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Policy Relevant Nordic Innovation Indicators

Development and Analysis of Innovation Indicators in the Nordic Countries based on CIS-surveys

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Recommendations and summary:

Knowledge, research and innovation are of crucial importance for the competitiveness of the modern economy, as well as for the high standard of living and welfare. In order to describe and better understand the role of knowledge and its effects it is vital to have sound statistical information on which to base policy design and evaluation.

The objective of this report is to identify the most relevant indicators of innovation for Nordic countries and to describe how these indicators can be interpreted and used as input for policy design. The report utilizes data from the 4th Community Innovation Survey (CIS4) covering the period 2002-04 to conduct a comparative statistical analysis of the Nordic countries.

The community innovation surveys (CIS) are conducted with the primary purpose of producing comparable indicators on more aspect of innovation. In CIS a core questionnaire is used as basis in all national surveys and the survey methodology is also harmonised with regard to coverage (NACE- and size-class), sampling, imputation and estimation, grossing up to national totals. The harmonised questionnaire and methodology should in principle ensure comparable results across countries. On the other hand, innovation activities are difficult to measure by statistical tools and may create difficulties with regard to comparability across countries and over time.

A large number of indicators have been published based on CIS, though up until now it is generally agreed that the CIS-surveys have been underused in that respect. In this report a number of indicators of innovation are developed and explored. The indicators are meant for different levels, from compound indicators for politicians, to sets of indicators for general policy makers, to detailed indicators for specialists designing specific policy recommendations.

The first part of the report examines innovation activities across the Nordic countries using basic innovation indicators. The most striking similarities and differences between the Nordic countries are illustrated and commented. The most common indicators based on the CIS4 questionnaire are shares of innovation active enterprises, co-operation in innovation projects, turnover of new or improved products, innovation expenditure, funding of innovation, effects of innovation and hampering factors for innovation.

The second part of the report discusses the development of composite indicators of innovation activity, linkages, conditions and effects, and new classifications for regionalization and globalization. The aim of this work is, by investigating new methods of constructing indicators, to promote the use of innovation data in analysis and policy making.

First, the findings of the report are presented as recommendations. Next the innovation performance of the Nordic countries is compared, using the recommended indicators.

A. Recommendations

A.1. Indicators of innovativeness

(Section 2.1 + Chapter 4 + Section 3.2)

The main international indicator of innovativeness is the *proportion of innovation active enterprises*, defined in CIS4 by EUROSTAT as the share of enterprises having introduced product or process innovations or having abandoned innovation activities during 2002-04 or still having ongoing activities by the end of 2006, see Figure 2.1. It is **only recommended** to use this indicator as an over-all indicator of innovativeness. The reason is that there are several problems using this kind of simple indicator.

Firstly, the classification of enterprises as innovation active is not completely clear and there may be small margins if an enterprise is classified as innovation active or not.

The next problem with this indicator is that it mixes input and output of innovation and does normally not include organizational or marketing innovation. A split by product and process innovation is shown in figure 2.4 and is **recommended** as a minimum. Also, all four types of innovations introduced can be illustrated in an indicator of *subtypes of innovations.* A **recommended** combination of product, process, organisational and marketing innovation to five classes is shown in Figure 4.7.

Another drawback when using proportions such as the ones described above is that each enterprise counts as 1, regardless of the size of the enterprise. The indicator does not tell what amount of employees (or of turnover) in the business sector that relates to innovation active enterprises. A breakdown by size class is thus **recommended** in presenting this simple indicator. Another option is weighting each enterprise with the number of employees. The indicator on the *proportion of employees in innovation active enterprises* uses this method, see Figure 3.8. It is thus **recommended** to also calculate the proportions on basis of the employees.

Finally, this indicator does not tell anything about the way the innovations are performed or introduced. By using more of the questions in the CIS-survey it is possible to define indicators of innovativeness with more outcomes than two and that illustrate various aspects of innovation. *Output based modes of innovation,* which classify enterprises according to the novelty of their innovations with respect to national and international markets, is defined with 4 categories, separating modifiers and adopters from two levels of novel innovators, see Figure 4.2. Aspects on the inventiveness and diffusion are included in an indicator of *Invention and diffusion*, see Figure 4.5. Here, invention refers to R&D or patent applications and diffusion to collaboration. In general, it is **recommended** to use one or more of these composite indicators described in Chapter 4, to provide a more complete view of the aspects of innovativeness in the business sector.

A.2. Expenditure and funding

(Section 2.4+3.1.1c; Funding: Section 2.5+Chapter 6)

Innovation expenditures could be a good measure of the degree of innovativeness of an enterprise, especially when measured as intensity in terms of turnover. However, many enterprises have large difficulties in accounting some of the expenditure types included, and a number of countries – including two Nordic – did not publish figures on innovation expenditures in CIS4 due to quality concerns. It is thus **recommended** that indicators such as total innovation expenditure, see Figure 2.13, and innovation intensity, see Figure 9.2, should be used very cautiously.

Also, the indicator on public funding is not included in the CIS4-questionnaires of all countries – including two Nordic countries. It is, however an important indicator, describing the extension of National funding and the ability of enterprises to be granted EU-funding. It is **recommended** that all Nordic countries include the question on funding in coming CIS-surveys and also consider the possible inclusion of questions on the amount and type of funding.

A.3. Linkages and barriers

(Linkages: Section 2.2 + Chapter 5; Barriers: Section 2.7+7.2)

The linkages regarding innovation for an enterprise are covered by questions on co-operation, information sources and acquisition of external knowledge. As these questions have many outcomes, they need to be compressed. One such composite indicator for external linkages is the *degree of interaction*, measured as arm's length or active co-operation, and the linkages being suppliers, market operators or public institutions, see Figure 5.1. Another indicator is the *drivers of innovation*, being market-, technology-, supplier- and/or internally drivers, see Figure 5.4. Both indicators are **recommended** as composite indicators, but the indicator on drivers of innovation needs some refinement and needs to include users as drivers.

The barriers for innovation are described by a number of hampering factors, see Figure 2.19. It is **recommended** to group these factors in four classes (see Figure 7.2) to make a better overview and reduce the number of indicators in further analyses. Measurement of barriers for non-innovative enterprises should be improved.

A.4. Effects of innovation

(Turnover: Section 2.3; Effects: Section 2.6+7.1)

The output of innovation activities are the introductions of new or significantly improved products, processes, management methods or marketing/sales methods. Indicators for this direct output are presented in A.1. A quantitative measure of the effect on product innovations is measured as share of turnover from innovated products, either new to the market or only new to the enterprise. This indicator, see Figure 2.9, is **recommended** as a basic innovation indicator.

The other effects included in the CIS4-questionnaire are more qualitative. There is a group of nine effects for product/process-innovations, see Figure 2.17 and a group of four

for organizational innovation, the latter only included in two Nordic countries. It is **recommended** to group the product/process-effects in three classes (see Figure 7.1) to make a better overview and reduce the number of indicators in further analyses.

A.5. Comparisons: countries, regions and other classifications

(Section 3.1 + Chapter 8 + Section 9.2)

When comparing performance of innovation between geographical units in specific countries, one should be aware that different performances on indicators might be caused either by structural differences between the geographical units or by differences in innovation performance on an industry basis or for given size-groups – or both. It is **recommended** that the effects of the structural differences are included at the country level, see Figure 3.2. It is also **recommended** to decompose country and industry/size level differences into those due to structural differences and those due to innovation performance (see Figure 3.6 and 3.7).

There are large differences in the innovation activities between regions, even among regions in the relatively small Nordic countries. Some of the reason for this is structural differences across regions as mentioned above. So it is **recommended** to use the same correction and decomposition of innovation indicators at the regional level as for country comparisons (see Figure 8.3-8.4). An additional problem is that a number of larger enterprises perform innovation activities in more units (establishments) within the enterprise, of which some are situated in other regions than the headquarters. However, the statistical unit in CIS is the enterprise and most headquarters of larger enterprises are situated in the capitals. If this is not taken into account, the capitals are “favoured” compared to other regions, see Figure 8.2. For regional data on innovation it is therefore **recommended** that some information on the innovation activities in other units outside the headquarters is collected in the CIS-surveys.

Enterprises are classified according to type of industry. These detailed classes have been added to fewer classes in this report. Also, the enterprises have been classified according to their degree of globalization, so the innovation indicators can be calculated for multi-nationals by controller, see Figure 9.2. It is **recommended** to include this classification.

A.6. “More and better data needed”

The quality of CIS4 may be improved by making some of the questions better, by restructuring the questionnaire, by introducing new questions and even by excluding some of the questions,.

Still, CIS4 is a rich source of information on innovation in the business sector. More details and information on specific issues may be needed, but there is a limit to the amount of information that can be gathered in one survey. Other – often ad-hoc surveys or supplementary modules – may have to be conducted in parallel, either on National, Nordic or European level. Linking the CIS-surveys at enterprise level with other surveys like structural business statistics and financial account statistics and linking with the international patent database will also enrich the information and open up for more types of indicators.

B. Summary – comparing the Nordic countries

The report illustrates the indicators with Nordic data from CIS4. Here, a summary of the findings are given.

B.1. Indicators of innovativeness

Share of innovation active enterprises

The share of innovation active enterprises is one of the most widely used indicators of innovativeness. A Nordic comparison shows that there are important similarities as well as dissimilarities in the innovation activity of the Nordic countries. Enterprises in Denmark, Iceland and Sweden are the most innovation active; 52 percent (Sweden: 50 percent) of all enterprises reported having innovation activity in these countries. In Finland, 43 percent of the enterprises had such activity, and in Norway 37 percent.

However, there are significant changes in the position of the Nordic countries, when instead looking at the proportion of employees working in innovation active enterprises. In Finland and Denmark 74-75 percent of the employees are working in innovation active enterprises, while for Sweden and Norway the proportions are 68 and 51 percent.

In general the innovation activity in manufacturing is higher than in services, and the innovation activity increases with the enterprises' size. This pattern holds true for all Nordic countries at the core industry level. The differences across the Nordic countries are lesser among large enterprises than among small enterprises. For this reason there is a pattern that the countries with the highest total shares of innovation active enterprises all have high shares of innovation active enterprises in the smaller size-classes.

The effect of the different industry structure in the Nordic countries is rather small. If Norway had an industry structure as the common Nordic the share of innovation active enterprises would increase 2 percentage points, while the Icelandic would decrease 1½. The changes for the other countries are less than 1 percentage point.

Types of innovators

The largest group of innovation active enterprises is the one consisting of enterprises that had introduced both product and process innovations, although this pattern is not strong in all countries. Enterprises involved only in product innovation are for most countries more common than enterprises involved only in process innovation, but in Denmark the shares are equal.

When including organisational and marketing innovations, Denmark has the highest increase in the proportion of enterprises – from having product or process innovation to having any of the 4 types of innovation – while Iceland has the least. However, Iceland has the largest proportion that has introduced all 4 types of innovation, while Norway has the least.

The indicator on the degree of novelty and spreading of the product and process innovations of the enterprises shows that among the innovation active enterprises 34-37 percent of the Danish, Finnish and Swedish enterprises are in-house developing products/processes to international markets, while this share is only 17-21 percent in

Iceland and Norway. The other composite indicator on inventiveness and collaboration also shows large differences among the Nordic countries, Finland having the largest proportion (49 percent) of inventive, collaborative enterprises and Denmark the smallest (28 percent) and Denmark dominating the non-inventive, collaborative group (35 percent) – with Norway having a much smaller share in this category, 13 percent.

B.2. Expenditure and funding

Innovation expenditure

At the core industry level certain similarities are evident between the three countries reporting innovation expenditure (DK, NO, SE). Intramural R&D is the single most important innovation cost component. Acquisition of machinery and equipment and extramural R&D come in second and third place, depending on the country, whereas the acquisition of external knowledge generally is the smallest innovation cost component.

A breakdown into size classes, however, shows vast dissimilarities. In manufacturing, the same holds true; the countries are much alike when one looks at total figures, but the dissimilarities are evident when figures are broken down by enterprise size. In services, it is hard to find a Nordic pattern for innovation expenditures at all.

Public funding of innovation

The data shows that public funding is much more common in Norway and Finland than in Denmark (no reporting from IS and SE). The single most important source is funding from the central government, including government agencies and ministries, but in Denmark the EU-funding is nearly at the same level.

In Denmark and Finland, the percentage of enterprises receiving public funding increases with enterprise size, whereas this is not the case in Norway.

B.3. Linkages

Co-operation on innovation

For the most part, Nordic countries are very similar when one looks at *who developed* the products and processes. Both among product and process innovators there are high shares of independent innovators – enterprises that develop their innovations alone – and very low shares of innovators who for the most part subcontract their innovation activity. Product innovators are even more inclined to develop their innovations alone (around 70 percent), and less inclined to co-operate or let others handle the development, than process innovators (50-55 percent develop mainly alone). Finnish enterprises show a higher propensity towards co-operation on innovation development than the other countries (for product innovations: 29 percent vs. 21-22 percent).

More enterprises responded positively to the question on *Co-operation on any of your innovation activities*. In Finland, Sweden and Denmark the shares for any co-operation are 43-44 percent, but just 29 and 33 percent for Iceland and Norway.

The most common co-operation partners in all Nordic countries are suppliers, and clients and customers. Finnish enterprises have the highest share of co-operation with any of the type of partner and geographically, while Icelandic and Norwegian enterprises tend to lag behind in the co-operation figures, except for public research institutes. Nordic enterprises tend to find their partners first and foremost within their own country, secondly within other European countries.

Information sources and co-operation

The composite linkage indicator – *the degree of interaction with external sources* – is measured for suppliers, the market and public partners. Most interaction with suppliers is at *arm's length* and with little variation between the three reporting countries (DK, FI, NO). With market partners a higher share of Finnish enterprises is co-operating than having arm's length compared to Denmark. Norway takes a middle position except in KIS-services. With the public partners Danish enterprises in high-tech manufacturing and KIS-services are using arms' length less and co-operation more.

B.4. Effects of innovation

Turnover from innovated products

The countries that have the highest shares of innovation active enterprises are not necessarily the countries that generate the highest turnover shares from innovated products.

Finland has the highest share of turnover from new and significantly improved products. A 15 percent share of the turnover in Finnish core industries comes from products that are new to the enterprise or new to the market. Sweden and Iceland are almost at the same level, followed by Denmark. Norway is, as in the case with innovation activity and employees in innovation active enterprises, at the bottom of the list.

In Denmark, Finland and Sweden the turnover from innovated products is higher in larger enterprises. Iceland is the only Nordic country in which turnover shares related to innovated products are higher in services than in manufacturing.

The effect of correcting for industry structure in the Nordic countries is quite dramatic for Finland and Norway. For Finland a large decrease from 15 to 10 percent seems to be caused by a downwards correction of dominant industries with high shares of turnover of innovated products. In Norway, it is the other way around (an upward correction of less dominant industries with high share of turnover of innovated products), but also the effect of a low share of turnover of innovated products in a dominant industry is decreased by using the common Nordic industry structure. This result shows that Nordic differences in part are due to differences in industry structure. When these differences in industry structure are taken into account, better comparisons can be made, even at industry level, and the basis for innovation policy design is thus improved.

Qualitative effects of innovation

The qualitative effects of innovation that are most frequently experienced to a high extent were *increased range of goods and services* and *improved quality in goods and services* – and this goes for all Nordic countries. At the aggregate level the product oriented effects (= market effects) from the innovations are relatively more important than the process oriented effects. The material and energy cost reductions and the regulation effects are experienced to a high extent by only a small share of the enterprises.

Cost effects and market effects are experienced to a high extent by relatively more enterprises in Sweden, while process effects are experienced to a high extent by relatively more enterprises in Denmark. In Iceland effects are generally experienced to a high extent by relatively fewer enterprises.

B.5. Hampering factors

Innovation active enterprises

The cost and funding of innovation are the most important hindrances for more innovation activities in innovation active enterprises in all Nordic countries, when measured as the share indicating high importance. Also, for Denmark, Iceland and Sweden the market factors are important hindrances, while the knowledge factors are important hindrances for fewer enterprises in all countries.

Non-innovation active enterprises

In all countries except Sweden one of the cost and funding factors is the hindrance that is most frequently reported of being of high importance for non-innovation active enterprises. In Sweden, market domination is the most important hampering factor.

Most factors are reported to be of high importance less frequently by non-innovation active than by innovation active enterprises. Hence, this part of the survey does not seem to fully capture what obstructs non-innovation active enterprises from innovating.

Reasons not to innovate

There is no universal pattern in the Nordic countries when it comes to reasons not to innovate. In all countries except Finland, the lack of demand for innovations is more important than prior innovations. Also, in all countries except Iceland more non-innovation active enterprises report that the reasons not to innovate are of high importance compared to the innovation active enterprises.

CONTENTS

ANNEXES

1. Introduction

Knowledge, research and innovation are of crucial importance for the competitiveness of the modern economy, as well as for the high standard of living and welfare. In order to describe and better understand the role of knowledge and its effects it is vital to have sound statistical information on which to base policy design and evaluation.

The objective of this report is to identify the relevant indicators of innovation for Nordic countries and how these indicators can be interpreted and used as input for policy design. To this aim, the report uses the indicators to conduct a comparative statistical analysis of the Nordic countries.

This report on innovation indicators will utilize the most recent CIS4 data (covering the period 2002-04) for developing and presenting indicators that can be used for benchmarking the Nordic countries regarding many aspects of innovation.

The Community Innovation Survey (CIS) provides data on innovation for all EU countries including Norway and Iceland. In CIS a core questionnaire, worked out by Eurostat, is used as basis in all national surveys[1]. The survey methodology is also harmonised with regard to coverage (NACE- and size-class), sampling, imputation and estimation, grossing up to national totals. Harmonised questionnaire and methodology should in principle ensure comparable results across countries. On the other hand, innovation activities are difficult to measure by statistical tools and may create difficulties with regard to comparability across countries and over time.

The first part of the report on innovation indicators examines the innovative activity across the Nordic countries using basic innovation indicators. The data used are mainly from the set of standard tables that all countries had to report to Eurostat for publication in the Eurostat database. The most common indicators based on the CIS4 questionnaire are:

- share of innovating enterprises
- cooperation in innovation projects
- turnover of new or improved products
- innovation expenditure
- funding of innovation
- effects of innovation
- hampering factors for innovation

The most striking similarities and differences between the Nordic countries will be illustrated and commented.

Comparisons of innovation indicators across countries are affected by the National industry and size structures. In this part indicators corrected for industry structure will be presented and commented including analyses of the contribution of the individual industries to the deviations. Also, the effects of using alternative weighting of the respondents will be analyzed.

[1] The core questionnaire is in Annex 1.

The second part of the report on innovation indicators discusses the development of composite indicators of innovative activity, linkages, conditions and effects. The aim of this work is, by investigating new methods of constructing indicators, to promote the use of innovation data in analysis and policy making.

Examinations of the usefulness or impact of innovation indicators for policy give the clear impression that this impact has so far been fairly minor (see eg. Arundel, 2006). R&D indicators are still the most widely used indicators of innovative activity. This may be due to a number of reasons. First, R&D data is considered to be of better quality. Second, policy makers lack innovation indicators that are as widely accepted and utilized as R&D. Due to this lack of 'communicability', policy makers find innovation measures less useful. Finally, policy makers may not be fully aware of the innovation data available or its potential uses.

This part will attempt to address these issues by developing a variety of innovation indicators that deepen the picture of innovation compared to what basic simple CIS4 indicators can provide. The potential uses of innovation indicators are many, among them:

- Single indicators of innovation which are easy to communicate

  These types of indicators are designed to supplement or in some cases take the place of R&D-based indicators as a policy and measurement tool.

  In order for these to be useful, they must be widely known and accepted as measures of innovation activity. This requires extensive analyses, both econometric and otherwise to examine the properties of the indicators.

- More detailed indicators that provide a more complete picture of how enterprises innovate

  These can be used in general analysis, to gain a better understanding of enterprise innovation and a more detailed measurement of innovation performance. Detailed indicators can also be used to provide information on specific policy issues of policy programs.

- Indicators for econometric analysis

  Indicators can provide a great deal of information on their own, by many issues, most notably the impact of innovation on productivity and growth, require econometric analysis using enterprise level data. Many analyses may require or benefit from the construction of indicators based on more than one innovation variable.

The focus is on the development of composite innovation indicators for use in policy. Composite indicators refer to indicators that are constructed using more than one variable. The indicators developed here are generally intended for detailed analysis. Our focus is not explicitly placed on developing a single communicable indicator, though we consider the indicators developed here to be useful intermediate steps towards developing single robust indicators of innovative performance.

The following types of indicators will be developed:

Indicators of innovativeness that go beyond simple indicators of product or process innovation to examine how different enterprises innovate, in terms of novelty, creative activity, breadth of innovative activity and reliance on diffused knowledge and technology.

Linkage indicators that focus directly on diffusion and interaction with different types of external sources. Also included here are main drivers of innovation activity. Linkage indicators are also closely related to the notion of open innovation developed by Chesbrough (2003) and can be useful in examining the impact of open innovation strategies.

Regional innovation indicators are in great demand, but they pose some challenges for survey design and collection. We propose indicators for comparing regions that take account of innovation activities in local establishments and differences in industry and size structure.

In addition, we also discuss a number of other relevant areas, among them:

- Indicators for globalization and for the role of multinational enterprises (MNE)
- Indicators for public involvement (receipt of public funding, participation in policy programs, cooperation with public research)
- Composite indicators of effects of innovation and barriers to innovation activity
- Indicators of the role of the market and demand

Part 1: Basic Innovation Indicators

2. Results based on simple indicators

2.1. Innovative enterprises

All core industries

In order to ensure comparability across Nordic countries, the group of covered sectors is restricted to those in Eurostat's Core NACE industries for innovation statistics[2]. In general terms, the core industries include mining and quarrying (including extraction of crude petroleum and natural gas), almost all manufacturing industries[3], and the large majority of service industries. While this provides a broad coverage of the service sector, there are a number of service industries that are not covered in this classification. Service industries not included here are: Motor sales, Retail trade, Hotels and Restaurants, Tourism, Real estate, Renting, other business services such as labor recruitment and industrial cleaning, Public administration and a number of public, community or social services. In terms of enterprise size, the analysis here covers enterprises with 10 employees or more.

There are important similarities as well as dissimilarities in the innovation activity of the Nordic countries. When one looks at all core industries, enterprises in Denmark and Iceland are the most innovative; 52 per cent of all enterprises reported having innovation activity in these countries.[4] Swedish enterprises follow at 50 per cent. In Finland, 43 per cent of the enterprises had such activity, whereas 37 per cent of the Norwegian enterprises reported the same.

When enterprises are divided into size-groups, it is apparent that the percentage of enterprises with innovation activity increases with enterprises' size. This pattern holds true for all the Nordic countries at the core industry level, as shown in figure 2.1.

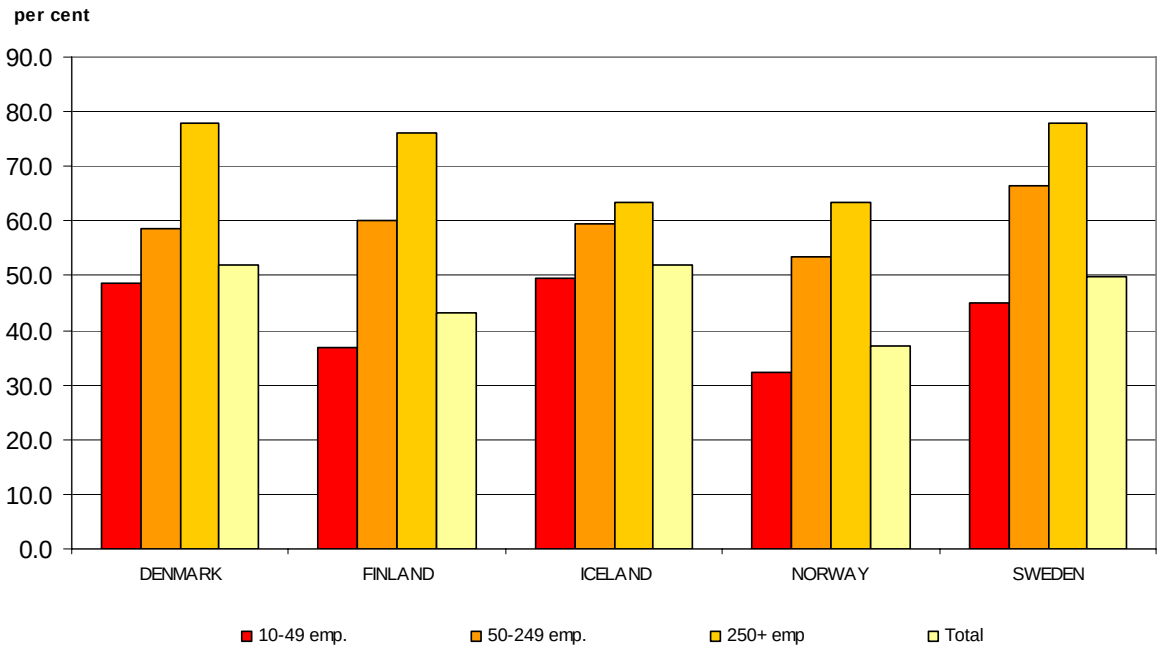
When looking at the distribution of the innovation active enterprises between size-classes, it is evident that percentage-wise, Denmark, Finland and Sweden are much alike; the percentage of innovation active enterprises in the larger size class is in the high seventies for all three countries. It seems that the reason for Finland's lower *total* percentage is the relatively low share among small enterprises having innovation activities, compared to Denmark and Sweden.

[2] For a definition of core industries (core NACE), core manufacturing industries and core services industries, see Annex 2.

[3] The one exception being NACE 23, *Manufacture of coke, refined petroleum products and nuclear fuel*.

[4] We examine the indicator *enterprises with innovation activity* which is the variable reported to Eurostat. *Enterprises with innovation activity* are defined as enterprises which introduced new or significantly improved products or processes, OR had ongoing or abandoned innovation activity during the observation period.

Figure 2.1 Enterprises with innovation activity, all core industries



Source: National CIS4 data for the Nordic countries. Share total enterprises.

Iceland stands out among the Nordic countries, in the sense that the difference in innovation activity between the size-groups is less pronounced. Iceland's high share with innovation activity among small enterprises makes up for the relatively small share with innovation activity among the larger Icelandic enterprises

Norway is similar in distribution to Denmark, Finland and Sweden, but shows lower *levels* of innovation activity for all size-groups. Large Norwegian enterprises have innovation activities as often as their Icelandic counterparts. However, the percentage among small and medium sized Norwegian enterprises with innovation activity is the lowest of all the Nordic countries. This, in turn, makes Norway the Nordic country with the lowest total share of innovation active enterprises.

In fact, there seems to be a pattern, that the countries with the highest total shares of innovation active enterprises all have high shares of innovation active enterprises in the smaller size-class.

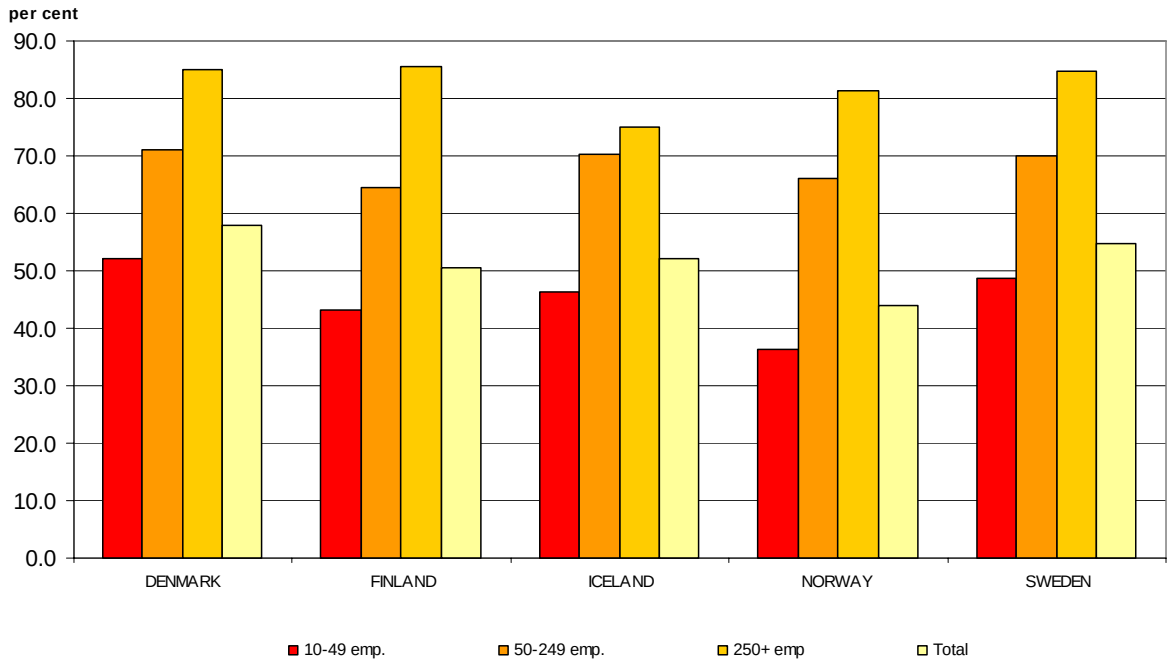
The five countries have quite different response rates. Norway, where the innovation survey is mandatory and non-responding enterprises are sanctioned, had a response rate of 96 per cent. In Finland the response rate was about 75 per cent, whereas around 65 per cent of the Swedish and Danish enterprises responded to the survey. In Iceland just over half of all enterprises responded to the survey. An argument could be made, that the response rate influences the results of the survey; if enterprises that actually have innovation activity are more inclined to take part in the survey than those without, the share of innovation active enterprises would be higher in countries with low response rates. However, the Danish non-

response survey (for CIS3) did not show any significant difference in the share of innovation active enterprises between the non-respondents and respondents. More empirical investigations are needed.

Manufacturing

As seen in figure 2.2, shares of innovation active enterprises are, with the exception of Iceland, higher in manufacturing than in all core industries. This holds for all size classes, with particularly large differences for large enterprises in Norway. Manufacturing enterprises with innovation activity are more evenly distributed across countries, at least for large and medium sized enterprises. As was the case for all core industries, a country's total share of enterprises with innovation activities in manufacturing is closely related to the share among the smaller enterprises.

Figure 2.2 Enterprises with innovation activity, manufacturing



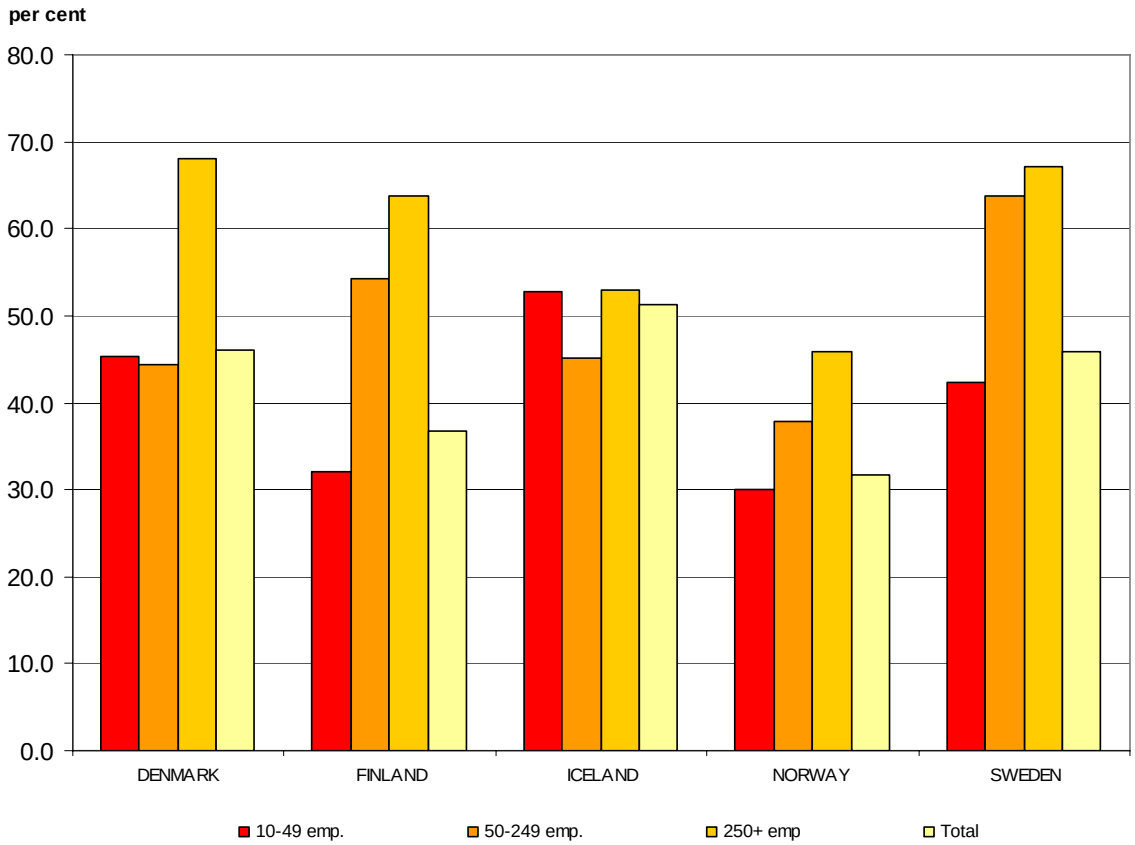
Source: National CIS4 data for the Nordic countries. Share total enterprises.

In Norway and Finland, the share of innovation active enterprises is relatively small in this group, compared to the other Nordic countries. So is the total share of innovation active enterprises in manufacturing industries in these countries. Iceland has the lowest share of enterprises with innovation activities among the largest manufacturing enterprises, but has a higher share than both Finland and Norway when all enterprises are considered.

Core services

The patterns seen in manufacturing are not evident in Nordic services industries, seen as a whole. Both in Denmark and Iceland there are larger shares of enterprises with innovation activity among small than among medium sized enterprises, as seen in figure 2.3.

Figure 2.3 Enterprises with innovation activity, core services



Source: National CIS4 data for the Nordic countries. Share total enterprises.

Fairly similar across countries, however, is the fact that the total share of innovation active enterprises in services, to a large extent mirrors the share in the smallest size-class. This is due to the large number of small enterprises in services, compared to manufacturing.

Types of innovation activities

Figure 2.4 shows innovation active enterprises split up into three types in Denmark, Finland, Norway and Sweden.[5] A prominent pattern is that the largest group in all four countries is the group consisting of enterprises involved both in product and process innovation. In Denmark,

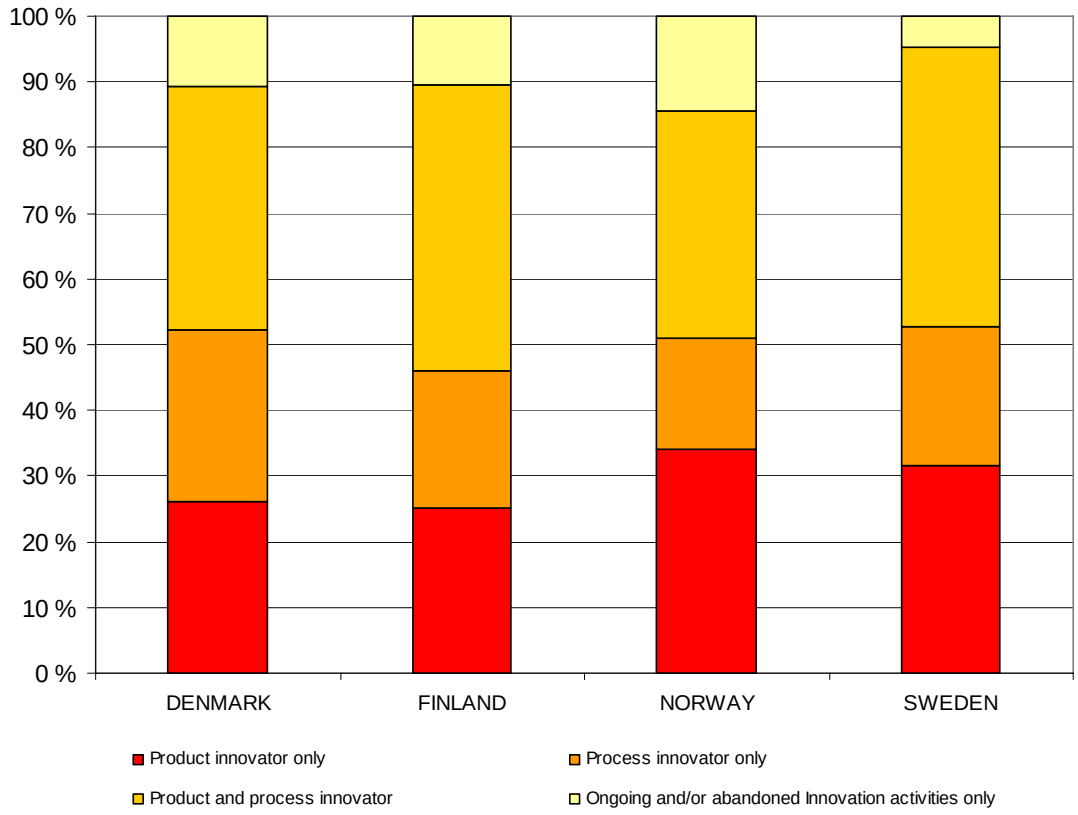
[5] Iceland is omitted from this figure as no Icelandic data on types of innovators was available.

Finland and Sweden, the share of enterprises involved in both product and process innovation is significantly higher than the shares of enterprises that only have one of the two. For Norway, however, the difference is only slight.

Another feature is that enterprises involved only in product innovation for the most part are more common than enterprises involved only in process innovation. This is with the exception of Denmark, where the shares of enterprises involved only in process or product innovation, respectively, are equal.

Sweden stands out, with high shares of enterprises with both product and process innovation, and enterprises with product innovation only. Norway also distinguishes itself; especially the relatively low share of enterprises with both kinds of innovation deviates from the Nordic pattern.

Figure 2.4 Innovation active enterprises by type of activity, all core industries



Source: National CIS4 data for the Nordic countries. Share innovation active enterprises.

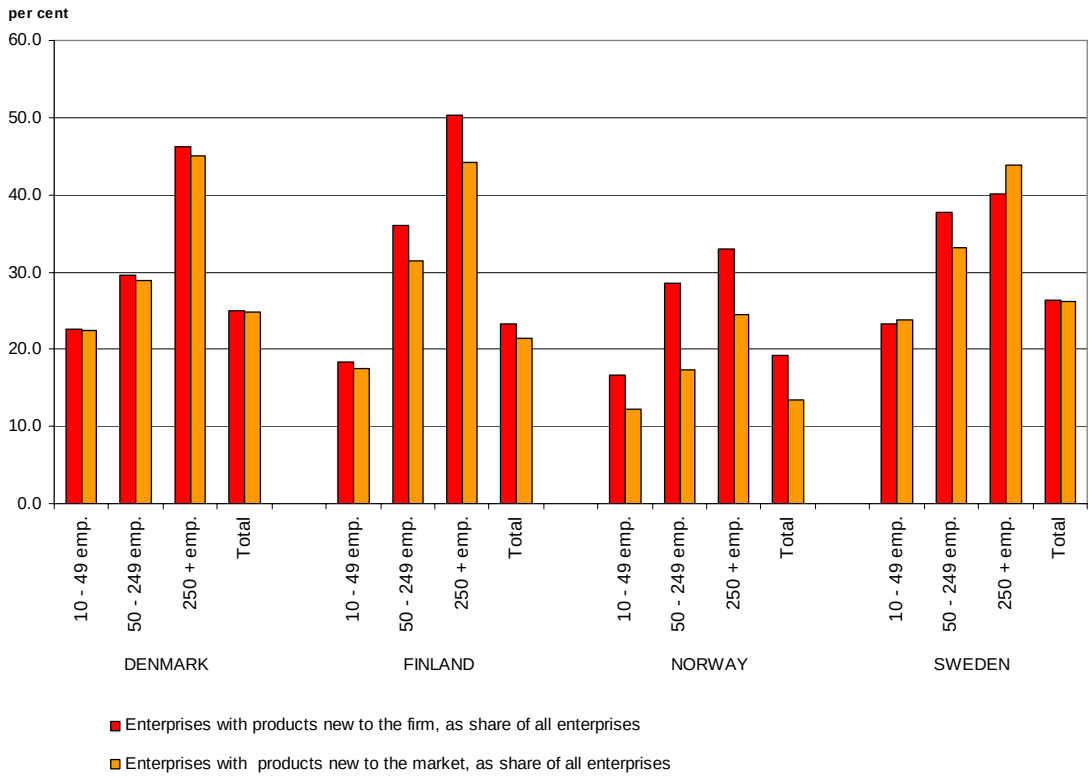
Product innovations may be divided into two sub-categories; products that are new only to the enterprise, and products that are new also to the enterprise's market. Figure 2.5 shows the share of enterprises that reported having introduced products that fell into these two categories.

In all four countries, products that were new only to the enterprise were more common than products that were new also to the market. However, for Danish and Swedish enterprises the

difference is only slight. For the largest Swedish enterprises, new-to-market products are actually reported more frequently than new-to-enterprise products.

In both Denmark and Sweden, there are high shares of enterprises that had products in either category. Sweden has the highest shares of enterprises with innovated products of the four countries in the figure, closely followed by Denmark. In both countries, the shares of enterprises reporting introducing innovated products are relatively high for all size-classes, although the percentages rise with enterprise size. Large Swedish enterprises stand out, because of the high share of enterprises that introduced products that were new also to the market, compared to enterprises that had introduced products that were new only to the enterprise.

Figure 2.5 Enterprises with products new to enterprise and new to market, all core industries



Source: National CIS4 data for the Nordic countries.

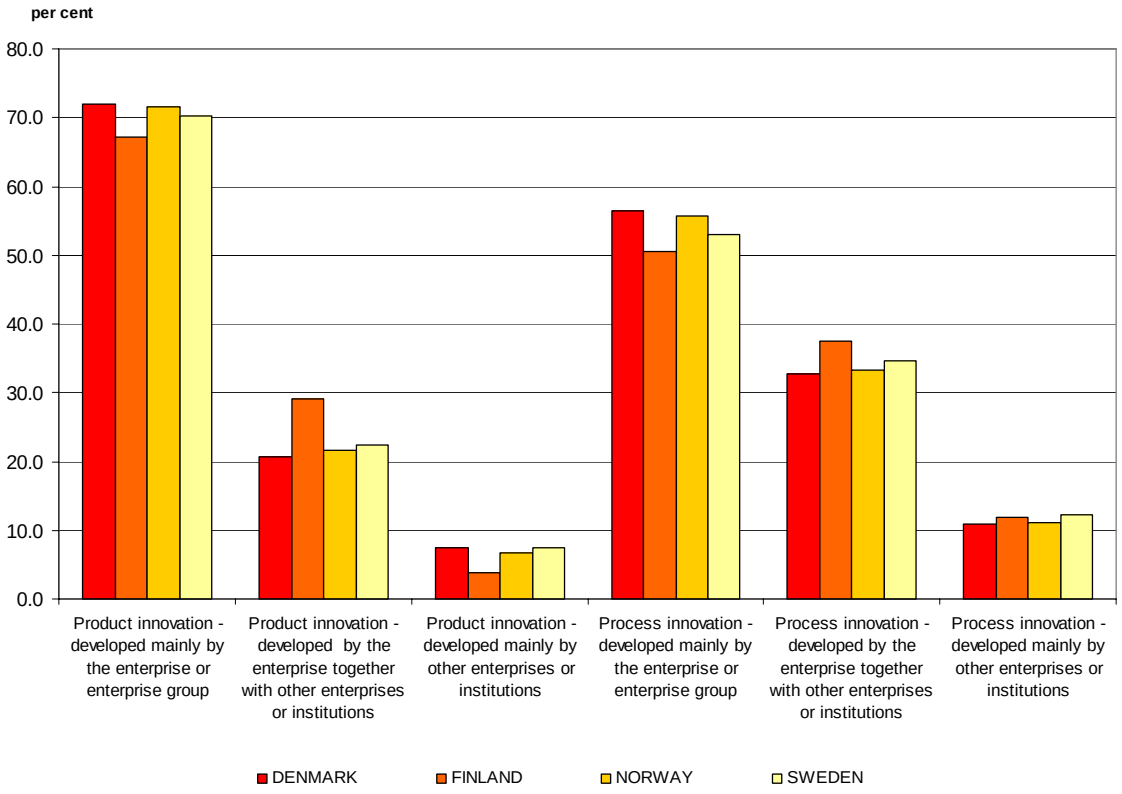
In Finland differences across size-classes are larger than in Denmark and Sweden. Although the largest Finnish enterprises often report introducing new products of both types, the total numbers are lower than those in Denmark and Sweden, due to relatively low shares of product introductions in the smaller size-classes.

Norwegian enterprises report relatively little of both types of innovated products, compared to the other three countries. The share of enterprises with products that are new also to the market deviates the most from the other countries.

2.2. Co-operation on innovation projects

Other important indicators of innovation are enterprises classified by main developer, and innovation classified by co-operation agreements. The former shows who developed the innovated products and processes, be it the enterprise alone, together with others, or mainly by other enterprises or institutions.[6] For the most part, Nordic countries are very similar when one looks at who developed the products and processes, as seen in figure 2.6.

Figure 2.6 Enterprises by main developer of the innovation, all core industries



Source: National CIS4 data for the Nordic countries. Share product and process innovators, respectively.

A striking feature in the figure is the correlation between product and process innovation, regarding who developed the innovated products and processes. Both innovation categories have high shares of independent innovators – enterprises that innovate alone, and very low shares of innovators who for the most part subcontract their innovation activity.

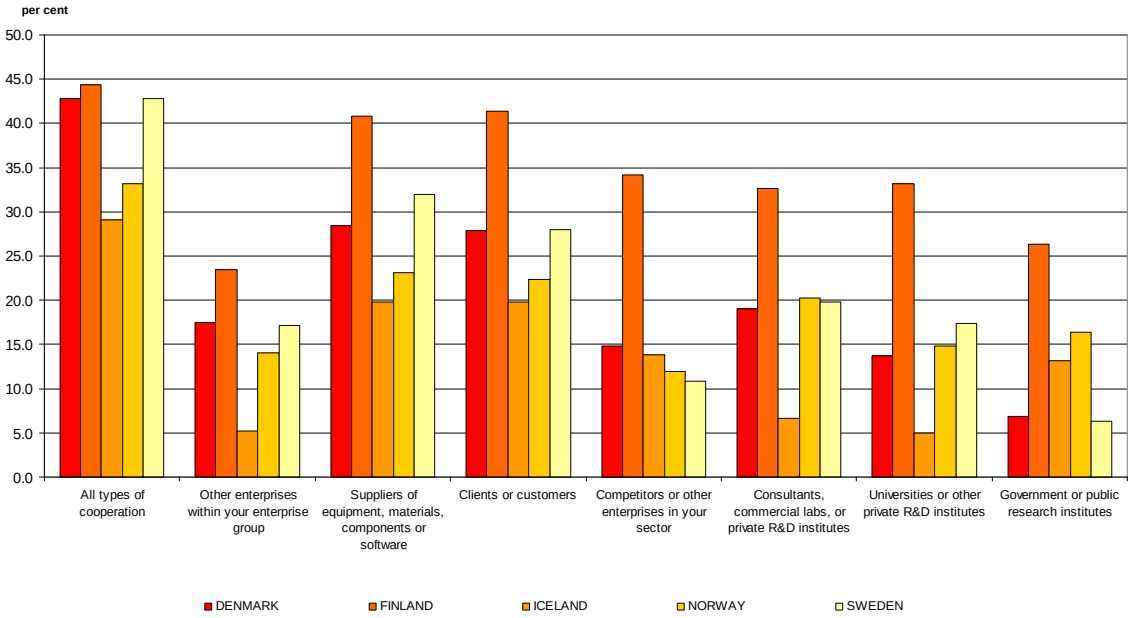
However, the figure also shows that there are consistent differences between product and process innovators. Product innovators are even more inclined to innovate alone, and less inclined to co-operate or let others handle the development, than are process innovators. This holds true for all four countries.

[6] Iceland is omitted from this figure as no Icelandic data on location of innovation was available.

As far as dissimilarities go, Finnish enterprises show a propensity towards co-operation on innovation development, compared to enterprises from the other countries. This holds true for Finnish product and process innovators alike.

This pattern re-emerges in figure 2.7, which shows co-operation on innovation activities. Finnish enterprises are only slightly ahead of Danish and Swedish enterprises when one looks at the share of enterprises that had any kind of co-operation agreement. However, when each type of co-operation partner is considered separately, Finnish enterprises report much more co-operation than their Nordic counterparts. This indicates that having several partners, or several co-operation projects, is more common in Finland than in the other Nordic countries.

Figure 2.7 Co-operation agreements on innovation activities, all core industries



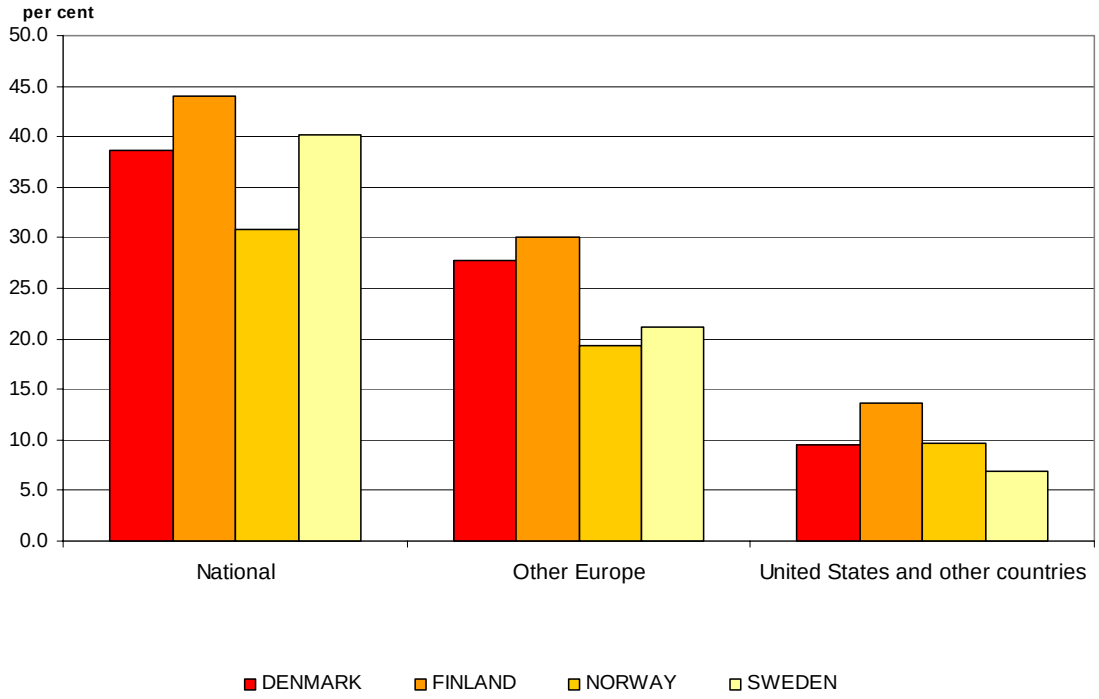
Source: National CIS4 data for the Nordic countries. Share innovation active enterprises.

Icelandic and Norwegian enterprises tend to lag behind in the co-operation figures. However, this is not true for all kinds of co-operation; regarding co-operation with the government and public institutes, for instance, only Finland has higher shares than Norway and Iceland.

The figure also shows that the most common co-operation partners in all Nordic countries are suppliers, and clients and customers. Figure 2.8 shows that Nordic enterprises also tend to find their partners first and foremost within their own country, secondly in other European countries.[7]

[7] No Icelandic data were provided on the nationality of the co-operation partners.

Figure 2.8 Co-operation agreements by nationality of co-operation partner, all core industries



Source: National CIS4 data for the Nordic countries. Share innovation active enterprises.

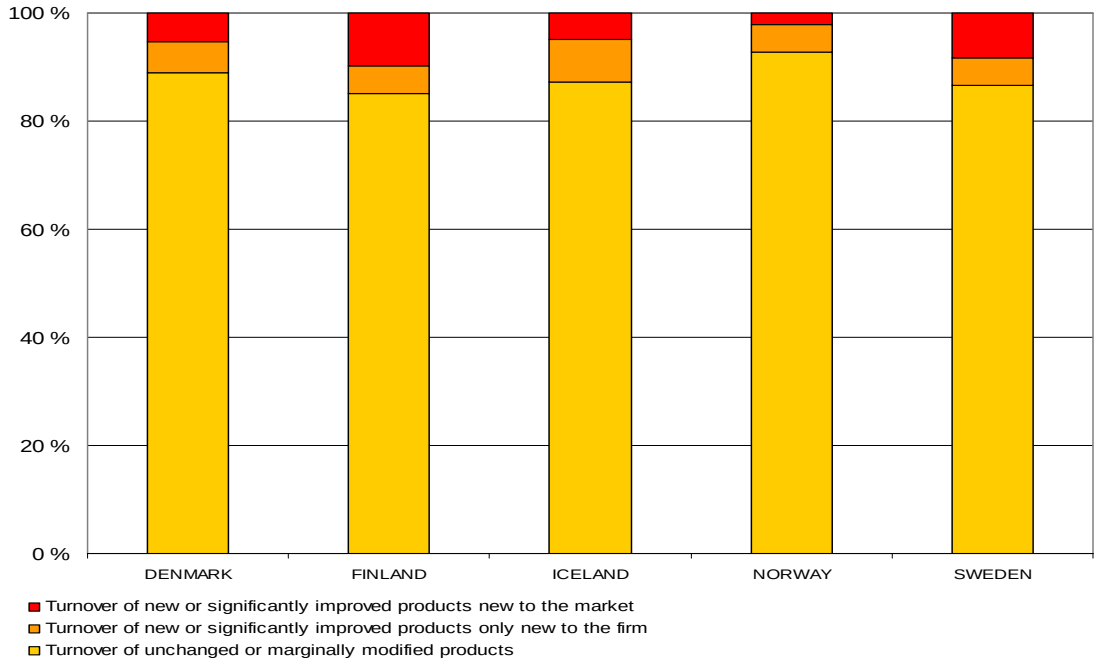
2.3. Turnover from innovated products

One of the key indicators in the Community Innovation Survey is turnover from innovated products as a percentage of total turnover. It is a key variable, because it indicates who makes money from innovation.

The countries that have the highest shares of product innovators are not necessarily the countries that generate the highest turnover shares from innovated products. Although Finland is not the Nordic economy with the highest share of innovators, Finland has the highest share of turnover from new and significantly improved products. As seen in figure 2.9, 15 per cent of the turnover in Finnish core industries comes from products that are new to the enterprise or new to the market. Sweden and Iceland are almost at the same level, followed by Denmark. Norway is, as in the case with innovation activity, at the bottom of the list.

Innovated products are divided into products that are new only to the enterprise and products that are new also to the market. In Finland and Sweden, the share of turnover generated from products that are new to the market, surpasses the turnover share from products that are new only to the enterprise. In the other three countries, it is the other way around. This may be significant; the countries, in which a higher share of the turnover is generated from products that are new to the market, have the highest shares of turnover from innovative products in total. This could potentially indicate that advances from novel (new to market) product innovations spill over to other (adopting) innovative enterprises.

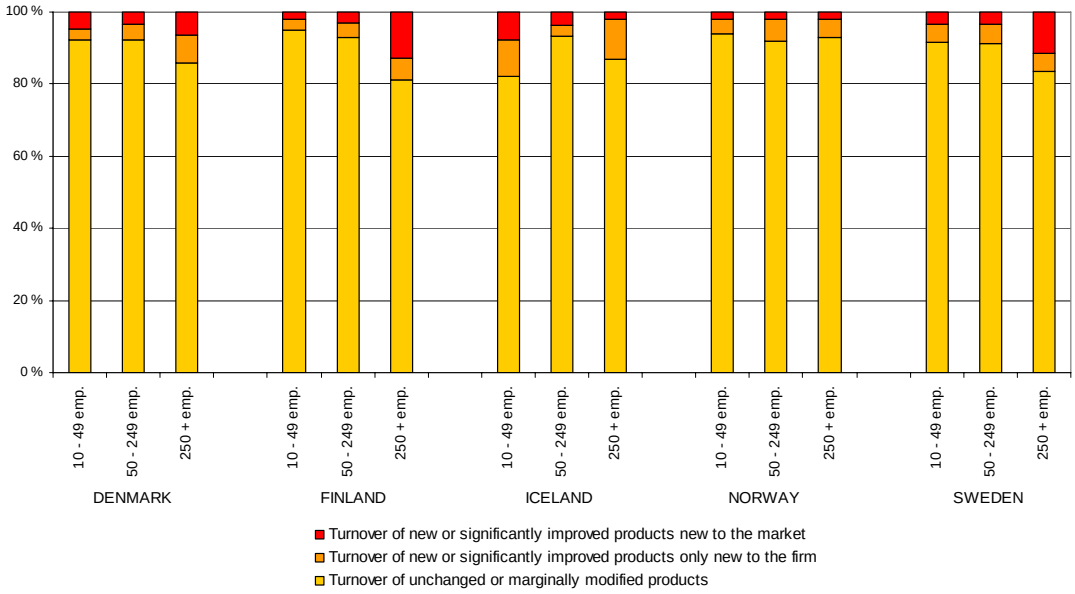
Figure 2.9 Turnover from innovations vs. unchanged products, all core industries



Source: National CIS4 data for the Nordic countries.

When one examines the turnover figures split up into size-classes, patterns can be quite hard to find, as seen in figure 2.10. Finland and Sweden, the countries in which innovated products generate the highest turnover shares in total, both have high figures for the largest enterprises compared to the other Nordic countries.

Figure 2.10 Turnover from innovations vs. unchanged products, by country and size-class, all core industries



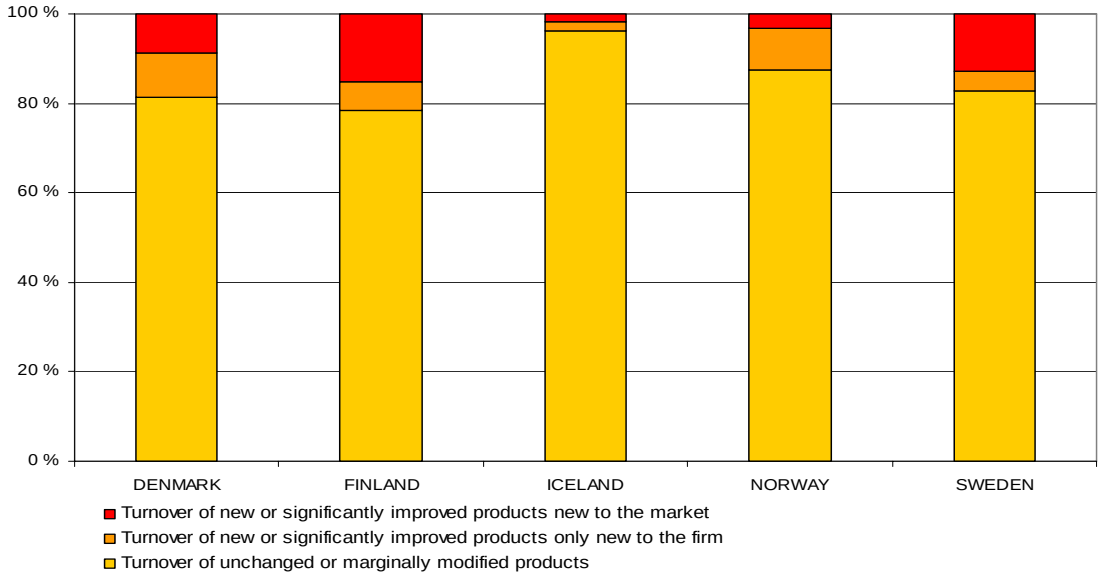
Source: National CIS4 data for the Nordic countries.

There is no general linear connection between enterprise size and turnover from innovated products across the Nordic countries. In Finland, Sweden and Denmark, large enterprises generate a higher share of their income from innovated products, compared to small and medium sized enterprises. In Iceland, small enterprises have higher turnover shares from innovations than do large enterprises. Furthermore, in Iceland, small enterprises also have higher turnover shares from new-to-market innovations, whereas it is the other way around in Denmark, Finland and Sweden. In Norway, there are only small differences between the size-classes.

Manufacturing

In manufacturing, Finland has the highest turnover shares from innovation followed by Denmark and Sweden. In Icelandic manufacturing industries, virtually all turnover is related to unchanged products, as seen in figure 2.11.

Figure 2.11 Turnover from innovations vs. unchanged products, manufacturing

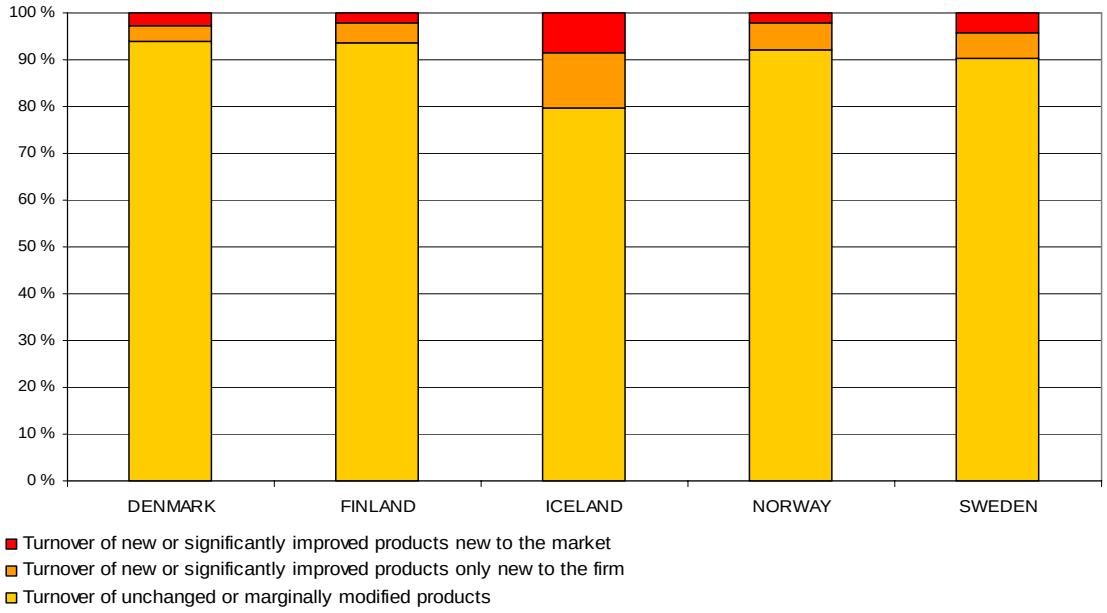


Source: National CIS4 data for the Nordic countries.

Core services

Figure 2.12 shows turnover shares from new and unchanged products in the services sector. Icelandic services enterprises stand out, as they have higher turnover shares from innovated products than their Nordic counterparts. In fact, Iceland is the only Nordic country in which turnover shares related to innovative products are higher in services than in manufacturing.

Figure 2.12 Turnover from innovations vs. unchanged products, core services



Source: National CIS4 data for the Nordic countries.

2.4. Innovation expenditure

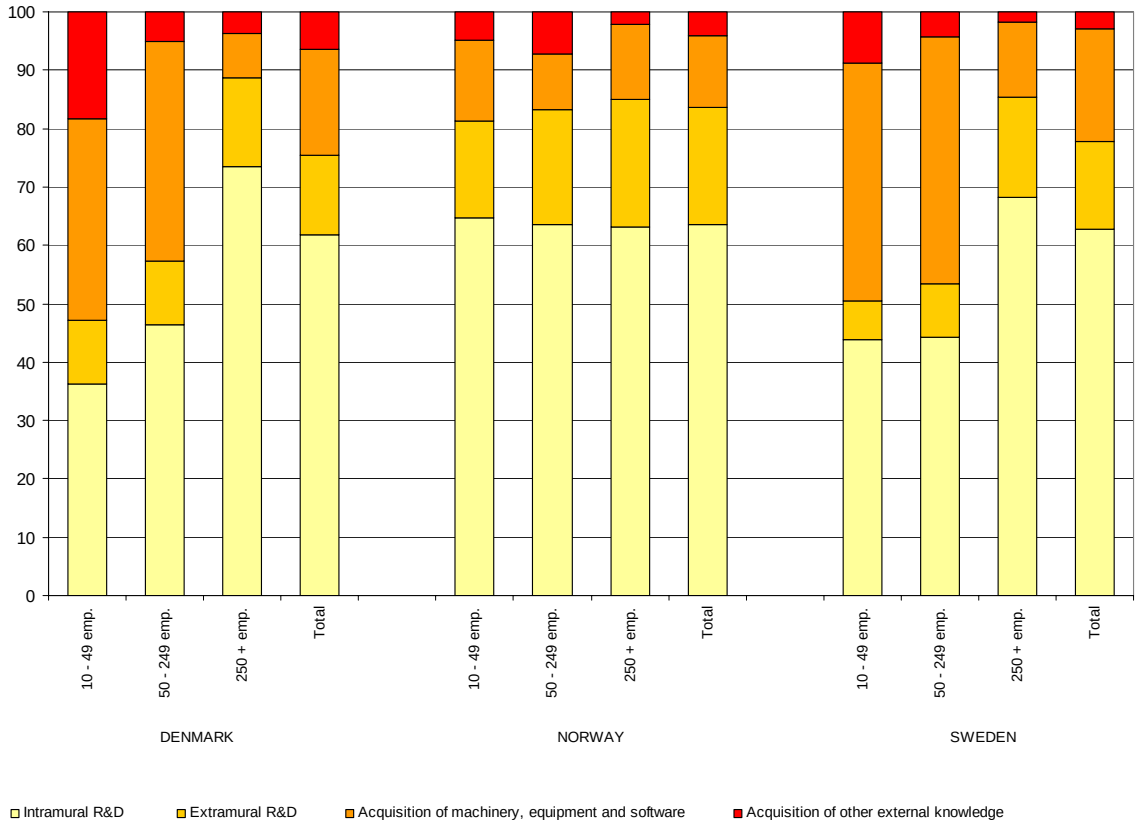
Unfortunately, data on innovation expenditure is only available for Denmark, Norway and Sweden. The expenditure on innovation activities is divided into four categories; intramural R&D, extramural R&D, acquisition of machinery, equipment and software used for innovation purposes, and finally, acquisition of other external knowledge.

All core industries

When looking at the data on innovation expenditures for the three countries, both patterns and dissimilarities are evident. Norway has rather high cost shares attributed to R&D, both intramural and extramural. At the core industry level, it is apparent for all three countries that the proportion of R&D costs rises with enterprises size, as seen in figure 2.13.

For Denmark and Sweden the differences across size-classes are the most prominent, whereas they are only slight in the Norwegian data. If one looks only at costs attributed to intramural R&D, relative expenditures rise with enterprise size in Denmark and Sweden, whereas small Norwegian enterprises actually spend more of their total innovation expenditures on intramural R&D than do larger enterprises. This seems to ensure that, although large Norwegian enterprises spend less of their total innovation budget on intramural R&D than their Danish and Swedish counterparts, this is made up for by small and medium sized Norwegian enterprises.

Figure 2.13 Innovation expenditure, all core industries



Source: National CIS4 data for the Nordic countries.

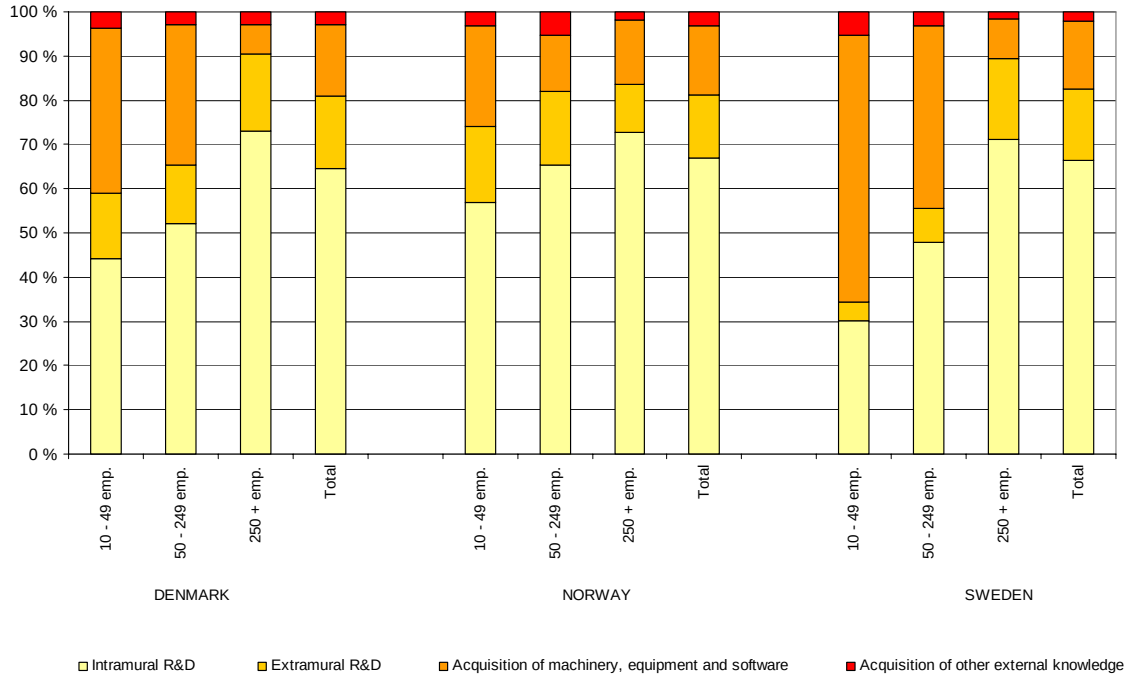
Also, the proportion of the costs attributed to acquisition of machinery, and acquisition of external knowledge, falls with enterprise size in Denmark and Sweden, whereas this is not the case in Norway.

Manufacturing

The three countries' distributions of innovation expenditures are rather similar when only the manufacturing industries are considered. Total innovation expenditure in manufacturing shows the same patterns across countries. This is shown in figure 2.14. R&D expenditure, relative to total innovation expenditure, rises with enterprise size, in all three countries.

There are, however, differences across countries when data is broken down by size class. Again, there are larger variations between size classes in Denmark and Sweden than in Norway.

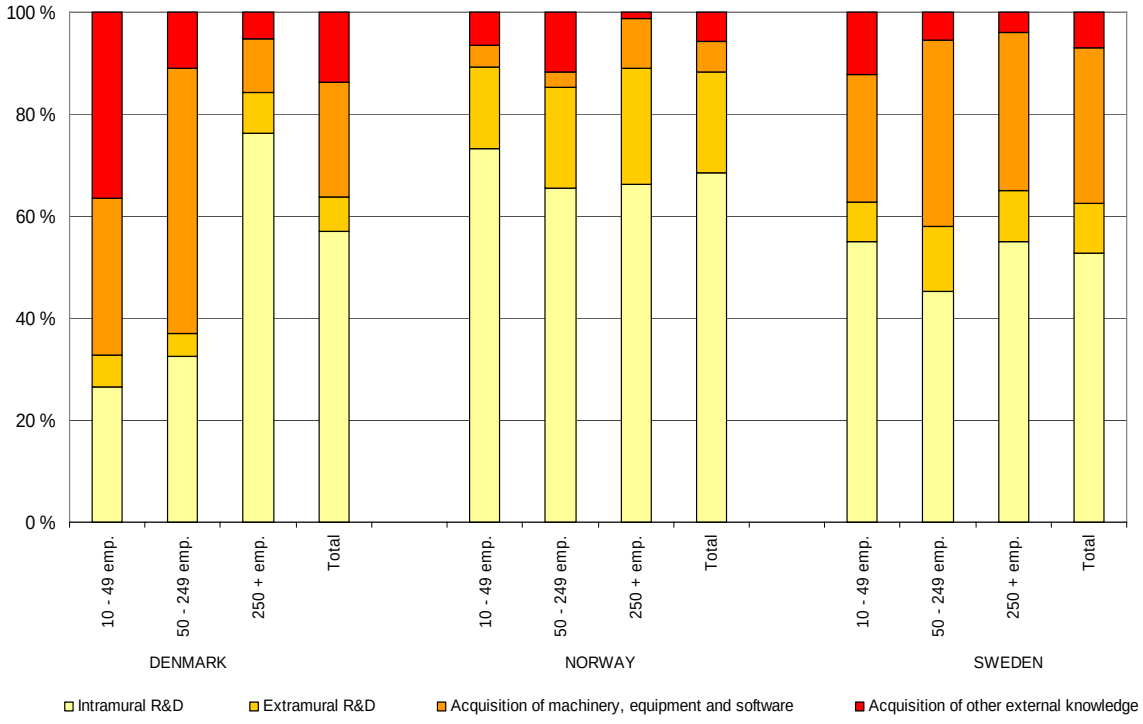
Figure 2.14 Innovation expenditure, manufacturing



Source: National CIS4 data for the Nordic countries.

Core services

Figure 2.15 Innovation expenditure, core services



Source: National CIS4 data for the Nordic countries.

It is hard to find a pattern at all, when examining the innovation expenditure undertaken in the services industries, as is evident in figure 2.15. The data shows vast dissimilarities, both across countries, and across size classes.

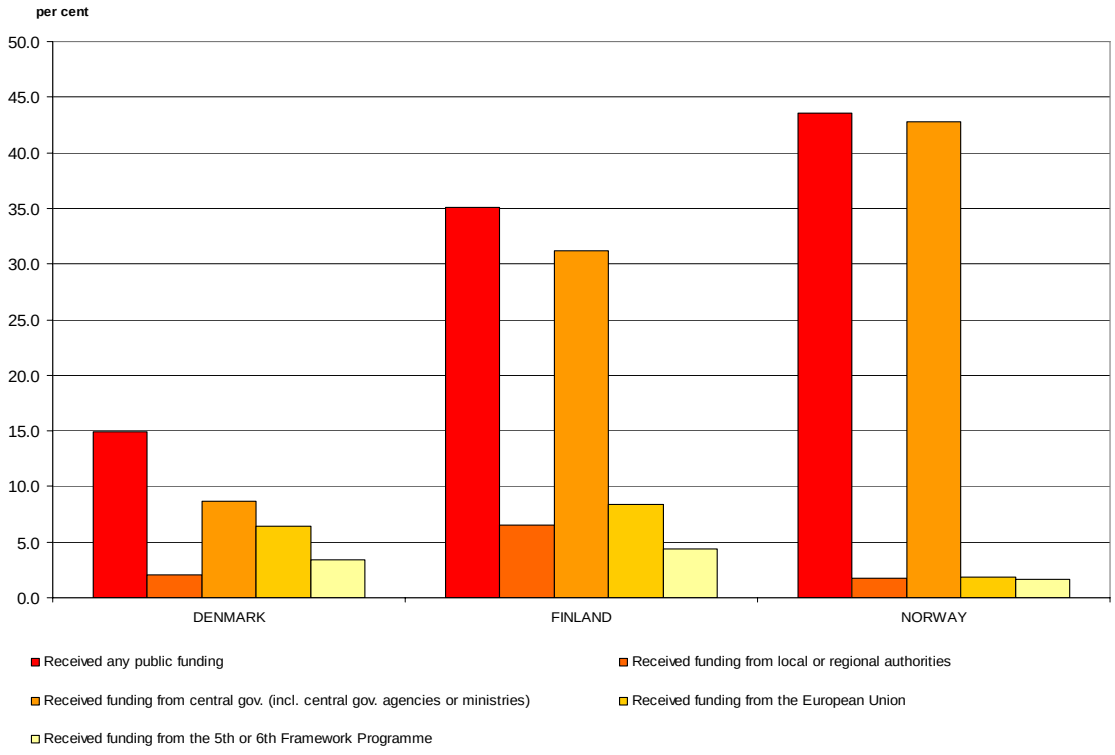
2.5. Funding of innovation

Figure 2.16 shows the percentage of enterprises which received public innovation funding. The public funding is sorted by source into five groups.

Perhaps the most prominent feature of the figure is that the Danish shares of funding recipients are much lower than those of Finland and Norway. As much as 44 per cent of the Norwegian enterprises and 35 per cent of the Finnish enterprises reported receiving public innovation funding during the observation period. Only 15 per cent of the Danish enterprises stated the same.

Another striking feature is the extent to which Norwegian enterprises received funding from the central government; 43 per cent reported receiving funding from central government sources. This is largely due to an R&D/innovation tax relief programme called SkatteFUNN. Very few enterprises reported receiving public funding from other sources; and the central government funding is to a great extent the reason why Norway has such a high share of funding recipients.

Figure 2.16 Innovation funding, by country and source, all core industries



Source: National CIS4 data for the Nordic countries. Share innovation active enterprises.

A large share of Finnish enterprises as well – 31 per cent – relied on funding from the central government. However, other forms of public funding are more common than in Norway. In Finland, reported innovation funding, and central government funding in particular, increases with enterprise size, whereas this is not the case in Norway.[8]

Danish enterprises do not report receiving public funding to the same extent. In total only 15 per cent of all innovation active Danish enterprises reported such funding. The percentage of enterprises receiving public funding increases with enterprise size. No single source is very prominent, contrary to the other two countries.

2.6. Effects of innovation

Figure 2.17 shows various effects that the enterprises observed as a result of their innovation activities. The enterprises were asked to report to which extent they observed a number of effects from their innovation activities. The figure shows the share of enterprises indicating these effects to a high extent.

The enterprises were asked to consider the following effects:

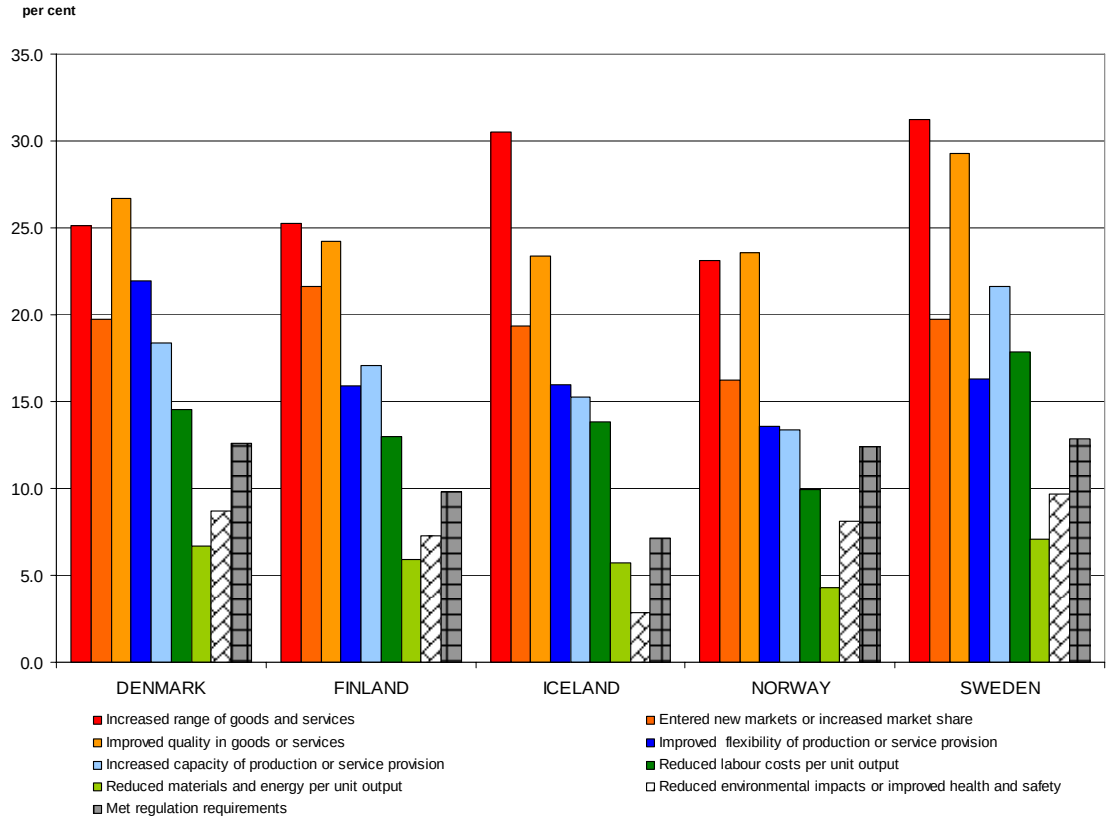
- **Market effects** (Increased range of goods and services; Increased market share; Improved quality of products)
- **Process effects** (Improved flexibility; Increased capacity)
- **Cost effects** (Reduced labour costs; reduced materials and energy)
- **Regulation effects** (Reduced environmental impacts or improved health and safety; Met regulatory requirements)

A pattern that stands out is how the two top effects of innovation activities are the same in all Nordic countries. The effects the enterprises most often experienced to a high extent were *an increased range of goods and services* and *improved quality in goods and services*. Both of these are market effects. Between 20 and 30 per cent of the enterprises reported that these effects were highly important in all five countries. A relatively high share of enterprises in all countries also entered new markets or increased their market share as a result of their innovation.

Process effects, in the form of *increased flexibility of production or service provision* or *increased capacity*, were also experienced by a large share of enterprises in all the Nordic countries.

[8] See table 3.12 in Annex 2 for innovation funding, by size classes.

Figure 2.17 Effects of innovation activities, all core industries



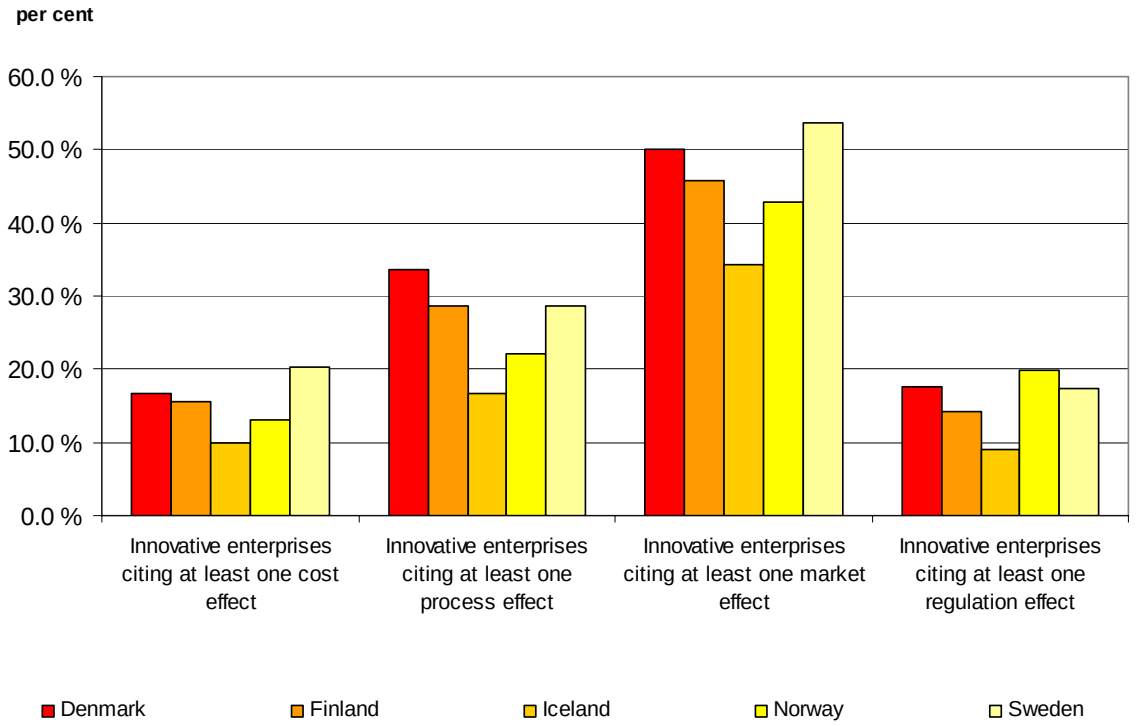
Source: National CIS4 data for the Nordic countries. Share innovation active enterprises.

Cost effects and regulation effects were only to a lesser extent reported as being important by the enterprises.

Figure 2.18 shows aggregate results for the effects for each country. The figure shows shares of product-process innovative enterprises that cite at least one factor in a given group (e.g. cost effects) as very important. Cost effects and market effects are slightly more important (in relative terms) in Sweden, while process effects are more important in Denmark. All types of effects are generally less important in Iceland.

Other than that, the aggregate results confirm the picture from figure 2.17: market effects from innovation activities are relatively more important for the enterprises than are process effects, whereas cost and regulation effects are experienced only by a smaller share of the enterprises.

Figure 2.18 Effects of innovation activities, aggregate results



Source: Own calculations based on national CIS4 data for the Nordic countries. Share innovation active enterprises.

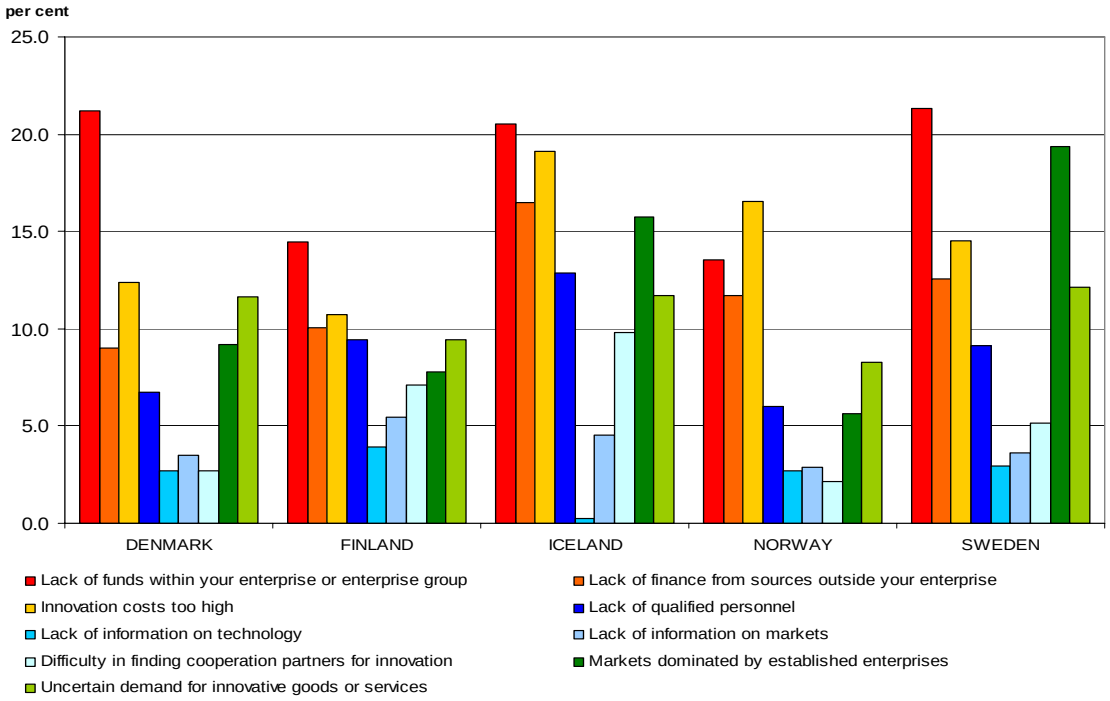
2.7. Hampering factors

The enterprises were also asked to which extent they had experienced a number of factors as hampering to their innovation activities. These factors may be split into three groups:

- **Market factors** (Market dominated by established enterprises; uncertain demand for innovative goods or services)
- **Funding/cost factors** (Lack of funds within enterprise; Lack of external finance; Innovation costs too high)
- **Knowledge factors** (Lack of qualified personnel; lack of information on technology; lack of information on markets; difficulty in finding co-operation partners)

Figure 2.19 shows hampering factors of high importance reported by enterprises with innovation activities.

Figure 2.19 Enterprises with innovation activity indicating the high importance of selected factors in hampering innovation activity



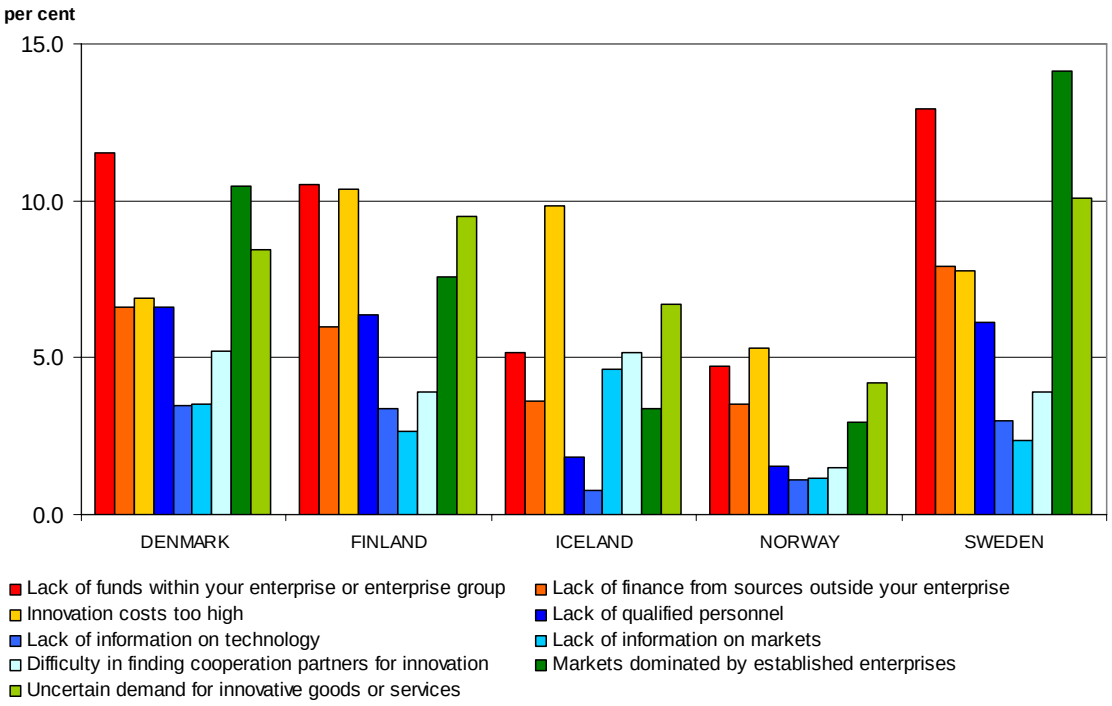
Source: National CIS4 data for the Nordic countries.

The figure shows that cost and funding factors are the most important hindrances for innovation in all five countries. With the exception of Sweden, *lack of funds* and *too high innovation costs* are the two factors that are reported most frequently as obstacles for innovation. In Sweden, lack of funds was reported by the largest relative share, but a large share of the enterprises also reported that their innovation activities were hampered as a result of the market domination of other enterprises. In Denmark, *lack of funds* is singled out as the most important factor, by almost double the share of enterprises than for other hampering factors. In Norway and Finland, the two countries with the largest shares of funding recipients, shares of enterprises citing *lack of funds* are much lower than in the other countries.

Generally market factors are more frequently reported as being important obstacles than knowledge factors, by innovation active enterprises. Finally, the importance of high costs as a hampering factor varies to some degree across countries, with the highest shares citing high costs in Iceland and Norway.

If one looks at the enterprises without innovation activity, the picture is not quite the same. Figure 2.20 shows the factors that are considered of high importance as hindrances to innovation, by enterprises without innovation activity.

Figure 2.20 Enterprises without innovation activity indicating high importance of selected factors in hampering innovation activity



Source: National CIS4 data for the Nordic countries.

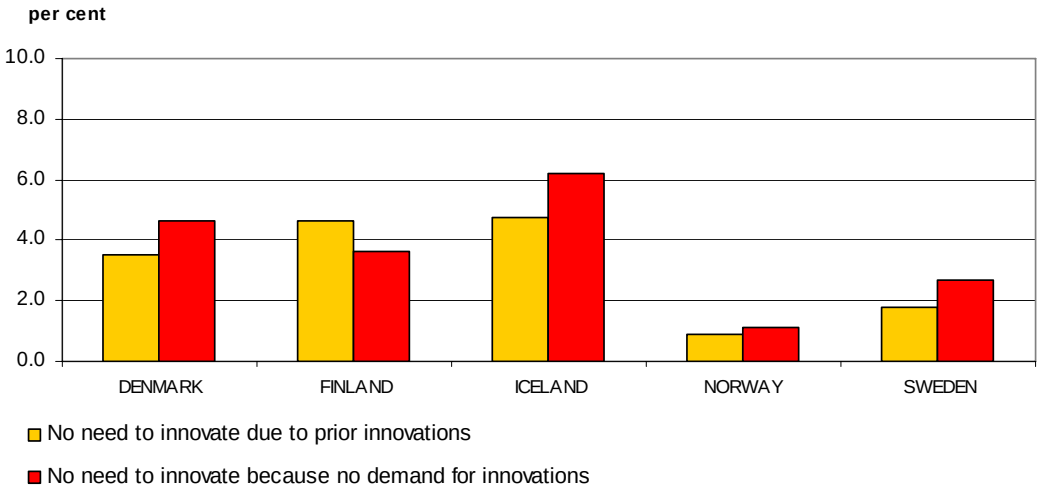
In all countries except Sweden one of the cost and funding factors is the most frequently reported obstacle for innovation. In Sweden, market domination is the most important hampering factor for enterprises without innovation activity. However, there seems to be more of a consensus among innovative active than non-innovative active enterprises about which hampering factors are the most important. Another prominent feature is the fact that most factors are reported less frequently by the non-innovative active than by the innovative active enterprises. Hence, this part of the survey does not seem to fully capture what obstructs these enterprises from innovating. This could be because they find the *question* irrelevant rather than the *factors* being irrelevant for their lack of innovation activity.

The questionnaire also contained questions that were specifically designed to find out what stopped enterprises from engaging in innovation activities, as opposed to what hindrances they met while engaging in such activities. Enterprises with innovation activity could also answer these questions, as they may have chosen not to innovate in one area, while innovating in another. Thus, the differences between innovation and non-innovation active enterprises can be examined. The enterprises were specifically asked if their lack of innovation was due to a *lack of demand for innovations*, or if they did not innovate *due to prior innovations*.

There is no universal pattern in the Nordic countries when it comes to reasons not to innovate. In all countries except Finland, the lack of demand for innovations is more important than prior innovations. This holds true both for enterprises with and without

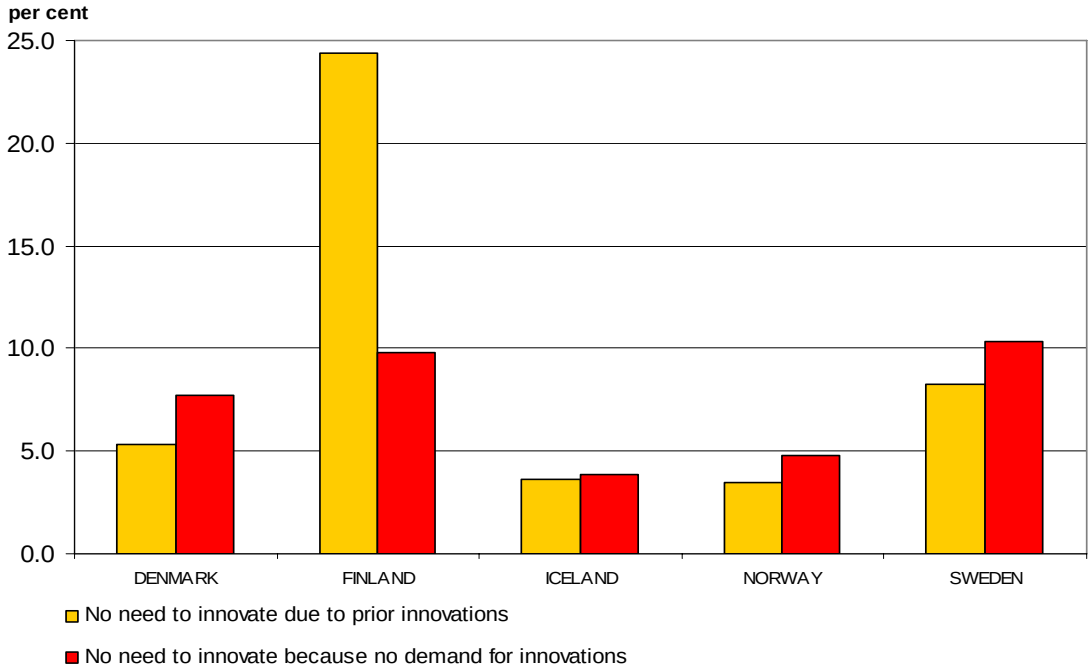
innovation activity in Denmark, Iceland, Norway and Sweden. However, the differences in relative importance of the two factors are not large. In Finland, prior innovations are more important than demand uncertainties. Especially for the non-innovation active enterprises, prior innovations are much more cited than a lack of demand, as a reason not to innovate.

Figure 2.21 Enterprises with innovation activity indicating high importance of selected reasons for not innovating



Source: National CIS4 data for the Nordic countries.

Figure 2.22 Enterprises without innovation activity indicating high importance of selected reasons for not innovating



Source: National CIS4 data for the Nordic countries.

Intuitively, one would expect fewer replies on *reasons not to innovate* from innovation active than from non-innovation active enterprises. For Denmark, Finland, Norway and Sweden this is also the case. However, the differences are not very prominent with the exception of Finland and, to a lesser extent, Sweden. For Iceland it is even the other way around; fewer non-innovation active than innovation active enterprises gave their reasons not to innovate in the Icelandic survey. Again, this could stem from non-innovation active enterprises not seeing the relevance of the question, rather than considering the different alternatives not relevant.

In Finland around a quarter of the non-innovation active enterprises cite prior innovations as reasons for not engaging in innovation activity. This is substantially higher than in all other countries, indicating a higher level of past innovation activity in Finnish enterprises. This result is somewhat difficult to find an explanation for. A potential explanation is that these enterprises have longer product life cycles than non-innovation active enterprises in the other Nordic countries. However, differences in industry structure across countries do not seem large enough to explain this.

3. Weighting and correcting for industry/size-structure

A way to improve the relevance of the innovation indicators is make correction for the industry/size-structure and to use alternative weights of the responding enterprises. This will give a better and deeper insight in the extent of the innovation activities and outputs in countries and regions and also in industries and size classes. However, one has to be careful in two ways, when selecting the weights and correcting the industry/size-structure. First, the estimations and corrections should be founded on proper statistical estimation and second, the description should be easily understood by other statistical producers and – in the end – the policy makers. Annex 4 contributes to the first point, while this Chapter hopefully contributes to the second.

3.1. Correcting for industry/size structure

Innovative performance varies greatly across industries and enterprise size classes. This can greatly impact the comparison of countries or regions. Indicators that take account of industry and size structure of regions or countries can thus be useful for the design of policy initiatives. For example, high levels of innovation activity in a country may be due to:

- A high share of enterprises in innovative industries
- High innovation performance in given industries (compared to inter country averages)

or both. Likewise, poor innovation performance may be due to:

- A high share of enterprises in less innovative industries
- Poor innovation performance on an industry basis
- High innovation performance on an industry basis but a high share of enterprises in less innovative industries

For overall policy design, it is important to know what overall innovation results actually reflect in terms of industry or size level innovation performance and overall industry structure. For this reason, methods for calculating 'corrected' indicators are introduced and used to correct various indicators of innovation for differences in industry structure and/or size between the 5 Nordic countries and further decompose the total deviation of a given country/region into two elements for each industry and/or size group: the deviation from the innovation indicator and the deviation from the structure. The methods are described in Annex 4.

Some of the indicators presented in the former Chapter will be used to illustrate various corrections. It has, however not been possible to use a combined industry/size-classification for all Nordic countries due to data and time limitations. Furthermore, the relatively small number of observations in certain industries adversely affects the results. For this reason, the standard 2-digit NACE industry classes used by Eurostat have been consolidated to 21 classes (see Annex 2), and no classifications are made for the corrections according to size. However, the size structure of enterprises deviates less across the Nordic countries than the industry structure and adjusts the aggregate results only in a minor way. Also, not all 5 Nordic countries are included in all indicators, as Iceland has not reported *number of employees* and Finland and Iceland have not reported *Total innovation expenditure.*

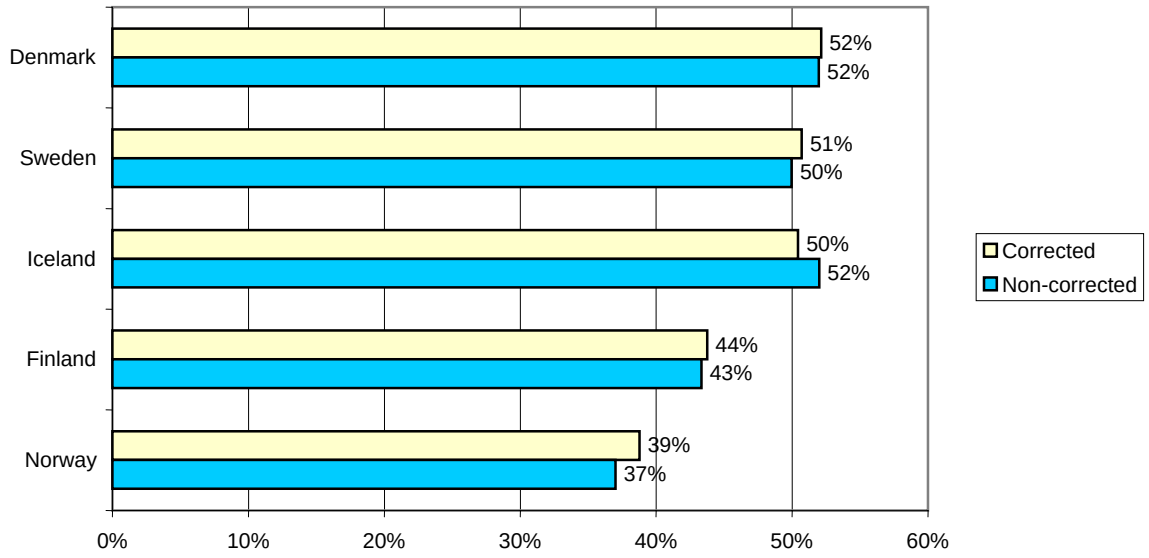
3.1.1. Correction of indicators at country level

There are three types of quantitative estimators in CIS4: *proportions*, being coded qualitative estimators (like proportion having product innovation; proportion of innovators with cooperation; proportion with "*high importance*" of "*Innovation costs too high*" as a hampering factor), *ratios* (like share of turnover from innovated products; innovation intensity) and *totals* (like innovation expenditure; turnover; employees). An indicator of each type will be corrected by the Nordic industry structure.

A. Proportion of innovation active enterprises

First the innovation active enterprises, being a **proportion**, will be calculated and corrected by the common industry structure of the Nordic countries, using (3a) and (7) in Annex 4, see Figure 3.1 (with countries sorted by the level of the corrected indicator).

Figure 3.1 Proportion of innovation active enterprises in core industries, corrected for industry structure, CIS4.



Source: National CIS4 data for the Nordic countries.

The effects of the correction for industry structure are rather small, highest for Norway.

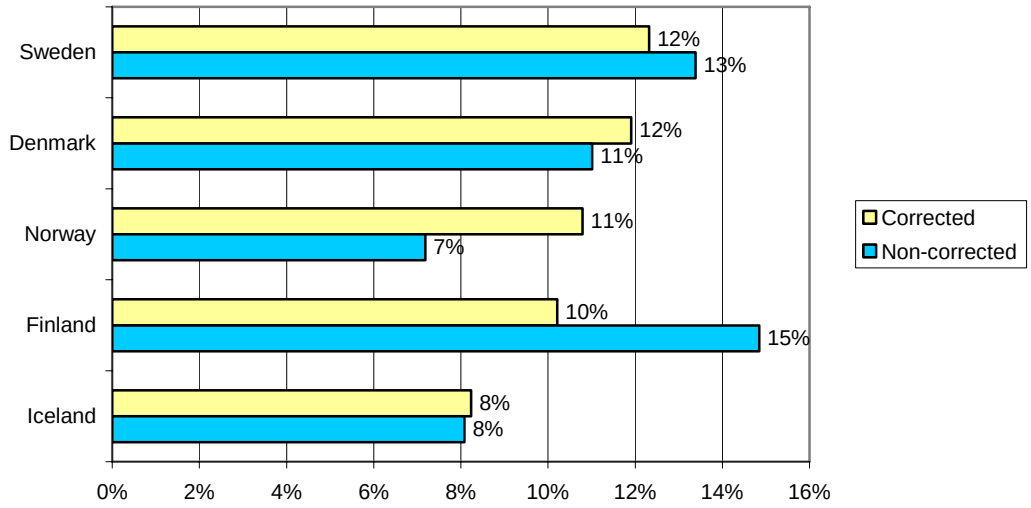
B. Share of turnover from innovated products

The share of turnover from innovated products is a **ratio** with the turnover from innovated products in the nominator and the turnover of the enterprises in the denominator, so the calculations are as in (2a) and (6) in Annex 4.

In Figure 3.2, the share of turnover from innovated products has been calculated for each Nordic country and corrected according to the common Nordic industry structure.

The effects of the correction are quite dramatic for Finland and Norway. For Finland the large decrease seems to be caused by a downwards correction of dominant industries with high shares of turnover of innovated products. In Norway, it is the other way round (an upward correction of less dominant industries with high share of turnover of innovated products), but also the effect of a low share of turnover of innovated products in a dominant industry is decreased by using the common Nordic industry structure.

Figure 3.2 Share of turnover from innovated products in core industries, corrected for industry structure, CIS4

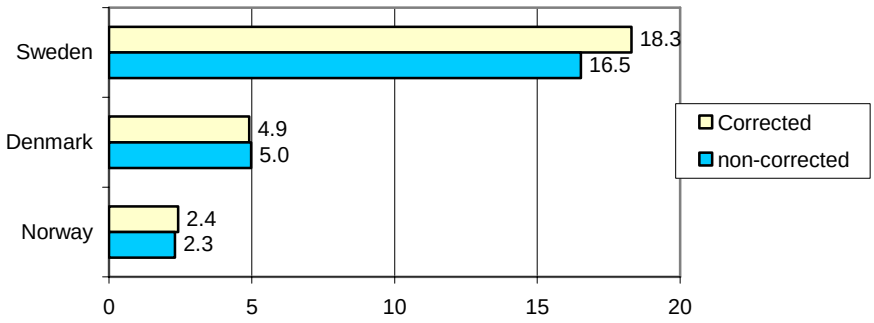


Source: National CIS4 data for the Nordic countries.

C. Innovation expenditure

The innovation expenditure is a **total**, so the calculations follow (1b) and (5) in Annex 4.

Figure 3.3 Innovation expenditure in core industries, corrected for industry structure, CIS4, 1000 mill €



Source: National CIS4 data for the Nordic countries.

The total innovation expenditure has been only been reported by Denmark, Norway and Sweden. This means that the correction concerns the common industry structure of these 3 countries, see Figure 3.3. While the Swedish innovation expenditure is increased with +11 %

when corrected for industry structure, not much happens to the Danish or Norwegian totals. These figures could be divided with the GDP of each country to make them comparable. This would however be more relevant with the R&D expenditure. Also, these corrected innovation expenditure could be divided by the turnover of enterprises in the same NACE- and size-classes to give the R&D-intensity. This would be a ratio-estimator.

3.1.2. Decomposition of deviations at industry/size level

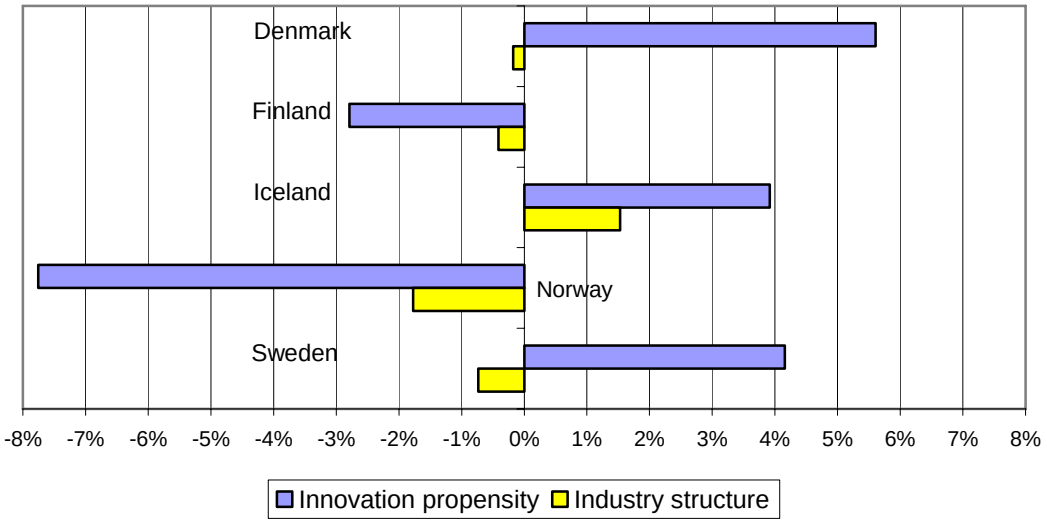
The details of the calculation of the correction for industry structure make it possible to decompose the deviation in each industry between the country and the Nordic average into a deviation in the level of the indicator and a deviation caused by the industry structure, see (8) and (9) in Annex 4. Afterwards, the deviations can be added to country level.

In some of the industries the sample size is relatively small. This increases the unreliability (error of margin) of the results and confidentiality rules might be broken. For these reasons the industry classes have been compressed to 12, when the results of single industries are presented in this report.

A. Proportion of innovation active enterprises

First the deviations for the indicator *innovation active enterprises* are calculated for each of the 21 industries, using (8) in Annex 4 and for each country the deviations are added. Figure 3.4 reports the total deviations between each country and the Nordic average, caused by innovation propensity and by industry structure. The results will be commented with the deviations per industry.

Figure 3.4 Decomposition of the deviation in the proportion of innovation active enterprises, percentage points, Nordic countries, CIS4



Source: National CIS4 data for the Nordic countries.

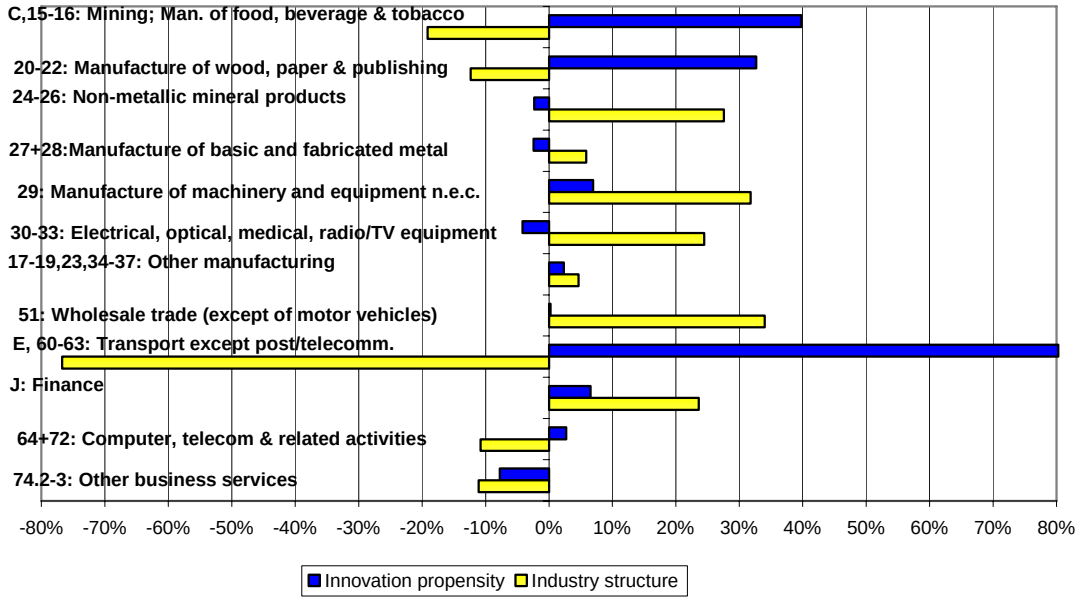
The relative deviations caused by the propensity to be innovation active and by the industry structure are presented in Figure 3.5a-e for each of the 12 compressed industries in each Nordic country.

The deviations vary much between the Danish industries. The proportion of innovation active enterprises is much higher than the Nordic average in industries *Mining; Food,beverage, tobacco; Wood,paper,publishing;Transportation*[9], but the same industries are relatively smaller than the Nordic average. An industry like *Manufacture of machinery and equipment* has both higher innovation propensity and higher share of enterprises, while it is the opposite with *Other business services*. In all, the Danish proportion of innovation active is 5.4 percentage points higher than the Nordic average, but decomposed the Danish propensity is 5.6 percentage points higher, while the industry structure causes the propensity to decrease 0.2 percentage points (see Figure 3.4).

The deviations are smaller between Finnish industries. Most industries have a lower propensity to innovate than the Nordic average except *Mining;Food,beverage,tobacco*. In all, the Finnish proportion of innovation active is 3.2 percentage points lower, mostly caused by lower innovation propensity - only 0.4 percentage points is caused by the industry structure.

Figure 3.5 Decomposition of the proportion of innovation active enterprises compared to the Nordic countries, relative deviations, CIS4

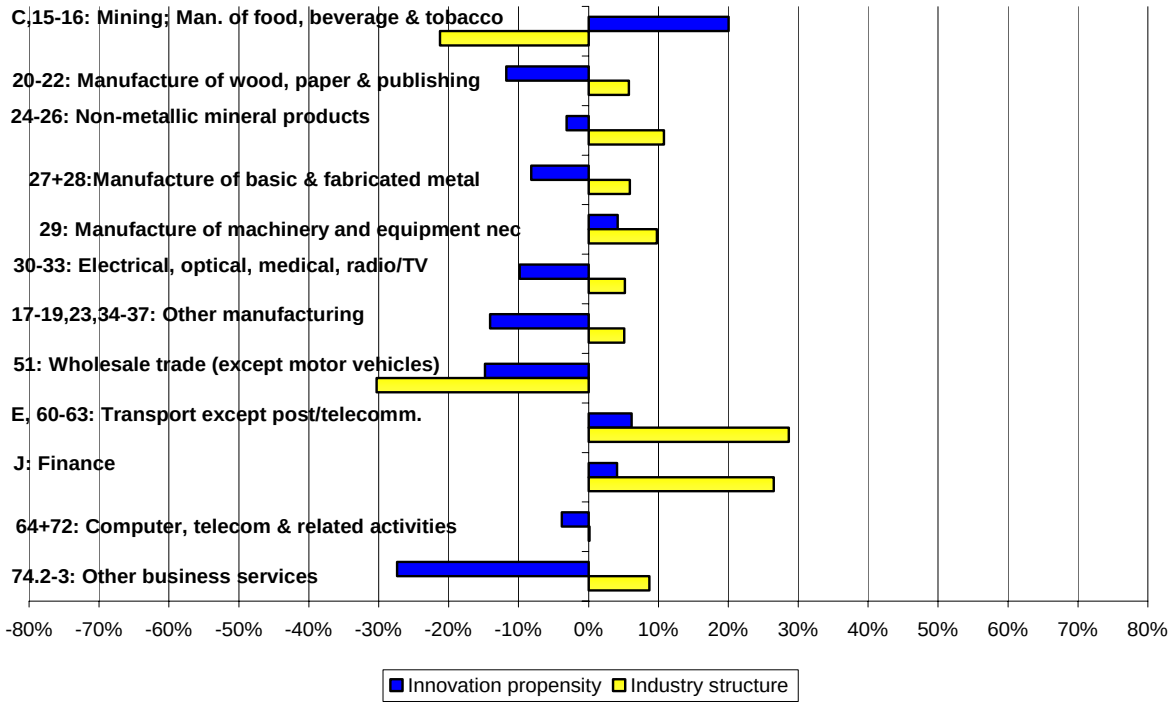
a. Denmark



The deviations are large between Icelandic industries, partly caused by the small numbers. Two industries are dominating, *Mining;Food,beverage,tobacco* and *Finance* and they also have a high proportion of innovators. On the other hand, *Other manufacturing* and *Other business services* have a very low propensity to innovate. Of the higher Icelandic propensity to innovate of 5.4 percentage points 1.5 percentage points is caused by industry structure.

[9] However, the high deviation for *Transportation* is caused by the fact that Denmark did not survey small enterprises (<50 employees) in that industry in CIS4.

b. Finland



c. Iceland

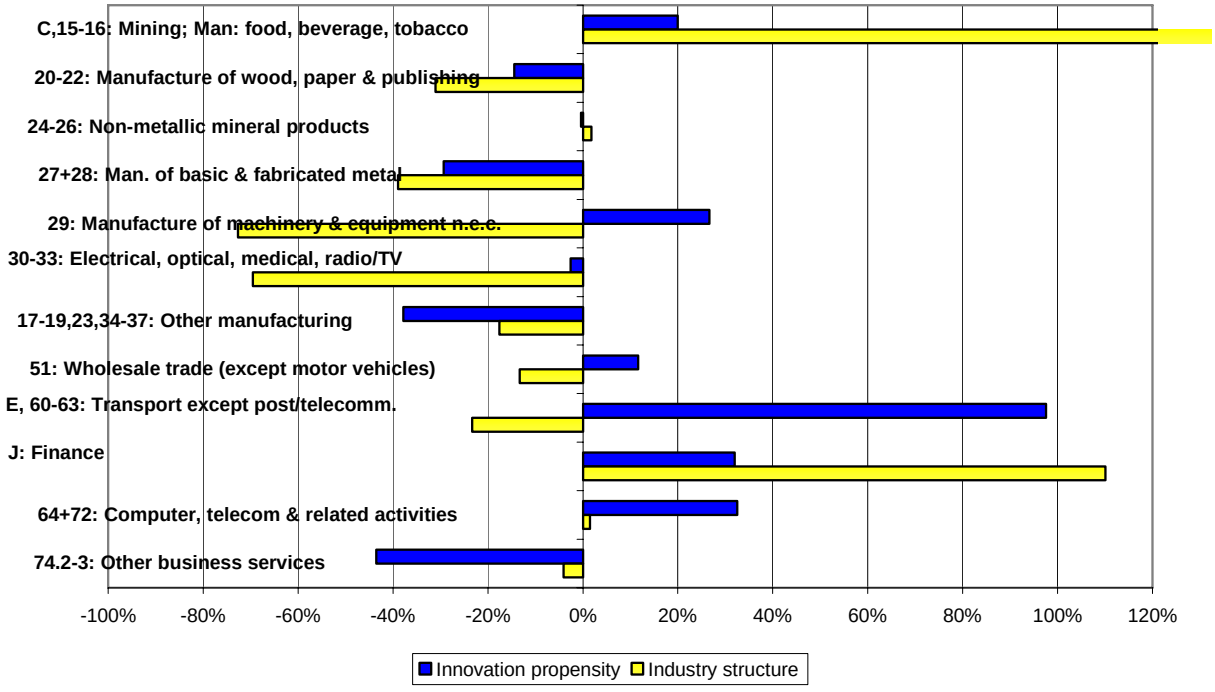
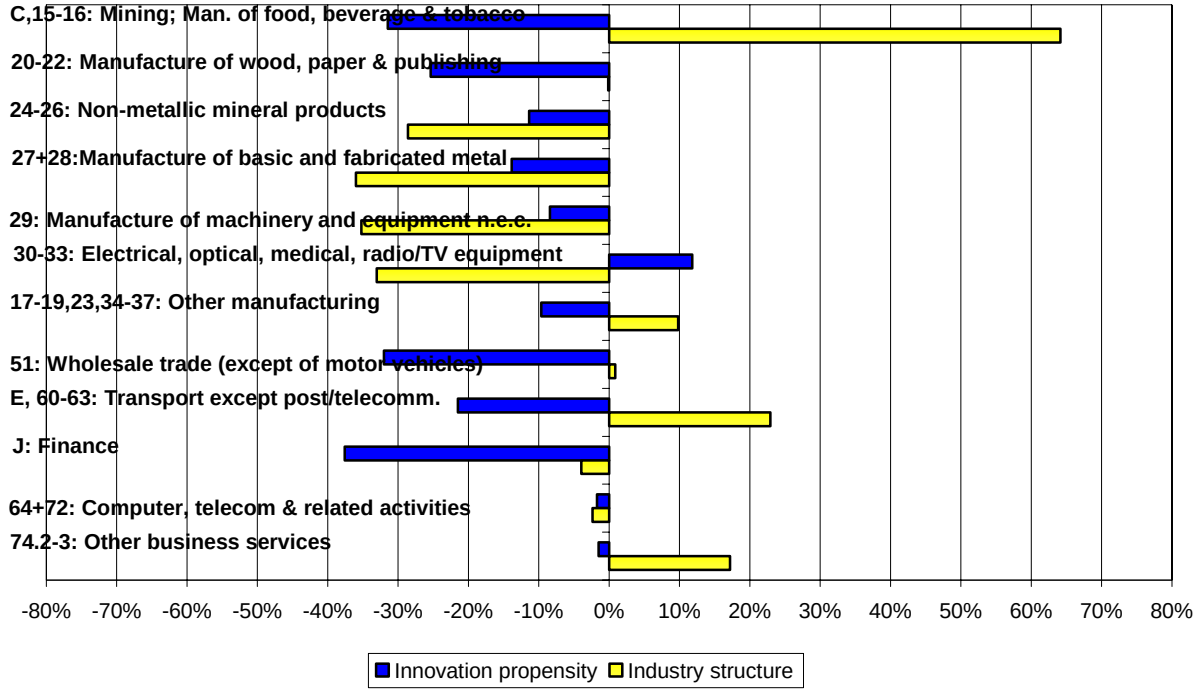


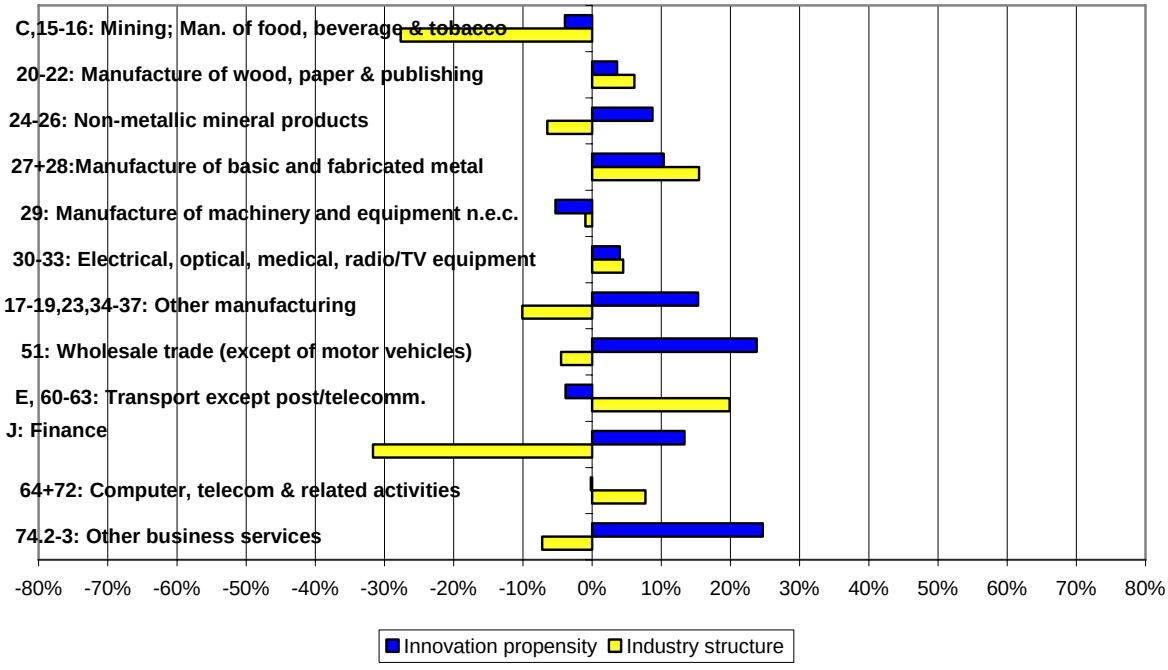
Figure 3.5d shows that most Norwegian industries have lower propensity to innovate than the Nordic average except for *Electrical, optical,radio/TV-manufacturing*; there are a lower proportion of enterprises in most of manufacturing (NACE *24-33*) and a higher in *Mining;Food,beverage,tobacco; Transportation,Finance;Other business services* than in the

other Nordic countries. In all, the Norwegian proportion of innovation active is 9.5 percentage points lower than the Nordic average. Of this 7.75 comes from the lower propensity to innovate and 1.75 from deviations in industry structure.

d. Norway



e. Sweden



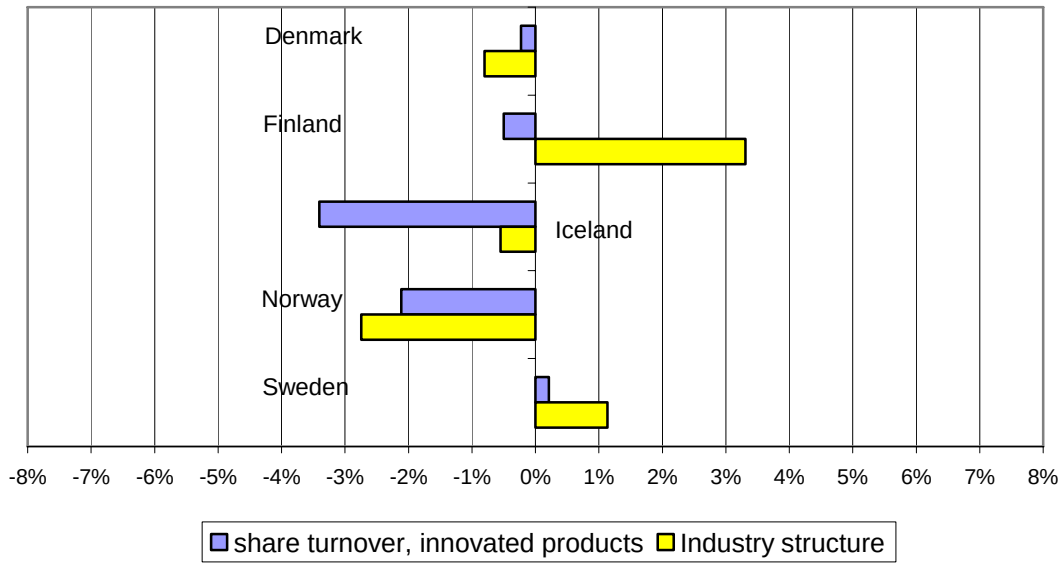
The deviations are smaller between Swedish industries. Most industries have a higher propensity to innovate than the Nordic average. The share of enterprises is markedly lower in *Mining;Food,beverage,tobacco; Finance*. The Swedish propensity to innovate is 4.2 percentage points higher than the Nordic average, but is reduced by 0.8 percentage points caused by the industry structure.

B. Share of turnover from innovated products

Also the decomposition of the deviations in the share of turnover from innovated products will be illustrated with the same 21 industries, compressed to 12 when presenting results per industry. The calculations will be using (9) in Annex 4. Here, the industry structure is expressed as the turnover instead of the number of enterprises as in the former part.

Figure 3.6 shows the total deviation of the share of turnover from innovated products between each country and the Nordic average, decomposed in the effect of industry structure and the effect of differences in the share of turnover. The deviations differ much from the deviations calculated for *proportion innovation active enterprises*, see Figure 3.4. A main reason is that the industry structure now is measured in terms of turnover. The results will be commented with the deviations per industry.

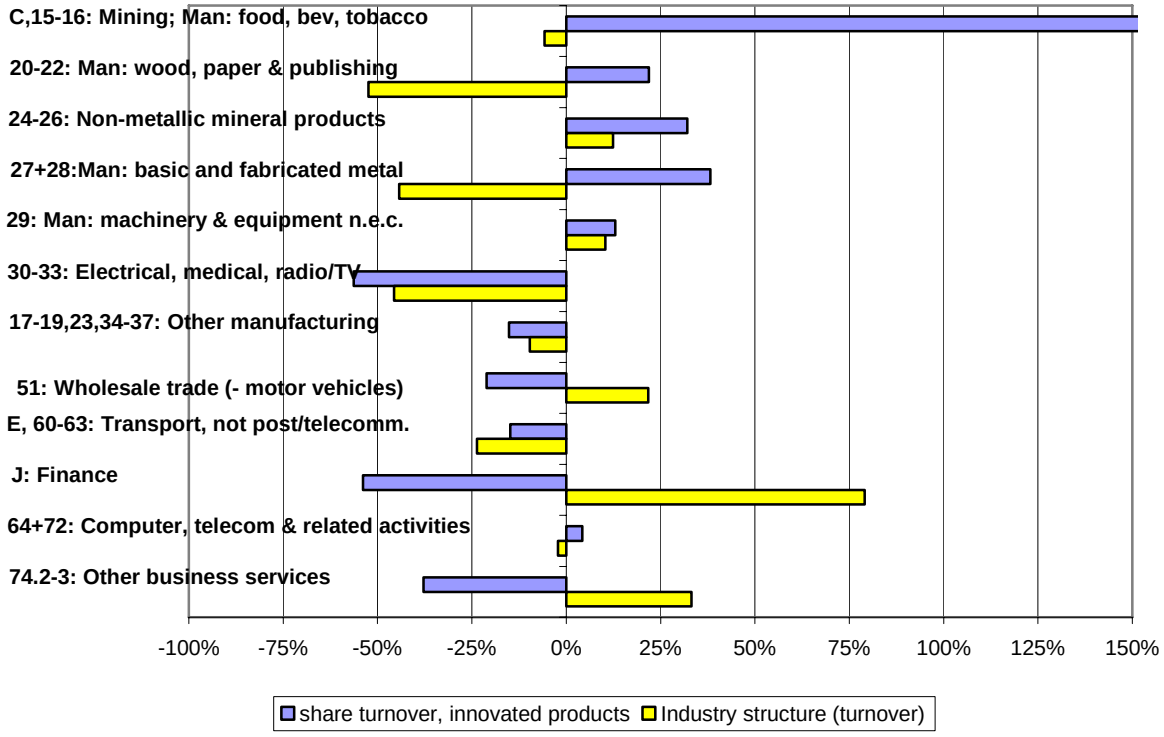
Figure 3.6 Decomposition of the deviation in the share of turnover of innovated products from Nordic averages, percentage points, Nordic countries, CIS4



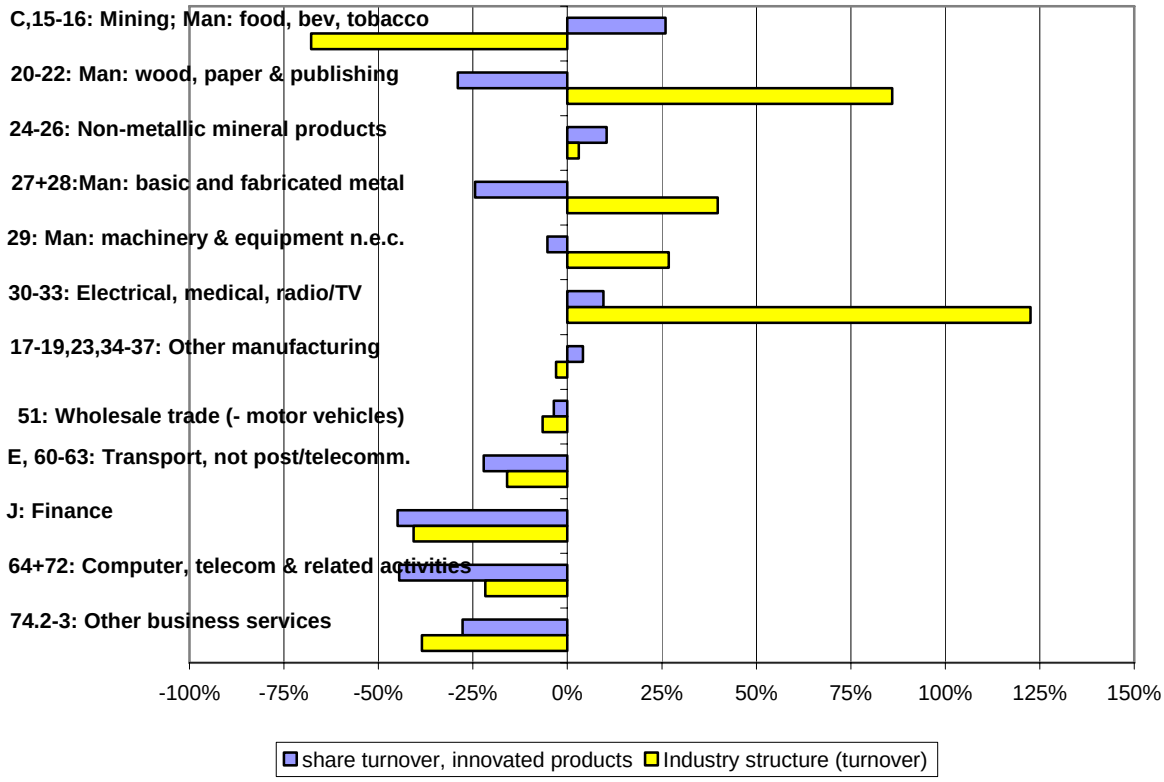
The deviations vary much between Danish industries. The share of turnover from innovated products is much higher than the Nordic average in industries *Mining; Manufacturing (NACE 15-29)*, but most of these industries are relatively smaller than the Nordic average. A much lower share of turnover from innovated products can be found in the industries *Electrical, optical,medico,radio/TV-manufacturing; Finance; Other business services*. In all, 78% of the lower Danish share of turnover from innovated products is caused by industry structure.

Figure 3.7 Decomposition of the share of turnover from innovated products compared to the Nordic countries, relative deviations, CIS4

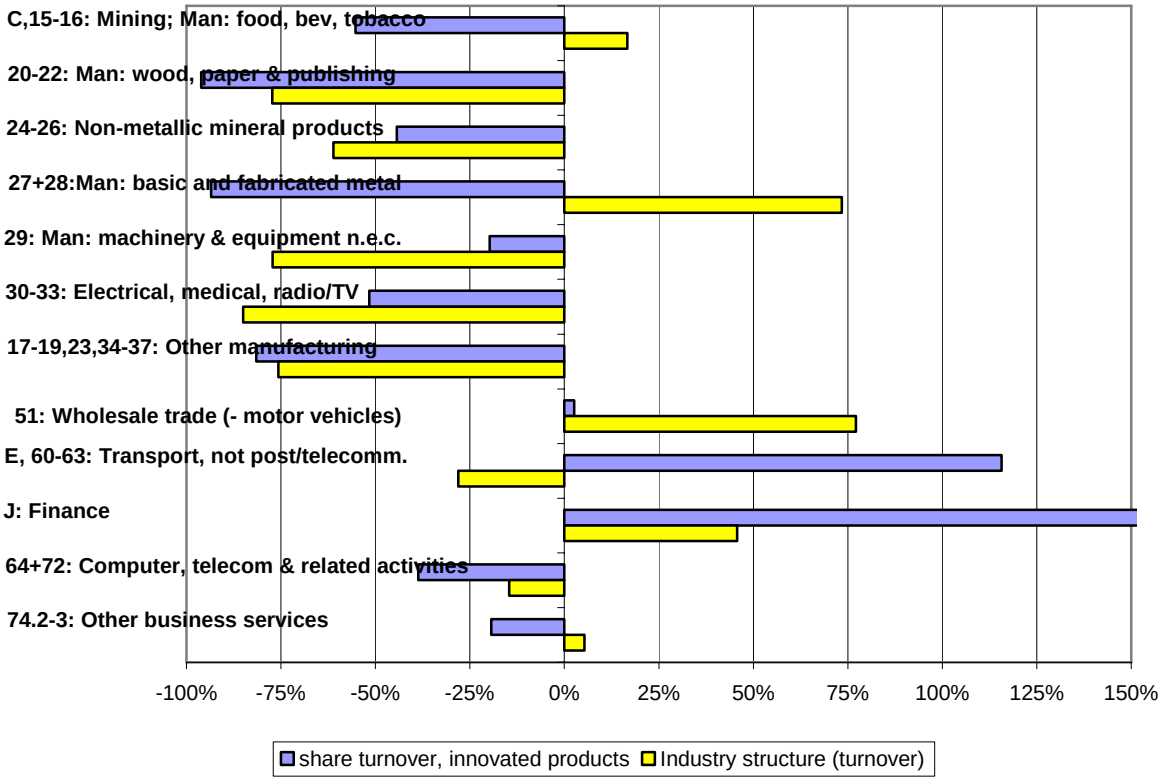
a. Denmark



b. Finland



c. Iceland



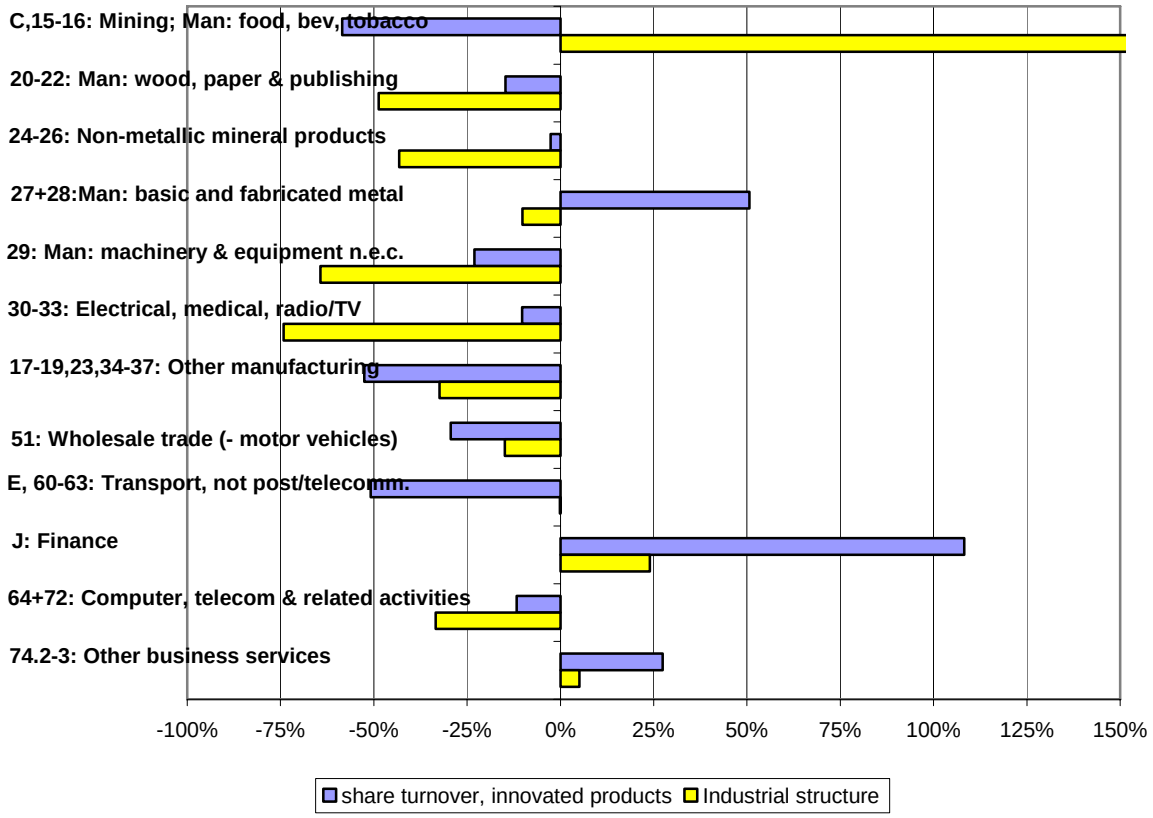
For Finland the most dominant effect is the size of the innovation intensive *Electrical,optical, medico,radio/TV-manufacturing;* and of the less innovation intensive *Wood,paper,publishing-manufacturing*. The share of turnover of innovated products only exceeds the Nordic average markedly in *Mining;Food,beverage,tobacco*. In all, the higher Finnish share of turnover from innovated products is fully caused by the industry structure. Without that effect the share of turnover from innovated products would be 0.5% lower than the Nordic average.

The industry structure in Iceland is quite different from the other countries, but this is not the main cause of the lower share of turnover from innovated products. In all industries but *Transportation; retail trade; Finance* the share of turnover from innovated products is lower than the Nordic average. This means that only 15% of the negative deviation from the Nordic average is caused by industry structure.

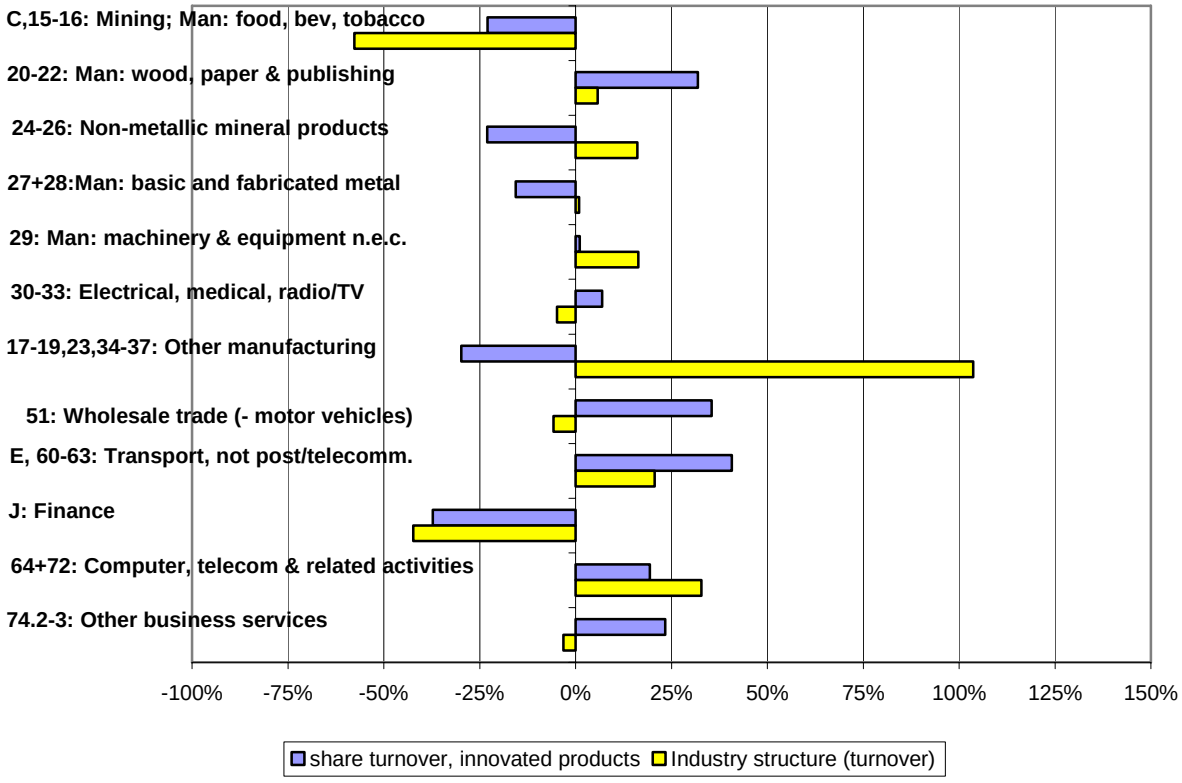
For Norway one industry is much larger than the Nordic average, but having a low share of turnover from innovated products. Only *Manufacturing of basic and fabricated metal; Finance; Other business services* have higher share of turnover from innovated products than the Nordic average. In all, 56% of the lower Norwegian share of turnover from innovated products is thus caused by the industry structure.

In Sweden, neither the industry structure nor the share of turnover from innovated products deviates largely from the Nordic average. The main difference is the larger *Other manufacturing* in Sweden (including motor vehicles), but having a lower share of turnover from innovated products. In all, the higher share of 1.3% is mostly caused by industry structure (85%).

d. Norway



e. Sweden



3.2. Weighting by some measure of size of the enterprise

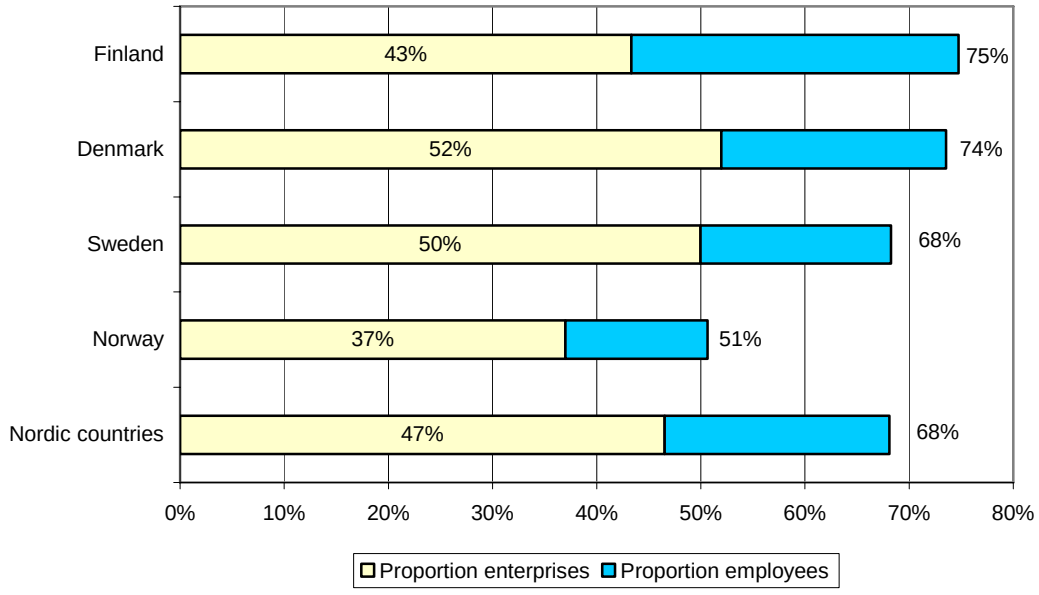
The idea of weighting the responding enterprises with other weights than the number of enterprises in the target population comes from the fact that enterprises in the target population of the CIS-surveys differ very much in size. For indicators based on counting (i.e. proportions) each enterprise counts only as one no matter the size of the enterprise. Thus, it does not matter much, how many of the larger (non-SME) enterprises that are innovating, as they only comprise a small part of all enterprises in the target population. Of course the situation for the larger enterprises can be illustrated by calculating the proportion by size groups, but that still doesn't solve the small influence of the larger enterprises on the National indicators of innovation.

When weighting a proportion by some measure of size it needs first to be decided which measure of size to use. In the CIS-surveys there are two candidates, the number of employees and the turnover. Mostly, the number of employees is preferred, because the turnover might not be available for all enterprises at the time of estimation and also because the level of turnover depends on the industry. Wholesale trade for instance has a higher level of turnover than other industries while R&D-services are lower and some have even no turnover.

A. Innovation active enterprises

The *Proportion of innovation active enterprises* is a counted indicator, but instead of counting enterprises being or not being innovation active one may count the number of employees in innovation active enterprises. In that way, the number of employees is used as a weighting factor, see (4b) in Annex 4. This means that the indicator tells the *proportion of employees working in an innovation active enterprise*.

Figure 3.8 Proportion of innovation active enterprises and proportion of employees in innovation active enterprises in core industries, CIS4

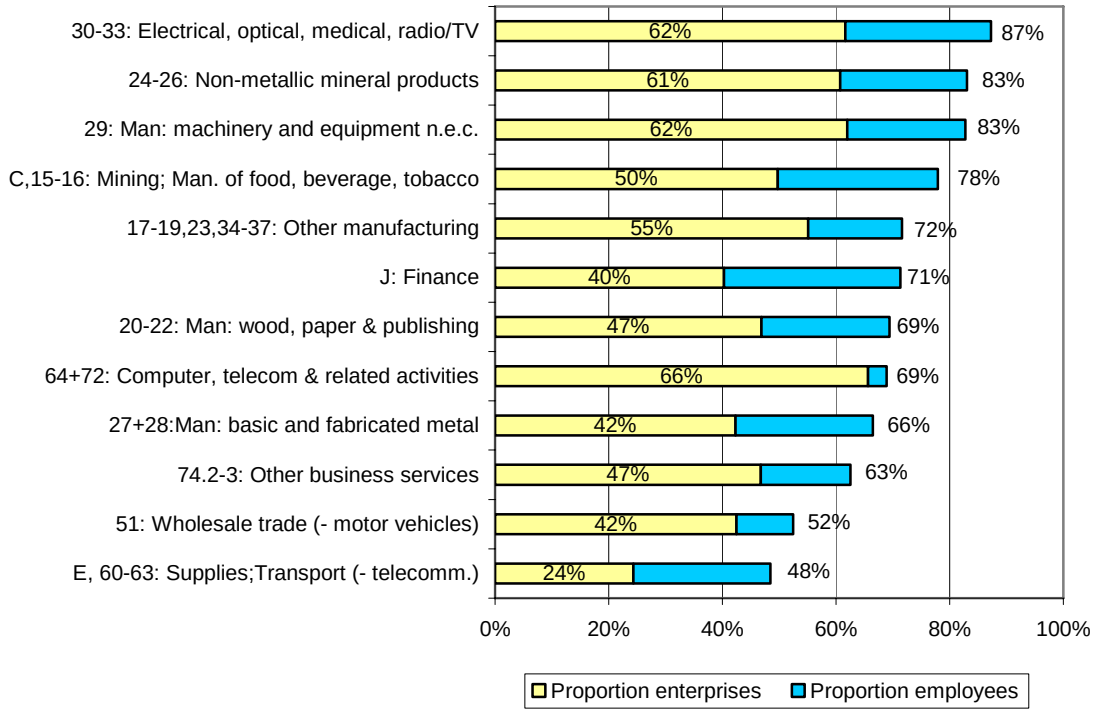


In Figure 3.8, this indicator is presented (excluding Iceland) and compared with the *proportion of innovation active enterprises*.

For the Nordic countries, the proportion based on employees is close to a half time higher than the proportion based on enterprises, from 47% to 68%. However, for Finland the increase is 72 % - from 43 to 75 % - probably caused by some very large innovating enterprises – while the impact is very similar for Denmark, Sweden and Norway. This changes the rank of the Nordic countries, so Finland has the highest share of employees in innovation active enterprises, while Denmark has the highest share of enterprises with innovation activities.

The impact differs, however much between the industry groups. Figure 3.9 illustrate this using the classification of industries in 12 classes and using the Nordic average. While the proportion is doubled in *Supplies;Transportation* and increased with around 30 percentage points for *Mining;Food,beverage,tobacco;Finance,* the increase is minimal for *Computer,telecom & related activities*. In fact, there is a decrease in the proportion in Norway and Sweden, so in these countries smaller enterprises in this industry have a higher share of innovation active enterprises. The effect is that *Computer,telecom & related activities* from being the industry with the highest share of innovation active enterprises only has an average share of employees in innovation active enterprises.

Figure 3.9 Proportion of innovation active enterprises and proportion of employees in innovation active enterprises, industry groups, Nordic countries, CIS4



Finally, also the proportion of employees in innovation active enterprises can be corrected for the industry structure. In Table 4.5, Annex 4 this correction is compared with the non-corrected proportions and as with the correction for the proportion of innovation active enterprises, the correction only has minor influence, mostly on Finland and Norway.

Part 2: Composite Innovation Indicators

4. Indicators of innovativeness

Simple indicators of the share of innovative enterprises are often used as general indicators of innovativeness. For example, one of the most widely used innovation indicators is the share of enterprises that in the observation period has implemented product or process innovations or has ongoing or abandoned innovation activities, see 2.1. However, as Arundel and Hollanders (2005) argue, these broad indicators fail to uncover the wide variation in innovative enterprises, giving an incomplete picture of how innovative enterprises are in a sector or country, and may potentially be misleading in international comparison. Enterprises can innovate in a large number of ways. For example, some enterprises may be at the cutting edge for their market, developing products and technologies that are truly novel. Other enterprises may invest little in in-house development activities and instead adopt new technologies from others. For some enterprises, organizational practices or marketing methods may form the core of their innovation activities.

The ability to classify and distinguish different types of innovative enterprises may be of great value for innovation policy design and for further analysis. There is a need for a clear and detailed view of enterprise innovation that aids in identifying policy needs and characteristics that may help in properly targeting innovation policies. For example, in terms of novelty, there is interest in identifying the most novel enterprises that are active in creating new knowledge, and also in promoting their development. However, in order to fully capitalize on this knowledge creation, it is important that a large share of enterprises adopt and implement this new knowledge in their own goods and services.

4.1 Innovation modes

Development work here takes as a point of departure classifications developed by Arundel and Hollanders (2005), which builds on Tether (2001) and Arundel (2003). Arundel and Hollanders use a variety of CIS innovation variables to characterize 4 types of innovating enterprises, or “innovation modes”. Their classification is based on two main criteria: the level of novelty of enterprises’ innovations and the degree of creative in-house activity. The four innovation modes are (parts of the description are taken from Arundel and Hollanders, 2005):

- **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 favorable, 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**

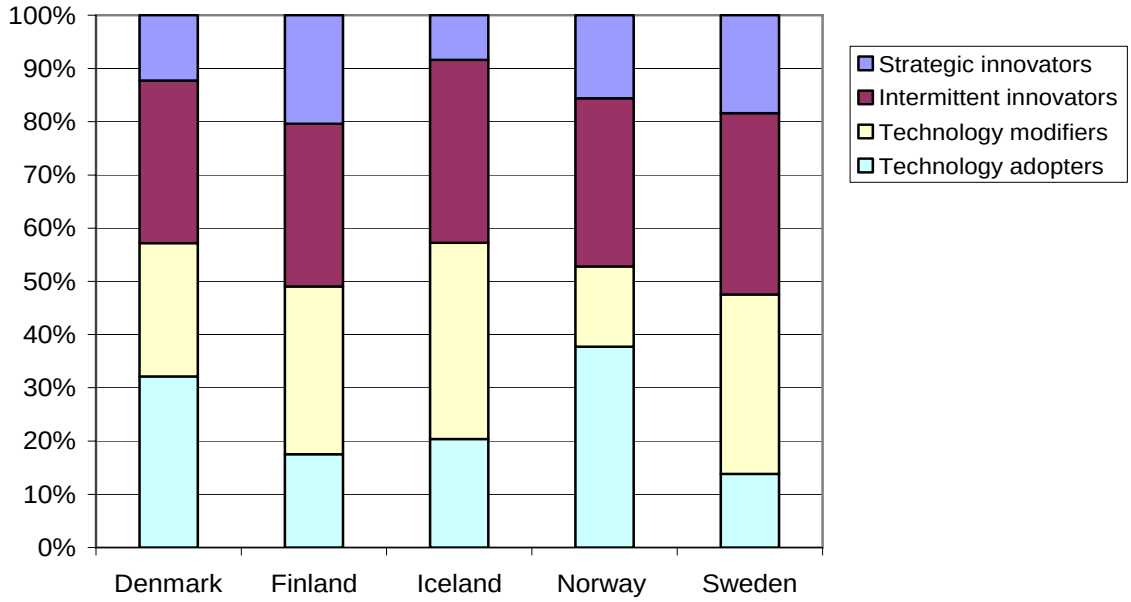
These enterprises modify their existing products or processes through non-R&D based activities. Many enterprises in this group are essentially process innovators that innovate through production engineering.

- **Technology adopters**

  These enterprises primarily innovate by adopting innovations developed by other enterprises or organizations.

Figure 4.1 shows the distribution of 'innovation modes' for Nordic countries. In terms of the most creative innovators, Sweden and Finland have the largest share of strategic and intermittent innovators, followed by Norway. This reflects to some extent the higher share of innovation active enterprises that conduct R&D in Sweden, Finland and Norway. Table 5.1 in Annex 5.a shows shares in absolute terms (ie. as share of total enterprises, both innovative and non-innovative). Denmark, Iceland and Sweden have the highest share of innovation active enterprises, though Sweden has a relatively higher share of strategic and intermittent innovators while Denmark and Iceland have a relatively larger share of modifiers and adopters.

Figure 4.1 Innovation modes for the Nordic countries, CIS4, all core industries. Percent of innovation active enterprises.



Source: Own calculations based on CIS4 data for the Nordic countries. Distribution of innovation active enterprises according to the four classifications.

4.2 Output-based technological modes

One drawback to the above classification is its degree of complication. In particular, the construction of intermittent innovators and technology modifiers are based on a variety of combinations of indicators, making it difficult to define them clearly. Note also that the classification relies very heavily on inputs, namely R&D (and whether it is continuous or

occasional). While R&D is indeed an indicator of creativeness, it could be argued to be more appropriate to put greater focus on output indicators as opposed to input indicators in measuring innovativeness. Furthermore, focus on R&D has often been argued to create a bias towards innovation in manufacturing enterprises.

An alternative to this is to base the classification (almost) solely on innovation outputs, implicitly using them as criteria for both novelty and creativity. The emphasis on novelty follows Arundel and Hollanders' classification, though we propose placing a greater emphasis on output measures, particularly whether product innovations are new to the market or new to the enterprise only. The 'market' comprises the enterprise's own competitive environment. Hence, a product innovation that is new to the market for a enterprise that operates on international markets may be considered more novel than a product innovation that is new only to a domestic market. Based on this, a fairly simple breakdown can be constructed for degrees of novelty:

1. New to the enterprise's market, enterprise operates on international markets

2. New to the enterprise's market, enterprise operates only on domestic markets OR new to the enterprise only (already existing on the enterprise's market), enterprise operates on international markets

3. New to the enterprise only, enterprise operates only on domestic markets

Using the above breakdown for degree of novelty, we propose two variants to Arundel and Hollanders' innovation modes, one based on technological (product and process) innovation only and the other based on both technological and non-technological (organizational and marketing) innovation.

Concerning technological innovation, the following classification is based on innovative novelty and in-house development:

- **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.

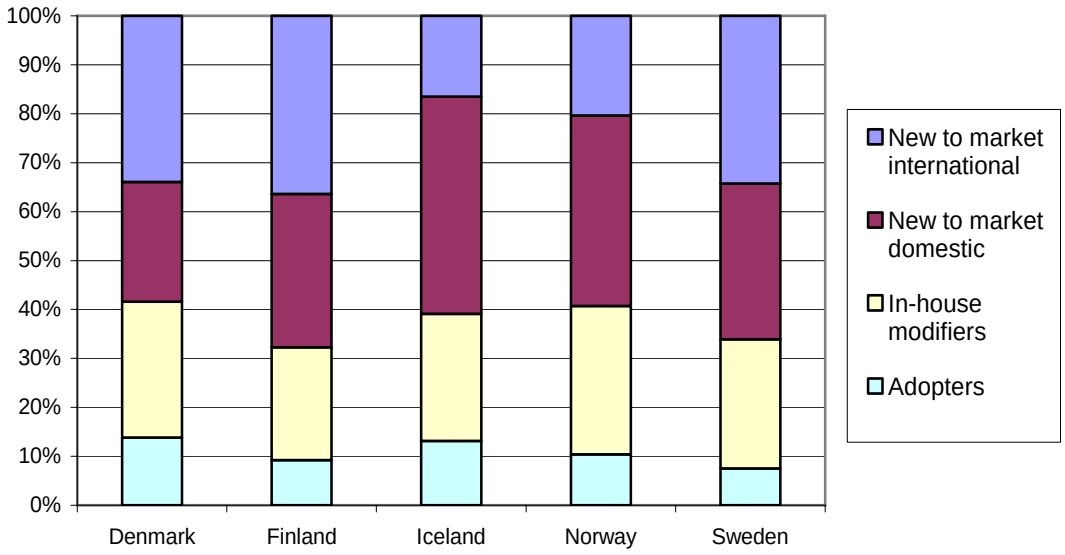
- **Adopters**

  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.

As with Arundel and Hollanders' innovation modes, this classification is mutually exclusive: enterprises are placed in the highest category for which they meet the criteria.

The overall picture here in figure 4.2 is somewhat similar to that in figure 4.1, which is to be expected to some extent given that this classification is a variant to the 'innovation modes'. Over 30 percent of innovation active enterprises are new to market international innovators in Denmark, Finland and Sweden, and around 20 percent in Norway and Iceland. In comparison with innovation modes, new to market international innovators are much larger than strategic innovators. This reflects that many new to market international innovators either do not conduct R&D on a permanent basis or are not engaged in cooperation for their innovation activities. Differences across countries are fairly small when looking at all novel innovators (ie. both new to market international and new to market domestic innovators). For Denmark, Iceland and Norway, around 60 percent of innovation active enterprises are new to market international and new to market domestic innovators, while shares are 5 to 10 percentage points higher for Finland and Sweden. Differences in adopters and modifiers are much less prominent here than for innovation modes. This is most likely due to the focus on R&D in innovation modes; i.e. Sweden and Finland have a higher R&D intensity which results in a lower share of adopters in figure 4.1.

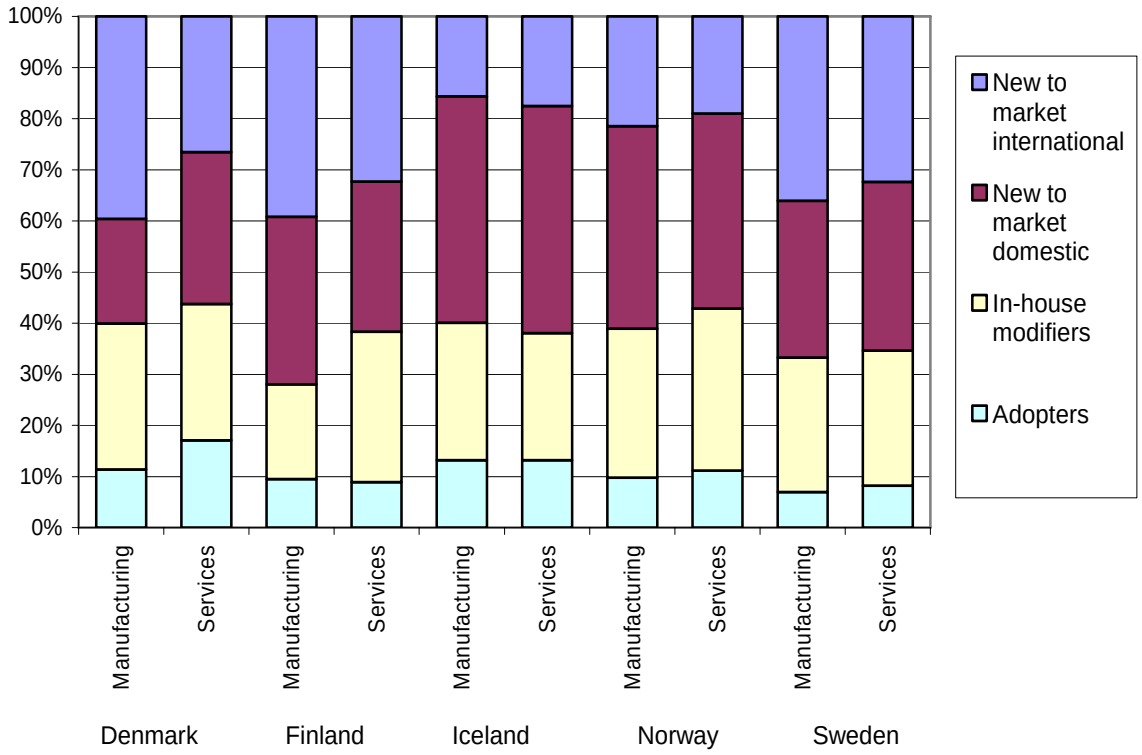
Figure 4.2 Output based technological modes for the Nordic countries, CIS4, all core industries. Percent of innovation active enterprises.



Source: Own calculations based on CIS4 data for the Nordic countries. Distribution of innovation active enterprises according to the four classifications.

Figure 4.3 shows output based modes for services and manufacturing. In general among innovation active enterprises, a lesser share of service enterprises are new to market international or domestic. The difference is largest for Finland and Denmark. As figure 4.3 indicates, differences are not large between manufacturing and services. These differences are, however, more substantial when examining in shares in terms of total enterprises (see table 5.2 in Annex 5.a). Comparing manufacturing and services, shares of innovation active enterprises are around 11-12 percentage points less in the Nordic countries (with the exception of Iceland), with the difference primarily found for new to market innovators. Otherwise the pattern across countries is broadly the same as aggregate totals.

Figure 4.3 Output based technological modes for manufacturing and services, Nordic countries, CIS4. Percent of innovation active enterprises.



Source: Own calculations based on CIS4 data for the Nordic countries. Distribution of innovation active enterprises according to the four classifications.

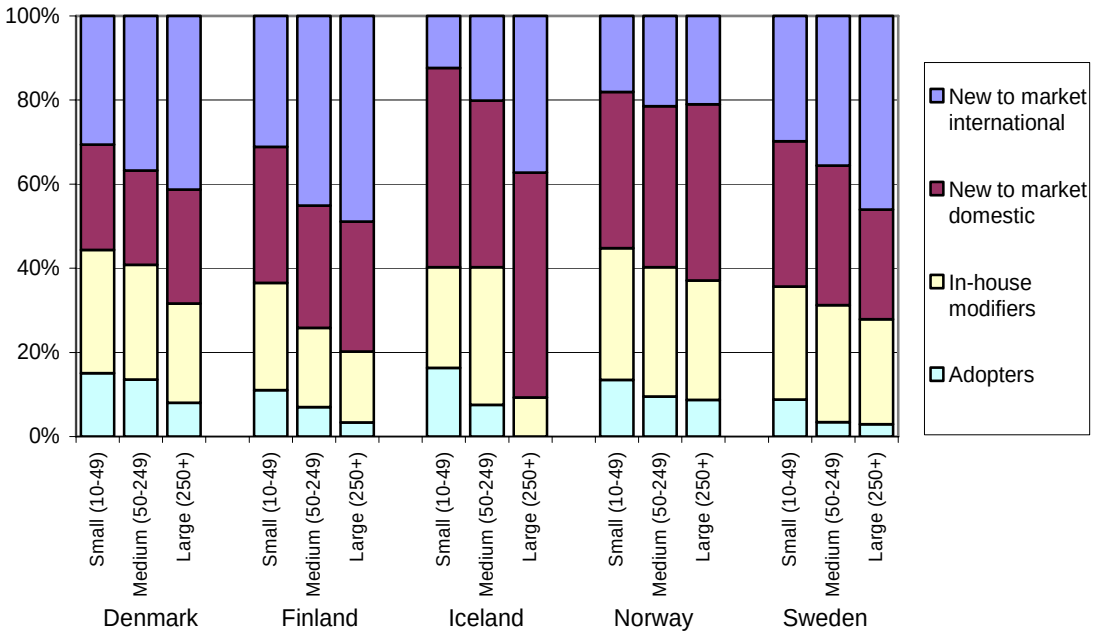
There is increasing emphasis in innovation research and policy discussions on non-R&D activities, with focus both on less R&D intensive enterprises and on non-technological innovation. Table 5.2 in Annex 5.a examines innovation for enterprises without R&D activities. Shares of innovation active enterprises (among those without R&D) are generally much lower than in the aggregate, 17 and 13 percent in Finland and Norway, and 25 percent in Sweden. Though, a sizable share of these enterprises have introduced new to market innovations, suggesting that not all novel innovative activity involves R&D. In comparison with the other countries, non-R&D enterprises in Denmark are much more innovative with 40

percent having innovation activities and 16 percent either new to market international or domestic innovators.

Figure 4.4 shows output based technological modes for enterprises' size classes. It can be seen that there is some cross country variation in innovation performance across size classes. As might be expected, shares of innovation active enterprises with innovation new to market innovations are strongly increasing in enterprise size.

For small enterprises, Iceland has the highest share of enterprises with innovation activities, followed by Denmark and Sweden. Though, this higher innovation performance is very evenly spread across type of innovative enterprises. On the other hand for medium and large enterprises, shares of Danish enterprises with innovation activities are several percentage points lower than for Finland and Sweden. This difference is mainly in terms of the most new to market innovators.

Figure 4.4 Output based technological modes by size classes, Nordic countries, CIS4. Percent of innovation active enterprises.



Source: Own calculations based on CIS4 data for the Nordic countries. Distribution of innovation active enterprises according to the four classifications.

Table 5.3 in Annex 5.a shows distributions across industry classes. The highest shares of novel enterprises are in high tech and high medium tech manufacturing, with generally over half of enterprises in these sectors being classified as new to market international or domestic innovators. It would appear that, for most markets within these industry groups, that strong competition makes novel innovations a necessity. The share of new to market international innovators is substantially lower in all other industries (with the possible exception of knowledge intensive services). At the other end, the share of adopters is

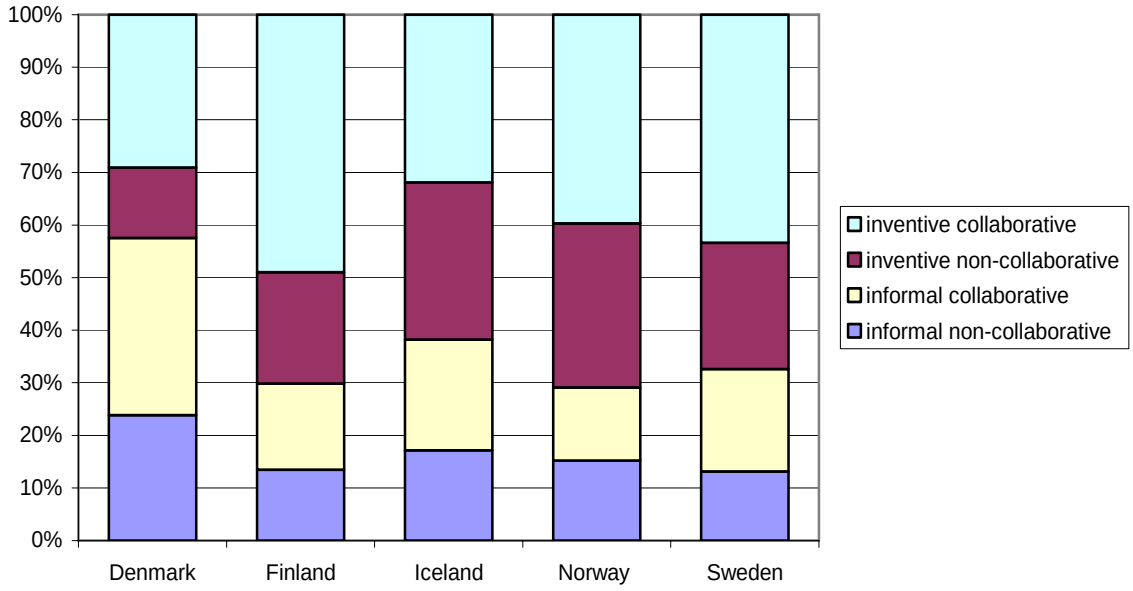
consistently low for all industry groups. It appears that variations in innovativeness across industries are for the most part due to shares of novel enterprises. Innovation activity in terms of adoption or slight modification of existing technologies is surprisingly constant across industries.

Looking broadly at innovation activity across countries, patterns of innovativeness are fairly similar for the more R&D intensive industries and more divergent for less R&D intensive industries. Within low tech manufacturing, Denmark has a substantially higher share of innovation active enterprises, due to high shares of modifiers and adopters. Within wholesale trade, Sweden has the highest share of innovation active enterprises, with a very high share of new to market domestic innovators.

4.3 Diffusion and Inventive activity

Two important dimensions of enterprise innovation are inventive or creative activities and diffusion. Arundel and Hollanders (2006) develop an indicator of innovative enterprises classified along these two dimensions. Inventive in-house activities are measured by in-house R&D or the application for a patent, while reliance of diffused technology is indicated either if enterprises' innovations were developed with or solely by others, or if the enterprise engaged in active innovation cooperation. **Inventive collaborative innovators** both carry out in-house creative activities and rely on diffusion in its innovation activities. **Inventive non-collaborative innovators** carry out creative in-house activities, but do not actively access external knowledge. **Informal collaborative innovators** do not carry out creative in-house activities but actively access external knowledge. Finally, **informal non-collaborators** do not have inventive in-house activities, nor do they actively access external knowledge.

Figure 4.5 Innovation active enterprises by collaboration and inventive activity, Aggregate data, Nordic countries, CIS4. Percent of innovation active enterprises.



Source: Own calculations based on CIS4 data for the Nordic countries. Distribution of innovation active enterprises according to the four classifications.

Around half of all innovation active enterprises in Finland are inventive collaborative, while the total share of inventive enterprises is around 70 percent in Finland, Norway and Sweden. The share is slightly less in Iceland. The high share of inventive collaborative enterprises in Finland and (to a somewhat lesser extent) in Sweden and Norway implies they are both active in creating new knowledge in-house and also in accessing knowledge from external partners.

In contrast to the other Nordic countries, Denmark has a much lower share of inventive collaborative enterprises. A substantially higher share of enterprises in Denmark has informal (or non-inventive) innovation activities compared to other Nordic countries, particularly among those with collaboration. This suggests a higher share of enterprises that rely on adoption of knowledge and technology from others, either actively (as in the case of informal collaborative innovators) or passively (informal non-collaborators).

4.4 Dual innovators

Service innovation, or the development of new services, is not a phenomenon that is restricted to the service sector. 'Traditional' manufacturing enterprises appear to be devoting an increasingly greater share of their activities towards the production of services[10]. However, there is a lack of statistical data on this trend and its scope, nor has there been much analysis of innovation processes for service development in manufacturing enterprises. The development and delivery of services may pose a whole new set of challenges for manufacturing enterprises, in terms of knowledge competences, organizational practices and distribution channels.

A special feature of the CIS4 survey is that it separates product innovations into goods innovations and service innovations. This allows us to identify service innovating enterprises across industrial classes in both the manufacturing and service sectors. Furthermore, we are able to identify those enterprises that are active in both good and service innovation, though we do not have any information on whether goods and service innovations are an integrated innovation or separate good and service innovations.

Dual innovators refer to enterprises that have implemented both a good and service innovation. An analysis of dual innovators can help provide a picture of how prevalent service innovation is in manufacturing enterprises (and likewise the prevalence of goods innovation in the service sector). In addition, it can help provide some information on how these enterprises innovate. In some cases it may be interesting to distinguish dual innovators (good and service innovators) in manufacturing from those in services (and enterprises with process innovations only can function as a default for PP innovative enterprises). For this reason we propose the following classification:

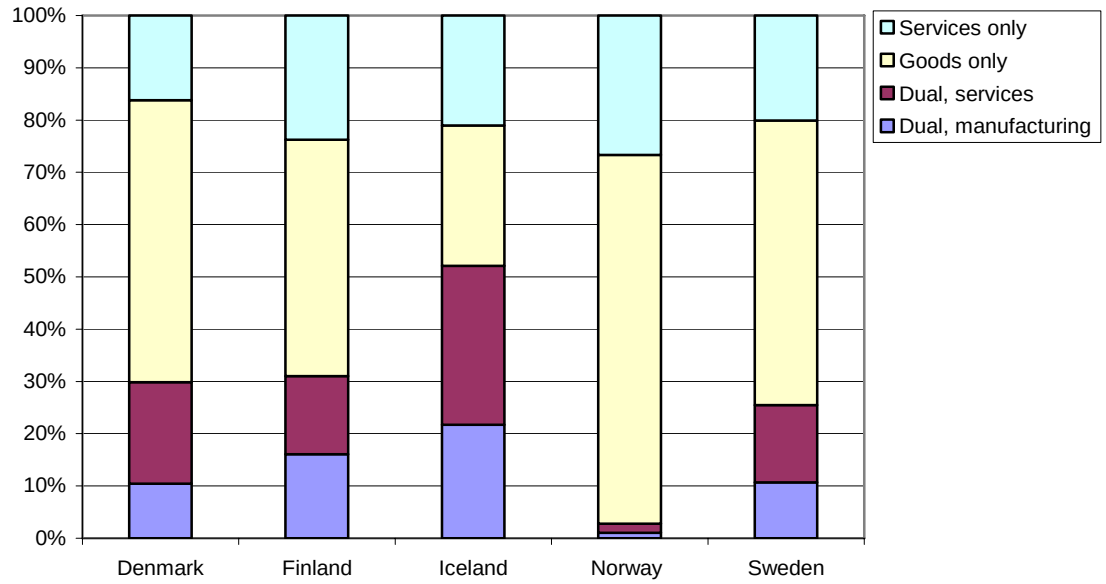
[10] See e.g. Howells (2004).

- Dual (good and service innovation) manufacturing
- Dual (good and service innovation) services
- Good innovation
- Service innovation
- Process innovation only

Figure 4.6 shows the aggregate shares of product innovators in the five Nordic countries, broken down according to type of product innovation[11]. In some cases it may be interesting to distinguish dual innovators (good and service innovators) in manufacturing from those in services. These two types are identified in figure 4.6.

In Denmark and Finland, around 30 percent of product innovators have introduced both good and service innovations, and around a quarter of all product innovators in Sweden. In Iceland, over half of product innovators are dual innovators. In Norway, however, the share of dual innovators is almost negligible. Given the large degree of homogeneity of the Nordic countries in most other aspects, this result is somewhat surprising. In Denmark, Iceland and Sweden a higher share of dual innovators is found in the service sector, whereas the opposite is the case for Finland.

Figure 4.6 Aggregate shares of product innovators by type of product innovation, CIS4, Nordic countries. In percent.



Source: Own calculations, CIS4 data. Based on Eurostat Core industries, 10 employees or greater.

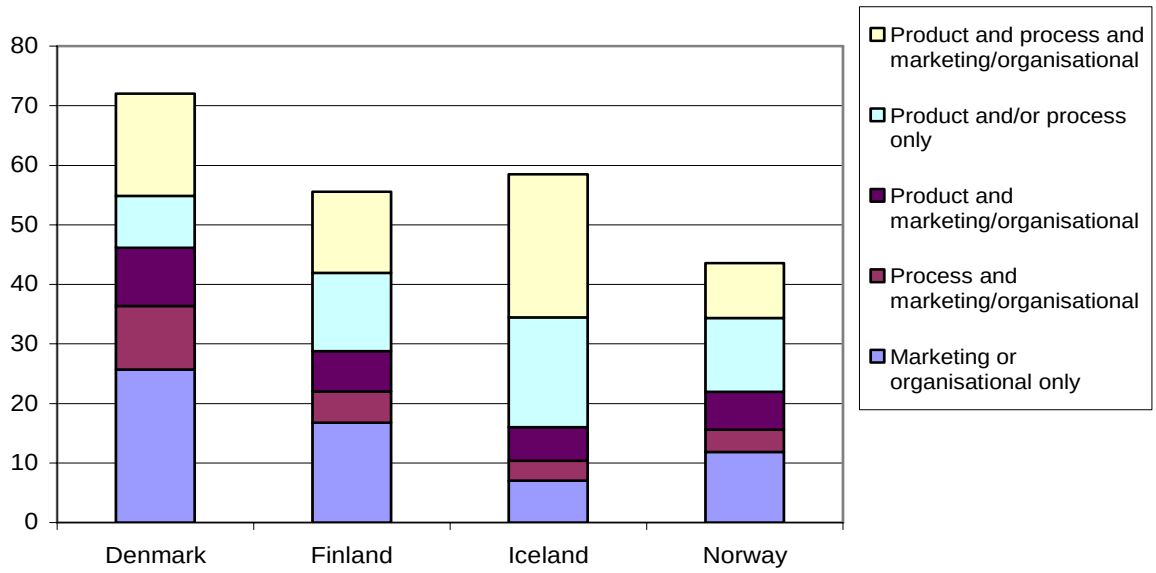
[11] Shares of enterprises with process innovations only are not shown in the figure.

4.5 Subtypes of technological and non-technological innovations

The Oslo Manual innovation concept includes four different subtypes: product, process, organizational and marketing innovations. The analysis of different combinations of subtypes is of interest both for the reasons to identify enterprises that have implemented more than one type of innovation, and also to examine linkages between different types of innovations. Multiple innovations may reflect that the enterprise is active in improving and renewing its activities *across* the enterprise: product development, internal processes, organization, marketing, etc. CIS4 does not contain information on whether different types of innovations are in fact linked or part of the same larger innovation. These links will be examined more directly in CIS2006 in some countries, where enterprises will be asked whether organizational or marketing innovations are related to other innovations. However, an examination of simple combinations of innovation types may still be useful to investigate a number of issues, particularly the prevalence of non-technological innovation among technological innovators.

The concepts of marketing and organizational innovation are new and not all EU countries included them in CIS4. Hence, results using non-technological innovation should to some extent be considered exploratory. Though, given the importance attached to the role of organizational innovation, it would seem worthwhile to attempt to examine these factors. Of the five Nordic countries, Norway, Denmark and Iceland included non-technological innovations in CIS4. Finland, however, included in CIS4 questions on organizational and marketing changes along the lines of those used in CIS3. While it should be emphasized that these questions are not fully comparable with those for Denmark, Norway and Iceland, we include them to give a rough comparison.

Figure 4.7 Subtypes of innovations for the Nordic countries, CIS4. In percent.



Source: Own calculations, CIS4 data. Based on Eurostat Core industries, 10 employees or greater. Data on organizational and marketing innovations are not available for Sweden. Note also that for Finland, non-technological innovation refers to questions of organizational and marketing changes. Thus, results for Finland may not be fully comparable to those for the other countries.

Figure 4.7 shows (technological and non-technological) innovative enterprises divided into 5 groups: enterprises with both product and process innovations plus non-technological innovation; product or process innovators without non-tech innovation; product or process innovators respectively, with non-tech innovation; and finally, non-tech innovators. In terms of total enterprises, Denmark has the highest share of enterprises with non-technological innovations, with over 60 percent having implemented a marketing or organizational innovation. In Finland and Iceland the share is around 40 percent and around 30 percent in Norway.

In terms of (tech and non-tech) innovative enterprises (enterprises that have implemented at least one type of innovation, as shown in figure 4.7), Iceland has both the highest share of enterprises with product, process and non-tech innovations and the highest share of technological innovators without a non-tech innovation. Note also that quite a small share of enterprises have implemented technological innovations only. Less than a third of (tech and non-tech) innovative enterprises have product and process innovations only in Norway and Iceland, around a quarter in Finland and less than 15 percent in Denmark.

4.6 Technological and non-technological modes

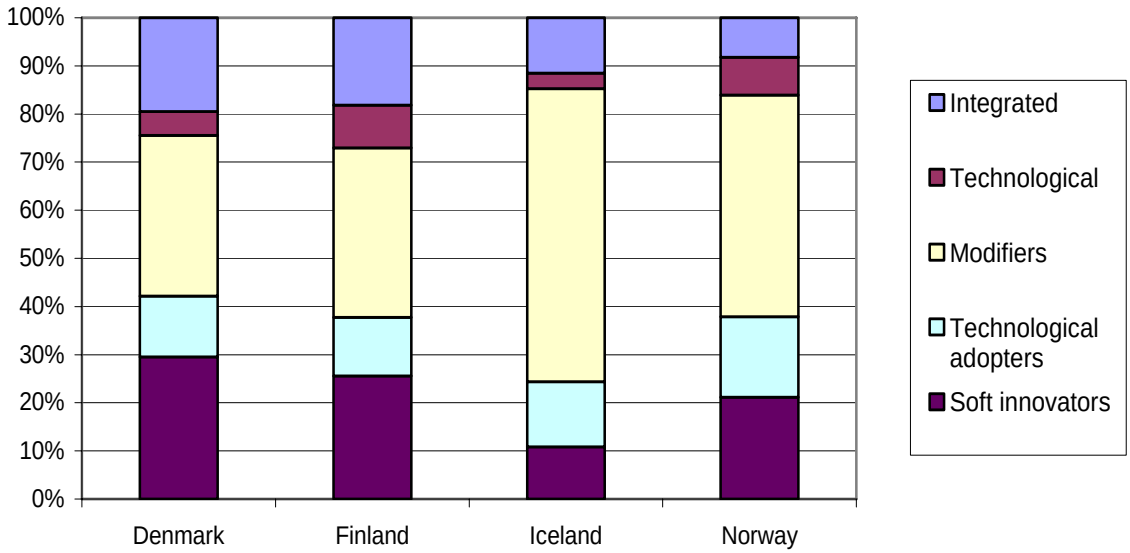
As noted above, multiple innovations may reflect wide reaching innovation activities across various functions in the enterprise. They may also be more active in integrating these different activities. Multiple innovations may also reflect that the enterprise places greater emphasis on capturing and utilizing knowledge and on building its learning capacity.

These two dimensions – 'breadth of innovations' and novelty – can be used to construct a typology of innovative enterprises based on all four types of innovations:

- **Integrated innovators**: Integrated innovators have implemented a new to market international product innovation and an organizational innovation, which indicates that innovation activity is implemented across the enterprise. As above, these enterprises have developed innovations in-house.
- **Technological innovators:** Like integrated innovators, technological innovators have implemented a new to market international product innovation in-house, but may not have introduced an organizational innovation.
- **Modifiers:** These enterprises have introduced a product or process innovation developed at least partly in house, but not new to international markets. This group is thus larger than the corresponding group in 'output-based technological modes'.
- **Technological adopters**: These enterprises have implemented a product and/or process innovation (or has ongoing/abandoned technological innovation activities), but neither of these were developed in-house.
- **Soft innovators**: These enterprises have introduced a marketing or organizational innovation, but have not introduced a technological innovation.

Figure 4.8 shows tech and non-tech modes for the Nordic countries. In examining shares of integrated and technological innovators it can be seen that for Denmark and Iceland, a high share of new to market international innovators have also implemented organizational innovations, whereas this share is much lower for Finland and Norway. The share of soft innovators is highest for Denmark and lowest in Iceland.

Figure 4.8 Technological and non-technological modes, Nordic countries, CIS4.

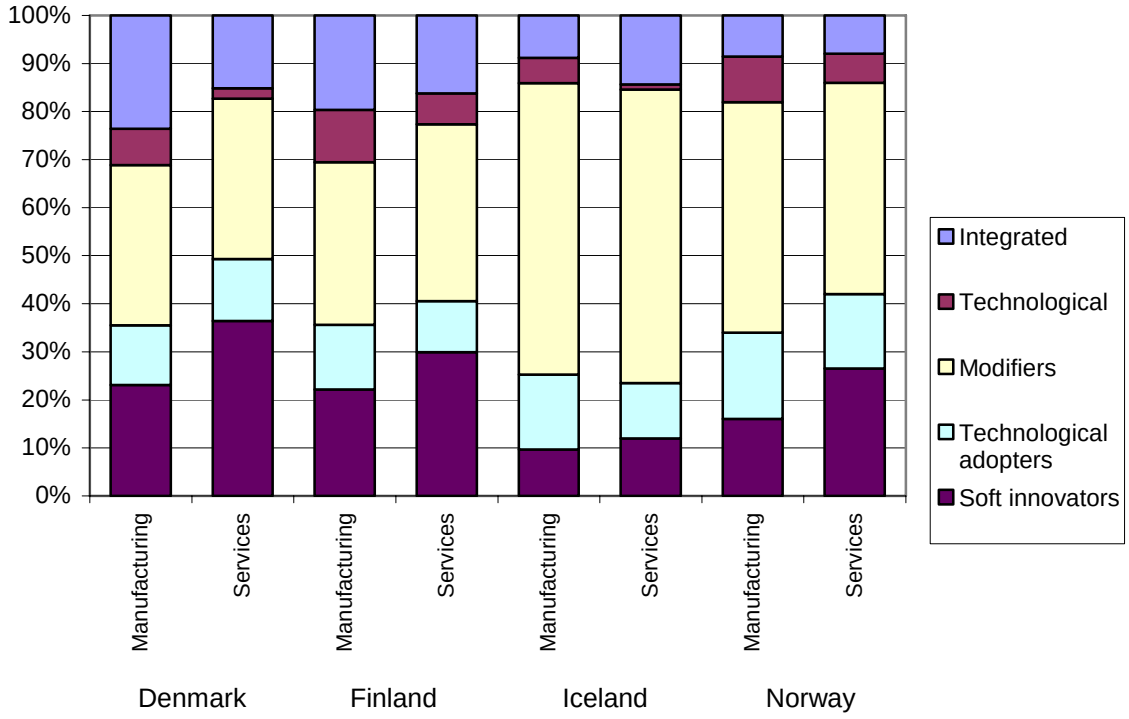


Source: Own calculations, CIS4 data. Based on Eurostat Core industries, 10 employees or greater.
Shares based on total number of enterprises with any of the four types of innovations, product, process, organizational or marketing, or with product-process innovation activity. Data on organizational and marketing innovations are not available for Sweden. Note also that for Finland, non-technological innovation refers to questions on organizational and marketing *changes* and thus may not be fully comparable to those for the other countries.

Figure 4.9 shows distributions for manufacturing and services. While differences are fairly moderate within manufacturing, they are much more pronounced for services (see also table 5.6 in Annex 5.a). The share of soft innovators within services is much higher in Denmark than in Finland, Norway and Iceland. Assuming these figures are comparable[12],this implies that a substantially higher share of non (technologically) innovative service enterprises in Denmark are actively innovating their business operations through changes in their marketing and/or organizational practices.

[12] For the case of Norway and Denmark, we have good reason to think they are comparable, as they are both based closely on the standardized CIS4 questionnaire

Figure 4.9 Technological and non-technological modes, manufacturing and services, Nordic countries, CIS4.



Source: Own calculations, CIS4 data. Based on Eurostat Core industries, 10 employees or greater.
Shares based on total number of enterprises with any of the four types of innovations, product, process, organizational or marketing, or with product-process innovation activity. Data on organizational and marketing innovations are not available for Sweden. Note also that for Finland, non-technological innovation refers to questions of organizational and marketing changes. Thus, results for Finland may not be fully comparable to those for the other countries.

5. Linkage indicators

The capture and use of knowledge are important factors in characterizing innovative enterprises. The role of linkages has been emphasized in a number of strands of innovation theory, among them innovation systems (eg. Lundvall, 1992; Nelson, 1993, Edquist, 1997), open innovation (eg. Chesbrough, 2003, 2006) and user-driven innovation (eg. Nordic Council of Ministers, 2006; von Hippel, 2005). CIS4 contains the following linkage or diffusion indicators:

- Information sources
- Innovation cooperation
- Acquisition of external knowledge
- Who developed product and process innovations (mainly by enterprise alone, mainly by others, or in cooperation with others)

Each of these may provide different information on enterprises' innovation activities, and may potentially be combined to analyze both types of sources of (inbound) diffusion, level of interaction, and their importance for enterprises' innovation activities. Among the questions of interest are:

- Which types of external sources are most important?
  - As passive information sources
  - As active cooperation partners
- To what extent external linkages are given great importance for enterprises' innovation activities?
- Do enterprises mainly rely on information sources or also tend to engage in active cooperation?
- Does the cooperation stretch over international boundaries?
- How prevalent do knowledge acquisitions seem to be compared to other types of diffusion?

Simple linkage indicators, for example of information sources or innovation cooperation, may be very informative in examining these issues, as is shown in Chapter 2 of this report. This section explores the use of composite indicators to provide additional insight on enterprises' access to and use of external knowledge.

5.1 Composite linkage indicators

CIS4 data contains information on a fairly long list of information sources or cooperation partners. This may be of value in some cases, however in others it may be beneficial to construct indicators based on more than one source. We propose the following list which is relevant for both information sources and innovation cooperation:

- Suppliers
- Market (Clients and competitors)
- Public research (Universities and government research)
- Open sources (Conferences, trade associations and scientific journals) (only relevant for information sources)

Note that suppliers are separated from other enterprises as sources. While similar types of enterprises may cooperate with clients or competitors, factor analyses indicate that enterprises that rely on suppliers as important external sources may be quite different than those that rely on clients or competitors. Interactions with public research institutions are of particular interest for policy, as many innovation policies focus on promoting industry-science relations. Open sources have in common that they all are sources of codified information. One type of source, consultants and commercial R&D labs, has been left out for simplicity, due to the fact that it is generally a less important external source. However, this source can clearly be included if desired.

Table 5.7 in Annex 5.b shows shares of enterprises with cooperation across the 8 industry groups in Denmark, Finland, Norway and Sweden.

Generally, enterprises within high tech manufacturing are most likely to cooperate with others compared to other sectors. This is particularly the case for cooperation with public research institutes. High tech enterprises are in general just as likely to cooperate with public research institutions as with other enterprises. However, in other sectors cooperation with suppliers or customers/competitors is often much higher than with universities or government research.

Looking at individual countries in comparison, cooperation in Finland is the highest across almost all industries and types of partners. Finnish enterprises are more likely to cooperate with customers and competitors, though the most substantial differences are for cooperation with public research and cooperation with international partners. For the four other countries, cooperation with both international partners and with public research is much lower. Cooperation with other enterprises is generally higher in Sweden than in Denmark, Norway and Iceland. In all countries, shares of enterprises that cooperate with suppliers are fairly similar to the share that cooperates with customers and competitors.

5.2 Degree of interaction with external sources: Arm's length and active cooperation

Data on information sources useful for innovation activities and on active innovation cooperation both provide information on enterprises' accessing and use of external knowledge. Data on innovation cooperation indicates what types of collaborative partners enterprises have for their innovation activities and their geographic location. This data however does not indicate the importance of these partners for enterprises' overall innovation activities. A general assumption is that collaborative partners are the most important sources of external knowledge, though this may not always be the case. Data on information sources on the other hand shows which types of sources are important for enterprises' innovation activities. However, this indicator does not provide information on what type of interaction was mainly involved, for example whether the interaction was one-way transfer of knowledge at 'arm's length' or if it involved active cooperation.

An indicator can be constructed that utilizes data on both information sources and cooperation. The objective is to examine for which enterprises a type of source (e.g. suppliers) is important as a source of information but only used at arm's length, or as an active cooperation partner. Arm's length interaction is denoted here as enterprises that cite a type of source as an important or highly important information source, but are not engaged in cooperation with them. 'Cooperation' here denotes enterprises that both cite market sources as important or highly important and are engaged in cooperation with them.

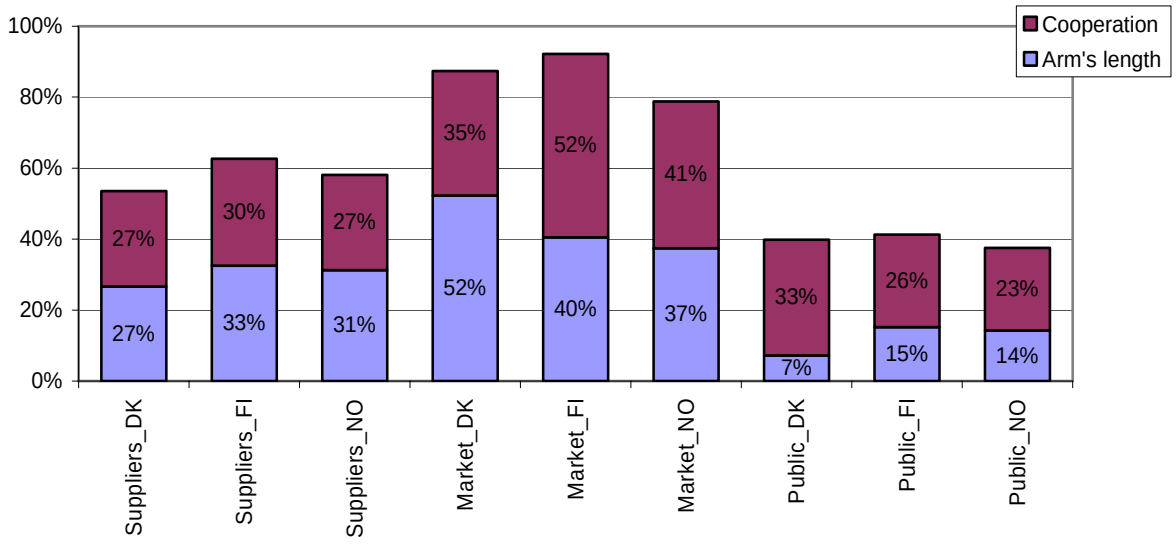
It identifies (medium and highly) important types of information sources and classifies according to those that use the source at arm's length and those that engage in active cooperation with the source. Using the three types of sources shown above - **suppliers**, **market** (clients and competitors) and **public** (universities and government research) - gives 6 outcomes in all:

- Supplier as (medium or highly) important arm's length source of external knowledge
- Supplier as (medium or highly) important source of external knowledge and active cooperation partner)

- Clients and competitors as (medium or highly) important arm's length source of external knowledge
- Clients and competitors as (medium or highly) important source of external knowledge and active cooperation partner
- Public research as (medium or highly) important arm's length source of external knowledge
- Public research as (medium or highly) important source of external knowledge and active cooperation partner

The ability to on the one hand identify the most important external sources of knowledge and on the other hand distinguish between arm's length accessing of knowledge and active cooperation may be useful for innovation policy. This allows policymakers to examine individual sectors or groups of enterprises and how they access external knowledge. For some enterprises it may be concluded that they are able to effectively access and utilize external knowledge without close interaction. In other cases however, these types of indicators may help to identify potential barriers to active cooperation that can be lessened through policy measures. In particular indicators of how and to what extent enterprises interact with public research institutions may be very relevant for policy use.

Figure 5.1 Interaction with external sources, High tech manufacturing, Denmark, Finland and Norway, CIS4, percent.

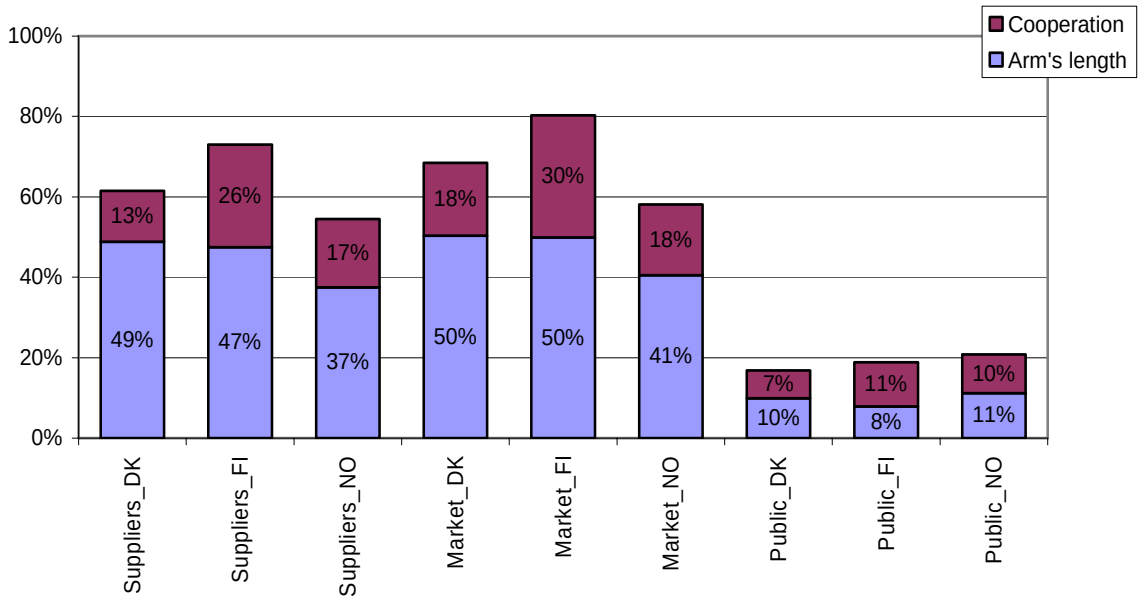


Source: Own calculations, CIS4 data. Based on Eurostat Core industries, 10 employees or greater. Arm's length interaction gives shares of innovation active enterprises that cite clients or competitors as important or highly important information sources, but are not engaged in cooperation with them. 'Cooperation' gives the share both cites market sources as important or highly important and is engaged in cooperation with them.

Figure 5.1 shows the interaction indicator for high tech manufacturing. In terms of importance as an information source, shares for each type of source are fairly similar across countries. This is also the case for types of interaction with suppliers, with just under half of the interactions involving active cooperation.

For interaction with market sources, 87 percent of Danish high tech manufacturing enterprises cite customers or competitors as important for their innovation activities, but only 35 percent are engaged in active cooperation. As can be seen from the figure, this is substantially lower than in Finland or Norway. The opposite pattern is present for interaction with public research. While almost equal shares cite public research institutions as important in the three countries, a much larger share of this interaction involves active cooperation for Danish enterprises[13].

Figure 5.2 Interaction with external sources, Low tech manufacturing, Denmark, Finland and Norway, CIS4, percent.



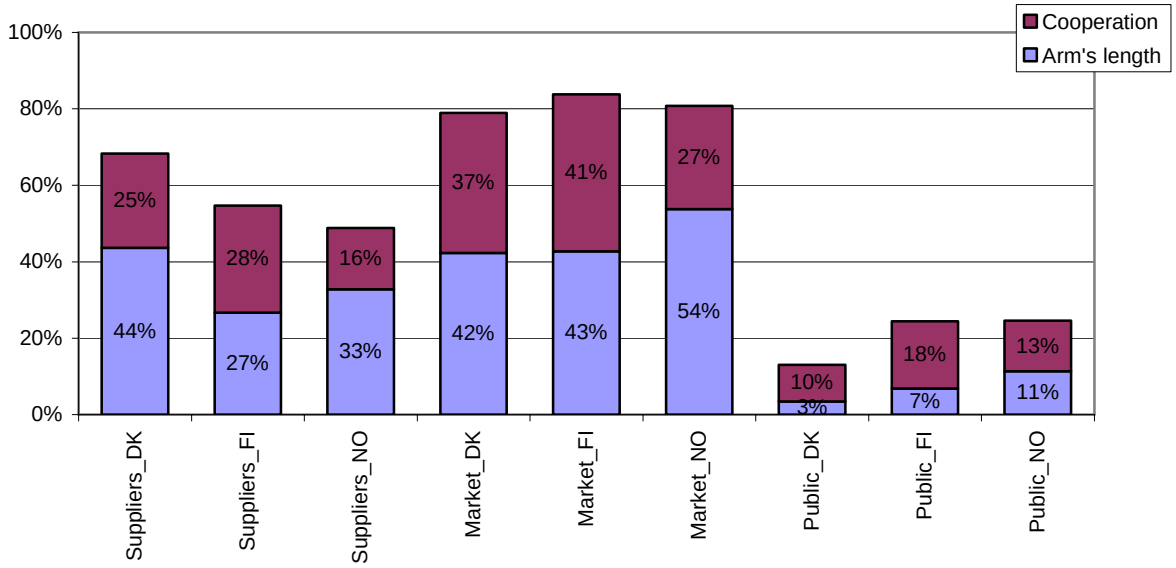
Source: Own calculations, CIS4 data. Based on Eurostat Core industries, 10 employees or greater. Arm's length interaction gives shares of innovation active enterprises that cite clients or competitors as important or highly important information sources, but are not engaged in cooperation with them. 'Cooperation' gives the share both cites market sources as important or highly important and is engaged in cooperation with them.

Figure 5.2 above shows the figures for low tech manufacturing. In comparison with high tech manufacturing, suppliers are a more important information source while market sources and public research are less important. However, in all cases the share of enterprises involved in active cooperation is much lower than for high tech manufacturing. Arm's length accessing of external knowledge is more prevalent for low tech manufacturing.

Figure 5.3 shows knowledge intensive services. As with high tech manufacturing, customers and competitors are the most important external source, and a high share of interaction with all types of sources involves active cooperation. However, interaction with public research is much lower than for high tech manufacturing.

[13] Note that this indicator only includes innovation cooperation for which the type of source was cited as important or very important. Shares of enterprises with cooperation may therefore vary from those in table 5.7 in Annex 5.b.

Figure 5.3 Interaction with external sources, Knowledge intensive services, Denmark, Finland and Norway, CIS4, percent.



Source: Own calculations, CIS4 data. Based on Eurostat Core industries, 10 employees or greater. Arm's length interaction gives shares of innovation active enterprises that cite clients or competitors as important or highly important information sources, but are not engaged in cooperation with them. 'Cooperation' gives the share both cites market sources as important or highly important and is engaged in cooperation with them.

5.3 Innovation drivers

Closely related to above discussion of linkages and which external sources are most important is the concept of innovation drivers. Innovation drivers are relevant for policy in a number of ways. For example, much innovation policy consists of R&D support, however the overall impact of these policies will depend greatly on how new knowledge and technology is diffused throughout the economy and implemented in new products and processes. Indicators of technology as a driver of innovation can be useful in this context.

There is also increasing focus on the role of consumers in product development (eg. Nordic Council of Ministers, 2006; Commission of European Communities, 2006). User driven innovation involves the use of knowledge of customer needs in the enterprise's innovation activities. It also implies a greater focus on the latter stages of product development and on market introduction. Furthermore, interaction with customers may not only concern identifying user needs, but also seeking solutions for the development of new products. This attributes users a greater role as a linkage source, potentially also as a source of new technological knowledge. For policy purposes, it is thus valuable to have indicators of the role of customers as a driver of product development.

This subsection develops composite indicators of innovation drivers. These indicators use data on product and process innovations and cooperation to develop indicators of the driving

forces of innovations. Data on the importance of information sources can also be used to construct these indicators[14] (see below).

The indicators are defined to be partially mutually exclusive, so that one can examine the distribution of enterprises according to these drivers. More specifically, enterprises may both be market and technology driven, but supplier driven and internally driven are defined as defaults for enterprises that are not market or technology driven.

- **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.

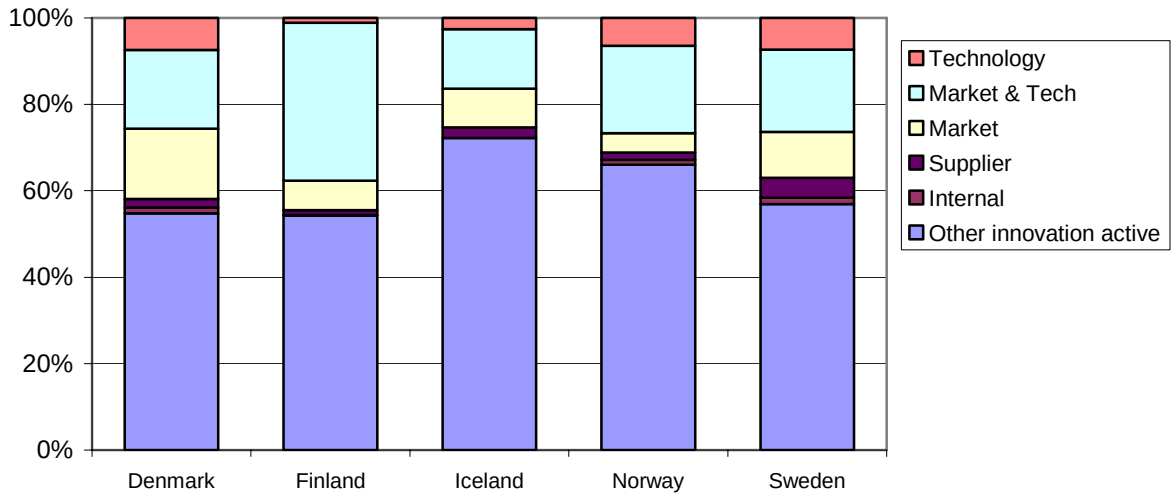
- **Internally driven innovation**

  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.

[14] However, data on information sources is not available for Sweden.

Figure 5.4 shows the results for the Nordic countries. It can be seen that less than half of all enterprises with innovation activity are classified by this indicator, limiting its usefulness. A main reason for this is the use of innovation cooperation as a proxy for innovation drivers. Many external sources may be important driving forces for enterprises without being involved in active cooperation. Keeping this in mind, a few things can be noted from figure 5.4. First, over a third of (innovation active) Finnish enterprises are both market and technology driven. Over 40 percent of Danish and around 35 percent of Swedish innovation active enterprises are either market or technology driven. With the partial exception of Sweden, a very small share of enterprises are supplier driven, implying that while suppliers may often be an important external source for innovation, they are seldom the sole drivers of enterprises innovation activities.

Figure 5.4 Innovation drivers based on innovation cooperation, CIS4, Nordic countries.

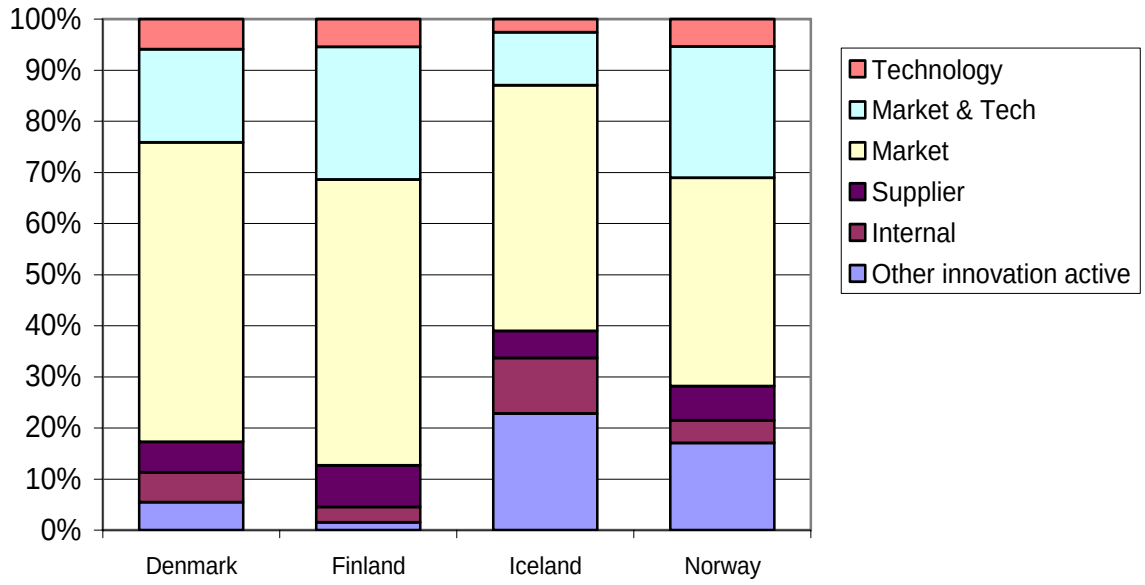


Own calculations based on CIS4 data for the Nordic countries. Shares are in terms of innovation active enterprises. Indicators are as described in text above.

An alternative to using innovation cooperation is to use information on the importance of external sources as knowledge providers for enterprises' innovation activities. Figure 5.5 shows results using data on information sources instead of innovation cooperation. Here an external information source is considered a driver if it is cited as an important or very important source for an enterprise's innovation activities.

As shown in figure 5.5, the indicator now classifies almost all innovation active enterprises in Denmark and Finland, and around 80 percent in Norway and Iceland. Data on information sources is not available for Sweden. By this measure, 55-60 percent of innovation active enterprises are market driven only. For Finland, an additional 25 percent are both market and technology driven, around 15 percent for Denmark. Around 5 percent of enterprises are technology driven only. Norway has an equivalent share of technological and market & tech driven enterprises to that of Finland, though a smaller share that is market driven only. Iceland, on the other hand, has a relatively small share of technology (and market & tech) driven enterprises, and a fairly large share that are market driven only. Shares of supplier and internally driven enterprises are generally between 5 and 10 percent for the 4 countries.

Figure 5.5 Innovation drivers based on information sources, CIS4, Nordic countries.



Own calculations based on CIS4 data for the Nordic countries. Shares are in terms of innovation active enterprises. Indicators are as described in text above. Data on information sources not available for Sweden.

5.4 Innovation drivers and stages of product development

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. Enterprises 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. Enterprises may draw on different sources at different stages of product development, and information on this may be very useful for understanding linkages.

An example is Industry-Science relations (see Polt et al, 2001). Public research institutions can potentially contribute to enterprise 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.

5.5 Indicators of the role of demand/market factors on innovation - Future directions

Demand plays an important role in innovation and has been the subject of increased policy interest. However, demand is a broad concept that may influence or play a role in enterprise innovation in a variety of ways, many of them central to the issue of linkages. 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 enterprise's innovation activities. Improving coverage of these topics in innovation surveys may greatly enhance our understanding of the role of demand and users in innovation. These aspects are very overlapping; though considering each individually helps to bring out specific points.

Lead-user innovation involves the participation of lead users in the actual development of new products (e.g. Lilien et al., 2002), while user innovation concerns innovations that are created by users independently (von Hippel, 2005). 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 attributes users a greater role as a linkage source, potentially also as a source of new technological knowledge.

Another aspect concerns how enterprises collect and utilize information on demand in their internal innovation processes, i.e. methods used by enterprises to analyze market demand and the flows of this information within the enterprise. 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. 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.

6. Public involvement

CIS4 has data both on public funding, use of public institutions as information sources, and on cooperation with public research institutions on innovation projects. The interest here is for example in identifying where public funding is going (which enterprises, sectors, etc.), which sectors have the most contact with public institutions and thus might be most likely to benefit from public policies or alternatively, which sectors have not been impacted and thus should receive greater attention in the future.

This is also part of a larger topic that is potentially of great policy relevance – linkages (use of, importance, etc.) institutional organizations. This could include a wide range of innovation support institutions within technology transfer, incubators, entrepreneurship, establishing networks, consulting, etc. 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.

7. Effects and hampering factors

The standard CIS4 questionnaire contains data on nine effects of product and process innovations and eleven barriers to enterprises' innovation activities. Data on effects provide both information on the outcomes of innovations and also the most important aims of enterprises' product and process development activity. Data on barriers identifies which factors are the greatest hindrances to innovation activities.

While such detailed information may be useful in some cases, in others it may be beneficial to have a few composite indicators that reveal the most important effects and barriers to innovation activity to be used in deeper analyses. Both the effects and hampering factors are organized in subgroups in the questionnaire, but the question is whether these subgroups can be used to construct composite indicators. This has been investigated by using factor analyses using CIS4-data from three Nordic countries, Denmark, Finland and Norway. Here, the results of the factor analyses and the derived composite indicators will be presented.

7.1 Effects of product and process innovation

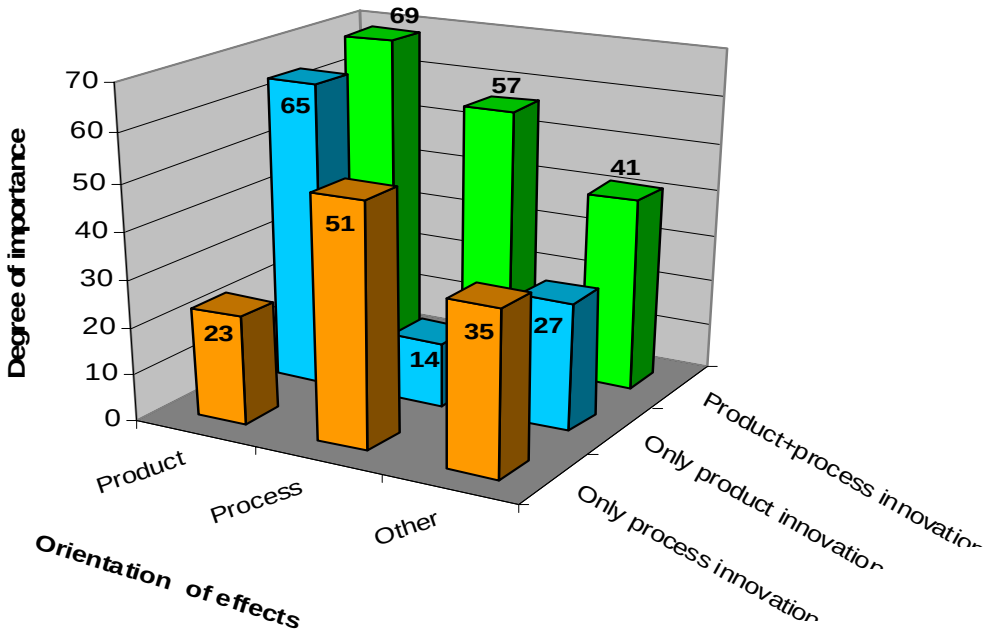
The effects of product and process innovation are organized in three subgroups – product oriented, process oriented and other effects. So, factor analyses with three factors have been performed, see the results in Annex 5.c. The factor analyses in all three countries confirm the existence of three latent factors, which each are loading on each of the three subgroups.

A composite indicator for each of the subgroups can be constructed by using the scoring coefficients of the factor analysis. Here, it is suggested to further rescale the indicator, setting

the minimum value to 0 (no effects in any of the effects of the subgroup) and the maximum value to 100 (*high* effects in all effects of the subgroup). In this way the composite indicators express the degree of importance of the effect.

The calculation of the values of the composite indicators in this way needs access to the micro data. There has not been time to perform such an analysis for all five countries, so only a single graph based on Danish data will be presented, see Figure 7.1. The graph illustrates the average value of the degree of importance for the three composite indicators for three types of enterprises. In average enterprises having both introduced product and process innovations have the highest degree of importance to all three effects. More tabulations like this are presented in Annex 5.c.

Figure 7.1 Degree of importance of the effects of product and process innovation by type of PP-innovation, Denmark, CIS4



Source: Own calculations based on CIS4 data for Denmark.

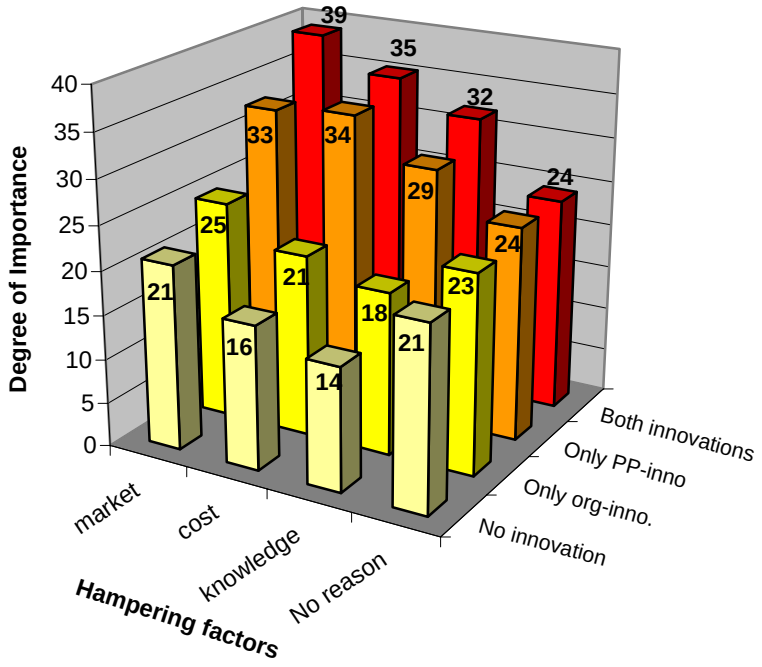
7.2 Hampering factors

The eleven factors that potentially may hamper innovation activities are organized in four subgroups – cost factors, knowledge factors, market factors and factors for not to innovate. So, factor analyses with four factors have been performed, see the results in Annex 5.c. The factor analyses in all three countries confirm the existence of four latent factors, which each are loading on each of the four subgroups.

A composite indicator for each of the subgroups can be constructed in the same way as described in 7.1 including the rescaling of the indicators. Also, only Danish data will be presented, due to lack of time to request the calculations in each country, see Figure 7.2.

The graph illustrates the average value of the degree of importance for the four composite indicators on hampering for four types of enterprises. For the barrier "*no reason to innovate*" the importance is at the same low level among the four types of enterprises. For the other barriers the importance increases, lowest for enterprises not having introduced any innovation, a bit higher for enterprises having introduced only organizational innovation, higher for enterprises only having introduced either product- or process-innovation and highest for enterprises having introduced both types of innovation. This means that the more involved the enterprises are in innovation the more they meet barriers, mostly market related. More tabulation like this is presented in Annex 5.c.

Figure 7.2. Degree of importance of barriers for innovating by type of innovation, Denmark, CIS4



Source: Own calculations based on CIS4 data for Denmark.

8. Regional and metropolis innovation

Indicators to compare **innovativeness of regions** have high priority for policy makers at EU-level, at Nordic and national levels and from regional authorities. At the European level the aim is to compare and benchmark the most innovative areas of Europe, see *Eurostat: Statistics in focus, June 2005*. Lately, there has also been heightened interest in comparing major cities – so-called city or **metropolis innovation**. The problems of providing comparable indicators differ from country-level to regional and city-level, see the discussion below.

8.1 Regional innovation – questions, sampling and correction

Indicators of innovation in regions are very much demanded, but the national CIS-samples can, however, in most cases not just be divided into regions. More problems arise concerning sampling and the location of innovation activities in enterprises with more establishments. Some countries have tried to collect regional data in different ways. The sample of the ongoing CIS-2006 both in Norway and Denmark has been increased with 50% to make it possible to calculate reliable regional innovation indicators. The problems of measuring regional innovation will be addressed and some results will be presented.

Stratification: All Nordic countries use sampling among small- and medium-sized enterprises from the population of enterprises. These samples are stratified according to industry and size as recommended in the methodological guidelines from Eurostat. Also, Finland stratifies the sample according to NUTS2-regions (Denmark and Iceland are each one NUTS2-region). If regional indicators are compiled in spite of no regional stratification the measures are less efficient for the smaller regions and may even be biased[15]. A way to repair the biasness is to stratify according to the selected regions and the industry/size-structure in each region after the data collection. The effect of this would be a new set of weights for the respondents and that might not result in the same values of the National indicators. In the regional analyses of Denmark and Norway in this paper no stratification after data collection is performed, but it is recommended to do that in coming innovation surveys. The best way will, however, be to define the regions before sampling and then stratify according to them[16].

Innovation in establishments: The second problem comes from the fact that a number of larger enterprises perform innovation activities in several establishments that may be situated in different regions of the country. By only counting the headquarters of such an enterprise as innovative and having innovation expenditure, a bias is obtained in favor of the capital of the country. This problem is addressed in Norway and Denmark:

In Norway the enterprises have to distribute their R&D expenditure using a specified list of their establishments. This can be used as a proxy for the distribution of innovation

[15] See Annex 7.a.

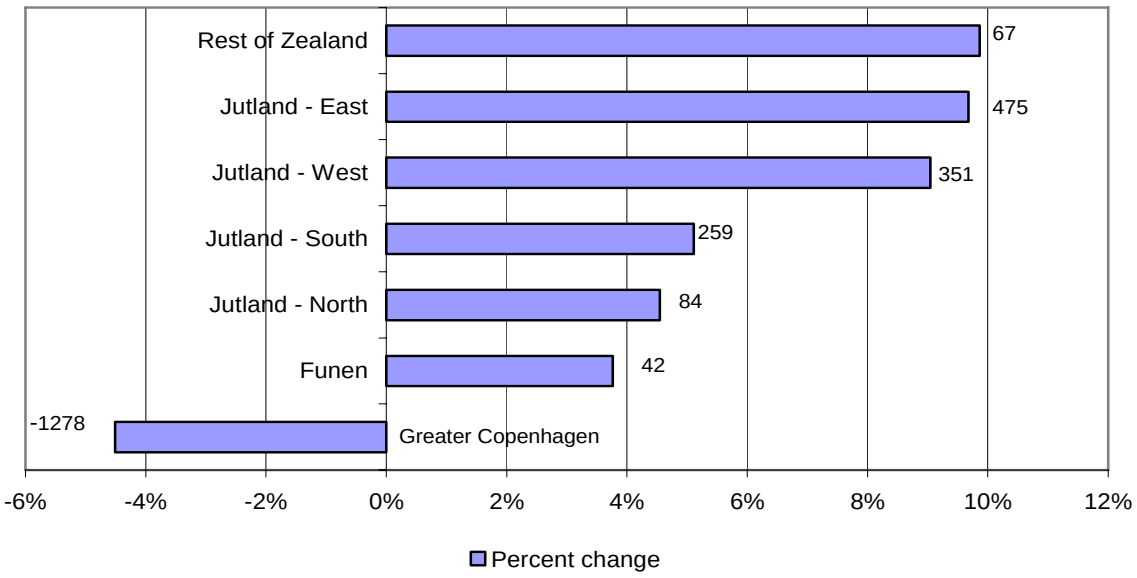
[16] This has been done in the Danish and Norwegian CIS2006-survey.

expenditure among the headquarters and the establishments. In the CIS-2006 survey the Norwegian enterprises also have to specify their innovation activity by their establishments.

In Denmark the problem is addressed by asking the enterprises in which establishments the innovation activities take place – and if at more places how much is conducted each place. As a proxy for establishments, post codes are used, see Annex 7.b.

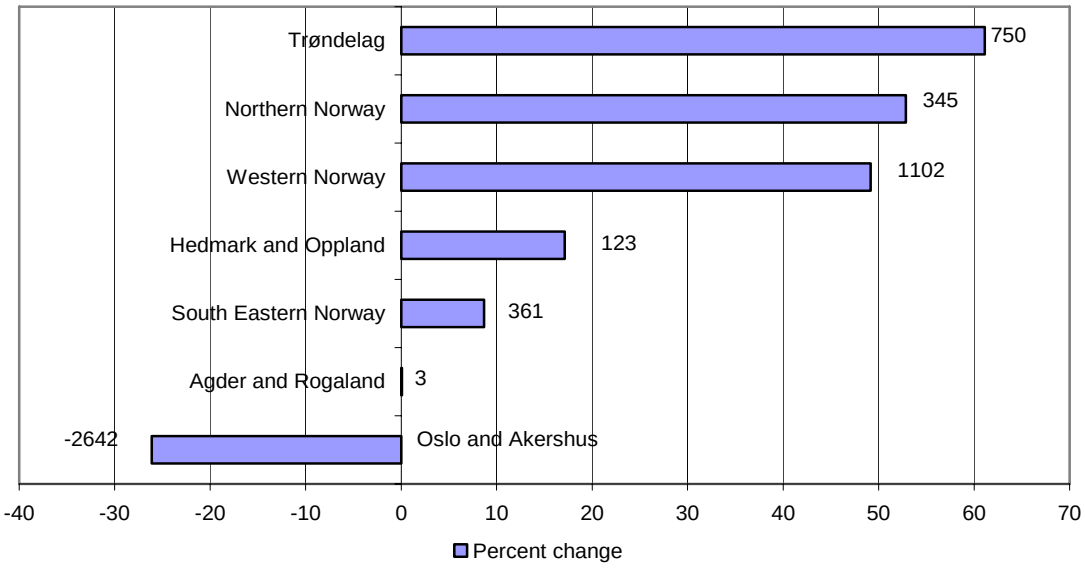
Effect on innovation expenditure: In the Danish CIS4, 10 % of the enterprises with innovation activities reported that the activities took place in two or more postal codes. Mostly larger enterprises reported, so the effect is that 17 % of all Danish innovation expenditures are performed outside the postal code of the headquarters of the enterprises. 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 8.1 Effect on innovation expenditure when correcting for innovation activities outside the region of the headquarters, DK, CIS4, mill DKK and percent.



In Figure 8.1 one can see that enterprises with headquarters in *Greater Copenhagen* “loses” nearly 5 % to other regions, while three other regions increases their innovation expenditure up to 10 % from establishments with headquarters outside their region – mostly in Copenhagen.

Figure 8.2 Effect on innovation expenditure when correcting for innovation activities outside the region of the headquarters, Norway, CIS4, mill NOK and percent.

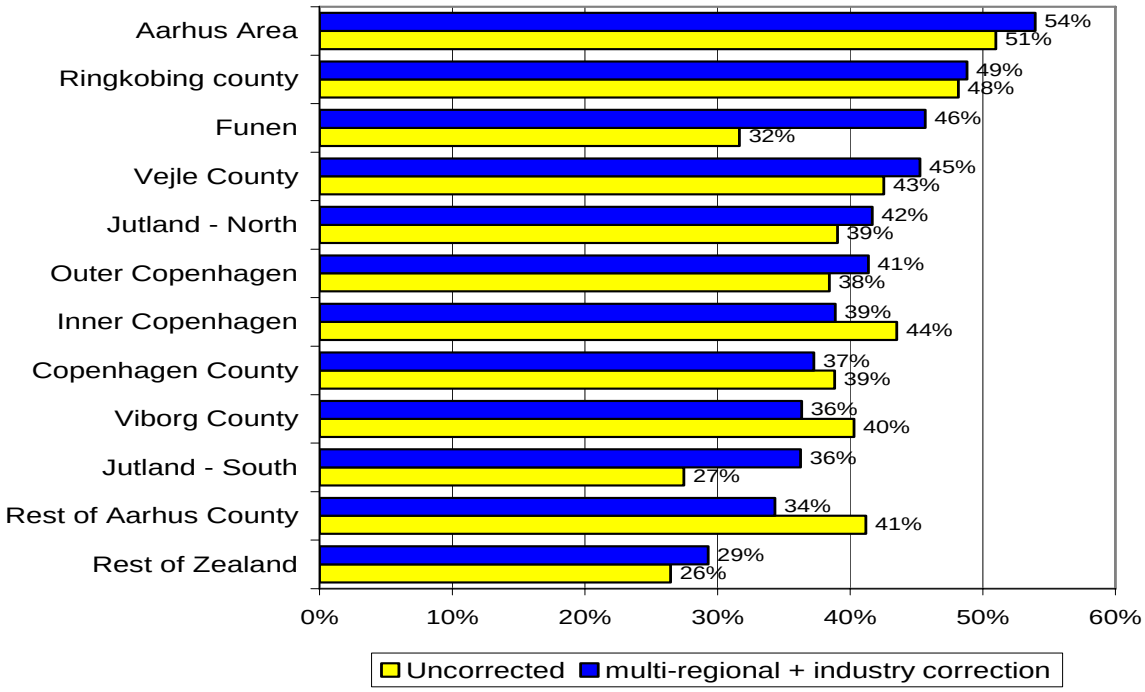


In the Norwegian CIS4, 20 % of the innovation expenditure moves to another of the 19 counties (*fylker*). Part of this is balanced when compressing the counties to 7 regions, but still the effect is much larger than in Denmark, see Figure 8.2. Enterprises with headquarters in *Greater Oslo* "lose" 26% of their innovation expenditure to other regions, while three other regions increase their innovation expenditure by 50% or more from establishments with headquarters outside their region – mostly Oslo.

Effect on proportion of enterprises with innovation expenditure: When estimating the proportion of enterprises with innovation expenditure – and other measures of innovation propensity – a principle for taking into account the innovation activities outside the location of the headquarters is needed. One possibility (see WP2006/6 from CFA) is that during the calculation of regional statistics one new respondent for each extra region that an enterprise has reported activities from is created. The consequence is a small inflation in the proportion with innovation expenditure compared to the national figure. When correcting *the proportion of enterprises with innovation expenditure* in the Danish CIS4 data for 12 regions, the national estimate is inflated by 1.4 percentage points.

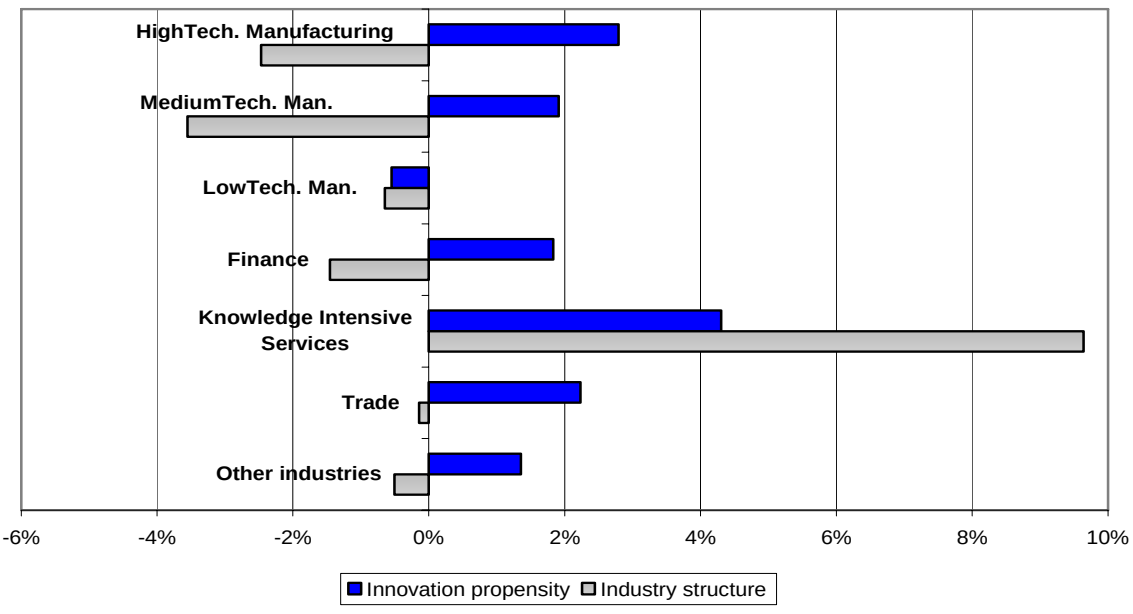
Correcting for regional differences in industry/size-structure: The regional indicators may be corrected for the differences between the regions caused by different industry and/or size. The calculations are identical to the calculations when correcting for differences between countries, see Chapter 3. As an example the proportions of enterprises with innovation expenditure, corrected for innovation in establishments and for industry/size structure, for each of 12 Danish regions are compared with the uncorrected proportions in Figure 8.3. The differences between uncorrected and corrected values vary much and the corrected indicator varies very much between the regions - and the Copenhagen area ends up taking only a middle position.

Figure 8.3 Proportion with innovation expenditure, uncorrected and corrected for multi-regional enterprises and industry/size-structure, CIS4, Denmark



Like illustrated in Chapter 3, it is possible to decompose the difference between the National (corrected) proportion and the regional proportion of enterprises with innovation expenditure into the deviation in innovation propensity and the deviation caused by industry/size-structure. This is illustrated in Figure 8.4 for *Aarhus Area.*

Figure 8.4 Decomposition by industry structure and innovation propensity for Aarhus Area compared with Denmark, CIS4, 2004. Percentage points.



8.2 City and metropolis innovation

Often, regions will be a combination of a larger city, probably with one or more higher education institutions, some smaller cities and some rural areas. Indicators for regions like that may be relevant for regional policy makers, but at National and international level it is being realized that it is more relevant to look solely at the larger cities – metropolises – where the dynamics of innovation are concentrated. As part of this a benchmarking of metropolises is relevant for understanding the differences – and the background for these differences.

For the Nordic countries it would give important insight to benchmark the capitals of the Nordic countries supplemented by one or two cities. However, the problems described in Chapter 8.1 on regional indicators still exist with city innovation. This means that it has not been possible to make some valid comparison of the larger cities of the Nordic countries on the basis of CIS4.

However, the innovation activities of the "larger urban zone" of each capital of the Nordic countries could be compared, when the right label of such a comparison is used:

"Innovation activities by enterprises operating from the Nordic Capitals"

The recommendation is hence to isolate the CIS-data of the Nordic capitals – and if needed re-weight them – in order to calculate a number of indicators, including the proportion of *Innovation active*, for the Nordic capitals. Also, a supplementary analysis should correct the proportion of innovation active enterprises for differences in industry/size-structure.

9. Innovation indicators for globalization and the role of multinationals

The international dimensions of innovation are comprised in two concepts:

- **Globalization**, that is the international orientation (geographic markets; ownership; linkages with abroad: information sources, cooperation, acquisitions)
- The role of **multinational enterprises** (enterprise groups with foreign corporate headquarters or with affiliates abroad)

9.1 Indicators of globalization

The CIS4-questionnaire includes a number of questions on the international orientation of the responding enterprises, like markets, ownership, EU-funding and linkages. There has not been time within the project to investigate the possibilities of constructing composite indicator(s) for the degree of globalization, but it is recommended to do that.

9.2 The role of multinational enterprises

The role of **multinational enterprises** for national and Nordic innovation has more dimensions:

- **Integration**: How much of the national innovation activities/expenditure is integrated with activities/expenditure in MNE's - domestic owned or foreign owned?
- **Control**: How much of the national innovation activities/expenditure is foreign controlled?
- **Propensity to innovate**: How different is the propensity to innovate and how different are the R&D and innovation intensities in MNE's compared to other enterprises.
- **Inward and outward** investments in innovation.

Indicators for integration and control may be identified through the CIS4-questions on *Enterprise group* and *Country of headquarters*. However, the responses of these variables are not of high quality, at least not in the Danish part of CIS4[17]. Other countries have not had the time to calculate the indicators suggested – nor to report on the quality.

The conclusion of the investigation of the Danish data is that if indicators on MNE's are demanded, then the information on group and headquarters needs to be checked outside the CIS-questionnaire to make it reliable. The examples in the following analyses for developing indicators are based on register data and the internet.

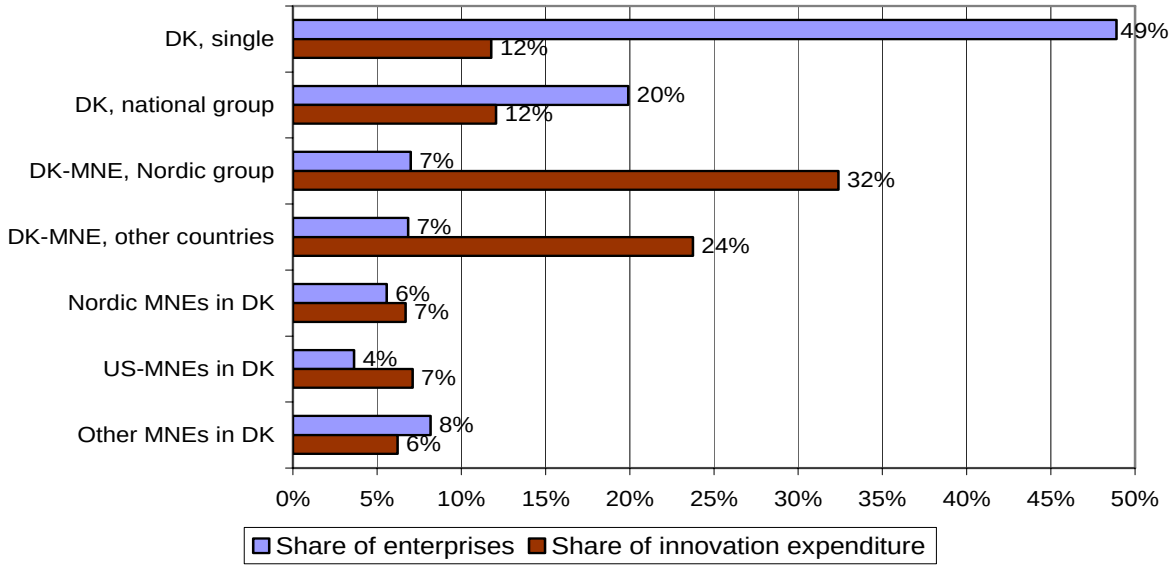
First, a **typology of enterprises** on enterprise groups and MNE's is defined. In this context special Nordic groups are defined:

- Single enterprises
- Enterprises that are part of a national group
- Multinational enterprises (MNE) with:
    - National headquarters and subsidiaries in other Nordic countries
    - National headquarters and subsidiaries in other countries (excluding Nordic countries)
    - Nordic (non-national) headquarters with national subsidiaries
    - US headquarters with national subsidiaries
    - Other foreign headquarters with national subsidiaries

Figure 9.1 shows the breakdown for Denmark. Danish owned enterprises are split into four categories: non-group enterprises, national groups, groups with subsidiaries in one or more other Nordic country and groups with subsidiaries in other countries excluding the Nordic countries. The foreign owned enterprise groups are split into three categories according to ultimate ownership: Nordic, US or another country.

[17] See Annex 5.d.

Figure 9.1 Share of enterprises and of innovation expenditure by type of enterprise, CIS4, Denmark



Integration:

31 % of the Danish enterprises are part of a MNE, thus being global through ownership. This can be seen from Figure 9.1, if summing the 5 types of MNE's. Of the rest, National groups account for 20 %. The Nordic link is present in 13 % of the enterprises, either by Danish enterprise groups having subsidiaries in another Nordic country or vice versa.

The share of innovation expenditure is markedly different. All MNE's account for 76 % and MNE's with Nordic relations account for 39 % of the innovation expenditure. This leaves only 24 % to domestic enterprises and groups. From Table 5.10 in Annex 5.d one can also calculate that 82 % of the Danish business R&D expenditure takes place in MNE's.

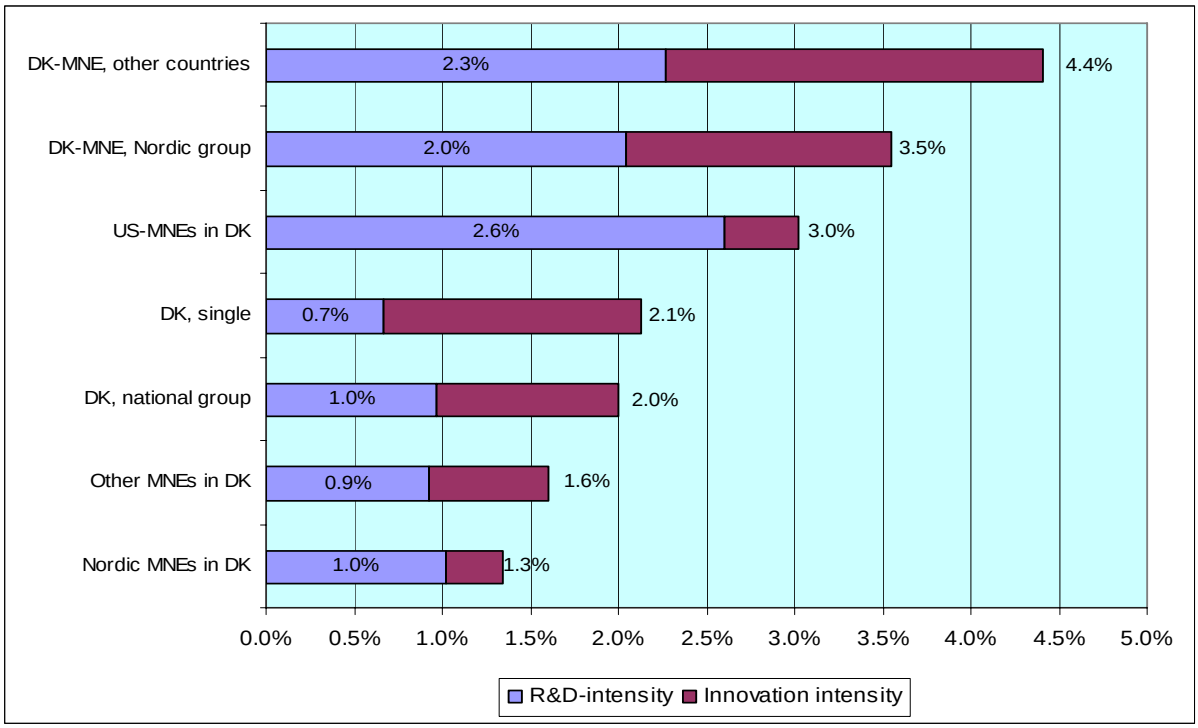
Control:

14 % of the enterprises are Danish MNE's, while the share of foreign MNE's is 18 %, of which 1/3 is Nordic. With the innovation expenditure the Danish MNE's accounts for 56 %, mostly among those with Nordic subsidiaries, while the foreign controlled only accounts for 20 %, of which 1/3 is Nordic.

Propensity to innovate:

R&D- and innovation intensities are calculated as the total expenditure divided by the total turnover in each of the 7 enterprise types, as shown in Figure 9.2. The highest innovation intensity is in the Danish MNE's, mostly in the group not operating in other Nordic countries. Also, the US-owned enterprise groups have a high intensity, while the Nordic-owned groups have the lowest innovation intensity. The R&D intensity divides the types into two classes – Danish MNE's and US-owned enterprise groups with R&D intensity above 2 percent as the first class and the rest of the enterprises as the second class having markedly lower R&D intensity, lowest in the non-group enterprises.

Figure 9.2 R&D- and innovation intensity, enterprise types, CIS4, Denmark



The *share of the different types of expenditure* may also be analyzed, see Table 5.11 in Annex 5.d. The domestic enterprises and groups have higher shares of the acquisitions, while these shares are substantially lower for foreign-owned enterprise groups. Higher shares of R&D expenditure are found in the US-owned enterprise groups and the Nordic related enterprise groups, while the share of other intramural activities is higher in Danish MNE's, not engaged in the Nordic countries.

The *shares of enterprises having R&D and innovation expenditure* (columns 1-2 in Table 5.11 in Annex 5.d) show another distribution and also a different pattern depending on kind of expenditure for some of the enterprise types. The lowest shares of R&D- and innovating enterprises are found in the non-group enterprises and the Nordic owned enterprise groups, and the highest shares are found in Danish MNE's followed by US-owned MNE's.

Inward and outward investments in innovation:

The lack of questions on acquired services and financial information split by domestic, Nordic, (EU,) and rest of the world does not make it possible to calculate meaningful indicators on inward and outward investments from existing CIS4-data.

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ANNEXES

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[18] _____

Postal code _____ Main activity[19] _____

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? [20] _____

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.

[18] NUTS 2 code

[19] NACE 4 digit code

[20] 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 enterprise?	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[21] 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 enterprise	☐☐☐ %
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 %

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 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

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

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 enterprise 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 <u>2004</u> only. (Include personnel and related costs)[22]

	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		☐

[22] Give expenditure data in national currency units.

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 enterprise 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	☐	☐	☐	☐
	Improved flexibility of production or service provision	☐	☐	☐	☐
Process oriented effects	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 enterprise structure or management methods that are intended to improve your enterprise'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 enterprises or public institutions, such as through alliances, partnerships, outsourcing or sub-contracting	☐	☐

		Yes	No
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?[23] Turnover is defined as the market sales of goods and services (Include all taxes except VAT[24]).

2002	2004
☐☐☐☐☐☐☐☐	☐☐☐☐☐☐☐☐

11.2 What was your enterprise's total number of employees in 2002 and 2004?[25]

2002	2004
☐☐☐☐☐☐☐☐	☐☐☐☐☐☐☐☐

[23] Give turnover in '000 of national currency units.

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

[25] Annual average. If not available, give the number of employees at the end of each year.

Annex 2. Classification of industries and size

Classifications of enterprises are needed when indicators of innovation are to be compared for different kinds of enterprises or for specific kinds of enterprises between countries or other geographical units. The two main general classifications of enterprises are *industry* and *size*, the latter normally measured by the number of employees.

2.1 Industrial classification

In order to ensure comparability across the Nordic countries, only enterprises in the Eurostat core groups of industries are included in this study. The enterprises are classified by the international 5-digit NACE-codes. This level is in general too detailed for presentation of results, by reasons of representativity, reliability and confidentiality. The 2-digit level of the NACE-codes is a more acceptable level, but not for small countries like the Nordic. The 2-digit NACE-classes are therefore combined to 21 classes, so that almost all Nordic countries have some responding enterprises in each class.

Table 2.1 Classification of industries in 21 and 12 classes according to NACE-codes

NACE-code	21 industries	12 industries
C	Mining and Quarrying	Mining; Manufacturing. of food, beverage & tobacco
15-16	Manufacture of food, beverage products and tobacco	
20-21	Manufacture of wood and paper	Manufacture of wood, paper & publishing
22	Publishing, printing and reproduction etc	
24	Manufacture of chemicals and chemical products	Manufacturing of non-metallic mineral products
25	Manufacture of rubber and plastic products	
26	Manufacture of other non-metallic mineral products	
27-28	Manufacture of basic and fabricated metal	Manufacture of basic and fabricated metal
29	Manufacture of machinery and equipment n.e.c.	Man. of machinery and equipment n.e.c.
30-31	Manufacture of electrical/optical equipment & machinery	Manufacturing of electrical/optical, medical, radio/TV equipment
32	Manufacture of radio, television etc.	
33	Manufacture of medical, precision and optical instruments	
34-35	Manufacture of transport equipment	Other manufacturing
17-19,23,36-37	Other manufacturing	
51	Wholesale trade (except of motor vehicles & motorcycles)	Wholesale trade
E	Electricity, gas, and water supply	Supply and transport (except post/telecomm.)
60-63	Transport expect post	
J	Finance	Finance
64	Post and telecommunications	Computer, telecommunication & related activities
72	Computer and related activities	
74.2-3	Other business services	Other business services

In some cases, the rules of confidentiality are however not fully fulfilled, so results presented in tables and graphs are further combined to 12 classes. Table 2.1 shows the NACE-codes in each class with 21 and 12 classes.

The basic indicators presented graphically in Chapter 2 are, however, only sorted in two classes, manufacturing and services.

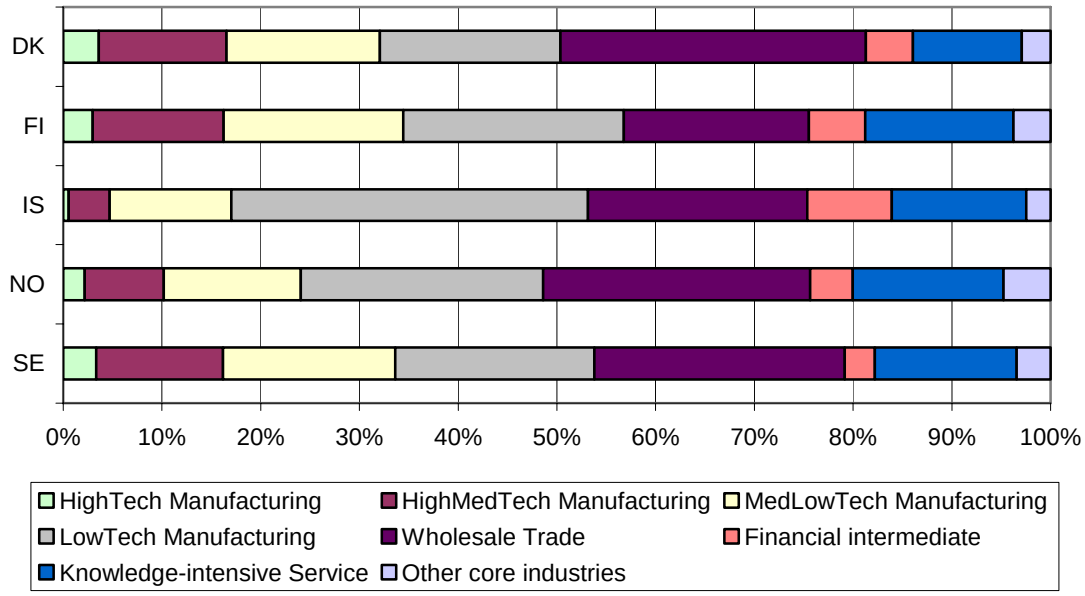
In Part 2 of the report another aggregated classification according to technology are used. This classification includes 8 industry classes. Tests at all Nordic data providers showed that this classification did only conflict very little with National confidentiality rules and mostly only when also broken down by size classes. The NACE-codes in each class are given in Table 2.2.

Table 2.2 Classification of industries according to technology defined by NACE-codes

Manufacturing	NACE codes	Service	NACE codes
HighTech Manufacturing	24.4, 30, 32-33, 35.	Wholesale Trade	51
MedHighTech Manufacturing	24.0-24.3, 24.5-24.9, 29, 31, 34, 35.2, 35.4-35.9	Financial intermediate	65-67
MedLowTech Manufacturing	23, 25-28, 35.1	Knowledge-intensive Service	64, 72, 74.2-74.3
LowTech Manufacturing	15-22, 36-37	Other core industries	10-14, 40-41, 60-63

The distribution of the enterprises in the 8 classes is illustrated for each of the Nordic countries in Figure 2.1. The graph illustrates that there are quite different industrial structures in the 5 Nordic countries, i.e. *HighMedTech Manufacturing* from 4% to 13% and *Wholesale Trade* from 19% to 31%.

Figure 2.1 Distribution of enterprises by industry classes, Nordic countries, CIS4

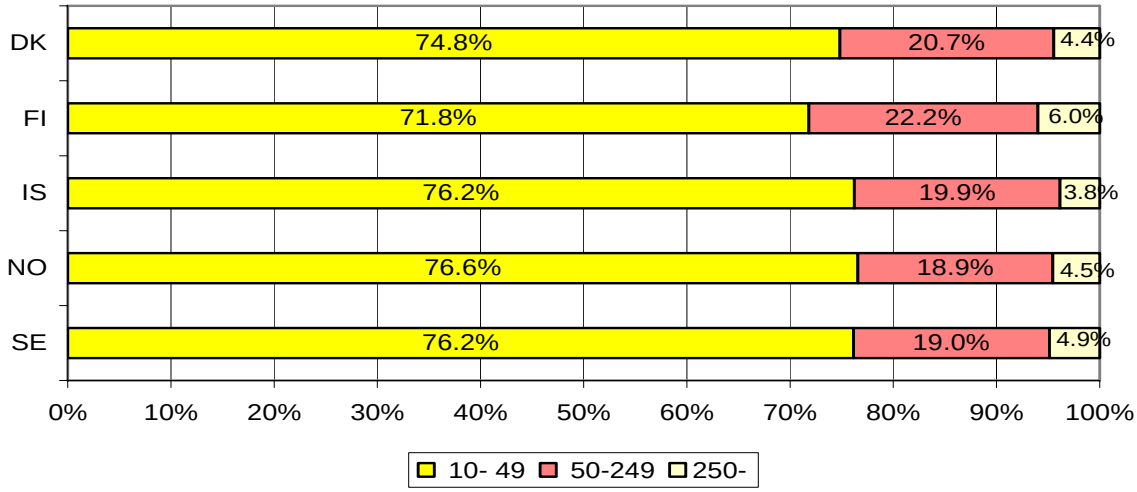


2.2 Size classes

The analyses will consider enterprises with 10 employees or more. The same three size classes are used as those recommended by Eurostat: 10-49 employees; 50-249 employees; 250 or more employees.

Figure 2.2 shows the distribution of enterprises in the core industrial groups in the 3 size classes. The variations in size among countries are much smaller than in industry. Especially, there is very little variation among Denmark, Iceland, Norway and Sweden, while Finland differs from the others by having more larger companies.

Figure 2.2 Distribution of enterprises by size classes, Nordic countries, CIS4



Annex 3. Tables of basic indicators

Table 3.1 Enterprises with innovation activity, per cent of all enterprises.

	Denmark	Finland	Iceland	Norway	Sweden
			All core industries		
10-49 employees	48.61	36.94	49.51	32.41	45.08
50-249 employees	58.71	60.09	59.49	53.48	66.54
250+ employees	77.77	76.02	63.33	63.42	77.80
All enterprises	51.97	43.29	51.99	37.01	49.96
			Core manufacturing		
10-49 employees	52.02	43.19	46.20	36.32	48.81
50-249 employees	71.14	64.59	70.37	65.98	69.92
250+ employees	84.92	85.43	75.00	81.25	84.86
All enterprises	57.77	50.52	52.02	44.02	54.86
			Core services		
10-49 employees	45.28	32.12	52.73	30.11	42.32
50-249 employees	44.47	54.35	45.21	37.84	63.70
250+ employees	68.11	63.82	52.94	45.91	67.19
All enterprises	46.01	36.82	51.37	31.61	45.90

Table 3.2 Type of innovation activity, core industries, per cent

COUNTRY	Product innovator only	Process innovator only	Product and process innovator	Ongoing and/or abandoned Innovation activities only	Non-innovation active enterprises
Denmark	13.6	13.6	19.2	5.6	48.0
Finland	10.9	9.1	18.8	4.6	56.7
Norway	12.6	6.3	12.8	5.3	63.0
Sweden	15.7	10.6	21.3	2.3	50.0

Table 3.3 Enterprises with products new to enterprise, and new to market, core industries, per cent

		Enterprises with products new to the enterprise, as share of all enterprises	Enterprises with products new to the market, as share of all enterprises
DENMARK	10-49 employees	22.6	22.5
	50-249 employees	29.6	28.9
	250+ employees	46.2	45.0
	All enterprises	25.1	24.8
FINLAND	10-49 employees	18.3	17.5
	50-249 employees	36.0	31.4
	250+ employees	50.4	44.1
	All enterprises	23.3	21.5
NORWAY	10-49 employees	16.6	12.2
	50-249 employees	28.6	17.4
	250+ employees	33.0	24.5
	All enterprises	19.2	13.5

SWEDEN	10-49 employees	23.3	23.8
	50-249 employees	37.7	33.2
	250+ employees	40.2	43.9
	All enterprises	26.4	26.2

Table 3.4 Enterprises by main developer of the innovation, core industries, per cent

	Enterprises with product innovation			Enterprises with process innovation		
	Product innovation - developed mainly by the enterprise or enterprise group	Product innovation - developed by the enterprise together with other enterprises or institutions	Product innovation - developed mainly by other enterprises or institutions	Process innovation - developed mainly by the enterprise or enterprise group	Process innovation - developed by the enterprise together with other enterprises or institutions	Process innovation - developed mainly by other enterprises or institutions
Denmark	72.0	20.6	7.4	56.5	32.7	10.8
Finland	67.1	29.0	3.9	50.6	37.5	11.9
Norway	71.6	21.7	6.7	55.8	33.2	11.0
Sweden	70.2	22.4	7.4	53.1	34.6	12.3

Table 3.5 Co-operation agreements on innovation activities, core industries, per cent

	All types of cooperation	Other enterprises within your enterprise group	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	Universities or other private R&D institutes	Government or public research institutes
Denmark	42.8	17.4	28.4	27.8	14.8	19.0	13.7	6.9
Finland	44.4	23.4	40.8	41.4	34.2	32.7	33.1	26.4
Iceland	29.1	5.3	19.8	19.8	13.8	6.7	5.0	13.1
Norway	33.2	14.0	23.1	22.3	11.9	20.3	14.8	16.3
Sweden	42.8	17.2	32.0	27.9	10.8	19.8	17.4	6.3

Table 3.6 Co-operation agreements by nationality of co-operation partner, core industries, per cent

	National	Other Europe	United States and other countries
Denmark	38.7	27.8	9.6
Finland	44.0	30.0	13.7
Iceland	-	-	-
Norway	30.9	19.3	9.7
Sweden	40.2	21.2	6.9

Table 3.7 Turnover from innovations vs. unchanged products, core industries, per cent

	Turnover of unchanged or marginally modified products	Turnover of new or significantly improved products only new to the enterprise	Turnover of new or significantly improved products new to the market
Denmark	89.0	5.8	5.2
Finland	76.9	8.0	15.1
Iceland	87.3	7.8	4.9
Norway	92.8	5.1	2.1
Sweden	78.5	8.2	13.3

Table 3.8 Turnover from innovations vs. unchanged products, by country and size, percent

		Turnover of unchanged or marginally modified products	Turnover of new or significantly improved products only new to the enterprise	Turnover of new or significantly improved products new to the market
DENMARK		All core industries		
	10-49 employees	92.2	3.0	4.7
	50-249 employees	92.4	4.3	3.2
	250+ employees	85.9	7.7	6.5
	All enterprises	89.0	5.8	5.2
		Core manufacturing		
	All enterprises	81.2	10.0	8.8
		Core services		
	All enterprises	94.0	3.3	2.7
FINLAND		All core industries		
	10-49 employees	95.1	2.9	2.0
	50-249 employees	92.9	4.0	3.1
	250+ employees	81.2	5.9	13.0
	All enterprises	85.1	5.1	9.7
		Core manufacturing		
	All enterprises	78.4	6.3	15.3
		Core services		
	All enterprises	93.8	3.9	2.3
ICELAND		All core industries		
	10-49 employees	82.1	10.2	7.7
	50-249 employees	93.4	3.0	3.6
	250+ employees	87.0	11.1	1.9
	All enterprises	87.3	7.8	4.9
		Core manufacturing		
	All enterprises	96.2	2.2	1.7
		Core services		
	All enterprises	79.8	11.7	8.5
NORWAY		All core industries		
	10-49 employees	94.0	4.1	1.9
	50-249 employees	92.0	5.9	2.1
	250+ employees	92.8	5.0	2.2
	All enterprises	92.8	5.1	2.1
		Core manufacturing		
	All enterprises	87.4	9.3	3.3
		Core services		
	All enterprises	92.2	5.6	2.2
SWEDEN		All core industries		
	10-49 employees	91.4	5.1	3.5
	50-249 employees	91.2	5.2	3.5
	250+ employees	83.5	5.1	11.4
	All enterprises	86.6	5.1	8.3
		Core manufacturing		
	All enterprises	82.9	4.3	12.8
		Core services		
	All enterprises	90.2	5.7	4.2

Table 3.9 Innovation expenditure, core industries, per cent

	Intramural R&D	Extramural R&D	Acquisition of machinery, equipment and software	Acquisition of other external knowledge
DK - Between 10 and 49	36.2	11.0	34.4	18.4
DK - Between 50 and 249	46.4	10.9	37.5	5.2
DK - 250 or more	73.4	15.2	7.7	3.7
DK - Total	61.7	13.6	18.1	6.5
NO - Between 10 and 49	64.7	16.6	13.8	4.8
NO - Between 50 and 249	63.6	19.7	9.6	7.2
NO - 250 or more	63.1	21.9	12.9	2.1
NO - Total	63.6	20.0	12.2	4.1
SE - Between 10 and 49	43.9	6.5	40.8	8.8
SE - Between 50 and 249	44.2	9.2	42.3	4.3
SE - 250 or more	68.2	17.2	12.8	1.9
SE - Total	62.8	15.0	19.2	3.0

Table 3.10 Innovation expenditure, manufacturing, per cent

	Intramural R&D	Extramural R&D	Acquisition of machinery, equipment and software	Acquisition of other external knowledge
DK - Between 10 and 49	44.2	14.8	37.4	3.6
DK - Between 50 and 249	52.2	13.2	31.7	2.9
DK - 250 or more	73.0	17.6	6.5	2.9
DK - Total	64.6	16.3	16.1	3.0
NO - Between 10 and 49	56.8	17.2	22.9	3.1
NO - Between 50 and 249	65.2	16.9	12.6	5.2
NO - 250 or more	72.7	11.0	14.5	1.9
NO - Total	66.9	14.2	15.6	3.2
SE - Between 10 and 49	30.2	4.1	60.5	5.2
SE - Between 50 and 249	47.8	7.7	41.3	3.2
SE - 250 or more	71.3	18.1	8.9	1.7
SE - Total	66.3	16.3	15.4	2.1

Table 3.11 Innovation expenditure, core services, per cent

	Intramural R&D	Extramural R&D	Acquisition of machinery, equipment and software	Acquisition of other external knowledge
DK - Between 10 and 49	26.6	6.2	30.9	36.4
DK - Between 50 and 249	32.5	4.5	51.9	11.1
DK - 250 or more	76.2	8.0	10.5	5.3
DK - Total	56.9	7.0	22.3	13.8

NO - Between 10 and 49	73.3	15.9	4.1	6.6
NO - Between 50 and 249	65.5	19.7	3.0	11.8
NO - 250 or more	66.3	22.8	9.5	1.4
NO - Total	68.6	19.6	6.0	5.7
SE - Between 10 and 49	54.9	7.8	24.9	12.4
SE - Between 50 and 249	45.3	12.7	36.5	5.5
SE - 250 or more	55.0	10.0	31.0	4.0
SE - Total	52.6	10.0	30.3	7.1

Table 3.12 Innovation funding, by source and size class, core industries, per cent

	Received any public funding	Received funding from local or regional authorities	Received funding from central gov. (incl. central gov. agencies or ministries)	Received funding from the European Union	Received funding from the 5th or 6th Framework Programme
DK - Between 10 and 49	13.2	2.2	7.6	4.7	1.7
DK - Between 50 and 249	17.6	1.8	10.1	9.3	5.7
DK - 250 or more	23.9	2.0	14.7	15.6	13.0
DK - Total	14.9	2.1	8.7	6.5	3.4
FI - Between 10 and 49	30.2	7.7	25.8	7.2	3.1
FI - Between 50 and 249	39.3	5.1	35.7	9.5	5.5
FI - 250 or more	57.7	2.5	57.1	13.6	10.1
FI - Total	35.1	6.6	31.2	8.4	4.3
NO - Between 10 and 49	43.4	1.5	42.6	1.5	1.4
NO - Between 50 and 249	44.1	2.1	43.6	1.3	0.8
NO - 250 or more	42.3	3.3	41.4	7.9	7.9
NO - Total	43.5	1.7	42.8	1.9	1.7

Table 3.13 Effects of innovation activities, core industries, per cent

	Increased range of goods and services	Entered new markets or increased market share	Improved quality in goods or services	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	Reduced environ-mental impacts or improved health and safety	Met regulation require-ments
Denmark	25.2	19.7	26.7	21.9	18.4	14.5	6.7	8.7	12.6
Finland	25.3	21.6	24.2	15.9	17.1	13.0	5.9	7.2	9.8
Iceland	30.5	19.3	23.4	16.0	15.3	13.8	5.7	2.9	7.2
Norway	23.1	16.2	23.6	13.5	13.4	10.0	4.3	8.1	12.4
Sweden	31.2	19.7	29.3	16.3	21.6	17.9	7.1	9.7	12.9

Table 3.14 Effects of innovation activities, aggregate results, per cent

	Innovative enterprises citing at least one cost effect	Innovative enterprises citing at least one process effect	Innovative enterprises citing at least one market effect	Innovative enterprises citing at least one regulation effect
Denmark	16.8 %	33.5 %	50.0 %	17.6 %
Finland	15.5 %	28.6 %	45.8 %	14.3 %
Iceland	10.0 %	16.7 %	34.3 %	9.0 %
Norway	13.2 %	22.2 %	42.9 %	19.8 %
Sweden	20.3 %	28.7 %	53.8 %	17.3 %

Table 3.15 Enterprises with innovation activity indicating the high importance of selected factors in hampering innovation activity, per cent

	Lack of funds within your enterprise or enterprise group	Lack of finance from sources outside your enterprise	Innovation costs too high	Lack of qualified personnel	Lack of information on technology	Lack of information on markets	Difficulty in finding cooperation partners for innovation	Markets dominated by established enterprises	Uncertain demand for innovative goods or services
Denmark	21.2	9.0	12.4	6.7	2.7	3.5	2.7	9.2	11.6
Finland	14.4	10.1	10.7	9.4	3.9	5.5	7.1	7.8	9.4
Iceland	20.5	16.5	19.1	12.9	0.2	4.5	9.8	15.8	11.7
Norway	13.5	11.7	16.5	6.0	2.7	2.9	2.1	5.6	8.3
Sweden	21.3	12.6	14.5	9.2	2.9	3.6	5.1	19.4	12.2

Table 3.16 Enterprises without innovation activity indicating the high importance of selected factors in hampering innovation activity, per cent

	Lack of funds within your enterprise or enterprise group	Lack of finance from sources outside your enterprise	Innovation costs too high	Lack of qualified personnel	Lack of information on technology	Lack of information on markets	Difficulty in finding cooperation partners for innovation	Markets dominated by established enterprises	Uncertain demand for innovative goods or services
Denmark	11.5	6.6	6.9	6.6	3.5	3.5	5.2	10.5	8.5
Finland	10.5	6.0	10.3	6.4	3.4	2.7	3.9	7.6	9.5
Iceland	5.2	3.6	9.8	1.8	0.8	4.7	5.2	3.4	6.7
Norway	4.7	3.5	5.3	1.5	1.1	1.2	1.5	3.0	4.2
Sweden	12.9	7.9	7.8	6.1	3.0	2.3	3.9	14.1	10.1

Table 3.17 Enterprises with and without innovation activity indicating the high importance of selected reasons for not innovating, per cent

Enterprises without innovation activity		
	No need to innovate due to prior innovations	No need to innovate because no demand for innovations
Denmark	5.3	7.7
Finland	24.4	9.8
Iceland	3.6	3.9
Norway	3.5	4.8
Sweden	8.3	10.4

Enterprises with innovation activity		
	No need to innovate due to prior innovations	No need to innovate because no demand for innovations
Denmark	3.5	4.7
Finland	4.7	3.6
Iceland	4.8	6.2
Norway	0.9	1.1
Sweden	1.8	2.7

Annex 4: Estimation, weighting and correction for industry/size-structure

4.1 Quantitative estimators in the CIS-surveys

From the questions in the CIS-surveys – and the demand for indicators from the regulation of EUROSTAT – one can derive 3 kinds of quantitative estimators: *totals* (like innovation expenditure; turnover; employees), *ratios* (like share of turnover from new products; innovation intensity) and *proportions*, being coded qualitative estimators (like proportion with product innovation; proportion of innovators with cooperation). These estimators are to be calculated taking into consideration the recommendations for weighting in the EUROSTAT methodological guidelines on stratification, enumeration and calibration. The ordinary weighting is by enterprise ($v_j = N_j / n_j$), so that the sum of the weights equals the number of enterprises in the target population (the selected industries and sizes of enterprises). In this way, the weight for an enterprise tells how many enterprises that it is representing. A few countries use the number of employees in the strata as ordinary weighting per stratum $\left[{}^{emp}v_j = \sum_{N_j} (emp) / \sum_{n_j} (emp) \right]$. The sum of weights will then equals the number of employees, but not necessarily the number of enterprises.

The calibration by i.e. the SAS-macro CALMAR may be used to ensure both parts: The sum of weights equals each stratum and the target population and the sum of weights multiplied with the number of employees equals the number of employees in each stratum and the target population. This is obtained by calculating individual weights for each responding enterprise.

For the estimate of **totals** this means that the unbiased estimate for stratum *j* goes like this:

(1a) $${}_X T_j = \sum_{k_j} v_{jk_j} \bullet X_{jk_j}$$

where *v* is the calibrated weight; k_j is enterprise *k* in stratum *j*;
X is the quantitative measure – i.e. innovation expenditure.

The estimates of the strata are then added to provide an estimate of the total for the target population (the selected industries and sizes of enterprises):

(1b) $${}_X T_c = \sum_j \sum_{k_j} v_{jk_j} \bullet X_{jk_j} = \sum_j {}_X T_j$$

where *c* is symbolizing a country.

Ratios are estimated by first estimating each stochastic variable of the ratio and then calculate the ratio. For stratum *j* it goes like this:

$$\text{(2a)}\quad R_j = \frac{\sum_{k_j} v_{jk_j} \bullet Y_{jk_j}}{\sum_{k_j} v_{jk_j} \bullet X_{jk_j}} = \frac{{}_Y T_j}{{}_X T_j}$$

where *Y* could be the turnover from new products and *X* the total turnover.

The estimate for the target population is calculated in the same way with separate estimation of each stochastic variable, just including all strata:

$$\text{(2b)}\quad R_c = \frac{\sum_j \sum_{k_j} v_{jk_j} \bullet Y_{jk_j}}{\sum_j \sum_{k_j} v_{jk_j} \bullet X_{jk_j}} = \frac{\sum_j {}_Y T_j}{\sum_j {}_X T_j}$$

Finally, **proportions** are estimated by classifying the qualitative variable in two outcomes with the values 0 and 1. This new variable is then estimated like a total, but divided with the relevant population size. For stratum *j* it goes like this:

$$\text{(3a)}\quad \overline{P}_j = \frac{\sum_{k_j} v_{jk_j} \bullet X_{jk_j}}{\sum_{k_j} v_{jk_j}} \qquad \text{where} \qquad \sum_{k_j} v_{jk_j} = N_j \quad \text{and}$$

where *X* is 0 or 1.

The estimate of the proportion for the target population is established in the same way, just summing over all strata:

$$\text{(3b)}\quad \overline{P}_c = \frac{\sum_j \sum_{k_j} v_{jk_j} \bullet X_{jk_j}}{\sum_j \sum_{k_j} v_{jk_j}} \qquad \text{where} \quad \sum_j \sum_{k_j} v_{jk_j} = N$$

4.2 Weighting by some measure of size of the enterprises

The idea of weighting the responding enterprises with other weights than the number of enterprises in the target population (eventually supplemented with calibration) comes from the fact that enterprises in the target population of the CIS-surveys differ very much in size.

This is not a problem for estimators based on totals or ratios, as they themselves include the size: larger enterprises have – in general – higher turnover and higher innovation expenditures. With proportions the situation is different, see the arguments in Section 3.2. When weighting a proportion by some measure of size it needs first to be decided which measure of size to use, see the considerations in Section 3.2.

The formulae below uses the employees in the weights, but one can substitute this with the turnover, if wished. The new weights should be equal to the number of employees in the

enterprises which are in the enterprise(s) that the responding enterprise represents. When the original weights are calibrated, this is obtained by multiplying each of these weights by the number of employees in the responding enterprise. The estimate for a proportion in stratum *j* goes thus like this:

$$\text{(4a)}\quad \overline{P}_j^{emp} = \frac{\sum_{k_j} v_{jk_j} \bullet (emp)_{jk_j} \bullet X_{jk_j}}{\sum_{k_j} v_{jk_j} \bullet (emp)_{jk_j}} \qquad \text{where} \qquad \sum_{k_j} v_{jk_j} \bullet (emp)_{jk_j} = \text{ total employment in}$$

stratum *j*

This is extended to the target population like in (3b):

$$\text{(4b)}\quad \overline{P}_c^{emp} = \frac{\sum_j \sum_{k_j} v_{jk_j} \bullet (emp)_{jk_j} \bullet X_{jk_j}}{\sum_j \sum_{k_j} v_{jk_j} \bullet (emp)_{jk_j}}$$

where $\sum_j \sum_{k_j} v_{jk_j} \bullet (emp)_{jk_j} =$ total employment in the total target population.

4.3 Comparisons based on correction of industry/size structure

Two benefits are obtained by correcting indicators for National or regional comparisons by the industry/size structure. First, new comparable values of the National/regional indicators are calculated, making it possible to focus the evaluation of the countries/regions on the real differences in the innovation indicators. Next, the decomposition of the total deviation of a given country/region into two elements for each industry and/or size group makes a deeper analysis possible.

The calculation of the corrected indicators starts out with the value of the indicator for each stratum, as calculated in (1a) for a total, (2a) for a ratio and (3a) for a proportion, but the way to make the correction differs.

With **totals**, one has to calculate the mean value and then blow the mean value up to the number of enterprises in that stratum, if the industry/size structure was as in the whole geographical area (here: the Nordic countries):

$$\text{(5)}\quad {}_X T_c^{corr} = \sum_{is} \left[\left(\frac{{}_X T_{isc}}{N_{isc}} \right) \bullet N_{is} \bullet \left(\frac{N_c}{N_{all}} \right) \right]$$

where the strata now are symbolized with *is* for industry/size
and values for all Nordic countries is symbolized with *all*.

With **ratios**, the correction can be obtained by blowing up the totals in each stratum to the level of the X-variable of the whole geographical area in that stratum – and then sum over all strata:

$$(6)\quad R_c^{corr} = \frac{\sum_{is}\left[{}_YT_{isc} \bullet \left({}_XT_{is} \Big/ {}_XT_{isc} \right)\right]}{\sum_{is}\left[{}_XT_{isc} \bullet \left({}_XT_{is} \Big/ {}_XT_{isc} \right)\right]} = \frac{\sum_{is}\left[{}_YT_{isc} \bullet \left({}_XT_{is} \Big/ {}_XT_{isc} \right)\right]}{\sum_{is}\left[{}_XT_{is} \right]}$$

Finally, **proportions** can be corrected by using the stratum and population sizes (N_{is} and N) of the whole geographical area, when summing the strata:

$$(7)\quad \overline{P}_c^{corr} = \frac{\sum_{is} N_{is} \bullet \overline{P}_{isc}}{N_{all}}$$

The number of industries and size classes can be so plenty compared to the size of the smaller geographical areas (i.e. Iceland) that there will be no observations in one or more of the industry/size-groups for one or more of the geographical areas. This means that it is not possible to make estimates in these strata for these countries $(T_{isc}, \overline{P}_{isc})$. This is however needed with this method, see (5)-(7), so estimates have to be produced in another way. In WP2006/6 from *The Danish Centre for Studies in Research and Research Policy*[26] a method for this is described and tested.

The decomposition mentioned above was presented for proportions in the (Feb. 07)-paper of the NIND-innovation subgroup, but for regions. Here, the decomposition is rewritten for countries:

$$(8)\quad \overline{P}_c - \overline{P}_{all} = \sum_i \left(\overline{P}_{ic} \bullet \frac{N_{iall}}{N_{all}} - \overline{P}_{iall} \bullet \frac{N_{iall}}{N_{all}} \right) + \sum_i \left(\overline{P}_{ic} \bullet \frac{N_{ic}}{N_c} - \overline{P}_{ic} \bullet \frac{N_{iall}}{N_{all}} \right)$$

In the same way one can decompose the deviations in a ratio, but here the total in the denominator needs to be used as the weighting factor:

$$(9)\quad R_c - R_{all} = \sum_i \left(R_{ic} \bullet \frac{{}_xT_{iall}}{{}_xT_{all}} - R_{iall} \bullet \frac{{}_xT_{iall}}{{}_xT_{all}} \right) + \sum_i \left(R_{ic} \bullet \frac{{}_xT_{ic}}{{}_xT_c} - R_{ic} \bullet \frac{{}_xT_{iall}}{{}_xT_{all}} \right)$$

The deviation of a total (i.e. innovation or R&D expenditure) for a given country compared with the Nordic total may be calculated by correcting the total of the Nordic country, so the total is based on the same number of units:

[26] Link: www.cfa.au.dk/Publikationer/Working_papers/WP2006_6.pdf

$$(10)\quad \Delta T_c = T_c - T_{all}\frac{N_c}{N_{all}} = N_c \bullet \overline{X}_c - N_{all} \bullet \overline{X}_{all}\frac{N_c}{N_{all}} = N_c \bullet (\overline{X}_c - \overline{X}_{all})$$

The decomposition of the deviations in each industry may be calculated on the basis of (9), substituting the proportions with the averages and multiplying with the total number in the country under consideration:

$$(11)\quad N_c \bullet (\overline{X}_c - \overline{X}_{all})$$
$$= \sum_i \left(\overline{X}_{ic} \bullet \frac{N_{iall}}{N_{all}} - \overline{X}_{iall} \bullet \frac{N_{iall}}{N_{all}} \right) \bullet N_c + \sum_i \left(\overline{X}_{ic} \bullet \frac{N_{ic}}{N_c} - \overline{X}_{ic} \bullet \frac{N_{iall}}{N_{all}} \right) \bullet N_c$$

If the calculation of the industrial corrections and the deviations per industry should be based on the number of employees (i.e. innovation or R&D expenditure per employee) or based on the turnover (i.e. innovation or R&D intensity) then all the numbers (*N*) should be substituted with the number of employees or the turnover.

4.4 Tables for *Estimation, weighting* and *correction for industry/size-structure*

A. Total:

Table 4.1 Innovation expenditure in core industries, corrected for industry structure, CIS4, mill €

Country	Innovation expenditure		Indexed: corrected/non-corrected
	Non-corrected	Corrected	
Denmark	4,976	4,918	99
Norway	2,308	2,421	105
Sweden	16,521	18,300	111
DK+NO+SE	23,806	25,639	108

Note: No information on innovation expenditure from Finland and Iceland.

B. Ratio:

Table 4.2 Share of turnover from new products in core industries, corrected for industry structure, CIS4.

Country	Share of turnover from new products		Indexed: corrected/non-corrected
	Non-corrected	Corrected	
Denmark	11.0%	11.9%	108
Finland	14.9%	10.2%	69
Iceland	8.1%	8.2%	102
Norway	7.2%	10.8%	150
Sweden	13.4%	12.3%	92
Nordic countries	12.0%	12.0%	100

C. Proportion

Table 4.3 Proportion of innovation active enterprises in core industries, corrected for industry structure, CIS4.

Country	Proportion innovation active enterprises		Indexed: corrected/non-corrected
	Non-corrected	Corrected	
Denmark	52.0%	53.1%	102
Finland	43.3%	44.6%	103
Iceland	52.0%	51.4%	99
Norway	37.0%	39.5%	107
Sweden	50.0%	51.7%	103
Nordic countries	46.5%	47.4%	102

Table 4.4 Proportion of innovation active enterprises and proportion of employees in innovation active enterprises, core industries, CIS4.

Country	Proportion innovation active		Indexed: employees/enterprises
	enterprises	employees	
Denmark	52.0%	73.5%	142
Finland	43.3%	74.8%	172
Norway	37.0%	50.6%	137
Sweden	50.0%	68.3%	137
Nordic countries[1]	46.5%	68.1%	146

Note 1: No information on employees from Iceland.

Table 4.5 Proportion of employees in innovation active enterprises, corrected for industry structure, CIS4.

Country	Proportion employees in innovation active enterprises		Indexed: corrected/non-corrected
	Non-corrected	Corrected	
Denmark	73.5%	72.6%	99
Finland	74.8%	72.1%	97
Norway	50.6%	53.8%	106
Sweden	68.3%	68.6%	100.4
Nordic countries	68.1%	68.1%	100

D. Decomposition

D.1. Share of turnover of innovated products

Table 4.6 Decomposition of share of turnover of innovated products, relative deviations, each country compared to the Nordic average, core industries, CIS4.

INDUSTRIES	Nordic countries		Denmark			
					Relative deviations	
	Share turnover, innovated products	Proportion of turnover	Share turnover, innovated products	Proportion of turnover	Share turnover, innovated products	Industry structure (turnover)
C,15-16: Mining; Man: food, bev, tobac	8.2%	13.1%	23.4%	12.3%	184%	-6%
20-22: Man: wood, paper & publishing	4.6%	7.3%	5.7%	3.5%	22%	-52%
24-26: Non-metallic mineral products	9.8%	6.1%	12.9%	6.8%	32%	12%
27+28:Man: basic and fabricated metal	7.7%	5.0%	10.7%	2.8%	38%	-44%
29: Man: machinery & equipment n.e.c.	20.4%	4.4%	23.0%	4.8%	13%	10%
30-33: Electrical, medical, radio/TV	45.4%	6.9%	19.8%	3.7%	-56%	-46%
17-19,23,34-37: Other manufacturing	28.9%	5.8%	24.5%	5.2%	-15%	-10%
51: Wholesale trade (not motor veh.)	7.1%	22.5%	5.6%	27.4%	-21%	22%
E, 60-63: Transport, not post/telecomm.	4.3%	11.9%	3.7%	9.1%	-15%	-24%
J: Finance	6.4%	8.7%	3.0%	15.6%	-54%	79%
64+72: Computer, telecom & related	16.1%	6.9%	16.7%	6.8%	4%	-2%
74.2-3: Other business services	12.0%	1.4%	7.5%	1.9%	-38%	33%
Total	12.0%	100.0%	11.0%	100.0%		
		Total absolute deviation (21 industries)			-0.2%	-0.8%

Annex 4

INDUSTRIES	Nordic countries		Finland		Relative deviations	
	Share turnover, innovated products	Proportion of turnover	Share turnover, innovated products	Proportion of turnover	Share turnover, innovated products	Industrial structure
C,15-16: Mining; Man: food, bev, tobacco	8.2%	13.1%	10.4%	4.2%	26 %	-68 %
20-22: Man: wood, paper & publishing	4.6%	7.3%	3.3%	13.5%	-29 %	86 %
24-26: Non-metallic mineral products	9.8%	6.1%	10.8%	6.3%	10 %	3 %
27+28:Man: basic and fabricated metal	7.7%	5.0%	5.8%	7.1%	-24 %	40 %
29: Man: machinery & equipment n.e.c.	20.4%	4.4%	19.3%	5.6%	-5 %	27 %
30-33: Electrical, medical, radio/TV	45.4%	6.9%	49.7%	15.3%	10 %	123 %
17-19,23,34-37: Other manufacturing	28.9%	5.8%	30.1%	5.6%	4 %	-3 %
51: Wholesale trade (not motor veh.)	7.1%	22.5%	6.9%	21.0%	-4 %	-7 %
E, 60-63: Transport, not post/telecomm.	4.3%	11.9%	3.4%	10.0%	-22 %	-16 %
J: Finance	6.4%	8.7%	3.5%	5.2%	-45 %	-41 %
64+72: Computer, telecom & related activities	16.1%	6.9%	8.9%	5.4%	-45 %	-22 %
74.2-3: Other business services	12.0%	1.4%	8.7%	0.9%	-28 %	-38 %
Total	12.0%	100.0%	14.9%	100.0%		
		Total absolute deviation (21 industries)			-0.5%	3.3%

INDUSTRIES	Nordic countries		Iceland		Relative deviations	
	Share turnover, innovated products	Proportion of turnover	Share turnover, innovated products	Proportion of turnover	Share turnover, innovated products	Industrial structure
C,15-16: Mining; Man: food, bev, tobacco	8.2%	13.1%	3.7%	15.3%	-55 %	17 %
20-22: Man: wood, paper & publishing	4.6%	7.3%	0.2%	1.6%	-96 %	-77 %
24-26: Non-metallic mineral products	9.8%	6.1%	5.4%	2.4%	-44 %	-61 %
27+28:Man: basic and fabricated metal	7.7%	5.0%	0.5%	8.7%	-93 %	73 %
29: Man: machinery & equipment n.e.c.	20.4%	4.4%	16.3%	1.0%	-20 %	-77 %
30-33: Electrical, medical, radio/TV	45.4%	6.9%	21.9%	1.0%	-52 %	-85 %
17-19,23,34-37: Other manufacturing	28.9%	5.8%	5.3%	1.4%	-82 %	-76 %
51: Wholesale trade (not motor veh.)	7.1%	22.5%	7.3%	39.9%	3 %	77 %
E, 60-63: Transport, not post/telecomm.	4.3%	11.9%	9.3%	8.6%	116 %	-28 %
J: Finance	6.4%	8.7%	19.2%	12.7%	199 %	46 %
64+72: Computer, telecom & related activities	16.1%	6.9%	9.8%	5.9%	-39 %	-15 %
74.2-3: Other business services	12.0%	1.4%	9.7%	1.5%	-19 %	5 %
Total	12.0%	100.0%	8.1%	100.0%		
		Total absolute deviation (21 industries)			-3.4%	-0.6%

Annex 4

INDUSTRIES	Nordic countries		Norway		Relative deviations	
	Share turnover, innovated products	Proportion of turnover	Share turnover, innovated products	Proportion of turnover	Share turnover, innovated products	Industry structure (turnover)
C,15-16: Mining; Man: food, bev, tobac	8.2%	13.1%	3.4%	33.1%	-58%	153%
20-22: Man: wood, paper & publishing	4.6%	7.3%	4.0%	3.7%	-15%	-49%
24-26: Non-metallic mineral products	9.8%	6.1%	9.5%	3.5%	-3%	-43%
27+28:Man: basic and fabricated metal	7.7%	5.0%	11.6%	4.5%	51%	-10%
29: Man: machinery & equipment n.e.c.	20.4%	4.4%	15.7%	1.6%	-23%	-64%
30-33: Electrical, medical, radio/TV	45.4%	6.9%	40.7%	1.8%	-10%	-74%
17-19,23,34-37: Other manufacturing	28.9%	5.8%	13.7%	3.9%	-53%	-32%
51: Wholesale trade (not motor veh.)	7.1%	22.5%	5.0%	19.1%	-29%	-15%
E, 60-63: Transport, not post/telecomm.	4.3%	11.9%	2.1%	11.9%	-51%	0%
J: Finance	6.4%	8.7%	13.4%	10.8%	108%	24%
64+72: Computer, telecom & related	16.1%	6.9%	14.2%	4.6%	-12%	-33%
74.2-3: Other business services	12.0%	1.4%	15.3%	1.5%	27%	5%
Total	12.0%	100.0%	7.2%	100.0%		
		Total absolute deviation (21 industries)			-2.1%	-2.7%

INDUSTRIES	Nordic countries		Sweden		Relative deviations	
	Share turnover, innovated products	Proportion of turnover	Share turnover, innovated products	Proportion of turnover	Share turnover, innovated products	Industrial structure
C,15-16: Mining; Man: food, bev, tobacco	8.2%	13.1%	6.3%	5.5%	-23 %	-58 %
20-22: Man: wood, paper & publishing	4.6%	7.3%	6.1%	7.7%	32 %	6 %
24-26: Non-metallic mineral products	9.8%	6.1%	7.5%	7.1%	-23 %	16 %
27+28:Man: basic and fabricated metal	7.7%	5.0%	6.5%	5.1%	-16 %	1 %
29: Man: machinery & equipment n.e.c.	20.4%	4.4%	20.6%	5.1%	1 %	16 %
30-33: Electrical, medical, radio/TV	45.4%	6.9%	48.5%	6.5%	7 %	-5 %
17-19,23,34-37: Other manufacturing	28.9%	5.8%	20.3%	11.8%	-30 %	104 %
51: Wholesale trade (not motor veh.)	7.1%	22.5%	9.6%	21.2%	36 %	-6 %
E, 60-63: Transport, not post/telecomm.	4.3%	11.9%	6.1%	14.4%	41 %	21 %
J: Finance	6.4%	8.7%	4.0%	5.0%	-37 %	-42 %
64+72: Computer, telecom & related activities	16.1%	6.9%	19.2%	9.2%	19 %	33 %
74.2-3: Other business services	12.0%	1.4%	14.9%	1.3%	23 %	-3 %
Total	12.0%	100.0%	13.4%	100.0%		
		Total absolute deviation (21 industries)			0.2%	1.1%

D.2. Proportion innovation active

Table 4.7 Decomposition of proportion of innovation active enterprises, relative deviations, each country compared to the Nordic countries, core industries, CIS4.

INDUSTRIES	Denmark		Finland		Iceland	
	Relative deviations		Relative deviations		Relative deviations	
	Innovation propensity	Industry structure	Innovation propensity	Industry structure	Innovation propensity	Industry structure
C,15-16: Mining; Man: food, bev, tobac	40%	-19%	20%	-21%	20%	282%
20-22: Man: wood, paper & publishing	33%	-12%	-12%	5.8%	-14%	-31%
24-26: Non-metallic mineral products	-2.3%	28%	-3.1%	11%	-0.4%	1.8%
27+28:Man: basic and fabricated metal	-2.4%	5.9%	-8.2%	5.9%	-29%	-39%
29: Man: machinery & equipment n.e.c.	6.9%	32%	4.1%	9.8%	27%	-73%
30-33: Electrical, medical, radio/TV	-4.2%	24%	-9.8%	5.2%	-2.6%	-70%
17-19,23,34-37: Other manufacturing	2.3%	4.7%	-14%	5.1%	-38%	-18%
51: Wholesale trade (not motor veh.)	0.2%	34%	-15%	-30%	12%	-13%
E, 60-63: Transport, not post/telecomm.	80%	-77%	6.2%	29%	98%	-23%
J: Finance	6.5%	24%	4.1%	27%	32%	110%
64+72: Computer, telecom & related	2.7%	-11%	-3.8%	0.1%	32%	1.5%
74.2-3: Other business services	-7.8%	-11%	-27%	8.7%	-44%	-4.1%
Total absolute deviation (21 industries)	5.61%	-0.17%	-2.79%	-0.41%	3.92%	1.53%

INDUSTRIES	Norway		Sweden	
	Relative deviations		Relative deviations	
	Innovation propensity	Industry structure	Innovation propensity	Industry structure
C,15-16: Mining; Man: food, bev, tobac	-31%	64%	-3.9%	-28%
20-22: Man: wood, paper & publishing	-25%	-0.1%	3.6%	6.1%
24-26: Non-metallic mineral products	-11%	-29%	8.7%	-6.5%
27+28:Man: basic and fabricated metal	-14%	-36%	10%	15%
29: Man: machinery & equipment n.e.c.	-8.4%	-35%	-5.3%	-0.9%
30-33: Electrical, medical, radio/TV	12%	-33%	4.0%	4.5%
17-19,23,34-37: Other manufacturing	-9.6%	9.8%	15%	-10%
51: Wholesale trade (not motor veh.)	-32%	0.9%	24%	-4.5%
E, 60-63: Transport, not post/telecomm.	-21%	23%	-3.8%	20%
J: Finance	-38%	-4.0%	13%	-32%
64+72: Computer, telecom & related	-1.7%	-2.4%	-0.2%	7.7%
74.2-3: Other business services	-1.5%	17%	25%	-7.2%
Total absolute deviation (21 industries)	-7.76%	-1.77%	4.16%	-0.73%

Annex 5. Tables of composite innovation indicators

a. Innovation modes

Table 5.1 Innovation modes, Nordic countries, CIS4. Share of types of innovative and non-innovation active enterprises.

	Denmark	Finland	Iceland	Norway	Sweden
			All enterprises		
Strategic innovators	6%	9%	4%	6%	9%
Intermittent innovators	16%	13%	18%	12%	17%
Technology modifiers	13%	14%	20%	6%	17%
Technology adopters	17%	8%	11%	14%	7%
Non-innovation active	48%	57%	47%	63%	50%
			Manufacturing		
Strategic innovators	9%	12%	5%	7%	12%
Intermittent innovators	19%	16%	17%	15%	19%
Technology modifiers	12%	14%	25%	7%	18%
Technology adopters	18%	8%	8%	14%	7%
Non-innovation active	42%	51%	45%	57%	46%
			Services		
Strategic innovators	4%	6%	4%	5%	7%
Intermittent innovators	13%	11%	19%	9%	16%
Technology modifiers	15%	13%	15%	4%	16%
Technology adopters	15%	8%	14%	14%	7%
Non-innovation active	54%	63%	48%	68%	54%

Source: Own calculations based on CIS4 data for the Nordic countries.

Table 5.2 Output based technological modes by main sector and R&D activity, Nordic countries, CIS4. Share of total innovative and non-innovation active enterprises.

	Denmark	Finland	Iceland	Norway	Sweden
			All enterprises		
New to market international	18%	16%	9%	8%	17%
New to market domestic	13%	14%	24%	14%	16%
In-house modifiers	15%	10%	14%	11%	13%
Adopters	7%	4%	7%	4%	4%
No innovation activity	47%	57%	47%	63%	50%
			Manufacturing		
New to market international	23%	19%	9%	9%	20%
New to market domestic	12%	16%	24%	17%	17%
In-house modifiers	17%	9%	15%	13%	14%
Adopters	7%	5%	7%	4%	4%
No innovation activity	41%	51%	45%	57%	46%
			Services		
New to market international	13%	12%	9%	6%	15%
New to market domestic	14%	11%	23%	12%	15%
In-house modifiers	13%	11%	13%	10%	12%
Adopters	8%	3%	7%	4%	4%
No innovation activity	53%	63%	48%	69%	54%
			No R&D		
New to market international	8%	3%	2%	0%	4%
New to market domestic	8%	3%	10%	2%	8%
In-house modifiers	14%	6%	11%	6%	8%
Adopters	9%	5%	9%	4%	4%
No innovation activity	60%	83%	67%	87%	75%
			R&D		
New to market international	51%	42%	24%	27%	40%
New to market domestic	30%	37%	56%	48%	35%
In-house modifiers	17%	18%	18%	24%	24%
Adopters	2%	3%	2%	2%	2%
No innovation activity	0%	0%	0%	0%	0%

Source: Own calculations based on CIS4 data for the Nordic countries

Table 5.3 Output based technological modes by industry, Nordic countries, CIS4. Share of total innovative and non-innovation active enterprises.

	Denmark	Finland	Iceland	Norway	Sweden
			High tech manufacturing		
New to market international	33%	40%	100%	25%	35%
New to market domestic	23%	15%	0%	32%	19%
In-house modifiers	13%	4%	0%	9%	11%
Adopters	2%	1%	0%	3%	5%
No innovation activity	30%	40%	0%	31%	30%
			High-Medium tech manufacturing		
New to market international	29%	31%	21%	18%	30%
New to market domestic	15%	20%	15%	27%	20%
In-house modifiers	16%	7%	17%	11%	10%
Adopters	5%	3%	17%	4%	2%
No innovation activity	35%	40%	30%	41%	38%
			Medium-Low tech manufacturing		
New to market international	21%	13%	10%	8%	17%
New to market domestic	9%	18%	15%	16%	14%
In-house modifiers	16%	8%	10%	13%	16%
Adopters	4%	6%	8%	2%	3%
No innovation activity	51%	55%	57%	60%	50%
			Low tech manufacturing		
New to market international	19%	18%	6%	7%	15%
New to market domestic	10%	14%	29%	14%	17%
In-house modifiers	19%	11%	17%	14%	15%
Adopters	12%	5%	4%	3%	5%
No innovation activity	39%	52%	45%	61%	48%
			Wholesale trade		
New to market international	12%	17%	5%	3%	17%
New to market domestic	12%	6%	14%	11%	17%
In-house modifiers	11%	8%	15%	10%	12%
Adopters	8%	4%	12%	5%	6%
No innovation activity	57%	64%	54%	71%	47%
			Financial intermediates		
New to market international	4%	1%		1%	4%
New to market domestic	18%	15%	35%	6%	17%
In-house modifiers	15%	18%	15%	11%	22%
Adopters	7%	8%	6%	7%	3%
No innovation activity	56%	58%	44%	75%	54%
			Knowledge intensive services		
New to market international	19%	18%	21%	17%	26%
New to market domestic	20%	21%	32%	23%	22%
In-house modifiers	14%	9%	9%	13%	13%
Adopters	6%	2%		2%	2%
No innovation activity	41%	50%	38%	44%	37%
			Other core industries		
New to market international	8%	4%	9%	2%	4%
New to market domestic	9%	6%	22%	6%	7%
In-house modifiers	21%	14%	11%	7%	11%
Adopters	10%	3%	11%	5%	2%
No innovation activity	52%	74%	48%	79%	76%

Source: Own calculations based on CIS4 data for the Nordic countries.

Table 5.4 Output based technological modes by size class, Nordic countries, CIS4. Share of total innovative and non-innovation active enterprises.

	Denmark	Finland	Iceland	Norway	Sweden
			Small (10-49 employees)		
New to market international	15%	12%	8%	5%	13%
New to market domestic	12%	12%	29%	10%	15%
In-house modifiers	14%	9%	15%	8%	12%
Adopters	7%	4%	10%	4%	4%
No innovation activity	51%	63%	38%	73%	56%
			Medium (50-249 employees)		
New to market international	20%	27%	14%	10%	23%
New to market domestic	12%	17%	28%	19%	21%
In-house modifiers	15%	11%	23%	15%	18%
Adopters	8%	4%	5%	5%	2%
No innovation activity	45%	40%	30%	51%	36%
			Large (250 +employees)		
New to market international	30%	37%	29%	13%	35%
New to market domestic	20%	24%	42%	26%	20%
In-house modifiers	17%	13%	7%	18%	19%
Adopters	6%	3%		5%	2%
No innovation activity	28%	24%	21%	37%	23%

Source: Own calculations based on CIS4 data for the Nordic countries.

Table 5.5 Shares of product innovators for manufacturing and service sectors, Nordic countries, CIS4. In percent.

	High tech manufacturing	HighMed tech manufacturing	MedLow Tech manufacturing	Low Tech manufacturing	Manufacturing total	Wholesale Trade	Transport	Telecommunications	Financial intermediate	IT consulting	IT software and data processing	Technical business service s	Services total
Denmark													
Dual innovators	11%	10%	8%	2%	7%	13%	4%	8%	4%	39%	23%	8%	13%
Goods only	31%	29%	20%	25%	25%	14%	0%	4%	1%	12%	14%	2%	11%
Services only	2%	5%	2%	3%	3%	3%	8%	22%	21%	12%	11%	12%	7%
Finland													
Dual innovators	10%	14%	7%	10%	9%	14%	3%	12%	2%	25%		4%	9%
Goods only	38%	31%	15%	20%	20%	12%	1%	1%	0%	13%		0%	6%
Services only	4%	2%	3%	4%	3%	2%	11%	25%	28%	16%		14%	11%
Iceland													
Dual innovators	75%	37%	21%	16%	19%	14%	16%	57%	43%		66%	15%	27%
Goods only	25%	15%	9%	25%	20%	12%	2%	0%	0%		17%	0%	4%
Services only	0%	17%	8%	2%	5%	2%	22%	29%	14%		9%	0%	13%
Norway													
Dual innovators	2%	1%	0%	0%	1%	1%	0%	1%	0%	5%	2%	1%	1%
Goods only	47%	41%	23%	22%	24%	18%	0%	7%	2%	26%	28%	13%	12%
Services only	5%	5%	4%	3%	4%	3%	6%	28%	15%	27%	25%	18%	9%
Sweden													
Dual innovators	13%	10%	7%	7%	8%	13%	1%	14%	8%	20%	30%	11%	11%
Goods only	37%	35%	23%	22%	25%	27%	2%	7%	2%	18%	18%	7%	15%
Services only	4%	4%	3%	5%	4%	5%	10%	15%	22%	20%	9%	24%	11%

Source: Own calculations based on CIS4 data. High tech manufacturing: 24.4, 30, 35.3, 32 -33; Medium-high tech: 24.0 – 24.3, 24.5 – 24.9, 29, 31, 34, 35.2, 35.4 -35.9; MedLowTech Manufacturing: 23, 25 – 28, 35.1; LowTech Manufacturing: 15 – 22, 36 – 37; Wholesale trade: 51; Transport: 60-63; Telecommunications: 64; Financial intermediates: 65-67; IT consulting: 72.0 – 72.1, 72.22 – 72.29; IT software and data processing: 72.2 – 72.21, 72.3 - 72.9; Business service – technical: 74.0 – 74.14, 74.4.

Table 5.6 Technological and non-technological modes, Nordic countries, CIS4. Share of total innovative and non-innovation active enterprises.

	Denmark	Finland	Iceland	Norway
		All enterprises		
Integrated	14	11	7	4
Technological	4	5	2	4
Modifiers	25	20	36	21
Technological adopters	9	7	8	8
Soft innovators	22	15	6	10
No tech/non-tech innovation	26	42	40	53
		Manufacturing		
Integrated	18	12	5	4
Technological	6	7	3	5
Modifiers	25	21	37	25
Technological adopters	9	8	9	9
Soft innovators	17	14	6	8
No tech/non-tech innovation	25	37	40	49
		Services		
Integrated	11	9	9	3
Technological	2	3	1	3
Modifiers	24	19	36	19
Technological adopters	9	6	7	7
Soft innovators	26	16	7	11
No tech/non-tech innovation	28	47	41	57

Source: Own calculations based on CIS4 data for the Nordic countries.

b. Composite indicators for Cooperation

Table 5.7 Innovation cooperation by industry and type of partner, Nordic countries, CIS4. Share of total innovation active enterprises.

Denmark	Suppliers	Market sources	Public research	International
HighTech Manufacturing	37%	40%	48%	29%
HighMedTech Manufacturing	37%	45%	14%	21%
MedLowTech Manufacturing	25%	31%	11%	4%
LowTech Manufacturing	19%	24%	13%	5%
Wholesale Trade	30%	29%	16%	17%
Financial intermediate	24%	26%	15%	5%
Knowledge-intensive Service	32%	40%	21%	12%
Other core industries	19%	18%	6%	3%
Finland	Suppliers	Market sources	Public research	International
HighTech Manufacturing	41%	54%	47%	50%
HighMedTech Manufacturing	53%	54%	49%	48%
MedLowTech Manufacturing	42%	44%	38%	24%
LowTech Manufacturing	38%	36%	28%	27%
Wholesale Trade	34%	35%	23%	32%
Financial intermediate	30%	30%	24%	13%
Knowledge-intensive Service	46%	50%	40%	34%
Other core industries	35%	34%	27%	18%
Iceland	Suppliers	Market sources	Public research	International
HighTech Manufacturing	25%	63%	100%	25%
HighMedTech Manufacturing	29%	39%	39%	5%
MedLowTech Manufacturing	14%	14%	7%	0%
LowTech Manufacturing	12%	17%	6%	3%
Wholesale Trade	30%	30%	34%	26%
Financial intermediate	34%	11%	6%	0%
Knowledge-intensive Service	25%	46%	18%	25%
Other core industries	0%	2%	2%	2%
Norway	Suppliers	Market sources	Public research	International
HighTech Manufacturing	39%	46%	36%	36%
HighMedTech Manufacturing	29%	28%	27%	15%
MedLowTech Manufacturing	26%	26%	25%	10%
LowTech Manufacturing	22%	23%	18%	6%
Wholesale Trade	18%	14%	13%	6%
Financial intermediate	28%	24%	8%	2%
Knowledge-intensive Service	23%	29%	22%	12%
Other core industries	18%	15%	18%	7%
Sweden	Suppliers	Market sources	Public research	International
HighTech Manufacturing	47%	44%	36%	22%
HighMedTech Manufacturing	42%	42%	29%	20%
MedLowTech Manufacturing	30%	37%	26%	7%
LowTech Manufacturing	35%	25%	18%	4%
Wholesale Trade	22%	11%	8%	3%
Financial intermediate	40%	36%	6%	8%
Knowledge-intensive Service	31%	36%	21%	14%
Other core industries	31%	34%	10%	3%

Source: CIS4 data for the Nordic countries. Market sources are customers or competitors. Public research is universities and government research institutions. International is cooperation with any type of partner abroad.

c. Effects and barriers – factor analyses and tables

Table 5.8 Results of factor analyses of effects and hampering factors in DK, FI, NO, CIS4

a. Effects of product and process innovation

		DK	FI	NO
Eigenvalues	1	3.9	4.8	3.5
	2	1.6	1.2	1.6
	3	1.1	0.9	1.1
Cum. Variance		74%	77%	77%
Std.Coeff>0.3	1	Flexibility Capacity Labour costs Mat+energy	Flexibility Capacity Labour costs Mat+energy	Flexibility Capacity Labour costs Mat+energy
	2	Range of goods Markets Quality	Range of goods Markets Quality	Range of goods Markets Quality
	3	Environment Standards	Environment Standards (Mat.+energy)	Environment Standards (Mat.+energy)

b. Hampering factors for product and process innovation

		DK	FI	NO
Eigenvalues	1	5.4	5.4	5.9
	2	1.4	1.6	1.6
	3	1.0	1.1	0.8
	4	0.7	0.7	0.6
Cum. Variance		77%	80%	81%
Std.Coeff>0.3	1	Personnel Technology Market-inform. Partners	Personnel Technology Market-inform. Partners	Personnel Technology Market-inform. Partners
	2	Finance-enterp. Finance-external Innovation-cost	Finance-enterp. Finance-external Innovation-cost	Finance-enterp. Finance-external Innovation-cost
	3	Prior innovation No demand	Prior innovation No demand	Prior innovation No demand
	4	Dominated Uncertain demand	Dominated Uncertain demand	Dominated Uncertain demand

Table 5.9 Degree of importance of effects and barriers, Denmark, CIS4

Table 5.9.a Degree of effects of product/process innovation, composite indicators, Denmark, CIS4

Classification	Outcome	Effects		
		Product	Process	Other
Product/process innovation	Only product innovation	64.8	13.9	27.2
	Only process innovation	23.2	51.2	34.6
	Product and process innovation	68.6	56.6	41.4
Organisational innovation	No	39.7	32.5	24.7
	Yes	51.0	41.3	33.2
Marketing innovation	No	44.0	37.1	29.6
	Yes	60.0	45.1	35.8
Intramural R&D	No	40.2	36.7	28.7
	Yes	55.4	41.6	33.5
Industry	Manufacturing	49.2	35.6	19.2
	Wholesale trade	52.1	44.9	36.6
	Knowledge Intensive Services	43.3	31.8	28.4
	Financial intermediate	50.0	33.7	26.7
	Other industries	33.8	40.7	26.5
Size	- 49	46.7	32.7	27.5
	50-249	47.9	41.1	32.6
	250-	52.6	47.3	35.6
All innovating enterprises		48.6	39.4	31.4

Table 5.9.b: Degree of importance of barriers for innovation activities, composite indicators, Denmark, CIS4

Classification	Outcome	Barriers			
		cost	knowledge	market	NonInno
Innovation Active	No	16.4	14.5	21.8	21.0
	Yes	33.9	30.3	36.2	24.3
Product/process innovation (PP-inno)	No	18.3	16.0	22.7	21.6
	Yes	35.0	31.4	37.8	24.2
Organisational innovation (org-inno)	No	20.9	18.0	24.1	21.7
	Yes	30.0	27.1	33.8	23.6
PP-inno/org-inno	No/No	16.3	14.0	21.0	20.8
	No/Yes	20.6	18.4	24.7	22.6
	Yes/No	33.5	29.0	32.7	24.2
	Yes/Yes	35.3	32.0	39.0	24.2
Marketing innovation	No	25.1	22.3	28.4	22.3
	Yes	32.5	29.4	37.2	25.1
Intramural R&D	No	21.3	19.1	25.6	22.3
	Yes	37.9	33.6	40.1	24.3
Industry	Manufacturing	32.3	28.9	36.1	24.9
	Wholesale trade	18.3	17.4	23.7	19.9
	Knowledge Intensive Services	29.2	23.8	28.9	20.8
	Financial intermediate	14.5	16.7	25.9	22.4
	Other industries	21.1	19.9	26.3	26.4
Size	- 49	28.5	23.3	29.2	21.0
	50-249	25.3	23.7	30.1	23.8
	250-	25.1	25.1	33.0	25.7
All reporting enterprises		26.7	23.8	30.3	22.9

d. Globalization – tables

Validation:

A validation of the answers to the question on headquarters in the Danish CIS4 showed that it is not answered by 24 % of the enterprises that claim to be part of a group. A thorough check of all responding enterprises in the Danish CIS4 using two private business registers and the internet revealed further that only 82 % seems to be giving the correct answer to the question on *Part of a group.* 9 % seems not to be a group, though claimed and 9 % the opposite way. With the *Country of headquarters* it is even worse. Only 55 % of the enterprise groups seemed to have claimed the right country, while 10 % seemed to have another country of headquarters than told in the CIS4-questionnaire. 13 % were new-found groups, not declaring themselves as a group in the CIS4-questionnaire, while the rest was the item non-response.

Table 5.10 Share of expenditure by enterprise type, CIS4, Denmark

Enterprise type	R&D activities	Other intramural activities	Acquired innovation	Total innovation expenditure
1 DK, single	7%	13%	20%	12%
2 DK, national group	11%	11%	15%	12%
3 DK-MNE, Nordic group	34%	26%	32%	32%
4 DK-MNE, other countries	22%	36%	23%	24%
5 Nordic MNEs in DK	9%	3%	4%	7%
6 US-MNEs in DK	11%	3%	2%	7%
7 Other MNEs in DK	7%	8%	5%	6%
All, core-nace and -size	100%	100%	100%	100%
Total amount (mia. DKK)	22.9	4.4	14.2	41.4

Source: Own calculations based on CIS4 data for Denmark.

Table 5.11 Innovation indicators, share of enterprises by enterprise type, CIS4, Denmark

Enterprise type	Share with					
	R&D expenditure	Innovation expenditure	Innovation activities	Product/process innovation	Organisational innovation	Marketing innovation
DK, single	12%	37%	46%	41%	51%	19%
DK, national group	23%	49%	55%	47%	58%	22%
DK-MNE, Nordic group	32%	53%	61%	54%	63%	18%
DK-MNE, other countries	39%	73%	77%	71%	74%	26%
Nordic MNEs in DK	11%	36%	53%	47%	73%	27%
US-MNEs in DK	27%	53%	60%	54%	74%	25%
Other MNEs in DK	20%	46%	60%	48%	64%	24%
All, core-nace and -size	18%	45%	53%	46%	58%	21%

Source: Own calculations based on CIS4 data for Denmark.

Annex 6. Composite indicator definitions and calculation

a. CIS4 variables used for the composite indicators

Variable name	Description
mareur	Sales in other EU countries
maroth	Sales in other (non-EU) countries
inpdgd	Good product innovation
inpdsv	Service product innovation
inpspd	Production process innovation
inpslg	Logistics process innovation
inpssu	Support process innovation
mktmet	Marketing method innovation
mktdes	Design marketing innovation
orgsys	Organisational systems innovation
orgstr	Organisational structure innovation
orgrel	Organisational relations innovation
coXY	innovation cooperation (X=within group(1), supplier(2), customer(3), competitor(4), commercial R&D lab(5), university(6), govt research(7); Y=domestic(1), other Europe(2), USA(3), Other countries(4))
rrdin	intramural R&D (binary)
rdeng	Continuous (1) or occasional (2) R&D
newmkt	new to market product innovation
inpdtw	Who developed product innovation: mainly enterprise itself(1), together with others(2) or mainly others(3)
inpcsw	Who developed process innovation: mainly enterprise itself(1), together with others(2) or mainly others(3)
rrdex	extramural R&D (binary)
roek	Acquisition of other external knowledge (binary)
rmac	Acquisition of machinery, equipment or software (binary)
ssup	suppliers as info source (None(0) to Very important(3))
scli	customers as info source (None(0) to Very important(3))
sentg	within enterprise or group as info source (None(0) to Very important(3))
scom	competitors as info source (None(0) to Very important(3))
sins	Commercial R&D as info source (None(0) to Very important(3))
suni	universities as info source (None(0) to Very important(3))
sgmt	government research institutions as info source (None(0) to Very important(3))

b. Intermediate variables constructed from CIS4 questionnaire variables for use in calculation of indicators

International markets
if mareur=**1** or maroth=**1** then marintl=**1**
Product innovation
if inpdgd=**1** or inpdsv=**1** then inpdt=**1**
Process innovation
if inpspd=**1** or inpslg=**1** or inpssu=**1** then inpcs=**1**
Marketing innovation
if mktmet=**1** or mktdes=**1** then inmkt=**1**
Organizational innovation
if orgsys=**1** or orgstr=**1** or orgrel=**1** then inorg=**1**
R&D cooperation (cooperation with commercial R&D labs OR universities OR government research institutions)
if (co51=**1** or co52=**1** or co53=**1** or co54=**1**
or co61=**1** or co62=**1** or co63=**1** or co64=**1**
or co71=**1** or co72=**1** or co73=**1** or co74=**1**) then corrd=**1**
Public cooperation (cooperation with universities OR government research institutions)
if (co61=**1** or co62=**1** or co63=**1** or co64=**1**
or co71=**1** or co72=**1** or co73=**1** or co74=**1**) then copub=**1**
Supplier cooperation
if (co21=**1** or co22=**1** or co23=**1** or co24=**1**) then cosupply=**1**
Market cooperation (cooperation with customers OR competitors)
if (co31=**1** or co32=**1** or co33=**1** or co34=**1**
or co41=**1** or co42=**1** or co43=**1** or co44=**1**) then comkt=**1**

c. Composite indicators

1. Innovation modes

Below are the main definitions used in calculating Arundel and Hollanders' innovation modes, which is modified slightly for CIS4 data (from original program provided by Anthony Arundel). The actual program contains a number of additional calculations designed to account for missing variables. However, only the main definitions are included in this annex.

Strategic innovators: strategic innovators conduct continuous in-house R&D, have introduced new to market product innovations, operate on international markets and have in-house development activities (measured either by innovation cooperation or that product or process innovations were developed by the enterprise itself or together with others).

if Rrdin = **1** and rdeng = **1** and marintl=**1** and newmkt = **1** and
(inpdt = **1** or inpcs = **1**) and co=**1** then mode="**Strategic innovator**"

Intermittent innovators: The construction of this mode is somewhat complicated, but essentially requires that enterprises have R&D, in-house development and some (but not all) of the other characteristics described above for strategic innovators.

else if Rrdin = **1** and rdeng = **2** and newmkt = **1** and
((inpdt = **1** and inpdtw in (**1**,**2**)) or (inpcs = **1** and inpcsw in (**1**,**2**)) then
mode="**Intermittent innovator**" (note that this mode is also defined for different combinations of the variables rdeng, newmkt, inpdtw/inpcsw and co)

Technology modifiers: the main requirement for this mode is that enterprises have introduced a product or process innovation (at least partially) through in-house development.

else if ((inpdt = **1** and inpdtw in (**1**,**2**)) or (inpcs = **1** and inpcsw in (**1**,**2**)))
and Rrdin = **1** and (rdeng =**2**) and newmkt in (**0**,**.**) then mode="**Technology modifier**" (note that this mode is also defined for different combinations of the variables rdeng, newmkt, inpdtw/inpcsw and co. Though requirements are lesser than for intermittent innovators, particularly in terms of novelty)

Technology adopters: The main requirement in terms of construction of this mode is thus that enterprises' product and process innovations have been mainly developed by others.

if ((inpdt = **1** and inpdtw = **3**) or (inpcs = **1** and inpcsw = **3**)) then mode="**Technology adopters**"

2. Output-based technological modes

if ((inpdt = **1** and inpdtw in (**1**,**2**)) or (inpcs = **1** and inpcsw in (**1**,**2**)))
and marintl = **1** and newmkt=**1** then output-mode=" **New to market international"**
else if ((inpdt = **1** and inpdtw in (**1**,**2**)) or (inpcs = **1** and inpcsw in (**1**,**2**)))
and newmkt = **1** then output-mode =" **new to market domestic**"
else if ((inpdt = **1** and inpdtw in (**1**,**2**)) or (inpcs = **1** and inpcsw in (**1**,**2**)))
then output-mode ="**In-house modifier**"
else if (inpdt = **1** and inpdtw=**3**) or (inpcs = **1** and inpcsw=**3**) then output-mode ="**Adopter**"

3. Output-based technological and non-technological modes

if marintl=**1** and newmkt = **1** and ((inpdt = **1** and inpdtw in (**1**,**2**)) or (inpcs = **1** and inpcsw in (**1**,**2**))) and (inorg=**1**) then tech and non-tech mode="**Integrated**"
else if marintl=**1** and newmkt = **1** and
((inpdt = **1** and inpdtw in (**1**,**2**)) or (inpcs = **1** and inpcsw in (**1**,**2**))) then tech and non-tech mode="**Technological"**
else if ((inpdt = **1** and inpdtw in (**1**,**2**)) or (inpcs = **1** and inpcsw in (**1**,**2**)))
then tech and non-tech mode="**Modifiers**"
else if (inpdt = **1** and inpdtw=**3**) or (inpcs = **1** and inpcsw=**3**) then tech and non-tech mode="**Adopters**"
if not (inpdt=**1** or inpcs=**1**) and inonab in (**0**,**.**) and (inorg=**1** or inmkt=**1**)
then tech and non-tech mode="**Soft**"

4. Innovation drivers

if (inpdt=**1** and comkt=**1**) and ((rrdin=**1** or rrdex=**1** or roek=**1** or rmac=**1**)
and corrd=**1** and (inpcs=**1** or inpdt=**1**)) then **mkt_tech_driven**=**1**;
else if inpdt=**1** and comkt=**1** then **mkt_driven**=**1**;
else if (rrdin=**1** or rrdex=**1** or roek=**1** or rmac=**1**) and corrd=**1**
and (inpcs=**1** or inpdt=**1**) then **tech_driven**=**1**;
if not (mkt_tech_driven=**1** or mkt_driven=**1** or tech_driven=**1**)
and (inpcs=**1** or inpdt=**1**) and cosupply=1 then **supply_driven**=**1**;
if not (mkt_tech_driven=**1** or mkt_driven=**1** or tech_driven=**1** or supply_driven=**1**) and
and (inpcs=**1** or inpdt=**1**) and (co11=1 or co12=1 or co13=1 or co14=1)
then **internal_driven**=**1**;

5. Composite indicators based on information sources and cooperation

if not (co21=**1** or co22=**1** or co23=**1** or co24=**1**) and ssup in (**2,3**) then sup_arms_length=**1**;
if (co21=**1** or co22=**1** or co23=**1** or co24=**1**) and ssup in (**2,3**) then sup_coop=**1**;
if not (co31=**1** or co32=**1** or co33=**1** or co34=**1** or co41=**1** or co42=**1** or co43=**1** or co44=**1**) and (scli in (**2,3**) or scom in (**2,3**)) then mkt_arms_length =**1**;
if (co31=**1** or co32=**1** or co33=**1** or co34=**1** or co41=**1** or co42=**1** or co43=**1** or co44=**1**) and (scli in (**2,3**) or scom in (**2,3**)) then mkt_coop =**1**;
if not (co61=**1** or co62=**1** or co63=**1** or co64=**1** or co71=**1** or co72=**1** or co73=**1** or co74=**1**) and (suni in (**2,3**) or sgmt in (**2,3**)) then pub_arms_length =**1**;
if (co61=**1** or co62=**1** or co63=**1** or co64=**1** or co71=**1** or co72=**1** or co73=**1** or co74=**1**) and (suni in (**2,3**) or sgmt in (**2,3**)) then pub_coop =**1**;

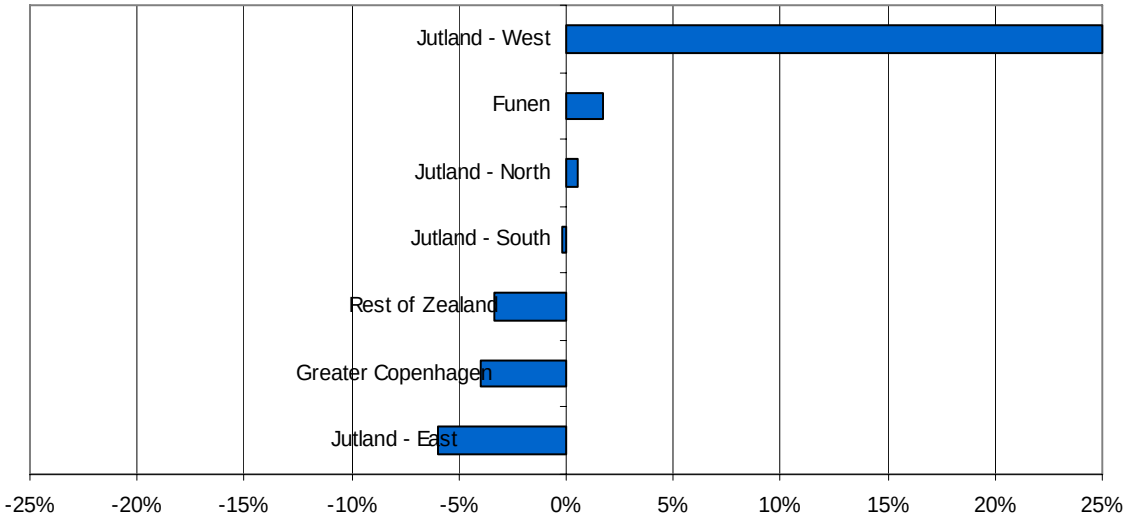
Annex 7 Regional innovation indicators

a. Effects of regionalisation of non-stratified sample

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 responding enterprises will not automatically be equal to the total number of enterprises in the region. For the Danish CIS4, the bias of this can be illustrated at regional level (with 7 regions): Greater Copenhagen: 41.9% of the population, but 39.3% of the weighted responses; Western Jutland: 9.8% of the population, but 12.3% of the weighted responses.

This bias is expressed as deviations in Figure A.7.1. 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.

Figure A.7.1 Differences between respondents (weighted) and population, regions, Denmark, CIS4



A post-stratification by regions may correct this, but the reliability of the regional indicators will still vary a lot, being low in smaller regions due to small sample sizes. For instance, in the Danish CIS4 the coefficient of variation for the share of innovators is close to 14 % in *Rest of Zealand*, but only 3 % for *Greater Copenhagen*.

b. Question on innovation activities in establishments, Danish CIS06-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**	%

c. Effects of allocating the innovation activities according to local establishments

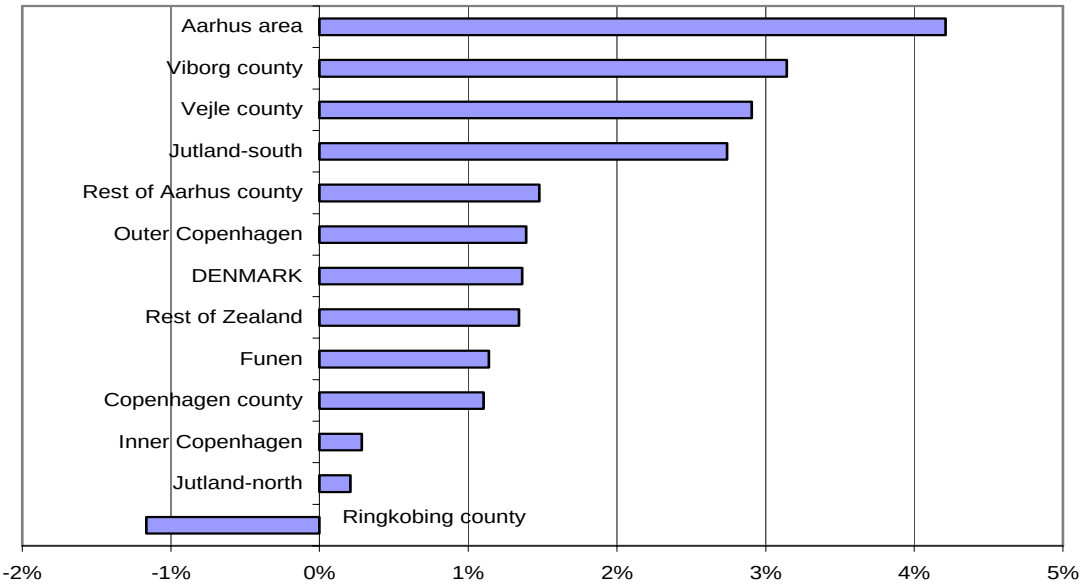
1. Effect on innovation expenditure:

See Chapter 8.1.

2. Effect on the proportion of enterprises with innovation expenditure:

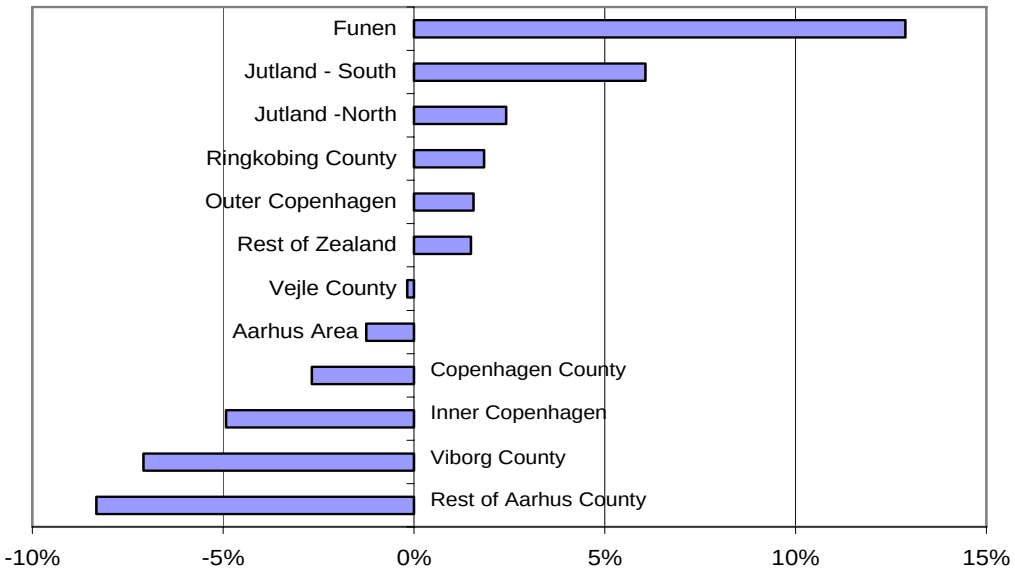
In Figure A.7.2 the effect of correcting *the proportion of enterprises with innovation expenditure* is illustrated for Danish CIS4 data when 12 regions are used. All, but one gets an increased proportion, due to the inflation from the new innovating establishments. The National estimate is inflated by 1.4 percentage points, 4 regions are inflated more and 3 less.

Figure A.7.2 Effect in proportion with innovation expenditure when corrected for innovation activities outside the region of the headquarters, Denmark, CIS4



Regions, like countries have different industry and size structure. This means that differences in innovation propensity may be explained by structure or by real differences. A correction like the one described for countries (see Chapter 3) may hence be recommended when comparing regions. The effects of this correction for the same 12 regions as above are illustrated in Figure A.7.3. Two regions get an increase of the proportion of enterprises with innovation expenditure of more than 5%, while 3 other regions decrease at least 5%.

Figure A.7.3 Effect in proportion with innovation expenditure when corrected for industrial/size-structure, Denmark, CIS4



The final indicator and decomposition: See Chapter 8.1.