EUROPEAN INNOVATION MONITORING SYSTEM (EIMS)

EIMS PUBLICATION N° 04

INNOVATION STRUCTURES AND PERFORMANCE IN NORDIC MANUFACTURING INDUSTRY

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Executive Summary

1. Today it is widely recognised that new data on the innovation processes in industry are needed in order to develop national and EU policies aimed at enhancing technological development. Thus, within the EU and the OECD large efforts are made to develop methods for making such surveys of innovation, and the European Commission (DG XIII (SPRINT/EIMS) and EUROSTAT) is presently carrying out a large scale postal innovation survey that will result in such a new database (the Community Innovation Survey).

2. However, until these data become available, we have to rely on older and more incomplete data sources. Thus, this report summarises the results from the first cross country innovation survey made: The Nordic Innovation Survey. This survey was performed in 1989, and was built on the experience from surveys previously carried out in Italy and Germany. It can be seen as a forerunner for innovation surveys now being carried out in the EU countries. The results presented here are based on 650 questionnaires from Denmark, Iceland, Finland, Norway and Sweden.

3. Both regarding innovation output and innovative activities we find that aggregate data cover big variations over firm size and sector. There is a clear tendency that small and, to a less degree, medium-sized firms have achieved the best innovative results; and correspondingly, it is apparently small enterprises which have made the, relatively, biggest innovative efforts. Over sectors we find the tendency that the two most research-intensive sectors have achieved the best results and that science based firms carry out an above-average number of innovative projects.

4. At the national level it is difficult to see any pattern in the differences between the Nordic countries. Innovative output *seems* to be higher in Denmark than in Finland and Norway. Norwegian firms *seem* so spend a large share of their innovation budget on R&D while Finnish firms *seem* to spend a large share of their innovation budget on acquisition of capital equipment connected to innovation. However, the similarities between innovative activity in the Nordic countries appear to be much more dominant. For example, it is small firms and the more research intensive sectors that have the largest share of innovation in their output; large enterprises conduct the majority of development projects, but in relative terms small enterprises carry out more projects than large enterprises do; R&D is the major post on innovation budgets in all countries, etc.

5. One of the methodological lessons learned from this analysis is that, to allow for cross country comparisons, large efforts is to required to make both questionnaires and samples as harmonized as possible in future surveys.

Contents

1. Introduction

1.1 Basis for the study

The basis for the study is firm-level databases of innovative activity in manufacturing industry in the five Nordic countries. The databases cover approximately 650 enterprises and they include information on both inputs to the innovation process, co-operation about innovations and outputs from the innovation process. It is, thus, possible to create a picture of industrial development which is more detailed than what can be pictured by the 'normal' indicators of technological development (R&D expenditure and patents).

The questionnaires used in the five Nordic countries were almost identical[1] and The Nordic Innovation Survey was thus the first attempt to make internationally comparable data on innovation. This work has been continued both by OECD alone in developing and publishing a manual on innovation surveys in the 'Frascati manual' family[2], by EEC and OECD together in developing an internationally approved innovation survey questionnaire and by EEC alone in initiating a co-ordinated innovation survey covering several of the EEC and EFTA countries.

This work has been markedly influenced by the Nordic Innovation Group[3] (especially Keith Smith and Mikael Åkerblom) which has played an active role both in the development of the manual and in the development of the questionnaire.

The method and the questionnaire in the Nordic Survey built on the experience from especially the first Italian innovation survey and the German IFO innovation surveys[4], and therefore it is not significantly

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[1] The Finnish questionnaire is enclosed as Annex 1. Only the Swedish questionnaire differed somewhat from the other questionnaires. Therefore Sweden is excluded from some of the tables in the report.

[2] *'The Oslo Manual'. OECD proposed Guidelines for Collecting and Interpreting Technological Innovation Data*, OECD/GD (92)26.

[3] Keith Smith and Erik Edvardsen, Norway; Mikael Åkerblom, Finland; Enrico Deiaco, Sweden; Thorvald Finnbjörnsson, Iceland and Arne Kristensen, Denmark.

[4] See e.g. *STI Review* No. 11 1992 for a short presentation of these and other Innovation Surveys.

different from other innovation surveys that have been conducted in other OECD countries[5].

The Nordic Industrial fund gave financial support to the Nordic Survey and the Nordic comparisons have been published in two works from The Nordic Industrial Fund: 'Innovation Activities in Nordic Countries', *Newsletter* No. 4-1991 which gave a short presentation of the survey and discussed some of the main results and 'Innovation Activities in Nordic Countries', *Information* No. 3-1991 with detailed tables from Denmark, Finland, Norway and Sweden. The Icelandic results have been published separately in 'Innovation Activities in Iceland' from the National Research Council of Iceland, 1992.

Parts of the data for this report have been found in the last publications and parts have been produced by the different countries especially for this report. A presentation of the samples is included as Annex 2.

1.2 Structure of the report

As indicated above this study is in three parts. The first part deals with the *inputs in the innovation process*. Here analysis covering for example costs of innovative activity, number of innovative projects and importance of factors inducing and hampering innovation will be performed. The second part concentrates on *innovation co-operation*, covering analysis of R&D co-operation. Finally, the third part analyses the *outputs from the innovation process*. This includes analysis of the share of sale and export originating from new products and share of turnover originating form products in early phases of their life cycle.

The analysis is performed according to firm size and according to sectors[6]. Firms are divided into three size groups: Small firms: 0-99 employees, medium-sized firms: 100-499 employees and large firms 500-employees[7].

When it comes to sectors we use the so-called 'Pavitt sectors': scale intensive firms, supplier dominated firms, science based firms and

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[5] See OECD/DSTI/EAS/STP/NESTI(93)2 for a comparison of some innovation survey findings.

[6] A description of the division of the sample into sectors is included as Annex 3.

[7] That the size group 'large firms' starts already at 500 employees may seem strange from a Central-European point of view, where many enterprises have over 10.000 employees, but in the Nordic region with only few large firms this division seems suitable. Furthermore it should be noticed that the survey unit is the business unit rather than the firm. The size distribution of the sample is presented in Annex 2.

specialised suppliers[8]. The rationale behind this division of firms in the manufacturing sector is three-fold: First, it is based on the view that innovative behaviour is different in sectors rather than in branches and that it is possible to trace a 'system of innovation interaction'[9] in the manufacturing sector. Second there is a methodological reason: the samples in the five countries were too small for valid branch analysis. And third, there is a practical reason: the analysis design gets much more handy if one works with four sectors rather than 10 or 15 branches.

The analysis will, thus, basically be descriptive, but it is the ambition in this study to go beyond the descriptive statistics into analysis by discussions the results of the two background variables in combination.

Before embarking in the analysis it is necessary to put forward a word of caution: This report builds on five Nordic pilot surveys which had the testing of different questions about innovative processes as their primary purpose. This, of course, implied that the samples were chosen so they would include firms particularly likely to carry out innovative activities. Therefore the samples included an over representation of firms carrying out R&D, and this limits the statistical significance of the results presented in this report. Thus, the results in this report cannot be applied to the whole manufacturing industry but, at best, to the R&D performing manufacturing industry.

Furthermore, one of the normal characteristics of pilot surveys, the relative small number of units surveyed, was also employed in this project, and this severely limits the possibility to put forward valid statistical conclusions in this report. However, once the survey has been conducted, and the methodological lessons have been learned, it would be silly not to perform any analysis of the data, and this, therefore, is what we propose to do in this report - bearing in mind the statistical weaknesses of the data.

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[8] Keith Pavitt: 'Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory', *Research Policy* No. 13, 1984. Annex 3 has a short description of the Pavitt sectors.

[9] A view partly based on the 'User-producer' approach and the 'Systems of Innovation' approach (e.g. Bengt-Åke Lundvall *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*, Pinter Publishers 1992). See Arne Kristensen: *Analysis of Inter-industry Innovation at the System Level*, (paper presented at 'Workshop on Evolutionary Economics and the Accumulation of Knowledge', Koldkær 1992) for a presentation of the view.

2. Background for innovation activities

In planning public policy directed towards industry and specifically towards technological development and innovation it is of crucial importance to know *how* firms innovate. One important aspect of this 'how' can be analysed by investigating which factors trigger innovation and, closely related, which factors hamper innovation. Such an analysis is included in section 2.1. In section 2.2 we delve further into 'how' by concentrating on enterprise's innovation efforts and analyse the size of and the structure of innovation expenditure and the number of and length of innovative projects.

2.1 Factors which trigger and hamper innovation

Inputs in the innovation process

At the 'total-level' (Table 2.1) the most important sources[10] of innovative ideas for all five countries are resources internal in the enterprise. These resources are Top management (between 50% and 80% of all firms consider the top management important), Internal R&D (between 50% and 70%), Marketing department (between 40% and 70%), Key persons in the enterprise (20-60%) and Production department (between 10% and 40%).

The next group of factors are external, namely co-operation with other industrial firms. Particularly important are Co-operation with customers (regarded important by between 45% and 90% of the respondents). Co-operation with other industrial firms and subcontractors are regarded important by up to 40% of the enterprises.

'Market factors' like ideas from Competitors products and from Fairs, exhibitions, etc. are rated differently for Finnish and Swedish firms on the one side and Danish, Icelandic and Norwegian firms on the other side. For Finnish and Swedish firms ideas from competitors products are important for app. 80% of the firms whereas the figure for Denmark, Iceland and Norway lay between 25% and 35%[11].

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[10] 'Important' are values 4 and 5 on a 0-5 point scale.

[11] Looking through the table one notices that the Finnish figures (and partly the Swedish figures) generally are higher than the figures from the other Nordic countries. In the survey set-up there is no observable reason for this.

Table 2.1 Sources of innovative ideas. % of firms rating a factor as important

	Top management	Internal R&D	Marketing department	Production department	Key persons
Denmark	62,3	55,2	41,3	12,8	57,1
Finland	61,4	68,5	70,1	38,5	.
Iceland	81,0	52,6	47,8	21,2	21,9
Norway	51,3	61,9	54,2	16,1	61,9
Sweden	60,3	70,3	61,0	32,2	.

	Acquired material technology	Acquired immaterial technology	Subcontrac-tors	Consultants	Other domestic firms
Denmark	18,7	14,0	4,0	18,4	25,3
Finland	44,9	23,2	28,7	17,6	34,9
Iceland	12,5	7,9	26,3	7,2	10,7
Norway	24,1	13,9	8,6	7,5	12,3
Sweden	29,5	15,3	13,5	15,1	40,6

	Research institutes	Universities, etc.	Customers demand	Government contracts	Competitors products
Denmark	14,2	12,5	54,4	12,4	30,5
Finland	12,4	23,8	88,2	5,1	81,8
Iceland	5,1	2,4	46,3	6,9	34,4
Norway	26,2	18,5	56,7	10,0	29,7
Sweden	23,9		86,0	17,2	76,7

	Fairs and exhibitions
Denmark	29,7
Finland	37,4
Iceland	24,0
Norway	25,6
Sweden	26,1

Source: Nordic Industrial Fund 1991.

The fourth group of factors is Acquirement of technology. This is important for between 10% and 45% of the firms.

The last group of factors is co-operation with the (primarily) public research system. This is a relatively unimportant group of factors (with a few exceptions important to under 20% of the responding enterprises), taking into account that the enterprises surveyed are the most R&D intensive in the Nordic countries.

If we look at the sources for innovative ideas in connection with firm size there are clear differences between small and large enterprises. Going into detail with all the 16 factors for three size groups and five countries is quite impossible, however, so we shall concentrate on a few marked tendencies. Because of their size the tables for this and the next sub-section have been placed in Annex 4a and 4b.

Top management is naturally of bigger importance for small enterprises than for large enterprises and the R&D department is most important for large enterprises (small enterprises may even not have one). Ideas from the production department are, generally, more important for medium-sized and large enterprises than for small enterprises.

Co-operation with the public research system is also generally more important for large enterprises, while co-operation with customers is more important for small and medium-sized enterprises than for large enterprises. Also fairs, etc. are more important for small enterprises, but for 'reverse engineering' (labelled 'Competitors products') there is no such tendency.

Turning to sources of innovative ideas distributed on sectors (Annex 4b) it is difficult to see any clear picture over all five countries. Therefore, in the following discussion, we present only some *general tendencies*.

The Top management is particularly important for supplier dominated and for science based firms. Internal R&D is important to science based firms, and to a lesser degree to supplier dominated firms, and almost the same applies for ideas from the Marketing department. Acquired material technology is most important for supplier dominated firms while Immaterial technology is equally important for supplier dominated firms and for science based firms.

Co-operation with universities, etc. (and, to a lesser degree, Co-operation with research institutes) is specially important for science based firms. Reverse engineering (Competitors products) is of special importance for supplier dominated firms.

Barriers to innovation

Table 2.2 shows that two economical factors are severe barriers to innovative projects: Excessive risks (serious barrier to innovation for between 45% and 60% of the firms (except for Iceland)) and Lack of risk capital which is an important barrier to innovation for 35-45% of the respondents - except for Swedish respondents (only 20%). As shown in Annex 5a the low Swedish figure is due to very low figures for large enterprises (5%) and medium sized enterprises (15%). Also internal factors like Lack of qualified personnel (20-45%) and Low quality of own R&D (important especially for Finnish enterprises (45%)) and Internal opposition to change seems to hamper innovation to some degree.

Insufficient market research is also a major barrier to innovation (important for 25% to 55% of the enterprises). A range of other factors in Table 2.2 are relatively less important.

Table 2.2 Factors hampering innovation. % of firms rating a factor as important

	Excessive risk	Lack of risk capital	Low quality on internal R&D	Lack of qualified personnel	Insufficient market research
Denmark	58,8	35,9	25,8	34,8	37,7
Finland	51,2	35,1	44,6	46,4	36,0
Iceland	17,7	43,1	17,6	20,5	58,3
Norway	51,7	38,1	10,3	32,3	27,0
Sweden	46,8	22,4	27,1	27,4	.

	Internal opposition to change	Lack of co-operation possibilities	Lack of information on university research	Innovations too easy to copy	Legal regulations
Denmark	21,9	16,5	9,8	9,6	8,8
Finland	27,1	14,1	30,3	33,9	23,3
Iceland	5,9	21,5	19,0	18,5	10,8
Norway	10,6	11,2	15,0	14,7	9,4
Sweden	.	11,0	13,0	21,9	22,6

Source: Nordic Industrial Fund 1991.

Analysis of size and sector distribution of hampering factors give a rather blurred a picture. Therefore the discussion will be kept short and the tables have been placed in Annex 5a and 5b.

It is primarily large enterprises that believe that the risks associated with innovative projects often is to high compared to the expected returns from the innovation. However, as discussed below (section 2.2), it is primarily large enterprises that carry out 'major' innovation projects, and therefore this trend could be expected. When it comes to the availability of risk capital it is, as expected, small enterprises which face the largest difficulties. It is also primarily small enterprises which experience problems with the quality of their R&D and the qualifications of their employees.

In general, it is primarily small enterprises that experience the barriers to innovative activity surveyed in this project.

In Denmark, Finland and Sweden it is clearly science based firms that see excessive risk as a serious hampering factor, but this is not the case in Norway and Iceland; there primarily supplier dominated firms and specialised suppliers see this factor as a problem[12]. When it comes to lack of qualified personnel the tendencies are similar.

2.2 Innovative efforts

Distribution of innovation expenditure

When we look at the size of and the structure of the amount spent on innovation we see rather large variations within the Nordic region. If we look at totals for the five countries (Table 2.3) we see that whereas R&D accounts for two thirds of innovation expenditure in Norway it only accounts for 40 per cent in Finland. The other countries lay between these extremes. Furthermore we see that acquisition of capital equipment connected to process innovation account for 2½ to 4 times as much in Finland as in the other countries. Below we shall show that we can account for most of the difference concerning the outstanding Finnish figures whereas we cannot discover the background for the high Norwegian figures in R&D.

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[12] One should notice, however, that the number of enterprises in the supplier dominated sector is very low in Norway and that Iceland has a rather small total sample (cf. the table with the sample in Annex 2). Therefore these results are particularly uncertain.

Table 2.3 Distribution of innovation expenditure

	R&D expenditure	Patents, etc.	Implementation	Marketing	Production equipment
Denmark	51,3	5,3	13,5	13,1	16,6
Finland	39,8	5,3	6,5	4,5	43,9
Iceland	54,2	4,1	12,6	12,3	17,3
Norway	67,5	2,4	9,6	9,8	10,4
Sweden	58,7	5,9	12,1	6,0	17,1

Source: Nordic Industrial Fund 1991.

If we decompose the figures and look, first, at size distribution in relation to innovation expenditure (Table 2.4) it turns out that it is medium-sized and small enterprises that spend the largest share of innovative expenditure on R&D. Besides this rather vague tendency, looking at all five Nordic countries, there does not seem to be unambiguous connections between firm size and distribution of innovation expenditure.

Table 2.4 Innovation expenditure distributed on firm size

	R&D expenditure	Patents, etc.	Implementation	Marketing	Production equipment
Denmark					
Small	51,2	8,0	16,6	12,4	14,1
Medium	60,6	5,0	9,0	9,9	15,5
Large	46,5	4,6	15,3	15,3	18,1
Total	51,3	5,3	13,5	13,1	16,6
Finland					
Small	31,8	20,0	7,6	6,3	34,7
Medium	45,3	7,7	6,7	6,1	34
Large	39,3	3,7	6,3	3,9	46,7
Total	39,8	5,3	6,5	4,5	43,9
Iceland					
Small	46,1	8,4	15,2	16, 0	14
Medium	58,8	0,4	5,5	1,4	33,9
Large	.	.	.	.	.
Total	54,2	4,1	12,6	12,3	17,3

Continued

Norway					
Small	72,2	1,2	6,4	11,3	8,9
Medium	67,8	2,8	9,7	10,9	8,4
Large	65,9	2,7	10,6	8,8	11,8
Total	67,5	2,4	9,6	9,8	10,4
Sweden					
Small	61,7	5,9	15,9	7,9	8,6
Medium	50,6	2,3	11,2	9,9	26,0
Large	58,9	6,1	12,3	5,8	16,9
Total	58,7	5,9	12,1	6,0	17,1

Source: Nordic Industrial Fund 1991.

Concerning sector distribution we see that in all countries except Iceland, it is science based enterprises that have the largest share of R&D in innovation expenditure. Furthermore specialised suppliers have a relatively big share of R&D. This is not surprising since these sectors are the most R&D intensive of the four sectors.

When it comes to other innovation expenditures 'Acquisition of capital equipment' clearly has a large proportion of innovation expenditure in scale intensive enterprises, especially in Denmark and Finland. This is hardly surprising since this sector primarily competes on economics of scale and therefore must be at the edge of development in production processes. This sector distribution is the reason for large figures in the Finnish sample hinted to above: Large scale intensive enterprises in Paper and pulp industry bias the Finnish figures towards acquisition of production equipment[13].

[13] Arne Kristensen 'Innovationsaktiviteter i de nordiske lande' in Nordic Industrial Fund (ed.): *Vitenskaps og teknologiindikatorer for Norden*, Oslo 1992.

Table 2.5 Innovation expenditure distributed on sectors

	R&D expenditure	Patents, etc.	Implemen-tation	Marketing	Production equipment
Denmark					
Scale intens.	33,7	8,6	11,3	9,1	37,1
Supp. domin.	48,4	8,8	6,1	6,9	29,6
Science based	67,8	3,5	7,7	8,3	12,5
Spec. supplier	54,6	4,3	16,4	16,0	8,5
Finland					
Scale intens.	42,8	3,4	5,3	3,7	44,6
Supp. domin.	33,1	15,3	8,0	9,7	33,7
Science based	74,1	5,5	4,0	4,2	12,1
Spec. supplier	56	10,6	9,0	4,9	19,3
Norway					
Scale intens.	65,9	65,9	1,5	7,8	7,3
Supp. domin.	40,7	40,7	0,0	19,9	7,4
Science based	68,3	68,3	2,6	10,4	10,2
Spec. supplier	59,8	59,8	3,6	12,7	12,7
Iceland					
Scale intens.	44,5	5,1	21,2	12,9	16,2
Supp. domin.	44,7	0,1	23,3	21,6	10,5
Science based	45,7	2,8	11,9	23,6	16,1
Spec. supplier	.	.	.	.	.
Sweden					
Scale intens.	46,8	10,3	25,3	5,8	11,2
Supp. domin.	61,2	0,0	6,2	9,4	23,2
Science based	67,1	2,6	4,3	4,0	21,6
Spec. supplier	54,5	6,8	5,3	17,7	11,7

Source: Arne Kristensen

Number of innovative projects[14]

When we turn to the number of and the length of innovative projects[15] (Table 2.6) the picture seems rather similar in Denmark, Finland and Norway, whereas Icelandic enterprises have considerably fewer innovative projects. In the three countries approximately half of the projects run for less than one year and only 4 to 5 per cent run for more than five years.

Table 2.6 Number of innovative projects

	Under 1 year	1-5 years	Over 5 years	Total
Denmark	5,1	4,1	0,4	9,6
Finland	5,4	4,6	0,4	10,4
Norway	4,0	4,2	0,3	8,5
Iceland*	1,0	1,5	0,2	2,7

* Time periods for Iceland are 0-1 year, 1-3 years and over 3 years.

Source: Nordic Industrial Fund 1991.

The similarities between the countries are repeated - this time including Iceland - in the distribution of innovation projects on firm size: In all countries large firms carry out the vast majority of projects (see Table 2.7) and medium-sized firms carry out more projects than small firms.

Table 2.7 Number of innovative projects distributed on firm size

Denmark	Under 1 year	1-5 years	Over 5 years	Total
Small	2,9	2,1	0,0	5,0
Medium	4,1	3,0	0,1	7,2
Large	5,2	11,1	2,3	18,6
Total	5,1	4,1	0,4	9,6

Continued

[14] Figures not available for Sweden.

[15] Defined as projects involving R&D. This definition is clearly unsatisfactory in a broader context, as innovations need not include any R&D. They may be based on learning (by using, by doing, by interacting, etc.) in the firm.

Finland				
Small	1,3	1,1	0,2	2,5
Medium	3,2	1,1	0,1	6,2
Large	14,2	2,9	0,1	27,5
Total	5,4	4,6	0,4	10,4
Norway				
Small	2,1	2,1	0,2	4,4
Medium	4,1	2,8	0,3	7,2
Large	8,7	5,5	0,7	14,9
Total	4,0	4,2	0,3	8,5
Iceland*				
Small	0,6	1,7	0,3	2,6
Medium	3,4	1,9	0,0	5,3
Large	.	.	.	.
Total	1,0	1,5	0,2	2,7

* Time periods for Iceland are 0-1 year, 1-3 years and over 3 years.

Source: Nordic Industrial Fund 1991.

This is hardly surprising, but elsewhere we have shown that in Denmark, Finland and Norway, small firms carry out more innovation projects than large firms *relative* to their size (Table 2.8). Although these figures are biased towards small firms since the majority of medium-term and long projects (and hence presumably the more 'radical' projects) are carried out by large and medium-sized firms, the tendency seems surprisingly marked.

Table 2.8 Number of innovative project per employee. Distributed on firm size.

	Small	Medium	Large
Denmark	0,084	0,031	0,011
Finland	0,175	0,030	0,020
Norway	0,139	0,036	0,014

Source: Arne Kristensen: 'Innovationsaktiviteter i de nordiske lande' in Nordic Industrial Fund (ed.): *Vitenskaps og teknologiindikatorer for Norden*, Oslo 1992.

When we look at sector distribution of innovative projects it turns out that science based firms carry out a relatively high share of projects -

especially medium-termed and long projects (see Table 2.9). This is also hardly surprising since these enterprises to a large extend are dependent on developing new products and processes in a very rapidly changing technology.

However, also scale intensive firms carry out many innovative projects (primarily projects with a time horizon less than one year). This can probably be ascribed to two circumstances. First that this sector includes a high proportion of large enterprises with many projects, and second that these firms are rather active in developing process innovations.

Table 2.9 Number of innovative projects distributed on sectors

	Under 1 year	1-5 years	Over 5 years	Total
Denmark				
Scale intens.	5,8	4,4	0,2	10,4
Supp. domin.	3,9	1,7	0,0	5,6
Science based	8,7	3,8	0,9	13,4
Spec. supplier	2,4	4,3	0,3	7,0
Finland				
Scale intens.	7,0	5,8	0,5	13,3
Supp. domin.	5,0	2,5	0,1	7,6
Science based	4,0	5,7	0,9	10,6
Spec. supplier	3,2	3,0	0,1	6,3
Norway				
Scale intens.	7,0	3,8	0,2	11,0
Supp. domin.	0,6	0,4	0,0	1,0
Science based	2,0	4,7	0,6	7,3
Spec. supplier	2,5	3,1	0,2	5,8
Iceland*				
Scale intens.	0,5	2,2	0,4	3,1
Supp. domin.	3,0	0,3	0,1	3,4
Science based	0,8	3,6	0,3	4,7
Spec. supplier	.	.	.	.

* Time periods for Iceland are 0-1 year, 1-3 years and over 3 years.

Source: Arne Kristensen

The sector with least innovative projects is supplier dominated firms, which, according to the underlying theory, are dependent on their suppliers in developing innovations

3. Innovation co-operation

In a world of rapidly changing technologies innovation co-operation gets increasingly important, as shown by e.g. Chris Freeman in *Research Policy* in 1991 (Vol. 20 No. 6.). Freeman distinguishes between ten different types of innovation co-operation (or networks):

1. Joint ventures and research corporations
2. Joint R&D agreements
3. Technology exchange agreements
4. Direct investment motivated by technology factors
5. Licensing and second souring agreements
6. Subcontracting, production sharing
7. Research associations
8. Government-sponsored joint research programmes
9. Computerised data banks for technical and scientific interchange
10. Other networks, including informal networks.

This section deals with point 1 and 2 on this list, i.e. research co-operation and joint R&D arrangements. These two are, also according to Freeman (1991, Table 2), the two most important forms for innovation co-operation in high-technology areas, and it is therefore relevant to concentrate on these two.

We perform the analysis both according to region of co-operation partner and according to co-operation type of co-operation partner.

3.1 Innovation co-operation according to region

The Swedish figures on geographical distribution of innovation co-operation cannot be directly compared with the figures form the other countries because the Swedish questionnaire included co-operation with suppliers, international research programmes and small R&D intensive firms in this question. This, naturally, increases the Swedish figures once they are aggregated over co-operation partners. Therefore they will not be commented upon here.

Generally the figures for Iceland lay far below the figures for the other Nordic countries (see Table 3.1). This is probably to some extend due to Iceland's geographic location. Although the importance of electronic communication (fax, E-mail, etc.) is growing rapidly, geographic proximity is still of vital importance for innovation co-operation[16]. This does not explain, however, why domestic co-operation is so weak in

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[16] See e.g. Bengt-Åke Lundvall (footnote 9) for an elaboration of this point.

Iceland, but there is no clear indications about this in the material presented here. Denmark also has a somewhat lower percentage of firms that co-operate with other Danish firms, but this is almost compensated for by a more active international co-operation (the share of non co-operating firms is only circa 5 %- points under Finland and Norway).

For all countries domestic co-operation is, barely surprising, much more important than international co-operation (65-80% in relation to 5-50%). Denmark is, also hardly surprising, taking into account that the year is 1988, more oriented towards co-operation with other EEC countries than Finland, Iceland and Norway. It is a bit more surprising that Denmark also is more oriented towards co-operation with USA and Japan than the other Nordic countries.

Table 3.1 Innovation co-operation distributed on region. % of firms that co-operate

	No co-operation	Own country	Other Nordic countries	EEC except Denmark	USA	Japan	Other countries
Denmark	25,6	65,4	28,0	47,7	20,4	10,2	4,9
Finland	17,1	79,7	21,9	23,6	12,1	5,1	5,9
Sweden*	5,0	84,5	36,6	51,4	30,0	13,1	9,3

	No co-operation	Own country	Other Nordic countries	EEC except Denmark	Other** countries
Norway	20,9	72,8	36,8	30,4	23,8
Iceland	47,0	24,0	17,7	5,7	5,7

* Swedish figures are not directly comparable (cf. p. 16).** Including Japan and USA.

Source: Nordic Industrial Fund 1991

When we turn to the size distribution of co-operating firms (Table 3.2) it is, as expected, clearly large enterprises that are most involved in co-operation (between 93% and 99% in domestic co-operation opposed to 55-70% for small enterprises). This tendency holds for co-operation with all regions, and it even gets more profound when we turn to international co-operation (see e.g. co-operation with USA in Denmark and Finland).

The sectoral distribution of innovation co-operation (see Table 3.3) shows less clear tendencies. Generally, scale intensive firms are the most active in domestic co-operation while science based firms are more internationally oriented in their choice of co-operation partners. Supplier dominated firms and specialised suppliers are less collaborative and primarily domestic oriented.

Table 3.2 Innovation co-operation distributed on size and region. % of firms that co-operate

	Own country	Other Nord. countries	EEC except Denmark	USA	Japan	Other countries
Denmark						
Small	54,9	23,1	40,5	9,0	4,6	1,5
Medium	77,0	27,6	50,6	34,5	10,3	8,0
Large	97,3	56,8	81,1	51,4	29,7	16,2
Total	65,4	28,0	47,7	20,4	10,2	4,9
Finland						
Small	65,1	10,5	3,8	3,9	0,0	1,5
Medium	85,3	24,5	31,4	10,9	4,7	3,6
Large	98,5	47,0	54,6	32,8	14,9	19,4
Total	79,7	21,9	23,6	12,1	5,1	5,9
Sweden*						
Small	85,7	14,3	28,6	9,5	14,2	4,8
Medium	81,3	30,2	48,8	27,9	7,0	7,0
Large	91,7	50,0	77,7	52,8	27,8	19,4
Total	84,5	36,6	51,4	30,0	13,1	9,3

	Own country	Other Nord. countries	EEC except Denmark	Other** countries
Norway				
Small	70,2	32,5	27,7	16,0
Medium	66,9	38,4	35,5	22,9
Large	93,1	45,3	26,8	47,9
Total	72,8	36,8	30,4	23,8
Iceland				
Small	22,9	22,9	11,4	11,4
Medium	25,0	12,5	0,0	0,0
Large	.	.	.	.
Total	24,0	17,7	5,7	5,7

*. Swedish figures are not directly comparable (cf. p. 16). ** Including Japan and USA

Source: Nordic Industrial Fund 1991

Table 3.3 Innovation co-operation distributed on sector and region. % of firms that co-operate

	Own country	Other Nordic countries	EEC outside Denmark	USA	Japan	Other countries
Denmark						
Scale intens.	83,2	40,5	50,7	31,7	13,4	9,5
Supp. domin.	77,9	36,8	44,2	0,0	1,2	0,0
Science based	77,4	32,3	60,7	19,8	10,2	5,2
Spec. supplier	47,9	18,8	37,4	17,9	8,9	3,1
Finland						
Scale intens.	81,5	24,0	25,0	11,2	2,3	5,2
Supp. domin.	75,0	16,3	13,9	2,3	6,9	0,0
Science based	79,3	24,9	37,3	18,8	15,8	15,4
Spec. supplier	78,6	19,5	21,0	16,1	5,7	6,6
Sweden*						
Scale intens.	84,9	38,6	54,8	26,8	16,2	8,4
Supp. domin.	100,0	37,0	37,0	0,0	0,0	0,0
Science based	83,7	29,5	59,5	49,5	16,4	9,6
Spec. supplier	81,9	25,7	44,7	27,6	9,7	12,1

	Own country	Other Nordic countries	EEC outside Denmark	Other** countries
Norway				
Scale intens.	80,6	37,3	22,5	23,2
Supp. domin.	61,9	0,0	0,0	16,6
Science based	65,7	45,2	42,7	17,3
Spec. supplier	68,8	27,9	22,6	26,8
Iceland				
Scale intens.	21,7	13,0	4,3	4,3
Supp. domin.	37,5	12,5	12,5	12,5
Science based	16,7	41,7	16,7	25
Spec. supplier	.	.	.	.

* Swedish figures are not directly comparable (cf. p. 16). ** Including Japan and USA

Source: Arne Kristensen

3.2 Innovation co-operation according to type of partner

Except for Iceland, which has much lower co-operation figures than the other Nordic countries, there is relatively little variation in the importance of different co-operation partners (Table 3.4). For Denmark, Finland and Norway other industrial firms, consulting firms and Research institutes seem to slightly more important than co-operation with units inside the same concern (there may not be one for all respondents and therefore it can be much more important for the firms in a concern[17]) and Universities, etc. This is not the case for Sweden. One should notice here, that different institutional set-ups of the private and public research system can influence the distribution of co-operation with the last three columns crucially[18].

Table 3.4 Innovation co-operation distributed on partner. % of firms that co-operate

	Units inside concern	Other industrial firms	Consulting firms	Research institutes	Universities etc.
Denmark	32,6	51,6	41,6	34,1	34,5
Finland	33,2	40,3	49,2	44,9	34,4
Iceland	0,0	17,2	5,7	18,3	2,9
Norway	38,2	47,9	28,5	52,1	33,6
Sweden	54,5	51,0	46,7	38,3	46,0

Source: Nordic Industrial Fund 1991

In Table 3.5 the figures for innovation co-operation by partner have been distributed on firm size. As expected we see the same tendency as in Table 3.3: Large enterprises are more involved in co-operation with all partners than medium-sized enterprises, which in turn are more co-operative than small enterprises. This, still, does not apply for Iceland.

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[17] In the data available for this report it is not possible to discriminate between independent firms and firms in a concern. The information was, however, collected for all countries, so it would be possible to go more thoroughly into this question.

[18] In Denmark, e.g., the technological service system is included in 'Consulting firms' while in Norway all of the technological service system is included in 'Research Institutes'. This is due to different institutional set-ups of the Danish and the Norwegian technological service systems.

Table 3.5 Innovation co-operation distributed on size and partner. % of firms that co-operate

	Units inside concern	Other firms	Consulting firms	Research institutes	Universities etc.
Denmark					
Small	19,2	44,8	30,8	29,5	25,1
Medium	50,6	55,2	60,9	35,6	40,2
Large	64,9	81,1	56,8	56,8	73,0
Total	32,6	51,6	41,6	34,1	34,5
Finland					
Small	17,0	22,7	44,1	31,6	11,9
Medium	38,7	39,9	49,0	42,6	41,1
Large	66,5	76,1	68,8	80,5	67,1
Total	33,2	40,3	49,2	44,9	34,4
Iceland					
Small	0,0	34,3	11,0	14,3	5,7
Medium	0,0	0,0	0,0	22,2	0,0
Large	.	.	.	.	.
Total	0,0	17,2	5,7	18,3	2,9
Norway					
Small	19,3	48,7	25,1	47,6	28,3
Medium	48,4	39,6	24,6	45,2	34,6
Large	69,4	63,7	46,8	80,0	46,2
Total	38,2	47,9	28,5	52,1	33,6
Sweden					
Small	14,3	38,1	38,1	9,5	38,1
Medium	55,8	46,5	46,5	34,9	39,5
Large	86,1	77,7	52,7	72,2	69,4
Total	54,5	51,0	46,7	38,3	46,0

Source: Nordic Industrial Fund 1991

Turning to the sectoral distribution of Table 3.4 it is difficult to see a clear picture. Nevertheless, a few tendencies can be extracted from Table 3.6: The firms that most often co-operate with industrial firms outside

their concern and with universities are science based firms; the firms that primarily work together with consulting firms are scale intensive firms and supplier dominated firms (except for Norway - see footnote 18).

Table 3.6 Innovation co-operation distributed on sector and partner. % of firms that co-operate

	Units inside concern	Other firms	Consulting firms	Research institutes	Universities etc.
Denmark					
Scale intens.	56,3	53,8	57,9	41,2	44,3
Supp. domin.	58,9	51,5	63,2	22,1	22,1
Science based	30,1	63,1	42,5	47,6	54,7
Spec. supplier	21,8	42,5	32,0	22,5	16,7
Finland					
Scale intens.	4,6	20,8	49,4	30,2	11,5
Supp. domin.	36,8	43,7	59,3	50,0	32,3
Science based	37,3	56,3	36,8	45,2	46,5
Spec. supplier	38,4	37,5	34,8	42,1	44,7
Iceland					
Scale intens.	0,0	12,5	2,0	37,5	0,0
Supp. domin.	0,0	13,0	4,3	13,0	0,0
Science based	0,0	66,7	16,7	8,3	16,7
Spec. supplier	.	.	.	.	
Norway					
Scale intens.	48,9	11,3	38,7	34,1	38,1
Supp. domin.	16,6	54,2	16,6	61,9	0,0
Science based	35,1	41,0	13,4	29,8	41,5
Spec. supplier	37,1	32,7	28,0	36,0	25,5
Sweden					
Scale intens.	60,6	53,9	51,3	44,5	39,0
Supp. domin.	74,0	100,0	37,0	37,0	0,0
Science based	49,5	61,0	49,0	26,0	55,4
Spec. supplier	47,6	39,7	42,5	38,0	54,6

Source: Arne Kristensen

4. Results of innovative activity[19]

Measuring results from innovative activity is not an easy task (cf. e.g. the work done over several years in OECD and EEC on output indicators). Even so, it is one of the central issues in innovation surveys to try to get a grip on innovation outputs, since the 'normal' measures of technological development (R&D and patenting statistics) only give indirect and partial results.

In the Nordic Innovation Survey four innovation output indicators were included: proportion of sale and export accounted for by new products, share of turnover in introduction and growth[20] and proportion of new products. Since the last indicator was different from country to country we shall only here report on the three first indicators.

4.1 Proportion of sale and export from new products

The shares of sale and export accounted for by new products varies considerably among the five Nordic countries in question; from 16% and 19% in Norway to 38% and 43% in Iceland. The distance between these two 'outlayers' can partly be explained from Table 4.2 and Table 4.3: In Iceland medium-sized (and science-based) firms have a very high share of new products, and in Norway, the very dominant resource based scale intensive sector has a very low share of new products. Whether these results are the consequence of biased sampling or whether they are 'real' is difficult to say, so therefore one should probably not draw to categorical conclusions.

Table 4.1 Proportion of sale and export accounted for by new products. %

	Sale	Export
Denmark	30,0	32,3
Finland	22,6	23,0
Norway	18,8	16,4
Iceland	37,6	43,4

Source: Nordic Industrial Fund 1991

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[19] Figures not available for Sweden.

[20] Even though the question about life cycle originally was included to give background information for questions about innovative strategies, it has proven to be an adequate output indicator.

However, leaving Norway and Iceland out of account, differences in the figures still go from Finnish 23% to Danish 30% and 32%, and these differences, as can be seen from Table 4.2 and 4.3, go through all size groups and all sectors. Hence it seems proper to suggest that innovation output has been higher in Denmark than in Finland (and Norway).

Going a bit more into detail about size distribution and innovative results (Table 4.2), we see that small firms in Denmark, Finland and Norway have a considerably higher share of new products. Since newly established firms are not included in the samples this is not due to 'newstarters'. As this picture is repeated in Table 4.5 for an other indicator it seems valid. And this result could be expected as large firms often have so-called 'milking cows' in old established and well-known products, whereas this more seldom is the case for smaller firms.

In Iceland the tendency is, surprisingly, the opposite: medium-sized firms have a much higher share of new products than small enterprises have.

Table 4.2 Proportion of sale and export accounted for by new products. Distributed on firm size. %

	Sale	Export
Denmark		
Small	50,3	50,2
Medium	30,9	41,6
Large	27,5	25,8
Total	30,0	32,3
Finland		
Small	32,5	39,5
Medium	28,5	29,8
Large	20,6	21,9
Total	22,6	23,0
Norway		
Small	39,9	42,7
Medium	19,3	24,6
Large	17,6	13,2
Total	18,8	16,4

Continued

Iceland		
Small	11,0	5,9
Medium	45,1	47,8
Large	.	.
Total	37,6	43,4

Source: Nordic Industrial Fund 1991

When we look at the sectoral distribution of these results (Table 4.3) there is a tendency that science based firms have a high share of new products, whereas the more traditional oriented scale based firms have the lowest share of new products. This is confirmed by the length of the life-cycle for different product types (also queried in the survey) which is much shorter for product form the science based sector than - especially - products from the scale intensive sector.

Table 4.3 Proportion of sale and export accounted for by new products. Distributed on sectors. %

	Sale	Export
Denmark		
Scale intens.	24,0	16,0
Supp. domin.	43,2	42,5
Science based	49,2	61,7
Spec. supplier	34,1	34,5
Finland		
Scale intens.	18,5	19,5
Supp. domin.	33,2	28,4
Science based	41,7	49,6
Spec. supplier	35,7	33,2
Norway		
Scale intens.	10,7	10,3
Supp. domin.	34,3	57,0
Science based	47,4	39,3
Spec. supplier	24,5	24,5

Continued

Iceland		
Scale intens.	38,7	26,8
Supp. domin.	55,7	53,8
Science based	83,8	57,9
Spec. supplier	.	.

Source: Arne Kristensen

4.2 Life cycle distribution of turnover

In the Nordic Innovation Survey the question on product's life cycle was asked at the product level[21] and this has two major advantages. First, it is methodologically and theoretically more correct to ask this question on products rather than on firms total sales. Second, since the respondents have provided information for, on average, 2,2 products it more than doubles the sample and consequently provides more valid results.

The aggregate results from this question (Table 4.5) generally show the same pattern as the previous question: Icelandic firms have a very big share of products in the introduction and the growth phase, whereas Norway has a relative small share in the early phases of product's life cycle. Denmark has a slightly higher share in early product phases than Finland has.

Table 4.4 Distribution of sales across product's life cycle. %

	Introduction	Growth	Stagnation	Decline
Denmark	6,5	38,7	46,9	7,9
Finland	5,9	35,9	49,4	8,8
Norway	6,0	26,8	57,3	10,0
Iceland	23,8	28,7	36,3	11,2

Source: Nordic Industrial Fund 1991

Size distribution of this question (Table 4.4) also shows the same pattern as did the former analysis (Table 4.2): Small firms have introduced considerably more new products (measured on turnover) than medium-sized and large firms have.

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[21] Cf. Annex 1 questions 1.1 and 1.5.

Table 4.5 Distribution of sales across product's life cycle. Distributed on firm size. %

	Introduction	Growth	Stagnation	Decline
Denmark				
Small	9,7	57,5	27,7	4,5
Medium	6,0	37,0	49,9	7,1
Large	6,3	37,5	47,7	8,5
Total	6,5	38,7	46,9	7,9
Finland				
Small	7,8	40,6	46,2	5,5
Medium	3,9	25,7	62,1	8,3
Large	6,3	38,3	46,3	9,1
Total	5,9	35,9	49,4	8,8
Norway				
Small	20,8	30,7	35,5	13
Medium	7,2	29,9	53,6	9,2
Large	4,4	25,2	60,3	10,1
Total	6,0	26,8	57,3	10,0
Iceland				
Small	27,6	27,3	33,3	11,8
Medium	7,0	34,6	49,6	8,8
Large	.	.	.	.
Total	23,8	28,7	36,3	11,2

Source: Nordic Industrial Fund 1991

Turning to life cycle distribution on sectors the picture from Table 4.3 is not repeated. In Table 4.6 specialised suppliers have the largest share of turnover in the products' early phases and science based firms have a considerably lower share. At first sight this result seems to be in contradiction with the conclusions to Table 4.3, but the length of the life cycle is not necessarily positively correlated with the share of products in its early phases - one could almost expect it to be the other way round since it is difficult to renew the product assortment as fast as necessary.

Table 4.6 Distribution of sales across product's life cycle. Distributed on sectors. %

	Introduction	Growth	Stagnation	Decline
Denmark				
Scale intens.	4,8	36,2	49,8	9,2
Supp. domin.	7,8	32,2	45,7	14,3
Science based	7,3	33,8	47,0	11,8
Spec. supplier	10,5	48,0	30,5	10,9
Finland				
Scale intens.	4,5	35,0	52,4	8,1
Supp. domin.	7,5	47,3	33,3	12,0
Science based	3,9	41,7	50,2	4,2
Spec. supplier	14,0	35,8	37,3	12,9
Norway				
Scale intens.	5,5	28,4	58,2	7,9
Supp. domin.	6,0	15,8	29,7	48,5
Science based	4,3	15,0	65,3	15,4
Spec. supplier	8,0	23,2	58,3	10,4
Iceland				
Scale intens.	16,5	28,8	38,5	16,2
Supp. domin.	26,6	18,9	44,5	10,0
Science based	35,8	35,0	26,7	2,5
Spec. supplier	.	.	.	.

Source: Arne Kristensen.

5. Conclusions

In this final section we shall conclude on three discussions, namely:

1. About the importance of firm size and sector affiliation for innovation.
2. About connection between innovative efforts and innovative results.
3. About similarities and differences between the Nordic countries.

Since the data material on which this report is based is rather weak (cf. the introduction) the conclusions presented in the following are *general tendencies*, and they should be interpreted with care.

5.1 Firm size, sector and innovation

Both regarding innovative results and innovative efforts we found that aggregate figures cover big variations over firm size and sector. There was a clear tendency that small and in lesser degree medium-sized firms had achieved the best innovative results, and, correspondingly, it was apparently small enterprises which had made the, relatively, biggest innovative efforts.

Over sectors we saw the tendency that the two most research-intensive sectors, science based firms and specialised suppliers, had achieved the best results and that science based firms carries out an over-average number of innovative projects.

Thus, firm size and sector affiliation do have important consequences for enterprise's innovative activity. One should notice, however, that there is a close connection between firm size and sector because of the theoretical underpinning of distribution of branches into sectors. Therefore, discussions of firm size and innovation should not be kept alone, but should be complemented with a discussion of sector affiliation and innovation.

We could propose the following *rough* conclusions on the sector division used in this report:

Scale intensive enterprises are large enterprises in process industries (e.g. cement, etc., foodstuffs, metal). They are rather active in process innovation (they have many innovative projects and they use the majority of innovation expenditure on production equipment); they have a low share of new products; they are active in domestic R&D co-operation. I.e. their primary source of competition and, consequently, their strategy in innovation activities, is exploitation of scale advantages.

Supplier dominated firms are small firms in traditional branches (furniture, textile, etc.). They have few innovative projects; they are very active in co-operation with other industrial firms, consulting firms and research institutes, they spend the majority of their innovation budget on process innovations. I.e. they are dependent on other firms in developing innovations.
Science based firms are primarily large, R&D intensive firms in chemicals and electronics. They have high shares of new products; they have many (and long termed) innovation projects; they spend most of the innovation budget on R&D; they are very active in co-operation with universities, etc. I.e. their competitive advantage, and hence their innovations, are based on R&D.
Specialised suppliers are manufactures of production equipment. They have high shares of new products; they spend relatively much on marketing and implementation of innovations; they are relatively R&D intensive. In short: they compete on their ability to adapt to customers needs.

These conclusions are, as already stressed, very rough generalisations, as the data is too weak to support valid conclusions even at this rather aggregated level. A branch analysis of the data has been performed in Arne Kristensen 1992 (see footnote 13), but the results put forward in that analysis were even more statistically uncertain. Therefore the choice made in this report seemed to be the best possible.

5.2 Connection between innovative efforts and results

As suggested in the previous section there seems to be some connection between innovative efforts and innovative results. If we measure on relative number of innovative projects (Table 2.8) it is small enterprises that make the biggest innovative effort, and it is also small enterprises that have achieved the best innovative results. These results can, however, be biased towards small enterprises, since all major innovative projects are carried out by large enterprises.

At sector level it is science based firms and specialised suppliers that carry out most innovative projects, and according to one output-indicator (Table 4.3) it is science based firms that have achieved the highest innovation ratio while specialised suppliers have achieved rather modest results. However, according to the other output-indicator (Table 4.6) specialised suppliers have obtained a high innovative output while science based firms have achieved modest results. Thus, although the picture is somewhat blurred, there seems to be a connection between input and output in innovation also at the sector level.

5.3 Similarities and differences between the Nordic countries

Before starting on a comparison of the Nordic countries - or any countries - it should be noticed that in making these comparisons one implicitly assumes that there exist no structural and institutional differences between the countries. This is never the case. Even among the Nordic countries which may seem rather similar at first sight, these differences exist[22]. Therefore one should be cautious of making too definite conclusions.

At the overall level it is difficult to see any pattern in the differences between the Nordic countries. Innovative output *seems* to be higher in Denmark than in Finland and Norway. Norwegian firms *seem* to spend a large share of their innovation budget on R&D while Finnish firms *seem* to spend a large share on acquisition of capital equipment connected to innovation.

However, the similarities between innovative activity in the Nordic countries *seem* to be much more dominant. For example it is small firms and the more research intensive sectors that have the largest share of innovations in their output; large enterprises conduct the majority of development projects, but in relative terms small enterprises carry out more projects than large enterprises do; R&D is the major post on innovation budgets in all countries, etc.

5.4 Closing remarks

If the reservations taken in the beginning of this section are going to be loosened new data is needed. And taking into account that the need for knowledge about technological development and innovation is increasing as the process of development is accelerating, one could safely add *urgently* needed.

Therefore the initiatives taken in EEC and OECD to allow for collection comparable data and the efforts from EEC to collect comparable data are very welcome. This will allow international comparisons much more detailed, statistically valid and in depth than the one presented here. However, the lesson learned from this analysis (and from the analysis presented at the OECD workshop in April 1993[23]) is that one should

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[22] Cf. e.g. Nordic Industrial Fund: *FoU-TRENDER*, nr. 2: 1990 and Birgitte Gregersen, Björn Johnson and Arne Kristensen: 'Comparing National Systems of Innovation. The case of Finland, Denmark and Sweden'. Forthcoming in Vuori and Vuorinen (ed.) *Explaining Technical Change in a Small Country - the Case of Finland*, Forthcoming, ETLA.

[23] Cf. footnote 5.

make big efforts to make both the questionnaires and the samples as identical as possible to allow for comparisons[24].

[24] And even more so if analysis on micro level data is going to be performed across countries.

CENTRAL STATISTICAL OFFICE OF FINLAND
Statistics on Science and Technology

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Tel. 358 0 17 341 Mikael Åkerblom
Ari Leppälahti

Kindly return the questionnaire before **30 June1989**

Innovation activities of Industry

General information

This questionnaire collects data on the foundations, scope, results and effects of the innovation activities of industrial companies.

The information should mainly be supplied at the company level. If more convenient, it may also be supplied separatively for individual units of the company. The data of concerns may be supplied by divisions comprising several companies.

The information is requested primarily on units operating in Finland. However, if units operating abroad play an important role in the innovation activities of units operating in Finland, the answer may also contain information on these units.

Some questions may not be equally appropriate to all units. If exact information is not available, an informed estimate may be supplied instead. Should this be impossible or meaningless from the point of view of the company or unit, the question may be left unanswered.

All information supplied should relate to the unit specified on page 2. Under statutory provisions concerning the Central Statistical Office of Finland, the data supplied are confidential and will only be used for statistical purposes. No information at the company level will be released to a third party.

Concepts and definitions

Innovation activities introduce something essentially new to a company's activities. This questionnaire collects information on product innovations (new or substantially improved old products) and on process innovations (new methods of production).

A product innovation refers to a product whose intended use, performance characteristics, technical properties, or materials and components use differ from the unit's previous products to the extent that it can be considered to be a new or essentially improved old product. A product innovation may include several incremental innovations relating to different components of the product. Product innovations may be based on R&D activities or on technology acquired by other means.

Products made to the customer's order (unit production) are not counted as product innovations unless they embody a significant R&D effort on the part of the company or otherwise represent major changes in the product's performance characteristics or field of application. Aesthetic (design based) innovations are not counted as innovations in this survey.

A process innovation refers to the adoption of new production methods. The methods may be intended for producing new or essentially improved goods or for essentially increasing the production efficiency of existing goods. Process innovations are based on R&D activities or on acquired technologies. Acquisition of new types of machine or equipment (but not the mere replacement of old models or extension of existing processes) can also be counted as process innovations.

Rationalisation of office routines, related acquistion of machinery and equipment included, is not counted as innovation.

General background information

Name of unit	Address of unit

Name and position of contact person	Telephone number of contact person

Turnover of unit in 1988 FIM million	Exports of unit in 1988 FIM million	Number of employees in unit at year's end 1988

Type of unit	Yes	No
Concern		
Parent company of concern		
Subsidiary company of concern		
Division of concern		
Other independent company		
Other (Please, specify)		

Mode of production	Yes	No
Serial production		
Unit production		
Process industry		

Does the answer include units operating abroard		

1. Information on the unit's most important product groups

Questions 1.1-1.6 deal with the unit's three most important product groups. The product groups may be defined according to the unit's own terminology, and data may be supplied only for one or two groups if so desired.

1.1 The most important product groups in proportion to turnover in 1988 (Please provide definitions of the product groups)

	Proportion of turnover %
Product group A :	
Product group B :	
Product group C :	

1.2 Country of biggest competitor in the most important product groups in 1988

	Market of Finland	Market of Nordic countries	Market of Western Europe	World market
Product group A				
Product group B				
Product group C				

If the competitor is Finnish, then Finland should be specified.
If there is no competition in the product group write no as an answer.

1.3 Expected growth in demand in the most important product groups over the next five years

Demand is expected to	Product group		
	A (x)	B (x)	C (x)
Increase			
Remain unchanged			
Decrease			

1.4 Unit's market shares for the most important product groups in 1988

	Market of Finland, total (%)	Market of Nordic countries, total (%)	Market of Western Europe, total (%)	World market, total (%)
Product group A				
Product group B				
Product group C				

1.5 Distribution of turnover for the most important product groups by phase of life cycle of products in 1988

	Product group		
	A (%)	B (%)	C (%)
Introductory phase			
Growth			
Saturation			
Decline			
Total	100	100	100

1.6 Estimated average duration of innovation projects and length of life cycles of products in the most important product groups

	Product group		
	A	B	C
Duration of innovation project (in years)			
Life cycle of product (in years)			

2.The foundations and the scope of innovation activities

2.1 Development strategies

For an evaluation of the unit's general development strategy, please indicate he importance of selected basic development alternatives for your unit according to the following scale:

0 = no information or impossible to evaluate
1 = not at all important
2 = sligthly important
3 = rather important
4 = important
5 = crucial

Encircle the relevant alternative	No inform.	Not important				crucial
Development strategies in relation to products and markets						
Present products, present markets	0	1	2	3	4	5
New products, present markets	0	1	2	3	4	5
Present products, new markets	0	1	2	3	4	5
New products, new markets	0	1	2	3	4	5
Development strategies in relation to technology						
Development of new technology for the industry	0	1	2	3	4	5
Further development of technology developed by others	0	1	2	3	4	5
Utilization of technology developed by others	0	1	2	3	4	5
Improvement of company's existing technology	0	1	2	3	4	5
Development strategies in relation to the use of inputs of production						
Use of new inputs	0	1	2	3	4	5
More efficient use of existing inputs	0	1	2	3	4	5
Energy conservation	0	1	2	3	4	5
Labour cuts	0	1	2	3	4	5

2.2 Innovative ideas

Impulses for innovation projects may come from many different sources. Please evaluate the importance of the following factors (scale as above):

Encircle the relevant alternative	No inform.	Not important				crucial
Internal impulses						
Top management	0	1	2	3	4	5
Internal R&D	0	1	2	3	4	5
Marketing	0	1	2	3	4	5
Production	0	1	2	3	4	5
System for initiatives	0	1	2	3	4	5
Impulses from markets						
Government contracts	0	1	2	3	4	5
Customer demand	0	1	2	3	4	5
Fairs, exhibitions, meetings	0	1	2	3	4	5
Competitive situation	0	1	2	3	4	5
Other external impulses						
Acquisition of material technology (e. g. machinery, equipment)	0	1	2	3	4	5
Acquisition of immaterial technology (licenses,information systems,know-how)	0	1	2	3	4	5
Co-operation with subcontractors	0	1	2	3	4	5
Co-operation with consultants	0	1	2	3	4	5
Co-operation with the Technical Research Centre of Finland	0	1	2	3	4	5
Co-operation with domestic universities and research institutes	0	1	2	3	4	5
Co-operation with foreign universities and research institutes	0	1	2	3	4	5
Co-operation with other companies (units)	0	1	2	3	4	5
Legislation, standards, regulations	0	1	2	3	4	5

2.3 Factors contributing to innovation activity

Several factors do contribute to the success of innovation projects. We ask you to evaluate the weight of the following factors according to the scale bellow:

0 = no information or impossible to evaluate
1 = not important at all
2 = sligthly important
3 = rather important
4 = important
5 = crucial

Encircle the relevant alternative

	No inform.	Not important				crucial
Internal factors						
Contributions of top management	0	1	2	3	4	5
Co-operation of R&D with marketing and production	0	1	2	3	4	5
Company's information service	0	1	2	3	4	5
External factors						
Use of technical services (testing, standardization, patenting)	0	1	2	3	4	5
Use of other advisory services (e. g. marketing, management)	0	1	2	3	4	5
Co-operation with subcontractors	0	1	2	3	4	5
Co-operation with the Technical Research Centre of Finland	0	1	2	3	4	5
Co-operation with other domestic research institutes	0	1	2	3	4	5
Co-operation with domestic universities	0	1	2	3	4	5
Co-operation with vocational institutes	0	1	2	3	4	5
Co-operation with foreign universities and research institutes	0	1	2	3	4	5
Co-operation with other companies (units)	0	1	2	3	4	5

2.4 Barriers to innovation activities

There are a number of factors which may hamper the launching and implementation of innovation projects. Please evaluate the importance of such factors according to the same scale scale as above in 2.3:

Encircle the relevant alternativ

	No inform.	Not important				crucial
Economic factors						
Risk related to innovation too big	0	1	2	3	4	5
Lack of funding	0	1	2	3	4	5
Own innovation potential						
Qualitative deficiencies in own R&D	0	1	2	3	4	5
Lack of qualified personnel	0	1	2	3	4	5
Lack of information on technology	0	1	2	3	4	5
Lack of information on markets	0	1	2	3	4	5
Resistance towards changes in company	0	1	2	3	4	5
Deficiencies in the availability of external services	0	1	2	3	4	5
Inadequate opportunities for co-operation	0	1	2	3	4	5
Others:						
Innovation too easy to use or copy	0	1	2	3	4	5
Regulations, legislation	0	1	2	3	4	5

2.5 Total cost of innovation activities in 1988

	FIM, millions	FIM, millions
Total costs of research and development in unit		
Intramural R&D		
Extramural R&D		
Total costs of other innovation activities		
Acquisition of technology		
Application of innovations		
Marketing of innovations		
Acquisition of new production capacity		
Total cost of innovation activities		

The aim of this question is to get a rough idea of the size of the unit's innovation expenditure. Accurate data derived from the unit's accounts are not necessary. If practicable, the data supplied should be broken down by subgroups of R&D expenditure and other innovation expenditure. Otherwise, enter the totals of R&D expenditure and other innovation expenditure.

Intramural R&D expenditure consist of current and capital costs for R&D undertaken by unit's own personnel, regardless of whether the activities have resulted in innovations or not.

Extramural R&D expenditure consist of acquisition costs for R&D services.

Expenditure for the acquisition of technology consist of patent and licence costs, i.e. administrative and legal costs related to patenting and licencing, and of other costs for the acquisition of external know-how.

The expenditure for the application of innovations covers the launching of the production of a new article or of an essentially improved existing article and the implementation of a new production process. Included are such costs as post-R&D product design, trial production as part of launching the production, tooling, education and organisational development.

The marketing expenditure of innovations covers market research, advertising campaings and trial marketing.

The acquisition of new production capacity covers machinery and equipment incorporating new technology and the acquisition of machinery, equipment and new buildings as part of the application of the innovation.

3. Results of innovation activities and their utilization

3.1 Product and process innovations in 1984-1988 and total number of products in 1988 (see "Conceps and Definitions" page 1)

	All products, total	Product group		
		A	B	C
Total number of products at year's end 1988				
Product innovations or new and substantially improved old products introduced on the market 1984 – 1988				
– of which: products not produced before by other companies				

Has the unit applied new production processes or methods in 1984 – 1988	Yes	No

If the answer is yes, how many?	

To ensure comparability, the data for 1984-1988 should be supplied according to the unit's organisational structure as of 1988.

In calculating the number of products, products should be differentiated by such criteria as target group, field of application, and essentially altered technical or other characteristic. Versions of the same product differing in size or colour are not counted as different products.

Product innovations can be defined on the basis of R&D projects that have resulted in marketable new products or in essential improvements in existing products. Thus, improvements in different parts of the same product are not counted as separate innovations.

Companies engaged in unit production may calculate the number of all products turned out within the given period of time unless the product base at year's end 1988 allows some other reasonable mode of definition. Correspondingly, product innovations may be defined as products turned out during the given period of time and which incorporate an essential amount of R&D.

In the space bellow, give a brief description of the method you have used in calculating product and process innovations

Criteria for calculating the innovations:

3.2 Unit's evaluation of the commercial success of new products or substantial product improvements introduced on the market during 1984-1988

	Total	Product group A	Product group B	Product group C
Success				
Failure				
Neither				
Too early to evaluate				
Total				

The figures for totals should be at least as great as nuber of product innovations in 1984-1988 as reported in section 3.1

3.3 New products and substantial improvements of old products in proportion to turnover and exports in 1988

Please tick the relevant alternative

%	Proportion of turnover (x)	Proportion of exports (x)
0 — 10		
11 — 20		
21 — 30		
31 — 40		
41 — 50		
51 — 60		
61 — 70		
71 — 80		
81 — 90		
91 — 100		
Impossible to estimate		

4. Research and development and purchase and sale of technology

	Yes	No
Has the unit engaged in internal R&D in the 1988?		

If the answer is yes, please respond to questions 4.1 – 4.3

If the answer is no, you may proceed to item 4.4

4.1 R&D projects in progress at year's end 1988 by estimated duration

Duration	Number of projects
A year or less	
Over a year, two years at most	
Over two years, five years at most	
Over five years	
Total	

4.2 Information on internal R&D activities in 1988

	Yes	No
Has the unit a separate R&D department or some other comparable unit providing services for the unit		
If yes, what is its share of the internal R&D expenditure		%
Has the unit participated in national or international technology programs in 1988 Please tick the relevant program	Yes	No
	(x)	
National technology programs of the Technological Development Centre		
Technology programs of the Nordic countries		
Eureka		
EC Programs		
ESA		
COST		
Scientific and technological co-operation with the CMEA-countries		

4.3 The relation of research and development to certain new technologies in 1988

Tick the relevant alternative

	Aim of unit's R&D	
	Development of new technics (x)	Application of new technics (x)
Information technology		
Microelectronics		
Materials in electronics		
Optoelectronics		
Computer technology		
Information systems, software		
Artificial intelligence, expert systems		
Data transfer technology		
Automation and control technology		
Biotechnics		
Enzymes		
Fermentation		
Gene technology		
Diagnostics		
Materials		
New steel materials		
Light metals		
Powder metallurgy		
Ceramics		
Composites		
Polymers		
New surface materials		
Supra conductors		

4.4 R&D contracts funded by the unit in 1988

Please tick the type(s) of institution with which the unit has signed a research contract.

	Domestic (x)	Foreign (x)
Other companies (or units) in the same concern		
Other industrial companies		
Consulting and service firms		
Inventors		
Technical Research Centre of Finland		
Other public research institutes		
Private research institutes		
Vocational institutions		
Universities		

4.5 Research co-operation of the unit in 1988

Please tick the relevant types of institution in different country groups.

	Finland (x)	Other Nordic countries (x)	EC 1) (x)	USA (x)	Japan (x)	CMEA (x)	Other (x)
Other companies (units) in the same concern							
Other industrial companies							
Consulting and service firms							
Inventors							
Technical Research Centre of Finland							
Other public research institutes							
Private research institutes							
Vocational institutions							
Universities							

1) Excluding Denmark

Research co-operation comprises joint R&D projects with other institutions and own projects formally linked to the projects of other institutions.

4.6 Purchase (acquisition) and sale of technology in 1988

Tick the relevant alternative

	Purchased in		Sold to	
	Finland	Other countries	Finland	Other countries
Patents				
Licences				
Technological consulting services				
Means of production or processes containing new technology				
Raw materials and intermediate goods containing new technology				
Information systems containing new technology				
Companies or parts of companies for the purpose of acquiring or selling technolgy				
Other (please specify)				

Comments concerning the data supplied and ideas and opinions related to the questions:

Annex 2 Samples

Sample by size of firm. Number of firms

	Small firms 0-99 employees	Medium-sized firms 100-499 employees	Large firms 500- employees	Total
Denmark	51	104	39	194
Finland	55	62	53	170
Iceland	35	8	0	43
Norway	51	54	32	137
Sweden	22	43	36	101
Total	214	271	160	645

Source: Nordic Industrial Fund 1991

Sample by Pavitt sectors. Number of firms*

	Scale intensive firms	Supplier dominated firms	Science based firms	Specialised suppliers
Denmark	74	18	43	59
Finland	21	99	21	56
Iceland	8	23	12	0
Norway	55	6	40	34
Sweden	45	3	21	30
Total**	203	149	137	179

* Cf. annex 3

** Total adds up to more than 645 enterprises because approximately 25 small very R&D intensive Finnish enterprises have been excluded from the size analysis.

Source: Arne Kristensen

Annex 3 Pavitt's taxonomy[25]

Background

Pavitt constructed his taxonomy on the basis of the SPRU database of over 2000 significant innovations in the British manufacturing sector between 1945 and 1979[26]. In this database each innovation is attributed three numbers from the British Minimum List Heading[27]: 1) the sector of production of the innovation; 2) the sector of use of the innovation; 3) the sector of the innovating firm's principal activity (1984: 345). The two first classifications allow Pavitt to trace each innovation from the producer to the user, which is the relevant characteristic in this connection.

Furthermore, Pavitt defines process innovations as innovations used inside the sector in which they are produced and product innovations as innovations used outside the producing sector, and he thus uses the sector as the point of reference in his definition of innovation rather than the firm.

These two main premises along with information on the means of appropriating benefits from the innovation and on user needs allow Pavitt make a sectoral division of innovating firms.

More precisely, the basis Pavitt uses for his division of the manufacturing sector in sub-sectors is:

> *Sources of technology:* Inside firms for example R&D-department and production engineering departments and outside firms for example customers, suppliers and government R&D laboratories.
>
> *User needs:* For example performance, reliability, quality, time of delivery or, simply, price can be decisive for the user's choice of supplier.

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25 Developed in Keith Pavitt: 'Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory', *Research Policy* No. 13, 1984.

26 The survey methods, the data limitations and the database are described in Townsend, J. et al: *Innovations in Britain Since 1945*, Occasional Paper No.16, University of Sussex, 1981.

27 Which corresponds to the Standard Industrial Classification (ISEC).

Methods to appropriate benefits from the innovation: For example patents, trademarks, secrecy or imitation lags.

Pavitt identifies 3 main sectors in the manufacturing industry, and one of these sectors, production intensive firms, he splits into two and he ends up with 4 sectors. The four sectors are:

Scale intensive firms: Large process oriented firms that produce price sensitive products in bulk materials (steel, cement and glass), consumer durables and transport equipment. They have highly developed production engineering departments that develop the majority of product innovations and part of the process innovations. The other source to product innovations is the specialised suppliers with whom they have complementary relationship. Their principal techniques of appropriating the benefits from innovation are secrecy in the production processes and know-how in the production.

Supplier dominated firms: Typically small firms in the traditional sectors of manufacturing (for example Textiles and Leather and footwear), agriculture, housing and private services. They have a relatively weak R&D-department, and most of the innovations are process innovations which come from the suppliers of equipment and material. They appropriate the benefits from innovations by trade marks, special design and marketing/advertising.

Science based firms: These, typically large, firms are found in chemical and electronic industry and the innovations are based in a massive R&D effort which, in turn, is dependent on the development in the underlying basic science. The firms are able to protect their innovations partly by entry barriers (costs by entering the sector are very high) and partly by patents, trademarks and secrecy.

Specialised suppliers: These firms are highly specialised in supplying machinery and instruments to other producers. Therefore they compete on the performance and reliability of their equipment rather than on price. Their emphasis is therefore on product innovations rather than on process innovations, and the methods of appropriation are firm-specific skills which result in both continuos developments of their products and the ability to adjust to user needs and user demands. The firms in this sector are usually small.

Sectors

Supplier dominated firms

32	Textile-, leather- and clothing
33.2	Furniture
34.2	Publishing and printing
39	Other manufacture

Scale intensive firms

31	Food, beverage and tobacco
33.1	Wood and wood products
34.1	Paper and pulp
35 - 35.22	Chemicals and chemical products (exc. drugs)
36	Stone, clay and glass
37	Basic metal
38.1	Fabricated metal products
38.4	Transport equipment

Science based firms

35.22	Drugs
38.25	Computers etc.
38.3	Electronics

Specialised suppliers

38.2 - 38.25	Machinery
38.5	Instruments

***Annex 4a** Sources of innovative ideas distributed on firm size. % of firms rating a factor as important*

Denmark

	Top management	Internal R&D	Marketing departmenet	Produktion department	Key persons	Acquired material technology	Acquired immaterial technology	Subcontrac-tors	Consultants
Small	72,5	48,7	36,0	5,4	57,5	13,8	16,4	0,7	29,8
Medium	50,0	61,4	51,1	23,4	54,4	27,2	14,1	9,6	4,6
Large	38,5	73,0	42,1	21,1	61,8	17,1	6,2	3,4	10,0
Total	62,3	55,2	41,3	12,8	57,1	18,7	14,0	4,0	18,4

	Other Danish firms	Research institutes	Universities and higher education	Customers demand	Government contracts	Competitors products	Fairs and exhibitions
Small	20,1	20,0	13,4	56,8	14,0	31,3	36,0
Medium	30,7	10,8	12,7	55,8	10,4	31,9	22,1
Large	21,2	6,1	9,1	37,8	11,5	23,1	14,3
Total	25,3	14,2	12,5	54,4	12,4	30,5	29,7

Finland

	Top management	Internal R&D	Marketing departmenet	Produktion department	Acquired material technology	Acquired immaterial technology	Subcontrac-tors	Consultants	Other Finnish firms
Small	68,1	64,3	69,0	43,6	51,8	28,7	34,3	18,0	29,6
Medium	59,1	70,4	71,1	41,0	42,7	20,5	15,0	22,9	39,8
Large	52,2	73,1	76,0	32,7	40,3	24,7	38,8	7,5	39,3
Total	61,4	68,5	70,1	38,5	44,9	23,2	28,7	17,6	34,9

	Research institutes	Universities and higher education	Customers demand	Government contracts	Competitors products	Fairs and exhibitions
Small	15,2	23,9	85,2	5,0	84,2	41,9
Medium	5,7	17,8	89,9	3,4	85,2	36,3
Large	18,1	31,7	91,0	1,5	85,0	38,3
Total	12,4	23,8	88,2	5,1	81,8	37,4

Norway

	Top management	Internal R&D	Marketing departmenet	Produktion department	Key persons	Acquired material technology	Acquired immaterial technology	Subcontrac-tors	Other units in same firm
Small	65,1	64,6	52,5	9,7	59,3	20,7	13,3	10,0	18,0
Medium	42,8	54,0	57,2	21,5	67,0	26,2	15,2	3,7	22,4
Large	31,1	71,4	52,5	22,5	58,7	29,1	12,8	15,3	25,0
Total	51,3	61,9	54,2	16,1	61,9	24,1	13,9	8,6	20,8

	Consultants	Other Norwegian firms	Research institutes	Universities and higher education	Foreign units	Customers demand	Government contracts	Competitors products	Fairs and exhibitions
Small	3,8	15,6	25,4	20,0	26,2	58,7	14,1	27,7	25,6
Medium	9,2	9,2	28,2	19,6	30,2	57,2	3,7	31,9	27,6
Large	13,8	9,7	24,5	12,2	12,8	50,0	11,7	30,6	21,4
Total	7,5	12,3	26,2	18,5	25,4	56,7	10,0	29,7	25,6

Iceland

	Top management	Internal R&D	Marketing departmenet	Produktion department	Key persons	Acquired material technology	Acquired immaterial technology	Subcontrac-tors	Consultants
Small	77,1	60,0	65,7	22,9	31,4	8,6	14,3	34,3	8,6
Medium	100,0	25,0	62,5	50,0	25,0	25,0	0,0	12,5	25,0
Large	.	.	.	.	.	.	.	.	.
Total	81,0	52,6	47,8	21,2	21,9	12,5	7,9	26,3	7,2

	Within same company	Other Icelandic firms	Applied research institutes	Universities and higher education	Customers demand	Government contracts	Competitors products	Fairs and exhibitions
Small	11,4	17,1	11,4	5,7	54,3	11,4	34,3	25,7
Medium	12,5	12,5	0,0	0,0	25,0	50,0	12,5	50,0
Large	.	.	.	.	.	.	.	.
Total	10,5	10,7	5,1	2,4	34,4	24,0	10,4	24,0

Sweden

	Top management	Internal R&D	Marketing departmenet	Produktion department	Acquired material technology	Acquired raw materials	Acquired immaterial technology	Suppliers	Consultants
Small	71,4	57,1	47,6	43,0	19,0	19,0	14,3	0,0	9,5
Medium	62,8	67,4	67,4	32,6	34,8	18,6	16,3	16,2	18,6
Large	44,4	88,9	55,5	22,2	25	8,3	13,9	16,7	11,1
Total	60,3	70,3	61,0	32,2	29,5	16,0	15,3	13,1	15,1

	Other Swedish firms	Universities and higher education	Customers demand	Government contracts	Competitors products	Fairs and exhibitions
Small	19,0	28,6	95,2	14,2	76,1	0,0
Medium	46,5	18,6	83,7	16,2	76,7	36,3
Large	44,2	33,3	27,9	22,2	77,8	36,6
Total	40,6	23,9	86,0	17,2	76,7	26,1

Annex 4b Sources of innovative ideas distributed on sectors. % of firms rating a factor as important

Denmark

	Top management	Internal R&D	Marketing departmenet	Produktion department	Key persons	Acquired material technology	Acquired immaterial technology	Subcontrac-tors	Consultants
Scale intens.	46,0	61,3	51,2	28,7	54,3	22,7	9,8	8,7	4,2
Supp. domin.	73,1	75,4	48,2	28,4	51,3	45,5	29,4	15,9	15,9
Science based	78,7	60,1	44,0	1,2	57,9	26,3	22,8	1,4	33,0
Spec. supplier	57,4	47,3	33,9	9,9	58,6	6,0	6,1	1,8	18,3

	Other Danish firms	Research institutes	Universities and higher education	Customers demand	Government contracts	Competitors products	Fairs and exhibitions
Scale intens.	4,0	4,1	9,7	48,2	7,0	25,6	13,8
Supp. domin.	20,6	31,0	15,9	60,3	34,5	56,9	50,0
Science based	5,4	32,5	20,9	54,0	31,7	47,2	31,0
Spec. supplier	6,8	4,6	4,7	56,8	0,0	18,5	33,6

Finland

	Top management	Internal R&D	Marketing departmenet	Produktion department	Acquired material technology	Acquired immaterial technology	Subcontrac-tors	Consultants	Other Finnish firms
Scale intens.	71,1	67,1	65,2	49,1	46,5	21,9	31,5	18,3	43,2
Supp. domin.	48,5	72,7	76,5	43,9	67,1	22,7	25,6	28,3	18,6
Science based	70,6	73,4	78,5	29,7	56,5	24,7	42,3	8,6	39,3
Spec. supplier	45,8	67,3	73,2	19,0	26,6	25,3	19,9	14,4	25,8

	Research institutes	Universities and higher education	Customers demand	Government contracts	Competitors products	Fairs and exhibitions
Scale intens.	13,7	26,4	86,2	3,8	82,9	41,6
Supp. domin.	2,4	9,2	85,0	12,1	90,5	48,8
Science based	6,2	22,0	81,5	8,3	71,7	34,1
Spec. supplier	16,8	26,7	95,3	2,8	79,1	25,5

Norway

	Top management	Internal R&D	Marketing departmenet	Produktion department	Key persons	Acquired material technology	Acquired immaterial technology	Subcontrac-tors	Other units in same firm
Scale intens.	49,4	58,7	53,3	24,3	62,1	31,6	9,2	9,0	27,4
Supp. domin.	47,9	73,3	66,9	12,3	83,5	47,9	20,4	0,0	19,0
Science based	53,8	70,6	61,2	11,9	62,0	19,2	23,4	13,7	28,4
Spec. supplier	59,4	62,4	50,9	10,4	67,1	19,7	15,0	3,5	22,4

	Consultants	Other Norwegian firms	Research institutes	Universities and higher education	Foreign units	Customers demand	Government contracts	Competitors products	Fairs and exhibitions
Scale intens.	14,4	12,9	27,4	17,5	33,9	54,6	0,0	24,3	25,4
Supp. domin.	0,0	0,0	15,1	0,0	0,0	83,5	0,0	31,3	38,1
Science based	3,0	17,7	29,1	25,2	33,9	57,3	24,3	37,0	26,5
Spec. supplier	8,3	15,1	29,0	21,1	13,6	57,3	12,8	27,9	22,8

Iceland

	Top management	Internal R&D	Marketing departmenet	Produktion department	Key persons	Acquired material technology	Acquired immaterial technology	Subcontrac-tors	Consultants
Scale intens.	82,6	43,5	52,2	21,7	34,8	4,3	17,4	34,8	4,3
Supp. domin.	87,5	50,0	75,0	37,5	12,5	37,5	0,0	25,0	25,0
Science based	75,0	75,0	83,3	33,3	33,3	8,3	8,3	25,0	16,7
Spec. supplier	.	.	.	.	.	.	.	.	.

	Other Icelandic firms	Applied research institutes	Universities and higher education	Customers demand	Government contracts	Competitors products	Fairs and exhibitions
Scale intens.	13,0	8,7	4,3	43,5	4,3	21,7	26,1
Supp. domin.	25,0	12,5	0,0	50,0	25,0	62,5	25,0
Science based	16,7	8,3	8,3	75,0	16,7	33,3	41,7
Spec. supplier	.	.	.	.	.	.	.

Sweden

	Top management	Internal R&D	Marketing departmenet	Produktion department	Acquired material technology	Acquired raw materials	Acquired immaterial technology	Suppliers	Consultants
Scale intens.	50,7	66,3	59,2	44,2	37,0	25,4	17,3	18,9	18,3
Supp. domin.	100,0	74,0	100,0	100,0	74,0	63,0	37,0	74,0	37,0
Science based	56,6	79,7	34,7	23,5	35,0	18,3	23,1	13,5	17,9
Spec. supplier	60,3	70,1	74,3	17,3	14,0	0,0	6,9	0,0	8,1

	Other industrial firms	Universities and higher education	Customers demand	Government contracts	Competitors products	Fairs and exhibitions
Scale intens.	39,3	31,5	78,6	19,8	76,1	17,9
Supp. domin.	74,0	0,0	100,0	0,0	100,0	100,0
Science based	36,2	29,1	93,6	24,3	76,1	33,0
Spec. supplier	40,0	15,7	87,9	12,8	78,2	25,9

***Annex 5a** Factors hampering innovation. % of firms rating a factor as important*

Denmark

	Excessive risk	Lack of risk capital	Low quality on internal R&D	Lack of qualified personel	Insufficient market research	Opposition to change	Lack of cooperation possibilities	Lack of information on universities etc.
Small	56,6	47,7	31,7	50,9	44,7	29,3	25,7	13,2
Medium	54,9	18,2	21,4	18,9	27,8	17,6	8,3	7,2
Large	81,1	16,1	15,2	17,1	33,3	6,1	0,0	3,3
Total	58,8	35,9	25,8	34,8	37,7	21,9	16,5	9,8

	Innovations too easy to copy	Legal regulations
Small	4,7	5,8
Medium	16,3	10,0
Large	7,1	14,3
Total	9,6	8,8

Finland

	Excessive risk	Lack of risk capital	Low quality on internal R&D	Lack of qualified personel	Insufficient market research	Opposition to change	Lack of cooperation possibilities	Lack of information on universities etc.
Small	48,8	31,7	42,2	50,4	23,0	30,1	11,0	32,6
Medium	48,6	32,5	52,2	43,1	41,3	25,5	11,4	28,9
Large	58,2	32,8	42,5	43,8	43,3	28,8	17,2	22,9
Total	51,2	35,1	44,6	46,4	36,0	27,1	14,1	30,3

	Innovations too easy to copy	Legal regulations
Small	36,7	20,3
Medium	32,8	22,0
Large	25,8	34,0
Total	33,9	23,3

Norway

	Excessive risk	Lack of risk capital	Higher costs than exptected	Insufficient public support	Innsufficient internal R&D	Low quality on internal R&D	Lack of qualified personel	Insufficient market research
Small	41,0	48,7	35,1	29,2	25,6	13,6	37,4	29,5
Medium	60,9	36,2	26,2	26,7	33,6	9,5	29,3	22,7
Large	61,7	12,2	28,0	5,6	27,0	3,1	24,5	29,5
Total	51,7	38,1	30,7	24,3	28,8	10,3	32,3	27,0

	Opposition to change	Lack of cooperation possibilities	Lack of available consulting services	Lack of information on universities etc.	Innovations too easy to copy	Legal regulations
Small	9,7	17,2	15,9	19,8	13,9	8,2
Medium	9,5	5,5	3,7	11,8	16,7	10,9
Large	15,3	6,7	2,5	8,6	12,8	9,2
Total	10,6	11,2	9,3	15,0	14,7	9,4

Iceland

	Excessive risk	Lack of risk capital	Higher costs than exptected	Government support to low	Too little internal R&D	Low quality of internal R&D	Lack of qualified personal	Insufficent market research
Small	11,4	60,0	34,3	31,4	37,1	31,4	31,4	54,3
Medium	37,5	12,5	0,0	12,5	25,0	0,0	12,5	50,0
Large	.	.	.	.	.	.	.	.
Total	17,7	43,1	28,7	33,6	42,9	17,6	20,5	52,3

	Opposition to change firm	Lack of cooperation outside	Lack of competence within other firms	Lack of technology and other consultance	Lack of information on universities	Innovation too easy to copy	Legel regulations
Small	11,4	14,3	17,1	11,4	28,6	8,6	14,3
Medium	12,5	12,5	0,0	0,0	25,0	12,5	37,5
Large	.	.	.	.	.	.	.
Total	5,9	21,5	8,2	5,8	19	18,5	10,8

Sweden

	Low expected returns	Lack of risk capital	Higher costs than expected	Low quality on internal R&D	Shortage of researchers	Shortage of other personel	Lack of cooperation possibilities	Lack of information on new technology
Small	57,1	66,7	42,9	23,8	28,6	42,9	19,0	14,2
Medium	44,2	14,0	41,9	27,9	27,9	30,2	9,3	14,0
Large	44,4	5,6	22,2	27,8	25,0	30,6	8,3	8,3
Total	46,8	22,4	37,6	27,1	27,4	32,8	11,0	13,0

	Innovations too easy to copy	Legal regulations
Small	33,3	66,7
Medium	23,2	14,0
Large	8,3	5,6
Total	21,9	22,4

***Annex 5b** Factors hampering innovation distributed on sectors. % of firms rating a factor as important*

Denmark

	Excessive risk	Lack of risk capital	Low quality on internal R&D	Lack of qualified personel	Insufficient market research	Opposition to change	Lack of cooperation possibilities	Lack of information on universities etc
Scale intens.	59,9	23,7	23,6	20,8	31,5	13,4	3,7	7,1
Supp. domin.	51,3	0,0	6,4	12,1	19,2	6,3	6,9	7,7
Science based	70,8	22,2	21,0	53,9	52,9	34,8	32,3	21,0
Spec. supplier	51,0	56,2	36,3	28,9	33,5	17,2	10,6	2,8

	Innovations too easy to copy	Legal regulations
Scale intens.	17,4	5,6
Supp. domin.	16,7	7,9
Science based	3,8	19,6
Spec. supplier	8,0	5,2

Finland

	Excessive risk	Lack of risk capital	Low quality on internal R&D	Lack of qualified personel	Insufficient market research	Opposition to change	Lack of cooperation possibilities	Lack of information on universities etc
Scale intens.	51,4	34,7	45,4	41,7	31,6	26,8	11,1	22,1
Supp. domin.	27,9	32,2	57,5	38,3	48,2	36,5	7,2	46,4
Science based	61,0	37,5	48,8	68,3	25,4	34,4	5,4	36,5
Spec. supplier	58,8	36,4	35,6	50,8	41,9	20,3	6,3	35,6

	Innovations too easy to copy	Legal regulations
Scale intens.	40,0	30,6
Supp. domin.	46,7	2,1
Science based	9,6	33,4
Spec. supplier	25,1	11,6

Norway

	Excessive risk	Lack of risk capital	Higher costs than exptected	Insufficient public support	Innsufficient internal R&D	Low quality on internal R&D	Lack of qualified personel	Insufficient market research
Scale intens.	56,1	29,1	22,7	18,6	42,4	16,6	37,5	30,5
Supp. domin.	60,3	52,2	57,3	57,3	35,6	23,5	50,4	59,1
Science based	47,9	40,4	39,1	28,2	23,0	3,3	30,1	29,5
Spec. supplier	65,6	57,5	34,6	34,5	25,4	14,3	35,0	17,2

	Opposition to change	Lack of cooperation possibilities	Lack of available consulting services	Lack of information on universities etc	Innovations too easy to copy	Legal regulations
Scale intens.	15,3	19,1	14,3	24,0	22,2	15,0
Supp. domin.	0,0	35,6	19,0	19,0	37,5	22,6
Science based	8,2	5,8	3,2	10,1	12,0	9,4
Spec. supplier	9,6	6,4	12,3	12,0	10,9	4,7

Iceland

	Excessive risk	Lack of risk capital	Higher costs than exptected	Government support to low	Too little internal R&D	Low quality of internal R&D	Lack of qualified personal	Insufficent market research
Scale intens.	26,1	43,5	13,0	26,1	34,8	26,1	26,1	43,5
Supp. domin.	12,5	37,5	12,5	0,0	50,0	12,5	37,5	62,5
Science based	0,0	75,0	66,7	50,0	25,0	33,3	25,0	66,7
Spec. supplier	.	.	.	.	.	.	.	

	Opposition to change firm	Lakc of cooperation outside	Lack of competence within other firms	Lack of technology and other consultance	Lack of information on universities	Innovation too easy to copy	Legel regulations
Scale intens.	17,4	8,7	13,0	8,7	30,4	8,7	21,7
Supp. domin.	0,0	12,5	0,0	12,5	12,5	25,0	12,5
Science based	8,3	25,0	25,0	8,3	33,3	0,0	16,7
Spec. supplier	.	.	.	.	.	.	.

Sweden

	Excessive risk	Lack of risk capital	Higher costs than exptected	Low quality of internal R&D	Shortage of researchers	Shortage of other personnel	Lack of cooperation possibilities	Lack of information on new technology
Scale intens.	44,8	17,1	41,6	32,5	33,8	29,6	9,1	14,1
Supp. domin.	37,0	63,0	74,0	37,0	37,0	37,0	37,0	37,0
Science based	57,4	33,8	49,0	24,7	31,5	41,4	6,7	16,7
Spec. supplier	47,3	19,4	24,5	22,5	17,8	33,4	13,8	6,9

	Innovations too easy to copy	Legel regulations
Scale intens.	25,4	30,5
Supp. domin.	63,0	0,0
Science based	23,1	38,2
Spec. supplier	13,8	5,9