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Policy Relevant Nordic Innovation Indicators

Statistical Indicators for R&D and Innovation -

A guide for Interpretation and Valuation

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1. Introductory comments

In recent years a more in-depth and fact based comparison and benchmark of national innovation policies have come into focus, e.g. OECD (2005, 2007a, b), European Innovation Scoreboard and the Innobarometer (www.proinno-europe.eu) among many others. Most of the effort has been set up to support an evidence based development of national and supra national innovation policy towards "best practice" coherent innovation policies that supplement and increase the effect of each other, e.g. EC (2007), the NIND, ServINNo and IGNORED projects at NICe and others. This common belief is explicitly expressed in the INNO-Metrics: *"Innovation is a key factor to determine productivity growth. Understanding the sources and patterns of innovative activity in the economy is fundamental to develop better policies. This is the aim of* ***INNO-Metrics****".* (c.f. www.proinno-europe.eu).

The debate on what we need to measure and how or why, have been intense and fruitful, such that there has been a move from "what can we say with the measurements we have" towards a qualified development of new measures that can measure "what we really want to know". This is also the purpose of the NIND project.[1] After the "Quality in Statistics" initiative by Statistics Sweden in 1999 (c.f. KEI, 2005), several workshops, seminars and conferences have in recent years had the measurement of innovation as theme, e.g. CEIES (2007), 2nd Inno-Views Workshop on innovation metrics in Ispra in 2007, the OECD-WPIA working group in 2006-07, the PRIME Network of Excellence among many others. These contributions typically extends and builds on the user-oriented approach developed by Eurostat (2003a, b), and has the purpose to find relevant indicators that support the evidence based innovation policy, e.g. *"The* ***INNO-Policy*** *TrendChart describes and analyses major innovation policy trends at national and regional levels across Europe in an independent way. It aims to contribute to policy assessment and to identify examples of good practice, thus improving the basis for decision making in innovation policy".* (c.f. www.proinno-europe.eu).

Innovation and R&D indicators are often used to give a short and easy comprehendible status of local, national or supra national innovation systems, i.e. conditions and development of society towards a knowledge based innovation society but it also includes frame work indicators that describes or measure the innovation system at hand. Most indicators are based on existing statistics and often become second best solutions to the present information need. This indicator interpretation guide is thought as examples of statistical indicators for R&D and innovation systems with a systematic evaluation of usefulness and pitfalls of the

[1] The WG NIND focuses on **how** relevant indicators can be measured, while WG Innocate focuses on **which** indicators that is most policy relevant.

indicators. The collection of indicators included is primarily based on work done in the two NIND work groups, WG Innocate and WG NIND.

In general, statistical indicators of all kinds represent a methodological challenge. Indicators applied for policy making represents in addition challenges like the listed below, and therefore all indicators shall be discussed and evaluated within a common context. Such a context is developed by Eurostat (2003a, b) and commented in CEIES (2005) with the recommendation to include all available information - inclusive warnings and usability needs and purposes. The guide also discusses pros and cons in relation to whom or what policy level the receiving actors or users are. Similarly, the guide will consider the firm specific confidentiality problem in splitting the indicator information as well as response burden among respondents giving the information on a regular basis.

All in all, the present analysis contribute with specific advises and an evaluation tool to policy makers' growing use of indicators in evidence based innovation policy all over the world but especially in the Nordic countries where it has been institutionalised during the last decade, cf. the NIND project reports. The aim of quality profiles for innovation indicators is similar to the **INNO-VIEWS** project, to *"explores new or better innovation policy instruments".* (c.f. www.proinno-europe.eu).

2. Selection and evaluation of indicators using a quality profile

Long traditions of compromises have resulted in a selection of "best-possible" indicators in indicator collections for benchmarking. Examples are the European Innovation Scoreboard, EIS, the World Competitiveness Index, WCI, and many others where indicators are selected due to availability and ability to contribute to the overall story. However, other indicators could be more informative, if they existed or could be created through intelligent use of other or new statistics (Bloch et al, 2007), so indicator collections have to be dynamic in such a sense that its composition is reconsidered on a regular basis, e.g. the revision of the EIS2005 and the minor changes in EIS2006 (EC, 2006). So there is a trade off between the perfect indicators for specific policy purposes and the use of available and already collected statistics.

In 2005, the "Comité consultatif européen de l'information statistique dans les domains économique et social", CEIES, had a conference seminar on "Structural Indicators", where the key role for indicators in a political context was on the agenda. The resulting publication (CEIES, 2005) summarised the conference contributions and policy advises and its conclusions are brought into this project due to their importance and generality. However, the concept of improved quality profiles started

almost a decade earlier, c.f. KEI (2005) for an excellent overview of development and methods for quality assurance used by statistics producers.

Among others, Ragland (2005) in CEIES (2005) discusses the difficulties in selecting relevant indicators for the US. The main problem is that no universal definition of quality in statistics exists although organisations like Eurostat, OECD and many national statistical institutions, NSIs, have specified quality securing systems, c.f. KEI (2005). Most definitions solely describe quality of statistics as their fitness for use or the degree to which they satisfy users needs, e.g. KEI (2005). However, in many cases there still exists a gap between producers' quality demand and users' policy needs, e.g. CEIES (2007). A typical conflict is between producers such as national statistical institutions that have accuracy and reliability high up on the agenda and users such as policy makers that have usability, relevance and comparability high on their agenda.[2] Hence, depending on the specific purpose of the indicators either quality (producer), usability (user) or both needs to be considered before the indicators are interpreted, analysed and used.[3]

Jouhette and Sproge (2005) propose that the quality profiles proposed in Eurostat (2003a, b) can be useful in the selection of valuable indicators.[4] Such quality profiles in statistics cover in the European statistical system, ESS, six standard items or catch phrases according to Jouhette and Sproge (2005), Eurostat (2003a, b), KEI (2005). Siune (2005) extends the list with a 7th item, namely political relevance which can be grouped as a sub item for the first item. The six items are listed below and are also gathered in a schematical fill-in table, cf. table A.1.[5]

The list of quality profile items or catch phrases used to evaluate the innovation and research related indicators is expanded into the following list:

[2] Examples have been seen where, producers refuse to publish indicators if the accuracy and reliability is to low in a statistical sense, and in other examples policy makers generalise on a few non representative case studies or poor statistical indicators.
[3] An example is Graversen and Marks (2006) benchmarking of the Danish private sector R&D with the other Nordic countries. The used indicators are the best available under the given restrictions concerning data limitations and accessibility, but still good enough to depict a pattern and rank the Danish strengths and weaknesses on a disaggregated branch and firm size level.
[4] In Heinemann et al (2005, p. 175), a short list of 11 indicators for innovation and research is treated, but only in a limited way.
[5] Muñoz (2005) lists eight criteria for selecting structural indicators to measure progress towards the Lisbon objectives. The eight criteria are [1)] Easy to read and understand, [2)] Policy relevant, [3)] Mutually consistent, [4)] Available in a timely fashion, [5)] Available for most member states, [6)] Comparable between countries, [7)] Selected from reliable sources and [8)] Do not impose too large a burden to collect. Also KEI (2005) present the quality profiles used by selected NSIs, while NESTI (OECD 2007c) had two meetings during 2006 on new indicators and their use by the policy community and the Blue Sky II meeting in Ottawa identified a list of 5 high-level issues to guide future indicator development.

1. **Relevance**
    a. Relevant to key issues, policies, or goals
        - Capacity to tell the story
    b. Easy to understand and meaningful to a variety of audiences
        - Relevance for political actions
        - Impact measure rather than activity measure

2. **Accuracy**
    a. Definitions
    b. Validity
    c. Drawn from reliable sources
        - Micro based rather than macro based (more detailed, diverse and nuanced data)

3. **Timeliness and punctuality**
    a. Recurrence frequency
    b. Punctuality frequency

4. **Accessibility and clarity**
    a. Availability
        - From existing sources or
        - From resource intensive data collections

5. **Comparability**
    a. Across countries and regions (incl. US, Japan, China and India)
    b. Over time, updated regularly
    c. Across types of companies
    d. Relevance for rankings and benchmarking

6. **Coherence**
    a. Development perspective
        - Developing insight for policy making
    b. Interaction or fit with other indicators
    c. Applicable for building indexes and rankings
        - Recommendations and potential pitfalls in rankings
    d. Warnings
        - When to be used for policy recommendations
        - If possible, a warning score could benefit the understanding

The quality profile can never stand alone but has to be introduced and followed up by a descriptive part that can be systematised in an ex ante part and an ex post part in the following way:

1. Introduction, e.g. EC (2006) and related to the relevance point in the quality profile
    a. Indicator name with a short or long description and definition depending on purpose and generality of the proposed indicator
    b. Interpretation of the indicator, e.g. Bloch et al (2007) mentioning examples and illustrations; whether it is a direct or indirect (i.e. an approximation) measure and what other indicators does it interact with

2. The quality profile can afterwards be followed by an evaluation of how usable it actually is for policy making purposes, e.g. CEIES (2005, 2007) and
    a. How, when and under which limitations it can be used
    b. Whether the quality profile needs to be reconsidered
    c. Is there a need for an improved indicator that is better and more efficient, e.g. level or intensity measure, importance of distribution or modes, status quo versus development and trends, suitability for benchmarking and evidence based policy

Overall the indicators can be valued on an objective scale in an overall score measuring the indicators reliability, level, policy usability, e.g. the national SII scores in EC (2006). However, such a purpose will not be pursued in this analysis since it relies on a subjective choice of methods, i.e. choice of simple or weighted adding of numbers or categorised summing etc. Hence, an overall score will be based on a subjective priority and second, the way towards a commonly agreed objective aggregation of the items in the quality profiles are time full and burdensome. There is no obvious and objective aggregation method and the following examples fully illustrates that some indicators may suit one purpose but not another such that the use of an indicator reveals on some best possible conditions for the specific case. Many indicators are failing or scoring low on some of the quality profile points but are still the best possible indicators available.

3. Examples on policy relevant indicator quality profiles

The examples in the present section cover policy, input, output or outcome, status quo as well as activity (e.g. how many innovates) and framework condition indicators, single as well as composite indicators and micro based as well as macro indicators. The indicators have been selected for this presentation as examples that illustrate the different purposes and outcomes of quality profiles or “importance” judgement of indicators and follow the evaluation points from section 2. For an easier and comparable overview, each quality profile and its items are set up in a summary table like the generalised one in table A.1 in the appendix.

3.1 Micro based innovation indicators

The examples in the present section cover indicators that are mentioned and analysed in the NIND project report by Bloch et al (2007), and are based on the CIS and R&D data collected for the national R&D and innovation statistics. The indicators in this section only cover innovation related indicators for the private sector firms but other type of indicators are covered in section 3.2.

The chosen examples are **Simple Indicators** (1st generation indicators) based on CIS experiences:

1. Share of innovating enterprises
2. Innovation Expenditure
3. Funding of Innovation
4. Effects of innovation

and the following **Composite Indicators** (2nd generation indicators):[6]

5. Output based modes from the series of "Indicators of innovativeness"
6. Innovation drivers taken out of the series of "Linkage indicators".

Evaluation of the indicators according to the dimensions described in Section 2 (see also table A.1) is given below, but the technical description and "evaluation" of each of the statistical indicators as presented by Peter Mortensen and Carter Bloch will not be touched in this paper.

3.1.1 Share of innovating enterprises

Definition:
Share of innovating enterprises is the number of enterprises that indicates innovation activities. Usually, innovation activities are defined as product or process innovation (PP-innovation) according to the corresponding CIS questionnaire. Recently, some analyses have used a broader definition including organisational and marketing innovation as well from the CIS questionnaire. The included enterprises are usually the enterprises covered in the CIS, i.e. certain sectors and exclusive enterprises with less than 10 employees.

The share of innovation enterprises is widely used and has due to its simplicity and easy usability a great relevance among users and especially policy makers. It is relatively easy to understand and it is meaningful to a large variety of audiences. The share of innovating enterprises can be used to approximate national innovativeness

[6] Neither of the two included here is in regular production but they can be constructed using CIS4 data.

so it has been used widely as a key indicator, i.e. highly policy relevant, since it has the capacity to tell the story about changes in innovation activities.
The indicator is considered as relative accurate although not fully consistent over time and between countries. It is usually defined according to the Oslo Manual (OECD, 2005c) and if it is collected according to this manual - such as the CIS -, it is time, sector and country consistent. However, observed differences in country levels have been difficult to explain and a warning is given in Bloch et al (2007). They claim that the firms have difficulties judging whether they are innovative or not.
The clear definitions and methodologies behind the CIS also secure a high validity of the indicator. The CIS is coordinated by Eurostat which secure timeliness, high punctuality and a frequency, that from 2004 and onward is at least biannual.[7,8]
Hence, its availability from existing sources like the CIS also secures it availability in the future and that sector differences influence the overall average.
All in all, the indicator must be considered the basic indicator although a warning must be stated due to country comparability problems and problems with the definition, understanding and use of the "innovation" term among responding firms.

Table 1. Quality profile for "share of innovating enterprises"

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance (especially political)	Widely used and key indicator for many purposes Easy understandable	Capacity to tell the story High political relevance An activity measure
2 Accuracy	Clear definition due to the CIS (Oslo Manual). In reality, firms have difficulties judging whether they are innovative or not. High validity due to methodology requirements from Eurostat If from CIS then very reliable source (especially CIS4 and onward)	Micro based data gives multiple possibilities for split of the indicator (e.g. sector, firm size, firm type, etc. etc.)
3 Timeliness and punctuality	Precise and biannual time schedule for CIS High punctuality in timeliness and quality	
4 Accessibility and clarity	Available through Eurostat with some years delay. Usually, earlier available on a national basis	The indicator is available from existing source, CIS , but CIS is in itself very resource intensive to collect with the required quality level
5 Comparability across countries over time	Comparable across regions as well as countries, over time and types of firms Relevant measure in rankings,	Is available for other countries that collect data according to the Oslo manual definitions, i.e. CIS-like data collection. This includes at

[7] In Denmark it seems like the CIS will be annually from 2006 and onward.
[8] Eurostat has increased the documentation on methodology requirements from the data collecting countries in the recent years.

	benchmarking and other comparisons if and only if it is corrected for differences in industry structure.	the moment many countries like Canada, EEA, Eastern European and Asian countries
6 Coherence	The CIS is developing and improving its quality. In recent years new types of innovation has been introduced, i.e. organisational and sales innovation, composite measures such as user innovation and open innovation. Most used and consistent measure is PP-innovative firms, i.e. product and/or process innovative firms. Be aware of how "innovative firm" is defined when comparing the indicator across time, sectors and countries.	Gives an immediate policy insight among policy makers, although the information value is low unless it is improved by further explanations. The indicator can be used for rankings and benchmarking but has to be corrected for industry structure when direct comparisons between countries or regions are made, i.e. compare on comparable units. Has to be used with care in policy recommendations since it partly depends on the given industry structure etc. Warning score: 2

Note: The warning score lies between 1 and 5, where 1 means "go ahead no warning" and 5 means "never use alone as a single indicator".

3.1.2 Innovation Expenditure

Definition: The innovation expenditures are defined as the firms' expenditures on PP-innovation in recent year. For CIS4 this is year 2004. The included enterprises are the firms in the CIS. The expenditures include R&D expenses as well as expenditures on additional PP-innovation activities.

The innovation expenditure attracts great attention due to its ability to be compared and related to other continuous variables such as GDP. Relative to GDP is becomes a comparable indicator across countries. Innovation expenditure also has great relevance for policy actions such as support integrated in new policy actions. The indicator is easy to understand from a user perspective so it is often used and have a high user demand rate.

From the producer point of view the indicator has a much lower priority since its validity is rather low. This is caused by the lack of consistent understanding among the respondents of what the innovation expenses actually are. Hence, the precision and reliability on the firm level is rather low although the aggregated measure may fit the correct total after all. Therefore the accuracy and the validity must be carefully discussed and verified when the indicator is used, especially for comparisons over time, sectors or countries.

All in all, the indicator is collected on a regular basis according to common definitions, c.f. OECD (2005c), and it is available through the CIS data collection. The most severe warning is due to problems with the definition, understanding and

use of the “innovation expenditures” term among responding firms, i.e. comparisons over time and countries can be problematic. The indicator is of great relevance for measuring the impact in form of policy initiatives.

Table 2. Quality profile for “innovation expenditures”

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance (especially political)	Widely used and key indicator for many purposes Easy understandable	Capacity to tell the story High political relevance An activity measure
2 Accuracy	Clear definition due to the CIS (Oslo Manual) High validity due to methodology requirements from Eurostat, but serious problems in reality due to lack of precision among responding firms, i.e. defining innovation expenditures If from CIS then very reliable source (especially CIS4 and onward)	Micro based data gives multiple possibilities for split of the indicator (e.g. sector, firm size, firm type, etc. etc.)
3 Timeliness and punctuality	Precise and biannual time schedule for CIS High punctuality in timeliness and the quality is documented although not the best	
4 Accessibility and clarity	Available through Eurostat with some years delay. Usually, earlier available on a national basis	The indicator is available from existing source, CIS , but CIS is in itself very resource intensive to collect with the required quality level
5 Comparability across countries over time	Comparable across regions as well as countries, over time and types of firms Relevant measure in rankings, benchmarking and other comparisons if and only if it is corrected for differences in industry structure.	Is available for other countries that collect data according to the Oslo manual definitions, i.e. CIS-like data collection. This includes at the moment many countries like Canada, EEA, Eastern European and Asian countries
6 Coherence	The CIS is developing and improving its quality. Although new innovation types have been introduced, the indicator usually measures the most used and consistent measure, namely expenditures on PP-innovation, i.e. product and/or process innovation. Be aware of how “innovation expenditure” is defined when comparing the indicator with others.	Gives an immediate policy insight among policy makers and the information value is high when it is used as an activity measure. Has to be related to total expenditures, total sales or similar. The indicator can be used for rankings and benchmarking but has to be corrected for industry structure when direct comparisons between countries or regions are made, i.e.

		compare on comparable units. Has to be used with care in policy recommendations since it depends on how "innovation expenditures" are understood in the firms. Warning score: 3

Note: The warning score lies between 1 and 5, where 1 means "go ahead no warning" and 5 means "never use alone as a single indicator".

3.1.3 Funding of Innovation

Definition:
Funding of innovation is usually measured as a dummy indicator for various public funding supports in the CIS and referred as share of PP-innovative firms with such public funding. When possible, for example in the R&D surveys, the amount of public support is gathered and referred as share of total R&D expenditures. The latter is very difficult to measure for innovation expenditures.

Funding of innovation is an indicator with great political relevance, not the least in the comparative perspective over time and across countries. Type of sources is relatively easy and often very precise, but when it comes to the amount of innovation funding, the indicator or measure becomes imprecise.
It has in its presentation more accuracy than actual validity due to the broad measurement categories, but it is applicable for building indexes and rankings.
The warnings have to be stated: Insecurity among respondents again referring back to the concept of innovation versus R&D and lack of precision in the responses following this.

Table 3. Quality profile for amount of "funding of innovation"

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance (especially political)	Not so often used indicator Used for specific purposes Easy understandable	Capacity to tell a story High political attention
2 Accuracy	Although clear definitions, the indicator is problematic when it comes to amount of funding.	Micro based data gives analytic possibilities
3 Timeliness and punctuality	Precise and biannual time schedule for CIS High punctuality in timeliness although the quality is not the best	High precision in the measurement of funding sources, but a warning has to be given since it is measured as used funding over one period and funded activities often covers other periods
4 Accessibility and clarity	Available through Eurostat with some years delay. Usually, earlier available on a national	Clarity in statement may be greater than clarity in measurement

	basis	
5 Comparability across countries over time	By definitions comparable across regions as well as countries, over time and types of firms	Given that the same definitions are used, comparability can be found
6 Coherence	The funding source indicator has a high and important impact factor. However, the amount of funding is usually very difficult to collect fully and correct.	Coherence ok Warning score: 1-2 (4 for amount of funding)

Note: The warning score lies between 1 and 5, where 1 means "go ahead no warning" and 5 means "never use alone as a single indicator".

3.1.4 Effects of innovation

Definition:
Effects of innovation comes from CIS where the PP-innovative firms are asked about **Market effects** (Increased range of goods and services; Increased market share; Improved quality of products), **Process effects** (Improved flexibility; Increased capacity), **Cost effects** (Reduced labour costs; reduced materials and energy), and **Regulation effects** (Reduced environmental impacts or improved health and safety; Met regulatory requirements)
The referred indicators are usually the share of PP-innovative firms with a specific experienced effect.

There is a growing or more precise booming political interest in measures or indicators on the outcome, output or effects of innovation and even more expectation about economic impact of innovation, so such an indicator has great relevance. However, the accuracy is relatively low, since respondents have difficulties in understanding and identifying the effects when asked about them. Timeliness and accessibility is high but due to the lack of accuracy there has to be stated severe warnings against the use of this indicator for comparability. However, summing the information in the single indicators to composite indicators is of great relevance due to the political interest in getting a single and simple measure of a complex situation.

However, another single dimension indicator that has been used for several years and nowadays must be called a basic indicator for effects of innovation is the "turnover from new products". This one is precise defined, fully usable but it only tells a part of the story. This indicator is not treated further here.

Table 4. Quality profile for "effects of innovation"

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance	Key indicators for policy	Very high political relevance

	(especially political)	evaluation Difficult to understand and sum	High political attention Tells only parts of a story
2	Accuracy	Clear definition due to the CIS (Oslo Manual) High validity due to methodology requirements from Eurostat If from CIS then reliable source (especially CIS4 and onward)	Depends on clarity of definitions behind measurements Micro based data gives multiple possibilities for split of the indicator (e.g. sector, firm size, firm type, etc. etc.)
3	Timeliness and punctuality	Precise and biannual time schedule for CIS	Problems related to punctuality due to time lag in effect
4	Accessibility and clarity	Available through Eurostat with some years delay. Usually, earlier available on a national basis	The indicator is available from existing source, CIS , but CIS is in itself very resource intensive to collect with the required quality level Case studies can be done; aggregate studies too with some caution
5	Comparability across countries over time	Comparable across regions as well as countries, over time and types of firms	Low comparability over time and innovation types, improvements very much wanted
6	Coherence	The CIS is developing and improving its quality. The used and consistent measure is effects of PP-innovation. Be aware of how the "effects" are defined when comparing the indicator with others.	Gives an immediate policy insight among policy makers, although the information value is low due to time lag and low consistency. Has to be used with care in policy recommendations since it heavily depends on the given definitions and their implement-tation. Warning score: 2-3

Note: The warning score lies between 1 and 5, where 1 means "go ahead no warning" and 5 means "never use alone as a single indicator".

3.1.5 Output based modes

Definition:

The four output based modes behind the indicator is defined on the basis of the firms' answers on the CIS questionnaire as new to the market international vs. domestic innovators, in-house modifiers, and adopters and it reveals their innovativeness ability or strategy (Bloch et al, 2007). The shares sum to 1.

New to market international innovators: These enterprises have introduced a product innovation that is new to international markets and have developed new products or processes in-house. Innovations for these enterprises have the highest degree of novelty and at the same time in-house development (product or process innovation developed by enterprise itself or together with others) indicates that these enterprises possess (at least some of) the capability to create novel products. **New to market domestic innovators:** These enterprises have introduced product

innovations that are novel for domestic markets, but not necessarily new for international markets (either new to market domestic or new to enterprise international). As with new to market international innovators, innovations are at least partially developed in-house. **In-house modifiers:** These enterprises have some in-house development activities, but product and process innovations already exist on domestic markets (new to enterprise domestic product or process innovators). These enterprises are thus adopters, but are able to adopt and implement the new technologies themselves. **Adopters:** These enterprises have not developed product or process innovations in-house, but have had them developed by others. This group thus includes all product and process innovators that have had all their product-process innovations developed externally, regardless of novelty.

This indicator is an excellent example of the new composite or 2nd generation indicators for innovativeness that increase the information value in an indicator by pooling the information value of several single indicators. Hereby, the indicator measures a theme instead of one single dimension of such a theme. The main difficulty using composite indicators is to define what they actually measure and especially what they do not measure, since a composite indicator is based on the actual numbers of available single indicators at hand and their clear definitions. Pooling these indicators in various ways gives different composite indicators with different information values. However, the present indicator is well defined and based on the CIS questions.
In general, composite indicators such as “output based modes”, heavily relies on a theoretical or at least sound economical base that justifies why this composite indicator defined and constructed in this specific way is interesting for policy purposes. When this is justified, composite indicators such as “output based modes” have very high policy relevance in relation to evaluation and measuring the outcome of innovation policy initiatives.

Table 5. Quality profile for “output based modes”

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance (especially political)	Not so often used yet, relatively NEW developed indicator Used for specific purposes May not be easy to understand	Capacity to tell a story High relevance for business and strategic planning
2 Accuracy	Although clear definitions, the indicator may be problematic, if single indicators used in the composite indicator varies between populations	Depends heavily on definitions Micro based data gives analytic possibilities
3 Timeliness and punctuality	Precise and biannual time schedule for CIS Usually, high punctuality in timeliness and punctuality	Can be measured punctual, depends on the indicators behind Lack of precision in the

			measurement, since it is measured over a time span earlier than collected
4	Accessibility and clarity	Can often be created through Eurostat data with some years delay. Usually, earlier available on a national basis	Exist in limited form, has to be constructed before use Risky due to clarity in statement greater than clarity in measurement
5	Comparability across countries over time	By definitions comparable across regions as well as countries, over time and types of firms if and only if it is measured and constructed in the same way	Given that the same definitions are used, some comparability can be found Not very much available
6	Coherence	When it is carefully collected it has a high and important impact factor. However, it is usually very difficult to collect it full and correct.	With greater strength of definitions coherence ok Warning score: 2-3

Note: The warning score lies between 1 and 5, where 1 means “go ahead no warning” and 5 means “never use alone as a single indicator”.

3.1.6 Innovation drivers

Definition:
The five innovation drivers behind the indicator is defined on the basis of the firms’ answers on the CIS questionnaire, cf. Bloch et al (2007). The shares sum to 1. **Market driven innovation:** This indicator aims to measure the importance of customers and markets for enterprises’ product development activities. The indicator is defined as enterprises with a product innovation and market cooperation (cooperation with clients or competitors). **Technology driven innovation:** This indicator tries to measure the importance (or simply the use) of technology/new knowledge for product or process innovation development. This is measured both by use of inputs (e.g. intramural R&D or the acquisition of external technology) and by cooperation with R&D-based sources, such as public research institutions or commercial R&D labs. **Both market and technology driven innovation:** Enterprises may both be market and technology driven, and it may be difficult to distinguish what factors are most important for a enterprise’s innovation. Furthermore, we may not be interested in distinguishing between the two: it would be informative to be able to identify enterprises that are both market and technology driven. Hence, enterprises may either be both market and technology driven, market driven only, or technology driven only. **Supplier driven innovation:** Suppliers are often important external sources of knowledge. Hence, a significant share of market or technology driven enterprises may also cooperate with their suppliers, and for other enterprises suppliers may be their sole external knowledge source. Those enterprises that access external knowledge mainly from suppliers will likely tend to focus on process innovation or the adoption of existing technology through their

suppliers. The classification here of supplier driven innovators focuses on the latter group, and includes enterprises that have cooperation with suppliers and are not market or technology driven. **Internally driven innovation:** Many enterprises do not engage in cooperation or rely heavily on external sources of information, instead relying on knowledge creation within the enterprise or from other enterprises within the same enterprise group. These enterprises are referred to as internally driven innovators. They are not engaged in cooperation with any enterprises outside of their enterprise group (in other words, their innovation activities are not market, technology or supplier driven). Instead they are either engaged in cooperation within their group.

The innovation driver indicator is another example of a composite indicator that can be used to tell a broader thematic story than the single indicators do separately. Again the main advantages is the ability to tell a more complete simultaneous story, and again the main drawback is the way it is constructed, i.e. how and why.

Table 6. Quality profile for "innovation drivers"

Evaluation item		Evaluation measure	Sub evaluation measure
1	Relevance (especially political)	Not so often used yet relatively NEW developed indicator Used for specific purposes May not be easy to understand	Great relevance for innovation supporting policies Capacity to tell a story
2	Accuracy	Although clear definitions, the indicator is problematic, if single indicators used in the composite indicator varies between populations	Depends heavily on definitions Micro based data gives analytic possibilities
3	Timeliness and punctuality	Precise and biannual time schedule for CIS Usually, high punctuality in timeliness and punctuality	Innovation drivers work over time, and therefore it has to fulfil timeliness and punctuality Lack of precision in the measurement, since it is measured over a time span earlier than collected
4	Accessibility and clarity	Can often be created through Eurostat data with some years delay. Usually, earlier available on a national basis	Many types of drivers Exist in limited form, has to be constructed before use Risky due to clarity in statement greater than clarity in measurement
5	Comparability across countries over time	By definitions comparable across regions as well as countries, over time and types of firms if and only if it is measured and constructed in the same way	Given that the same definitions are used, some comparability can be found Not very much available
6	Coherence	When it is carefully collected it has a high and important	With greater strength of definitions coherence ok

	impact factor. However, it is usually very difficult to create it full and correct.	Warning score: 3

Note: The warning score lies between 1 and 5, where 1 means “go ahead no warning” and 5 means “never use alone as a single indicator”.

3.2 Indicators from other studies

The list from Bloch et al (2007) only covers indicators that can be constructed on the basis of CIS, and especially CIS4. Since it only covers the private sector firms – and excludes certain branches as well as small firms there is a need for additional indicators for the remaining part of the national innovation system. This is for example Government Expenditures on R&D[9], cross disciplinarity in R&D, but also overall national indicators on ICT, biotech, nanotech or environment, and entrepreneurship as well as spin-off firms, e.g. input as well as output measuring indicators. Among many contributors the following section is mainly focused on indicator examples proposed in CEIES (2005, 2007), Arundel et al (2007), Bloch (2007), Mortensen (2007) and OECD (2007a, c).

3.2.1 Service innovation

Definition:
Service innovation, or the development of new services, is not a phenomenon that is restricted to the service sector. A special feature of the CIS4 survey is that it separates product innovations into goods innovations and service innovations. Service innovation is defined as product innovative firms that are performing service innovation, cf. Bloch (2007).

The term ”**service innovation**” is not identical to ”innovation in the service sectors”. Where the first can and is found among all types of firms across all sectors, the latter covers all types of innovation among firms in the service sectors solely.

Service innovation has in recent years gained an increasing interest among policy makers, due to the fact that “services” counts for an increasing share of GDP and productivity growth in most developed countries. Hence, a “service innovation” indicator can be a single indicator if it is measured as such, or it can be a composite indicator if it for instance is constructed from other indicators as in Bloch (2007) or Arundel et al (2007).e.g. CIS based.

The definition of “service innovation” is still vague and mostly based on CIS4 results gathered for other purposes. Hence, it is not very precise in the sense that it only covers part of a larger story. Recent work by Bloch, Arundel and OECD among

[9] So far, public sector innovation is not measured or even defined to be measurable.

others has narrowed the definition and determined examples of composite indicators that measure “service innovation”.

Table 7. Quality profile for “service innovation”

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance (especially political)	Increasing use and interest among policy makers Used for specific purposes Easy to understand	High relevance for innovation policies High political attention Capacity to tell a story
2 Accuracy	Although clear definitions, the indicator is problematic, due to imprecise definitions	Depends on clarity of definitions behind measurements Micro based data gives analytic possibilities
3 Timeliness and punctuality	Precise if based on CIS, else data source dependent	Can be measured punctual, depends on the indicators behind
4 Accessibility and clarity	Can often be created through Eurostat data with some years delay. Usually, earlier available on a national basis	Exist in limited form, has to be constructed before use
5 Comparability across countries over time	By definitions comparable across regions as well as countries, over time and types of firms if and only if it is measured and constructed in the same way	Given that the same definitions are used, some comparability can be found Not very much available
6 Coherence	When it is carefully collected it has a high and increasing impact factor.	With greater strength of definitions coherence ok Warning score: 2-3

Note: The warning score lies between 1 and 5, where 1 means “go ahead no warning” and 5 means “never use alone as a single indicator”.

3.2.2 Government Expenditures on R&D

Definition:
The government expenditures indicator is collected according to the Frascati Manual and its definitions. Hence, it is a well known indicator that has a high reliability. It can be used as weak approximation for public sector innovation.

Although the public sector innovation is still not defined in a measurable way, an indicator for the public sector R&D has existed since the first Frascati Manual. Nowadays, the main part of the public sector expenditures on R&D is measured in most countries and published in a comparable way by OECD. The indicator used for comparisons are usually the Government Expenditures on R&D per GDP in percent. Such a measure is relatively easy to compare among most countries. As an indicator, the Government Expenditures on R&D (or alternatively Higher Education Expenditures on R&D, HERD, or Gross Domestic Expenditures on R&D, GERD) in

percent of GDP can also be used to measure the structural conditions for firms in a country, assuming that a higher percent makes it easier for firms to cooperate and gain access to new knowledge.

Table 8. Quality profile "Government Expenditures for R&D"

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance (especially political)	Frequently used in benchmarks Easy to understand	Relevant for structural frame policies Medium political attention Capacity to tell a story
2 Accuracy	Clear definitions according to the Frascati Manual. Assumed very precise and accurate	Micro based data gives some analytic possibilities
3 Timeliness and punctuality	Precise and biannual time schedule for CIS High punctuality in timeliness and quality	Measured punctual
4 Accessibility and clarity	Available through Eurostat with some years delay. Usually, earlier available on a national basis	The indicator is available from existing statistical sources
5 Comparability across countries over time	Comparable across regions as well as countries, over time and types of firms Relevant measure in rankings, benchmarking and other comparisons	Is available for most other countries that collect data according to the Frascati manual definitions
6 Coherence	Coherent over time and location for the last forty years	Gives an immediate policy insight among policy makers. The indicator can be used for rankings and benchmarking. Warning score: 1

Note: The warning score lies between 1 and 5, where 1 means "go ahead no warning" and 5 means "never use alone as a single indicator".

3.2.3 R&D or innovation cooperation between firms and research institutions

Definition:
The indicator is based on single indicators for cooperation with research institutions in the R&D or CIS questionnaire. Hence, the indicator is a "simple" composite indicator.

An indicator for the degree of cooperation between firms and research institutions, public-private cooperation, can be made in many ways and is extremely relevant as an indicator for the flow of knowledge in the national innovation system. Such a measure is important for measuring the need (if to low) or efficiency (if adequate) of

policy incitements. The rationale is that more cooperation secures a higher "social value for money" of public sector R&D and innovation.
Many questionnaires and case analyses have in the past decades focused and measured on the indicator, but the most coherent and country comparable indicator is created from the Eurostat R&D or innovation data, which is collected regularly, based on a consistent data collection methods. Hence, the validity in form of accuracy, timeliness and punctuality of these secures a high comparability across countries, regions, sectors etc.

Table 9. Quality profile for "Public-private cooperation"

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance (especially political)	Very used indicator Used for policy purposes Easy understandable	Capacity to tell a story High political attention
2 Accuracy	Clear definitions, but the indicator is based on the understanding of the concept "cooperation"	Micro based data gives analytic possibilities
3 Timeliness and punctuality	If from Eurostats R&D or CIS: Precise and biannual time schedule High punctuality in timeliness	High precision in the measurement but difficult to measure correctly
4 Accessibility and clarity	Available through Eurostat with some years delay. Usually, earlier available on a national basis	Risky due to clarity in statement greater than clarity in measurement
5 Comparability across countries over time	By definitions comparable across regions as well as countries, over time and types of firms if and only if it is measured correct/comparable	Given that the same definitions are used, comparability can be found
6 Coherence	When it is carefully collected it has a high and important impact factor.	With considerable focus on definitions coherence ok Warning score: 2-3

Note: The warning score lies between 1 and 5, where 1 means "go ahead no warning" and 5 means "never use alone as a single indicator".

3.2.4 Cross disciplinary cooperation

Definition:
Cross disciplinarity is an add-on to firms' cooperation in general. The definition of the indicator is cooperation within or between partners from one of six disciplinary areas, natural, technical, health, agricultural, social sciences or humanity. It has gained increasing importance in recent years but it is very difficult to find collected data.

In recent years the belief in cross disciplinarity has gained strength due to the thoughts that also lead to the descriptions on user innovation and open innovation,

namely that efficient cross disciplinarity can increase the outcome of R&D and innovation. As such, indicators on cross disciplinarity have got a high policy impact and the policy requirement for them is still increasing even though they usually are difficult to define as well as understand.

Table 10. Quality profile for "Cross disciplinary cooperation"

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance (especially political)	Very seldom used indicator Used for specific policy purposes Easy understandable	Capacity to tell part of a story Increasing political attention
2 Accuracy	Relative clear definitions, but the indicator is based on the understanding of the concept behind "cross disciplinarity"	
3 Timeliness and punctuality	Not collected on permanent basis	High precision in the measurement but difficult to measure correctly
4 Accessibility and clarity	Sometimes available from national sources	Risky due to different collection methods and definitions
5 Comparability across countries over time	Comparable across regions, countries, time and types of firms and institutions if and only if it is measured correct	Given that the same definitions are used, comparability can be found
6 Coherence	When it is carefully collected it has a high and increasing impact factor.	With considerable focus on definitions coherence ok Warning score: 4-5

Note: The warning score lies between 1 and 5, where 1 means "go ahead no warning" and 5 means "never use alone as a single indicator".

3.2.5 Composition of firm staff, level of education?

Definition:
The HC indicator can be defined in many ways. Usually, labour force surveys can be used to create comparable indicators on educational averages based on comparable ISCED or HRST figures. The R&D statistics data can also be used regarding researchers. The indicator is usually referred as shares of all employees or of employees of interest. The indicator is an indicator on structural frame conditions.

The HC aspects of firms' employees have always been high on the policy agenda as a structural indicator that can be improved on through national policies, hereby improving the firms' competitiveness and transformation from labour intensive towards knowledge intensive production. With the increasing focus on R&D and innovation cooperation, the HC aspect has regained its importance, since firms needs a high absorption capacity when it cooperates on R&D and innovation or do it internally.

There exist several sources for indicators on the firm staff's education level. For comparability reasons, the main source is the Labour Force Surveys, LFS, from Eurostat.[10] Unfortunately, it is individual based and therefore does not systematically equal the firm based R&D or innovation surveys from Eurostat. Hence, another widely used indicator in relation to innovation studies is the R&D study itself. Herein, an aggregated measures on the firms' composition of R&D employees and can be used as an indicator for educational level.

Table 11. Quality profile for "firm level of education"

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance (especially political)	Often used indicator for structural frame conditions Used for specific policy purposes and as explanatory input Easy understandable	Capacity to explain parts of a story Medium political attention
2 Accuracy	Clear definitions in Eurostat surveys	Also the common ISCED and HRST definition can be used
3 Timeliness and punctuality	If from Eurostats LFS or R&D: Precise and biannual time schedule	High precision in the measurement
4 Accessibility and clarity	Usually available from national sources	
5 Comparability across countries over time	By definitions comparable across regions, countries, over time and sometimes also over types of firms and institutions if and only if it is measured in a comparable way	Given that the same definitions are used, comparability can be found
6 Coherence	When it is carefully collected it has a high explanatory power	Coherence ok Warning score: 2

Note: The warning score lies between 1 and 5, where 1 means "go ahead no warning" and 5 means "never use alone as a single indicator".

3.2.6 Flexicurity

Definition:
Flexicurity is a contraction of flexibility and security and it is not defined in a statistical sense. An operational definition in such a sense could be the sum of the national unemployment percentage, share of unemployment insured employees, and the number of days the employer has to pay when an employee is fired.
The flexicurity term is used to characterise the rigidity in the labour market and therefore an indicator or the labour markets ability to be respond on innovative behaviour and structural (national and global) changes.

[10] Other countries outside the Eurostat covered area has similar surveys collected in a comparable way.

Flexicurity is a contraction of flexibility and security. It characterise a system with high flexibility in the labour market, e.g. relative easy to fire employees, and a high degree of social security among unemployed, e.g. high long term unemployment insurance. Denmark is an example of a country that so fare scores high on a flexibility indicator, but all the Nordic countries scores high on this indicator due to the Nordic welfare model. Such an indicator becomes interesting due to Denmark's high economic success in the past decade and the wish to become similar form France among others. However, it is difficult to measure in a comparable way since it is poorly defined so fare. Most often it is a macro measure that is used to benchmark a country's development against some others.

Table 12. Quality profile for "flexicurity"

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance (especially political)	A relevant indicator for structural frame conditions Used for specific policy purposes and as explanatory input Easy to understand but difficult to implement	Partly capacity to tell a story Variating political attention
2 Accuracy	Poor definitions in statistics and in surveys	Variating according to sources
3 Timeliness and punctuality	Depends on sources behind this composite indicator	High precision in the measurement but difficult to measure correctly
4 Accessibility and clarity	Mostly available from national sources	Very risky due to clarity in statement greater than clarity in measurement
5 Comparability across countries over time	Small degree of comparability across countries, and over time, but this relies on how it is defined	Given that the same definitions are used, comparability can be found
6 Coherence	When it is carefully collected it has a medium explanatory power	Warning score: 5

Note: The warning score lies between 1 and 5, where 1 means "go ahead no warning" and 5 means "never use alone as a single indicator".

3.2.7 Preparedness for innovation

Definition:
The indicator is here defined as being product, process, organisational and/or marketing innovative in the previous period. Hence, this composite indicator can graduate the innovativeness ability in a firm and therefore be used to characterise the firm specific need in relation to policy initiatives.

A common fact in innovation studies is the historical dependence, e.g. the best prediction of firms innovativeness is the previous period value. Such Gaussian behaviour can be predicted in a more qualified way by measures on firms or institutions innovation history and port folio of cooperation partners, in order to give a more precise indicator on the potential for improved innovation behaviour.
An example is a firm without previous innovation that needs cooperation or help to innovate a product. Such a firm needs another type of help (in form of policy initiatives) than a firm that has a long innovation or R&D track.

Table 13. Quality profile for "preparedness for innovation"

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance (especially political)	A relevant indicator for structural frame conditions and the need for policy initiatives Used for specific policy purposes Easy to understand	Large capacity to tell a story Medium political attention High policy maker attention
2 Accuracy	Clear definitions, but the indicator is based on the availability of previous period data	Micro based data gives analytic possibilities
3 Timeliness and punctuality	If from CIS: Precise and biannual time schedule High punctuality in timeliness	High precision in the measurement
4 Accessibility and clarity	Available through Eurostat with some years delay. Usually, earlier available on a national basis	
5 Comparability across countries over time	By definitions comparable across regions as well as countries, over time and types of firms if and only if it is measured correct/comparable	Given that the same definitions are used, comparability can be found
6 Coherence	When it is carefully collected it has a high and important explanatory power.	With considerable focus on definitions coherence ok Warning score: 1-2

Note: The warning score lies between 1 and 5, where 1 means "go ahead no warning" and 5 means "never use alone as a single indicator".

3.2.8 Dominant innovation type in firms

Definition:
This composite indicator is a variant of the output based modes defined by Bloch et al (2007). Here, the indicator is characterising innovation modes that tell whether a firm is innovating by purpose or not. It is based on Arundel and Hollanders (2005) and modified in Bloch et al (2007). Here, we use the latter definition, namely
Strategic innovators: For these enterprises, innovation is a core component of their competitive strategy. They perform R&D on a continuous basis to develop novel

product or process innovations. They are the main source of innovations that diffuse to other enterprises. **Intermittent innovators**: These enterprises perform R&D and develop innovations in-house when necessary or favourable, but innovation is not a core strategic activity. For some, their R&D efforts focus on adapting new technology developed by other enterprises to their own needs. **Technology modifiers**: These enterprises modify their existing products or processes through non-R&D based activities. Many enterprises in this group are essentially process innovators that innovate through production engineering. **Technology adopters**: These enterprises primarily innovate by adopting innovations developed by other enterprises or organizations.

Another historically dependent indicator is the dominant innovation type in firms. It is an important indicator in analyses of the development in national innovation systems as well as in cross country analyses. Also as an early warning indicator, it has its relevance among policy makers that wants to change the national agenda or wants to target policy initiatives. The indicator could be defined in other ways.

Table 14. Quality profile for "dominant innovation type in firms"

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance (especially political)	A relevant indicator for structural frame conditions and status quo pictures Used for specific policy purposes Easy to understand	Capacity to tell a story Medium political attention High policy maker attention
2 Accuracy	Clear definition due to the CIS (Oslo Manual) High validity due to methodology requirements from Eurostat If from CIS then very reliable source (especially CIS4 and onward)	Micro based data gives multiple possibilities for split of the indicator (e.g. sector, firm size, firm type, etc. etc.)
3 Timeliness and punctuality	Precise and biannual time schedule for CIS High punctuality in timeliness and the quality is documented although not the best	
4 Accessibility and clarity	Available through Eurostat with some years delay. Usually, earlier available on a national basis	The indicator is available from existing source, CIS , but CIS is in itself very resource intensive to collect with the required quality level
5 Comparability across countries over time	Comparable across regions as well as countries, over time and types of firms Relevant measure in rankings, benchmarking and other	Is available for other countries that collect data according to the Oslo manual definitions, i.e. CIS-like data collection. This includes at the moment many

	comparisons if and only if it is corrected for differences in industry structure.	countries like Canada, EEA, Eastern European and Asian countries
6 Coherence	The CIS is developing and improving its quality. Although new innovation types have been introduced, the indicator usually measures the most used and consistent measure, namely PP-innovation, i.e. product and/or process innovation. Be aware of how type of "innovation" is defined when comparing the indicator with others.	Gives an immediate policy insight among policy makers and the information value is high when it is used as an activity measure. The indicator can be used for rankings and benchmarking but has to be corrected for industry structure when direct comparisons between countries or regions are made, i.e. compare on comparable units. Has to be used with care in policy recommendations since it depends on how type of "innovation" is understood in the firms. Warning score: 2

Note: The warning score lies between 1 and 5, where 1 means "go ahead no warning" and 5 means "never use alone as a single indicator".

3.2.9 Plurality

Definition:
The plurality indicator is a composite indicator based on four firm specific characteristics; share of women and foreigners, educational and age distribution among employees. Based on this a Shannon or entropi index can be constructed like in DamVad (2007) can be constructed.

Plurality in firms is a relatively new and upcoming indicator that has proven its relevance in a few recent studies, e.g. DamVad (2007) for the Danish Council for Technology and Innovation. The higher the plurality index in firms, the higher is their innovation probability as well as productivity. Firms with a more equal gender ratio, lower[11] age dispersion among employees, higher ethnicity share or higher dispersion in educational levels all have a higher plurality measure in the index.

Table 15. Quality profile for "plurality"

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance (especially political)	A relevant indicator for policy Seldom used for policy Relatively easy to understand	Capacity to tell a story Low political attention Increasing policy maker

[11] This contradicting result on age dispersion, that LOWER dispersion increases innovation probability is probably caused by the fact that younger forms are more often innovative, have on average younger employees, i.e. lower age dispersion.

		attention
2 Accuracy	Poor ad hoc definitions in statistics and in surveys	Variating according to sources
3 Timeliness and punctuality	Depends on sources behind this supposedly composite indicator	Difficult to measure consistent
4 Accessibility and clarity	Mostly available from national sources, however based on international defined data	Risky due to low clarity in measurement
5 Comparability across countries over time	So far small degree of comparability across countries, over time, firms, institutions.	Given that the same definitions are used, comparability can be found
6 Coherence	When it is carefully collected it has a high policy impact	Warning score: 3-4

Note: The warning score lies between 1 and 5, where 1 means “go ahead no warning” and 5 means “never use alone as a single indicator”.

3.3 Concluding remarks

The present section has set up and illustrated how direct or indirect statistical indicators for R&D and innovation performance can be valuated through the use of a quality profile. The quality profile is highly usable for this purpose, but never the less, it never substitutes normal sound sense. Therefore, the quality profile includes points of importance, but it does not rank the indicators by an ordinal scale. Doing this would remove the sound sense aspect.

Section 2 describes the quality profile and its components. The first item is item in the quality profile is “relevance”, both in statistical and policy maker sense. This is basically the most important item in the profile. Often an indicator as the word says indicates, meaning that it is a second best measure for the actual problem at hand. Sometimes an indicator measures something else than intended and thereby loosing its relevance. This can happen with composite indicators where the construction of the indicator may bias its profile.

The second item in the quality profile is “accuracy” which is more important among producers such as statistical bureaus than among users such as policy makers. However, a stand point in between is often the most beneficial for the use of the indicators. An example is “innovation expenditures” which is a relevant and needed indicator but the accuracy is low so this indicator should only be recommended to policy makers with a warning.

The third item is the “timeliness and punctuality” item which is mostly and producer related item. However, the item becomes important among policy makers if the indicator is needed for reoccurring policy evaluation etc.
The fourth item in the quality profile is “accessibility” which again is an important item for policy makers, researchers as well as producers. The most valuable case is when

the best or correct indicator is fully available to everybody on a free and regular basis, collected without an increased response burden. This could be the composite indicators based on CIS or similar indicators. However, they are usually only second best indicators and therefore only second to perfect.

The fifth item in the quality profile is “comparability” which is an increasingly important item among policy makers and researchers trying to benchmark nations, regions or sectors or making analyses over time and/r across borders. Such rankings and effect evaluations are rocketing in importance all over the world.
The sixth and last item in the quality profile is “coherence” which we believe is the most important of all the six items in the quality profile. From our user perspective, this item boils down the other items into a single question about whether the indicator is usable for the actual purpose, what the warnings as well as potentials are for the indicator at hand.

So the general purpose of the quality profile is that it can be an evaluation list to be fulfilled by users before they use a potential indicator. The quality profile justifies such the use of an indicators but it also justifies that an indicator may be skipped for the actual problem at hand.

Having access to an indicator is not the same as saying that the indicator is good and shall be used. Sometimes it is better not to use it!

4. Conclusion

The present paper has defined and shown how statistical indicators for R&D and innovation can be valuated through the use of quality profiles. The quality profile concept developed by Eurostat among others is found to have a high and important value in the selection process of choosing usable indicators by policy makers. The schedule with six items is a minimum list of items that policy makers and others have to consider when they use indicators.

The overall impression of the analyses results in the following recommendations, of which some are already implemented in some NSI, but usually not at all among policy makers, i.e. users:

1. Statistical indicators for R&D and innovation
    a. Have a high information value among policy makers and shall be used systematically
    b. shall always be accompanied by a quality profile following the proposed schedule in table A.1 in the appendix
2. New indicators for R&D and innovation require

    a. a fuller and more detailed quality profile to justify their use
    b. careful and theoretically based use of the involved single measures, when the new indicator is a composite indicator.
3. Development of composite indicators is becoming increasingly important for policy purposes, but
    a. it also requires a “proper” and “fair” use by policy makers since an arbitrary choice of indicators will end supporting arbitrary policy initiatives
    b. it is important to show how the composite indictors are constructed and why they are used (and why some others are not used).
4. NSIs shall go forward spreading the use of quality profiles by supplying them – and demanding others to do the same.
5. Policy makers shall justify their use of specific indicators
    a. and give alternatives and explain why these alternatives are not used.
    b. and explain what the purpose is by the use of the chosen indicators.

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6. Appendix

Table A.1. Evaluation list for policy related innovation indicators

Evaluation item	Evaluation measure	Sub evaluation measure
1 Relevance (especially political)	• Relevant to key issues, policies, or goals • Easy to understand and meaningful to a variety of audiences	• Capacity to tell the story • Relevance for political actions • Impact measure rather than activity measure
2 Accuracy	• Definitions • Validity • Drawn from reliable sources	• Micro based rather than macro based (more nuanced data)
3 Timeliness and punctuality	• Recurrence frequency • Punctuality frequency	
4 Accessibility and clarity	• Availability	• From existing sources or • From resource intensive data collections
5 Comparability across countries over time	• Across countries and regions • Over time, i.e. updated regularly • Across types of companies • Relevance for rankings and benchmarking	Inclusive major economies such as US, Japan, China
6 Coherence	• Development perspective • Interaction or fit with other indicators • Applicable for building indexes and rankings • Warnings	• Developing insight for policy making • Recommendations and potential pitfalls in rankings • When used for policy recommendations • A warning score that ease the understanding