quite a lot. Some problems however remain with certain indicators or breakdowns or with the provision of regional data where there is no comprehensive Community response at this stage. Outside Europe, a number of countries follow the CIS model, others such as the United States seem to be more concerned about re–engineering the whole data production process.

Respondents, i.e. businesses, seemed to have become more used to the innovation surveys. This would partly explain the better data quality. However certain questions need to be better clarified to companies in order to increase the data quality further. On the other hand, there is an increasing awareness of the Commission to the statistical burden on businesses, its measurement and reduction. And the CIS is concerned in this respect even if it is not a main player. However, with a CIS every two years some rationalisation of field work could be envisaged (putting R&D surveys and CIS together? Or using better administrative data?) We will have to deal with these issues in the future.

Users also had a word to say at this seminar. The European Innovation Scoreboard released every year by DG Enterprise and Industry is well known and has a considerable impact on the policy debate on knowledge creation, transmission and innovation in Europe. This scoreboard is expanding into various dimensions: the regional and the sectoral ones. These scoreboards as well as other data uses will ask for more and better CIS data, and will also look more closely at, for example, to the various types of innovation. More recommendations for innovation surveys will be coming from this corner, such as the better measuring of linkages.

The new Eurostat/OECD **Oslo Manual was drawn up and released in 2005**. It has not really been fully implemented yet. This has to be done in the coming years. Improved measurement of the new types of innovation such as organisational and marketing is required. They increasingly counterbalance the traditional technological product and process innovation. Some piloting is ongoing in Europe. The results need to be consolidated and integrated into the next waves of the CIS.

New and existing innovation indicators: this was an interesting debate covering the under–exploitation of the CIS, innovative and complex indicators as well as on the CIS micro–data access. The conclusion seems to be clear: more needs to be done in this respect. More needs to be done in compiling better and more complex indicators, going beyond the simple ones available at this stage. Also more needs to be done with regard to the better and central use of the micro–data of innovation and other surveys. Researchers are already accessing the confidential and anonymised CIS 3 micro–data. This has to be followed–up with the CIS 4. I hope we will get more national agreements to the CIS anonymisation method by June 2007. However the data access for researchers has to be simplified; for the moment, the administrative process in this respect is too long and too complicated.

Looking ahead to the next waves of innovation surveys, in particular the CIS 2008, the table seems to be already overloaded. Many additional user needs are communicated such as the better measurement of linkages, eco–innovation, innovation and public procurement, etc. On the other hand, the CIS cannot get much longer nor more complicated: we have seen the effects of such a survey with falling data quality. So we will have to prioritise the different user needs.

Concerning **data analysis**, we have seen that some differences between countries are also due to differences in the structure of economic activities and size classes. When taking these differences systematically into account, this will improve the relevance of the data. More sectoral and country specific analysis is needed. This could be done by better co–operation between statisticians and economists, NSIs and researchers.

In conclusion:

- **Quality issues should be continuously addressed. This is by the way fully in line with the recommendations of the Code of Practice which was adopted in 2005 by the European Statistical System. These recommendations are now assessed by a round of peer reviews in all Member States and Eurostat. For the CIS, quality reports have been sent by Member States and will be summarized by Eurostat. Nevertheless some common work on the comparability issue could be further developed, such as the face–to–face testing of certain concepts and definitions or other small scale piloting.**

- **The Community Innovation statistics need to be better communicated. Many users out there do not know them or do not know them sufficiently. We have to work on better dissemination of the CIS results. This would increase its recognition further.**

- **Make more out of the CIS micro–data in producing more sophisticated CIS indicators in using more questions than before; try to stabilise these indicators in establishing them as being of good relevance and fully recognised.**

- **Keep the future CIS manageable in size, in concepts and definitions, many changes were made in the past which affected its recognition and data quality. Adaptations need to be made with regard to the new types of innovations, linkages or other issues, but we should not be too radical. In my opinion we have to consolidate further the CIS.**

- **Integrate better the various parts of Statistics on Science, Technology and Innovation at international level: we have seen the differences to R&D statistics, Statistics on Human Resources in Science and Technology or other parts: the survey results show sometimes similar data being rather different in results: shall we have a Frascati/Oslo Manual in one edition?**

- **The same is true for the national level where the CIS could, for example, be linked to the Structural Business Survey or other surveys. This should also increase the data quality.**

- **Put the CIS micro–data use forward: this is one larger issue which goes beyond the CIS only: there are other surveys being candidates for better micro–data use and for micro–data linkages with the CIS: I think the option of non–action is no option any more: just how fast can we act?**

To conclude: I would see a large opining for more and better use of the Community Innovation statistics, this would also mean a shift away from the 3% type of R&D input indicators. To look at the latter ones will not be enough any more in the years to come. Do we need CIS based indicators of the same nature which we can sell to policy makers?

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