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Industrial innovation in Finland

First results of the Sfinno-project

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Foreword

The history of the Sfinno-project can be traced back to the founding of the VTT Group for Technology Studies in 1992. One of the first projects of the group aspired to systematically collect data on the development and commercialisation of innovations in order to establish a good micro-level database on technological change in Finnish industry. The idea was to dig deeper into the rapid industrial renewal of the 1980s, when the electronics industry emerged as the third pillar of the Finnish economy alongside the forestry and metal industries. Moreover, the project aimed at providing more concrete innovation indicators capturing innovation output as a complement to R&D statistics and macro-level indicators.

Due to the increasing scale and scope of the group's activities, the first phase of data collection was undertaken with limited resources alongside various other and more urgent obligations. In May 1997 the project was revitalised through financial support of Tekes, and this report is a first descriptive analysis of the data that has been collected in a more systematic way since 1998. Although the basic aims of the project have remained the same, the database now has the sufficient critical mass needed for a wide range of different studies of both qualitative and quantitative nature. Meanwhile, the data has been complemented with more recent innovations relating to the entry of new small firms and the emergence of the software-related innovations in particular. Hopefully the work that has been done so far will be continued, facilitating more extensive longitudinal studies in the future.

The Sfinno-project and this report has benefitted from the input of many persons. First of all we would like to thank Tekes for providing the necessary funding, and the director of our group, Tarmo Lemola, for the inspiration and comments that we have received on previous drafts of the report. The role of Ari Leppälahti from Statistics Finland has also been invaluable and Jukka Hyvönen has been of important assistance at various points in time. We have also benefitted greatly from comments by Jari Eskola of the University of Tampere. Finally, we want to thank the survey respondents who have provided us with the necessary data on the innovations. The report has been co-written by the authors. Christopher Palmberg has been the project manager since 1998.

Otaniemi 26.3. 2000

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Abstract

This report provides the first results of an ongoing research project called Finnish Innovations (Sfinno). The aim of the project is to provide a new viewpoint on structural and technological change in Finnish industry through analyses of innovations commercialised in the 1980s and 1990s. Our approach differs from firm-level studies, since we have taken the identification of individual innovations as our starting point and have collected additional data through a mail survey. We also have basic data on the firms commercialising the innovations.

The report analyses the results of the survey descriptively, while more in-depth studies will follow in subsequent stages of the project. We present the results as changes over time according to the year of commercialisation of the innovations, across industries and firm size groups.

The number of innovations is growing steadily, indicating that our methods for identifying the innovations have been consistent. The database covers extensively different industries and firm size groups, when compared with the distribution of patenting. Particularly interesting is the large share of software-related innovations and innovations originating from smaller firms. Innovations from R&D-intensive industries are more often new to the firms and the markets, the firms are relatively more focused in terms of knowledge input and the innovations more often find generic application and receive higher shares of public funding compared with the more traditional industries. The smaller firms require relatively more knowledge about the commercialisation of core technology, innovate more often in response to market niche, and are more dependent on public programmes and support than larger firms. Moreover, innovations from smaller firm become exportable less often. Overall, market-related factors, such as customer demand, market niche and collaboration with customers are characteristics of the innovation processes, although some interesting differences emerge over time and across firm size groups. Domestic collaborative partners are more important than foreign ones, and technology programmes are more important for involving smaller firms in collaboration.

Our approach seems to be particularly useful for identifying and studying new small firms and emerging sectors. Moreover, analyses can be anchored directly to innovation output and specific types of innovations, whereby new interpretations of traditional innovation indicators become possible.

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1 Introduction

1.1 Background

This report relates to an ongoing research project at the VTT Group for Technology Studies called Finnish Innovations (hereafter Sfinno). The aim of the Sfinno-project is to provide a new perspective on structural and technological change in Finnish industry during the 1980s and 1990s from the viewpoint of individual innovations. For this purpose we have constructed a unique database consisting of 1482 Finnish innovations commercialised during the 1980s and 1990s.[1] The database contains basic data on the innovations and the commercialising firm. It also contains survey data on the origin and sectoral use of innovations, R&D collaboration, public support and commercial significance of the innovation (see appendix 1 for the questionnaire).[2]

The report is a follow-up to a number of more methodologically oriented working papers and conference presentations published during 1999 (Palmberg et al. 1999, Leppälahti & Palmberg 1999 and Palmberg & Toivanen 1999). The purpose of the report is to provide first results and interpretations and to highlight basic issues that emerge from this new perspective. Thus, this report should be considered a descriptive starting point for more focused in-depth analyses at later stages of the project, including comparisons with the Community Innovation Survey (CIS) undertaken by Statistics Finland.

The Sfinno-project finds its relevance in the context of the recent renewal of Finnish industry, which mainly is characterised by the relatively rapid growth of R&D-intensive industries during the 1980s and 1990s. These developments are spearheaded in particular by the telecommunications industry and the rapid growth of Nokia. Nonetheless, there is still a lack of in-depth understanding of the broader background structures and mechanisms behind these aggregate developments, the 'tip of the iceberg'. This concerns in particular a micro-level understanding of the distribution, nature and origin of innovations, and their commercialisation and diffusion in specific sectoral and firm settings. Structural change in the Finnish

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[1] The number of innovations varies, depending on the exact criteria that we apply in defining innovations. The grand total is 1620 innovations, including inventions that have not reached the markets.

[2] The final phase of the survey, undertaken during January and February 2000 and covering some 200 innovations, has not been included in this report due to time constraints.

industry has thusfar been studied mainly from the perspective of industrial clusters and macro-economic indicators, whereby innovations and innovation processes remain invisible. On the other hand, studies using firm-level data suffer from the fact that indirect proxies are used to capture the output of innovative activity. Our alternative approach tries to compensate for these weaknesses by focusing on the very core of the process of industrial renewal, the development and commercialisation of innovations. Our approach thus differs from firm-level approaches such as the CIS (the subject approach), since we take the identification of individual innovations as the starting point and then collected data on the innovations and the related firms as a separate exercise (the object-approach). Hence, our database contains data on innovation output and the firms, which have developed and commercialised these innovations.

1.2 A note to the reader

It is appropriate to stress certain aspects of the database that have shaped the way that we present the results. Since the database contains both basic data on all the innovations and firms (hereafter called the whole data) and also more detailed survey data on 642 innovations (hereafter called the survey data), we present the whole data separately from the survey data. The whole data enables us to describe the basic structure and coverage of the database. Moreover, it is possible to link the whole data to firm-level databases, thus extending the potential use of the data further. The survey data provides more details on the origin, development and commercial significance of the innovations.

Apart from presenting the overall results, we basically have three ways to analyse our data: according to the year of commercialisation of the innovations, the industry of the commercialising firms, and the firm size groups. The year of commercialisation enables us to locate the innovation and the associated development processes in time. We can thus make some observations regarding how the nature of innovations and their development processes change over time. The comparison across industries reveals differences in the operating environment of the firms, while the firm size groups reveal the influence of firm-level contexts. In the report we try to harness these different viewpoints as extensively as possible. Moreover, we again stress that all our data on the innovations have been collected at the level of individual innovations even though we locate them to specific industries and firm size groups according to the firm-level data.

When we present the overall results we include all innovations irrespective of the year of commercialisation. When we analyse changes over time using the year of commercialisation of the innovations, we have selected three time periods: 1985-89, 1990-94, and 1995-98. The selection of these periods is motivated by the fact that they mark the boom years of 1985-89, the depression in the early 1990s (1990-94), and the recovery years of 1995-98. Furthermore, this periodisation provides reasonable coverage in terms of the number of innovations for each period. We will use these time periods throughout the report if not otherwise stated.

For presenting the distribution of innovations across industries we use the tol95 classification of the firms main industrial activity as provided by Statistics Finland.[3] The tol95 classification makes a basic distinction between manufacturing industries and the service sector. We basically stick to this standard classification at the two-digit level with the exception that we have disaggregated the service sector to match the sectoral distribution of the innovations more effectively. Hence, the service sector comprises wholesale and retail trade, software, architectural and engineering activities, research and development, other miscellaneous services and holding companies. Since the disaggregation of the survey data suffers from the limited number of observations in some industries at this stage of the project, we only comment on industries with reasonable coverage.

The firm size groups are determined by the number of employees of the firms. In this report we have to rely on cross-sectional firm data mainly from 1996. This means that our observations related to specific firm size groups are not necessarily valid for innovations commercialised in the 1980s or early 1990s, if the firm size has changed significantly compared with the 1990s. Our way to minimise this problem has been to assign rather large firm size groups, whereby it might be assumed that shifts across the groups are less frequent that restructuring within the groups. These firm size groups are 1-9, 10-99, 100-999, and over 1000 employees. Of these, the firm size group of 1-9 employees is the most problematic since it is presumably the most turbulent in terms of firm size growth. Again we have also tried to maximise the coverage in terms of the number of innovations within each category. Finally, it should be noted that we do not go beyond the firm size class in discussing the firms in the case of the survey data, since we observed confidentiality during data collection.

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[3] The tol95 industrial classification is compatible to the Nace used in the EU.

2 The whole data

2.1 A brief note on the methodology

The whole data consists of 1482 Finnish innovations commercialised during the 1980s and 1990s. Our definition of an innovation relies loosely on the definitions provided in the Oslo Manual (1997). We have defined an innovation as an invention that has been commercialised on the market by a business firm or the equivalent. As a minimum requirement, the innovation has had to pass successfully the development and prototype phase, involving at least one major market transaction. The bottom-line for inclusion of an innovation in the database has thus been "a technologically new or significantly enhanced product compared with the firm's previous products". We have only included innovations that have been commercialised by firms registered as domestic.

The whole data has been compiled using a combination of three different methodologies for the identification of innovations: expert opinion, reviews of trade and technical journals, and reviews of the annual reports of large firms. Of these three, expert opinion and literature-based reviews are relatively well established methodologies in innovation studies similar to Sfinno (see e.g. Townsend et al. 1981, Wallmark & McQueen 1991, Kleinknecht & Bain 1993). The reviews of the annual reports of large firms, however, take a somewhat different point of departure since the innovations have been identified through our subjective judgement in collaboration with the firms.

The use of expert opinion for the identification of innovations began in 1992 as a part of another project. It has involved a large number of experts representing different industrial and technological fields from industry, the Technical Research Centre of Finland, the National Technology Agency of Finland (Tekes) and the technical universities. These experts were asked to list significant innovations according to our definitions and criteria and to identify the year of commercialisation and the commercialising firm. The result of this exercise has been the identification of 258 innovations.

The literature reviews were undertaken by students. From a list of some 60 Finnish eligible trade and technical journals we selected 18 to cover as extensively as possible all the major industries (see appendix 2 for the list of journals). The students were told to focus on articles dealing with the introduction of new products which conformed to our definitions and criteria for an innovation. They listed and described these, noted the year of commercialisation (if available) and the name of the commercialising firm, the journal number and the relevant pages. This resulted in the identification of 1040 innovations, the majority of all the innovations in the database. In addition, we have included lists of award-winning innovations in the literature reviews.

Due to the importance of a few large firms in the Finnish economy, we also decided to include these on a case-by-case basis (altogether 22 firms, se appendix 3) since we feared that they would not be covered sufficiently and in enough detail in the literature reviews. The selection of firms was also made on the basis of their R&D spending and patenting, as we assumed that firms investing heavily in R&D and patenting could also be considered innovative. Again, a group of students helped us by first listing all the new products that these firms had launched during 1985-98. Thereafter, we approached the firms with the lists of product launches, and our definitions and criteria of an innovation, asking them to pick out those products which they considered especially important and innovative. In this way, a group of 137 innovations were identified. Another group of 138 innovations has been identified more or less unsystematically from miscellaneous written sources, the www or by researchers at the VTT Group for Technology Studies.

Our combination of different methodologies for the identification of innovations was intended to secure the coverage of the data across different industries and firm size groups (see the following chapter). On the other hand, this also implies that it will be more difficult to control for biases. These biases might for example arise if the experts have been inclined to identify relatively more innovations originating from bigger firms, while the literature reviews have identified relatively more innovations from smaller firms. Another bias in favour of innovations from larger firms might arise from the review of annual reports on a case-by-case basis.

In order to check for biases, we have cross-compared the source of identification of innovation across the firm size groups. The results of these exercises confirm that a relatively larger share of innovations from smaller firms have indeed been identified through literature reviews. On the other hand, the experts have not had a noteworthy bias in favour of innovations from bigger firms. Moreover, the share of innovations which have been identified from more than one source is relatively small, indicating that the combination of different methodologies has indeed enhanced the coverage of the database.

2.2 The basic structure and coverage of the whole data

For the survey data, the year of commercialisation of the innovations have been provided by the respondents. For the rest of the innovations the year of commercialisation originates from the judgement of the experts, the articles in trade and technical journals, and the annual reports of the large firms. In cases where the articles in the technical and trade journals have not contained any information on this, we have used the year of publication of the articles which describes the innovation in question as an approximation.

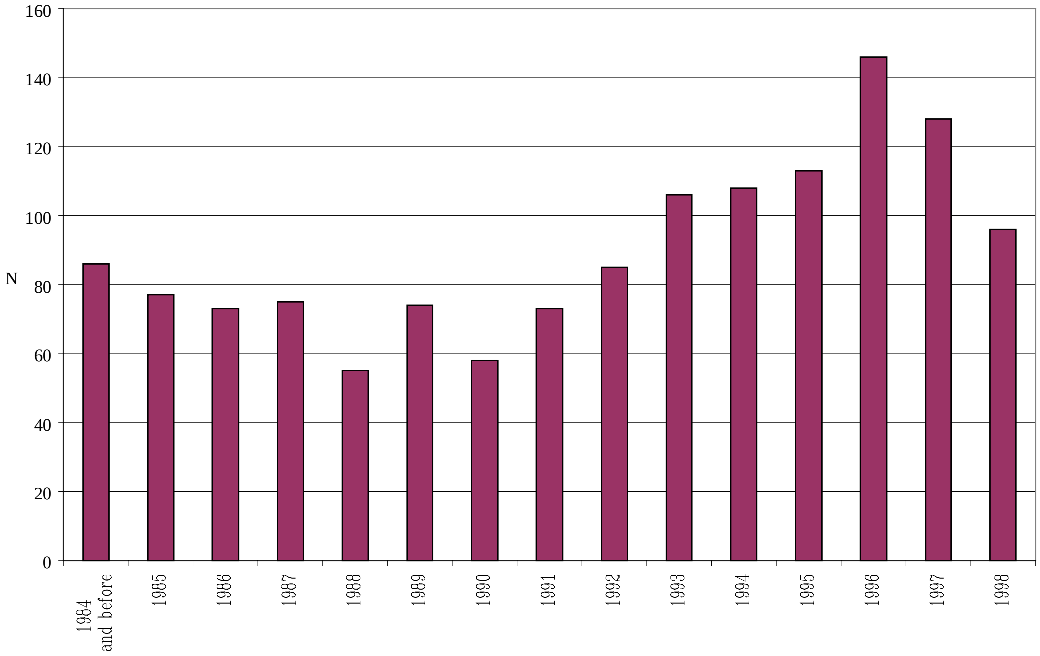

Figure 1. The year of commercialisation of the innovations.

Figure 1 illustrates that we have restricted the identification of innovations to the period 1985-98, even though some innovations have been commercialised many years prior to that. The trend in the number of innovations commercialised annually is steadily rising, with the exception of slumps in 1989 and 1991. Starting from 1996, the numbers decrease primarily because there is a lag in the rate at which innovations are reported in journals. Overall, however, the rising trend up until 1996 suggests that our methodology for identifying innovations is consistent from year to year. The trend also makes sense tentatively since it is consistent with other indicators, such as R&D expenditures, patenting and the growth of the electronics industry in particular.

Due to the fact that a firm may have more than one innovation included in the database, the number of innovations is not equivalent to the number of firms. Altogether, the whole data contains 952 firms, which have commercialised the 1482 innovations. As was mentioned in the introduction, an advantage of our innovation-oriented approach is that we can move beyond the industry of the firm, and focus on the nature and development processes of innovation output. Nonetheless, since innovations always originate from firm-level activity, it makes sense to present the structure of the whole data according to the sectoral and size distribution of the firms commercialising the innovations.

In order to have some indication of the coverage of our data with respect to the distribution of innovation-related activities in Finnish industry, we use patent data as an approximation for innovation output. The use of patent data as an indicator of innovation output is not unproblematic due to the well-known fact that there are firm- and industry-specific differences in patenting strategy and the propensity to patent. It is also uncertain whether a patent will always result in an innovation (see e.g. Pavitt 1988, Grupp 1998 on the use and misuse of patents). Nonetheless, for our purposes patents are the only viable way to assess the coverage of the database since they are available as long time series and cover a reasonably large number of observations across different industries and firms (the software industry is the only exception). Moreover, patents are the closest we come to our level of analysis of individual innovations that also includes small firms.

In table 1 we present the distribution of innovations and patents according to the tol95 classification of the firms. We combine two different data sources, our database of innovations commercialised during the 1990s and patent data consisting of all Finnish patents granted to firms by the National Board of Patents during the 1990s.[4] We present the distribution as a percentage of the total number of innovations in the database and the total number of patents granted. It should be noted that patents also cover processes developed in-house, while our data mainly covers products on the markets. The comparison is therefore intended only as a rough assessment of the degree that our database covers innovative sectors.

[4] We have to restrict our comparison to the 1990s, since our database covers only patents granted in the 1990s at this stage of the project. Nonetheless, since the majority of the innovations have been commercialised during this period we regard these years as a reasonable benchmark.

Table 1. A comparison of the distribution of innovations compared with the distribution of patents across industries (per cent of total).

Industry	Innovations N= 897 %	Patents N= 4504 %
Agriculture, forestry and fishing	0	0
Mining and quarrying	1	0
Foodstuffs	8	1
Textiles and clothing	1	1
Wood products	1	1
Pulp & paper	4	2
Printing and publishing	-	-
Oil and chemicals, rubber and plastics	7	9
Other non-metallic mineral products	1	2
Basic metals, fabricated metal products	5	5
Machinery and equipment	15	23
Electrical and optical equipment	18	26
Transport equipment	2	2
Other manufacturing, recycling	1	1
Electricity, gas and water supply	1	2
Construction	1	2
Wholesale and retail trade	8	4
Software	10	0
Architectural and engineering activities	7	5
Research and development	3	5
Other services	5	4
Holding companies	3	6

The whole data covers innovative industries relatively well since the distribution of innovations across industries corresponds closely to the sectoral distribution of patents. The major difference is the relatively better coverage of the foodstuffs and software industries in terms of innovations. The higher share of innovations compared with patents in the software industry is simply explained by the fact that software has not been patentable until very recently. In the case of the machinery and the electrical and optical equipment industry, the share of patents exceeds that of innovations. One explanation for this difference is that these industries are dominated by a few large firms with many product lines, resulting in a relatively large share of patents compared with other industries.

The large share of innovations and patents in wholesale and retail trade is surprising since one might not expect these firms to be innovative. On closer inspection, this result is partly explained by the fact that multisectoral firms have been included in this industry in the tol95 classification, even though they are also involved in the development and production of new products in their other business areas. Also, it might be the case that many wholesale traders and retailers are merely commercialising the innovations developed by other firms. A similar problem is encountered in the case of holding companies where the developing and producing firms are typically organised under one umbrella organisation. In these cases the innovations and patents have been assigned to the 'wrong' level of firm activity.

The other side of the coin is to look at the distribution of innovations across the firm size groups (figure 2). Again, we also include our patent data for comparison, subject to the above-discussed reservations.

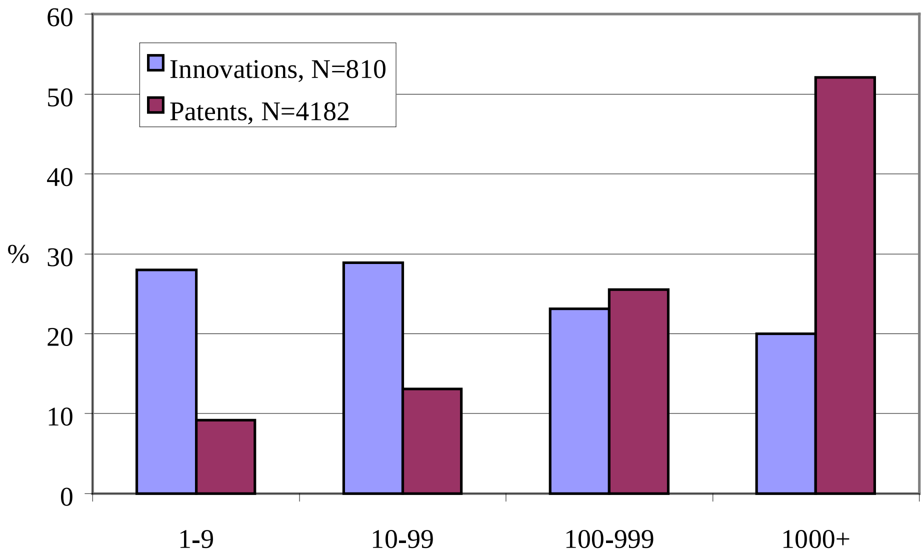

Figure 2. Comparison of the distribution of innovations compared with the distribution of patents across firm size groups (per cent of total).

The distributions only correspond to each other for firms with 100-999 employees but diverge quite significantly for the other firm size groups. The share of innovations exceed that of patents for firms with 1-9 and 10-99 employees, while the share of patents exceed by far the share of innovations for firms with over 1000 employees. The figure thus suggests that our methodologies have managed to identify relatively better innovations and innovative firms from the smaller firm size groups. This is interesting, since many surveys, such as the CIS for example, typically exclude smaller firms due to high sampling costs. This also reflects the underlying firm structure in Finland with a relatively abundance of small firms. On closer investigation, we noted that the majority of small firms have only one innovations, in particular for firms with less than 10 employees.

2.3 The product class of the innovation

Apart from the year of commercialisation of the innovations and data on the commercialising firm, the whole data also contains the product class of the innovations. We have assigned a disaggregate product class to each innovation, based on the description of the innovation and additional information that we have at our disposal.[5] The product classes provide one alternative for moving beyond the industry of the firm to analyses of innovation focused on particular products and types of innovations (table 2).

At the level of aggregation used in table 2, the distribution of innovations according to product classes is more or less similar to the distribution of innovations according to the industry of the commercialising firm, with machinery, electrical equipment and instruments predominating. The product classes nonetheless give a more complex picture of the breakdown of the types of innovations in these industries.

[5] The product classes are based on the tol95 classification provided by Statistics Finland.

Table 2. The product class of the innovations.

Product class	N
Agriculture, fishing and trapping, mining	3
Foodstuffs	114
Textiles, clothing	7
Wood products	28
Pulp & paper products	53
Oil- and petroleum-based products	12
Industrial chemicals	26
Pharmaceuticals	23
Other miscellaneous chemicals products	27
Rubber and plastics products	48
Glassware, porcelain and other non-mineral products	31
Iron and steel, other metals	24
Metal products	69
Motors, turbines	11
Agricultural machinery	17
Metal-bending and working machinery	47
Mining and drilling machinery	15
Pulp & paper machinery	40
Other miscellaneous machinery	150
Office machinery	33
Electrical machinery, appliances	69
Electronic circuits and telecommunications equipment	71
Radio- and television equipment	6
Instruments	171
Cars and equipment	18
Ships and boats, other misc. transport equipment	24
Household appliances, other miscellaneous goods	16
Energy and water supply, teletransmissions	4
Construction	14
Software services	195
Other miscellaneous services	15
Total	1412

In the case of machinery, a large part of the innovations are miscellaneous machinery. Another major part consists of metal-bending machinery and pulp & paper machinery. Turning to electrical equipment and instruments, we can see the dominance of different kind of instruments in particular and electronic circuits and telecommunications equipment. The large share of electronic circuits and telecommunications equipment is related mostly to Nokia, although these products do not dominate the whole data to the extent that perhaps might have been expected.

The single most important product class is software services, in practice software programmes. This product class is also the only one, which shows considerable growth in the 1990s compared with the 1980s when we look at changes over time. Another interesting observation is that other classes usually associated with the service sector, especially other miscellaneous services, appear much less important than in table 1. Hence, many innovations originating from the service sectors are industrial products compatible with our definition of innovations. This suggests that analyses of the service sector using the industry of the firms' main activity might produce rough interpretations of the nature of innovation in services if the characteristics of the output are not taken into account.

Apart from high-tech products, such as instruments, electronic circuits and telecommunications equipment, the whole data also contains a relatively large share of more traditional products. In particular, foodstuffs, pulp & paper products, rubber and plastic products, and metal products stand out as relatively important classes. The share of products from electricity, gas and water supply and construction is negligible. The products of these industries evidently do not conform to our definition of an innovation.

3 Analysis of the survey data

3.1 Survey practicalities and the coverage of the survey data

Owing to various practicalities related to the extensive time period covered and organisational changes among the firms, a significant amount of preparatory work was required before we could mail the questionnaires. The major criteria for the survey was that the firm was still active according to the firm registers and that a knowledgeable respondent could be identified, who had followed the various development phases of the innovation. This was deemed especially important in the case of larger firms. In the case of small firms, we often picked the firm manager under the assumption that he would direct the questionnaire on to the relevant person.

The mail survey was undertaken in four successive phases between December 1998 and October 1999. Each phase was followed up with two reminders and an e-mail message in cases where we had access to the address. In October 1999 a last, fourth, reminder was sent to all respondents who had not yet answered. In the meanwhile, the questionnaires received were run through a control program designed to check for internal inconsistencies in the answers. All inconsistencies led to further contacts with the respondents with the aim of minimising the item non-response. In some cases, as a consequence of interaction with the respondents, the name of the innovation was altered.

The response-rate for our mail survey reached 64 per cent. We posted 1235 questionnaire; 689 were returned. The overcoverage, or the number of innovations relating to deceased firms, was 151 despite the fact that we had tried to exclude these from the survey at the outset. Therefore, the survey data in practice covers only active firms, even though the innovations might already have exited the market. After the above mentioned criteria that we adopted for excluding, e.g. uncommercialised inventions, we are left with the 642 innovations as the survey data that we analyse in the following chapters.

Since older innovations were more difficult to link to an active firm and a knowledgeable respondent, the response rate is higher for innovations commercialised in the 1990s, compared with the 1980s. Compared with the whole data, the survey covers around 50 per cent of all innovations throughout the 1990s. Between 1985 and 1990, the survey covers roughly only 30 per cent on average. Across industries, the survey provides relatively good coverage of the pulp & paper, oil, chemicals, rubber and plastics industries, the metal and metal products industries, the machinery and equipment industries, as well as the transport equipment industry. For these industries the coverage is over 50 per cent. Compared with industry, the service sector receives slightly less coverage.

Across firm size groups, the coverage is more stable and the structure of the firm population covered by survey reflects the structure of the firm size groups in the whole data. Nonetheless, we seem to have relatively better coverage of firms with less than 100 employees in the survey data. In particular, only around 30 per cent of innovations originating from firms with over 1000 employees are covered. Hence, we have been less successful in identifying knowledgeable respondents from the bigger firms. This is especially true in the case of Nokia, and Nokia is relatively underrepresented in the survey data compared with the whole data.

3.2 Nature of innovations

Through the survey we get a better idea of the nature of innovations. We included questions on their degree of novelty and the nature of the knowledge input involved in the development of the innovations. Furthermore we asked about the sectoral use of the innovations (see section 3 in the questionnaire).

3.2.1 Degree of novelty

The respondents assessed the degree of novelty compared with the firms´ previous activities at the time of the commercialisation of the innovation. We provided the basic distinction between entirely new innovations, significant and minor improvements compared with previous products. Moreover, respondents assessed the degree of novelty from the market point of view, with the distinction between innovations new to the Finnish market and new to the global markets. The overall results are summarised in table 3.

Table 3. The degree of novelty of the innovations.

Degree of novelty compared with the firms previous products and activities N=602	Degree of novelty from the viewpoint of the markets		
	New to the Finnish market %	New to the global markets %	Total %
Entirely new	14	52	66
Significant improvement	8	23	31
Minor improvement	2	1	3
Total %	24	76	100

Altogether 66 per cent of the innovations are regarded as entirely new to the firm, while 34 per cent are regarded as significant or minor improvements. Of those innovations regarded as entirely new to the firm, 52 per cent are also regarded as new to the global markets. For significant improvements the relative share also regarded as new on the world markets remains more or less the same. If we incorporate the different time periods in the analysis, no major changes in the degree of novelty are observed.

The degree of novelty is interesting from a sectoral point of view, since it might provide some indication of the dynamics and rate of renewal across industries (table 4). In the oil, chemicals, rubber and plastics, machinery, electrical and optical equipment industries, and architectural and engineering, the share of innovations regarded as entirely new compared with the firms' previous products lies close to the average. Innovations in these industries are regarded to a relatively larger extent as new to the global markets as well. In the foodstuffs industry, pulp & paper, metals and metal products, the share of innovations regarded as entirely new to the firms is relatively lower. In the foodstuffs industry, 64 per cent of the innovations are merely regarded as new to the Finnish markets. In software, close to 70 per cent of the innovations are characterised as entirely new to the firms. However, a relatively large share of these software innovations are regarded as new only to the Finnish markets if we compare with the average.

Table 4. The degree of novelty of the innovations across industries.

	Degree of novelty compared with the firms´ previous products and activities					Degree of novelty from the viewpoint of the markets			
Industry	N	Entirely new %	Significant improvement %	Minor improvement %	Total %	N	New to the Finnish markets %	New to the global markets %	Total %
ALL	623	64	32	4	100	602	24	76	100
Mining and quarrying	3	67	33	0	100	3	33	67	100
Foodstuffs	29	59	24	17	100	28	64	36	100
Textiles, clothing	7	71	29	0	100	7	29	71	100
Wood products	8	88	13	0	100	8	50	50	100
Pulp & paper	24	42	50	8	100	23	35	65	100
Printing and publishing	4	100	0	0	100	4	50	50	100
Oil, chemicals, rubber, plastics	55	62	36	2	100	55	20	80	100
Other non-metallic mineral products	7	86	14	0	100	7	0	100	100
Basic metals, fabricated metal products	37	51	46	3	100	35	20	80	100
Machinery and equipment	114	60	34	6	100	106	18	82	100
Electrical and optical equipment	97	64	34	2	100	93	14	86	100
Transport equipment	18	56	39	6	100	15	33	67	100
Other manufacturing, recycling	9	56	33	11	100	9	33	67	100
Electricity, gas and water supply	6	83	17	0	100	6	17	83	100
Construction	10	90	10	0	100	10	10	90	100
Wholesale and retail trade	48	71	27	2	100	47	19	81	100
Software	53	66	28	6	100	49	37	63	100
Architectural and engineering activities	45	67	33	0	100	43	14	86	100
Research and development	6	78	22	0	100	9	11	89	100
Other services	33	79	21	0	100	29	31	69	100
Holding companies	6	67	33	0	100	6	50	50	100

Having said the above, it should be noted the concept 'new to the firm' is problematic in the case of new small firms which, by definition, are always involved in new activity and the development of new products. Therefore, it is possible that industries dominated by new small firms also have a bias in favour of entirely new innovations. These are mainly software and architectural and engineering activities and engineering. In table 5, we present the degree of novelty of the innovations across the different firm size groups.

Comparing the firm size groups, we can detect a clear pattern in the sense that the smallest firms with 1-9 employees indeed appear to introduce a larger share of innovations regarded as entirely new compared with their previous products. When we look at the bigger firm size groups the share of significantly improved innovations increases, indicating that these are primarily engaged in the upgrading of previous products. Overall firm size does not differentiate to any greater extent between the degree of novelty of the innovations from the market point of view.

Table 5. The degree of novelty of the innovations across firm size groups.

	Degree of novelty compared with the firms´ previous products and activities					Degree of novelty from the viewpoint of the markets			
Firm size group	N	Entirely new %	Significant improvement %	Minor improvement %	Total %	N	New to the Finnish market %	New to the global markets %	Total %
ALL	588	64	32	4	100	602	24	76	100
1-9	163	76	22	2	100	157	21	79	100
10-99	200	64	32	4	100	187	25	75	100
100-999	131	57	37	5	100	125	26	74	100
1000+	94	50	45	5	100	90	22	78	100

3.2.2 The nature of knowledge input

In order to get some hints about the nature of the knowledge input that was required for developing the innovations, we included a question distinguishing between the commercialisation of core technology, the combination of different components or modules, the development of process technology and the commercialisation of service concepts. The respondents were asked to pick only one alternative.

Our distinction between different types of knowledge is not straightforward since it is unclear, for example, how "the commercialisation of core technology" should be interpreted. Is it related to a narrowly defined niche product or to the development of a particular kind of process technology? Or is the emphasis on issues related to the commercialisation process itself rather than to the nature of the innovation? Despite these reservations, we see some differences across industries (table 6).

Overall, 40 per cent of the innovations have required knowledge about the combination of different components or modules. In 35 per cent of the cases the commercialisation of core technology is an important type of knowledge. The importance of process technology is less significant and, perhaps surprisingly, knowledge related to the commercialisation of service concepts appears rather unimportant.

In the oil, chemicals, rubber and plastics industries, and in the electrical and optical equipment and software industries, the importance of the commercialisation of core technology stands out when compared with the average. On the other hand, in the metal and metal products industries, machinery and equipment, and the transport equipment industry, the combination of components or modules is especially important. In the foodstuffs industry and pulp & paper in particular, the development of process technology is relatively more important compared with the average. In the foodstuffs industry, software and in other services, the service aspect also receives a relatively important score. The importance of service concepts is negligible in all other industries.

Table 6. The nature of the knowledge required for the development of the innovations across industries.

Industry	N	Commercialisation of core technology %	Combination of different components or modules %	Process technology %	Service concepts %	Other %	Total %
ALL	621	35	40	16	4	5	100
Mining and quarrying	3	67	33	0	0	0	100
Foodstuffs	28	32	21	29	11	7	100
Textiles, clothing	7	14	14	57	0	14	100
Wood products	8	13	38	50	0	0	100
Pulp & paper	24	33	25	38	4	0	100
Printing and publishing	4	50	25	0	25	0	100
Oil and chemicals, rubber and plastics	55	45	22	20	2	11	100
Other non-metallic mineral products	7	29	29	43	0	0	100
Basic metals, fabricated metal products	38	26	50	18	0	5	100
Machinery and equipment	114	33	49	13	4	1	100
Electrical and optical equipment	97	44	44	6	0	5	100
Transport equipment	17	24	59	18	0	0	100
Other manufacturing, recycling	9	33	44	22	0	0	100
Electricity, gas and water supply	6	17	83	0	0	0	100
Construction	10	10	30	30	10	20	100
Wholesale and retail trade	47	30	57	6	2	4	100
Software	53	42	38	6	9	6	100
Architectural and engineering activities	45	38	33	22	4	2	100
Research and development	9	22	33	44	0	0	100
Other services	33	36	24	15	18	6	100
Holding companies	6	0	50	17	17	17	100

Table 7. The nature of the knowledge required for the development of the innovations across firm size groups.

Firm size group	N	Commercialisation of core technology %	Combination of different components or modules %	Process technology %	Service concepts %	Other %	Total %
All	586	35	40	16	4	4	100
1-9	161	39	37	14	4	7	100
10-99	200	34	43	17	4	3	100
100-999	131	32	47	16	1	5	100
1000+	94	35	30	21	9	5	100

In table 7 we present the results across the firm size groups. Intuitively, we expected that smaller firms would be more focused on the commercialisation of core technology while larger firms might be more involved in the combination of components or modules and the development of process technology due to their larger resources and more diversified strategies.

Even though no clear pattern emerges, it is indeed the case that the smallest firms with 1-9 employees require relatively more knowledge of the commercialisation of core technology compared with larger firms. Knowledge related to the combination of components or modules seems to be relatively more important in the middle size firm groups with 10-99 and 100-999 employees. The largest firms with over 1000 employees are in fact relatively less dependent on knowledge related to the combination of different functional parts or modules compared with the average. Nonetheless, they seem to have a more diversified knowledge base due to the more equal distribution of scores across the different types of knowledge compared with the other firm size groups.

3.2.3 Sectoral use of innovations

Since a major part of our innovations consists of various types of machinery, it is to be expected that a large part of the innovations are also used in other industries. We approached this issue with a question on whether the innovation is used by other firms in order to make the basic distinction between consumer goods and business-to-business goods. As a follow-up, we asked the respondents to indicate within which industries other firms are using the innovations. We differentiated between 23 user industries, covering both manufacturing and the service sector.

Since we cannot distinguish between different types of usage of the innovations and the volume of inter-industrial flows of innovations, we cannot draw conclusions about the rate of diffusion of innovations. What we nonetheless do get is an indication of the degree to which different types of innovation find applications in other industries, which in turn tells us something about the generic nature of the innovations.

In the following, we present the overall share of innovations which are used in other industries, and the share of innovations used by more than five other industries. It is of course somewhat arbitrary how many industries we set as a benchmark for identifying generic innovations with widespread use. We chose five industries as the benchmark since there was a clear drop in the share when we changed the benchmark from four industries to five industries. In table 8, we present the results across industries.

Altogether 57 per cent of the innovations are used by firms in other industries. Some 8 per cent are used by firms in more than five other industries, and can thus be considered innovations with generic application. The share of innovations from the foodstuffs industry, the oil, chemicals, rubber and plastics, electrical and optical equipment industries which are used by firms in other industries lies close to the average. Surprisingly, the share drops to 50 per cent in the machinery and equipment industries. Innovations from the software industry has the highest share, followed by architectural and engineering activities.

Table 8. Share of innovations used by firms in other industries across industries.

Industry	N	Share of innovations used by firms in other industries %	Share of innovations used by firms in more than five other industries %
ALL	616	57	8
Mining and quarrying	3	33	0
Foodstuffs	27	60	7
Textiles and clothing	7	43	14
Wood products	8	75	0
Pulp & paper	24	58	0
Printing and publishing	4	50	0
Oil, chemicals, rubber, plastics	55	58	2
Other non-metallic mineral products	7	100	14
Basic metals, fabricated metal products	38	50	5
Machinery and equipment	113	50	7
Electrical and optical equipment	94	55	15
Transport equipment	18	44	0
Other manufacturing, recycling	9	33	0
Electricity, gas and water supply	5	60	0
Construction	10	60	0
Wholesale and retail trade	47	68	9
Software	33	70	9
Architectural and engineering activities	45	62	4
Research and development	9	56	0
Other services	33	64	21
Holding companies	6	50	0

If we look at the share of innovations used by firms in more than five different industries, we get a clearer picture. In this case the electrical and optical equipment and the software industries stand out as those with the relatively largest share of innovations with generic application. All other of the above mentioned have shares lying close to the average, with the expectation of the oil, chemicals, rubber and plastics industry.

Table 9. Share of innovations used by firms in other industries across firm size groups.

Firm size group	N	Share of innovations used by firms in other industries %	Share of innovations used by firms in more than five other industries %
ALL	582	57	8
1-9	161	60	5
10-99	197	57	11
100-999	130	59	5
1000+	94	56	10

Across the firm size groups no significant differences emerge. For the smallest firms with 1-9 employees, the share of innovations used by firms in other industries is slightly higher than average. The share of innovations used by firms in more than five other industries is slightly lower than average. Firms with 10-99 employees and the largest firms with over 1000 employees introduce innovations with generic application relatively more often.

3.2.4 Summing up

The large share of innovations regarded as entirely new to the firms and the global markets indicate that our methodologies for identifying innovations have captured significant innovations, in the sense that they have implied changes in the underlying knowledge-base of the firms while also providing the market with products with new characteristics. It might also be the case that a more incremental type of innovations, that is gradual improvements compared with the firms´ previous activities and the markets, have been more difficult to capture with our methodologies since they are less readily identifiable as having a particular year of commercialisation and clearly distinguishable artefactual conceptualisation.

When we look at industries with a sufficient number of observations, it seems that these more significant innovations dominate in industries such as the machinery, electrical and optical equipment industries, which are also high R&D-spenders. The software industry is an interesting exception where small firms introducing innovations regarded as new dominate, but these are relatively more often considered new only to the Finnish markets. Innovations of the more incremental type are found in the more traditional foodstuffs, pulp & paper, metals and metal products industries.

In the foodstuffs industry and the pulp & paper industry in particular, innovations are relatively more often achieved through development of process technology. In the metal and metal products industry, this is typically achieved through the combination of components or modules. For smaller firms, innovation seems to require relatively more knowledge about the commercialisation of core technology compared with the larger firms. Perhaps this reflects a narrower focus in terms of technologies and products, as well as the particular challenges that small firms face in commercialising their innovations on the global markets. The largest firms appear to be engaged in developing relatively more diversified knowledge-bases, as their innovations require a wider combination of different types of knowledge compared with the smaller firms.

A majority of the innovations are used by firms in other industries. Across industries, it is particularly the electrical and optical equipment and the software industries which produce innovations with generic application, while innovations originating from the oil, chemicals, rubber and plastics industries are to a surprisingly low degree of the generic type. Across firm size groups the largest firms and firms with 10-99 employees introduce relatively more often innovations with generic applications.

3.3 Nature of innovation processes

In the survey we asked the respondents to judge the importance of different factors contributing to the origin of innovation. We also asked about the importance that they assigned to different collaborative partners during the innovation process. We distinguished between not important, of minor importance, important and very important (see sections 5 and 8 in the questionnaire). It should thus be noted that we do not know whether a particular factor or collaborative partner influenced the innovation process or not. We only know to what extent the particular factor or partner was regarded as important. It therefore makes sense to highlight the positive end of the scale (important or very important) and pay less attention to the negative end (not important or of minor importance).

3.3.1 The origin of innovations

Our survey contains data on the factors contributing to the origin of the innovations, ranging from the nature of competition, market- and demand-driven factors, science and technology, to various public sector activities, regulations, legislations, standards and licenses. The overall results are summarised in table 10.

Market-related factors clearly dominate the results, as almost 90 per cent of the respondents regarded the observation of a market niche as important or very important for the origin of the innovations. Customer demand was regarded as important in close to 80 per cent of the innovations. New technologies, the intensification of price competition, environmental factors, and the threat posed by rival innovations follow, in the order of importance. Public procurement and the availability of a license apparently play a negligible role.

Table 10. Factors contributing to the origin of innovation.

Contributing factor N=631	Very important %	Important %	Minor Importance %	Not Important %	Total %
Intensification of price competition	8	19	25	48	100
Threat posed by rival innovation	7	17	25	51	100
Observation of a market niche	49	40	5	6	100
Customers demand	37	40	14	9	100
Public procurement	2	5	14	79	100
New scientific breakthrough	8	7	11	74	100
New technologies	17	22	13	48	100
Public research or technology programme	4	13	18	64	100
Environmental factors	14	14	15	7	100
Regulations, legislation, standards	8	17	17	58	100
Availability of a licence	3	3	4	90	100

A more complex picture emerges once we look beyond the aggregate data. Here, the relevant options are to look across the time periods (figure 3) and across the different firm size groups (figure 4) due to low number of observations in combination with the large number of factors considered. In both figures we add the share of respondents regarding particular factors as important or very important into a combined class. For the sake of clarity, we talk about important factors when we refer to this combined class.

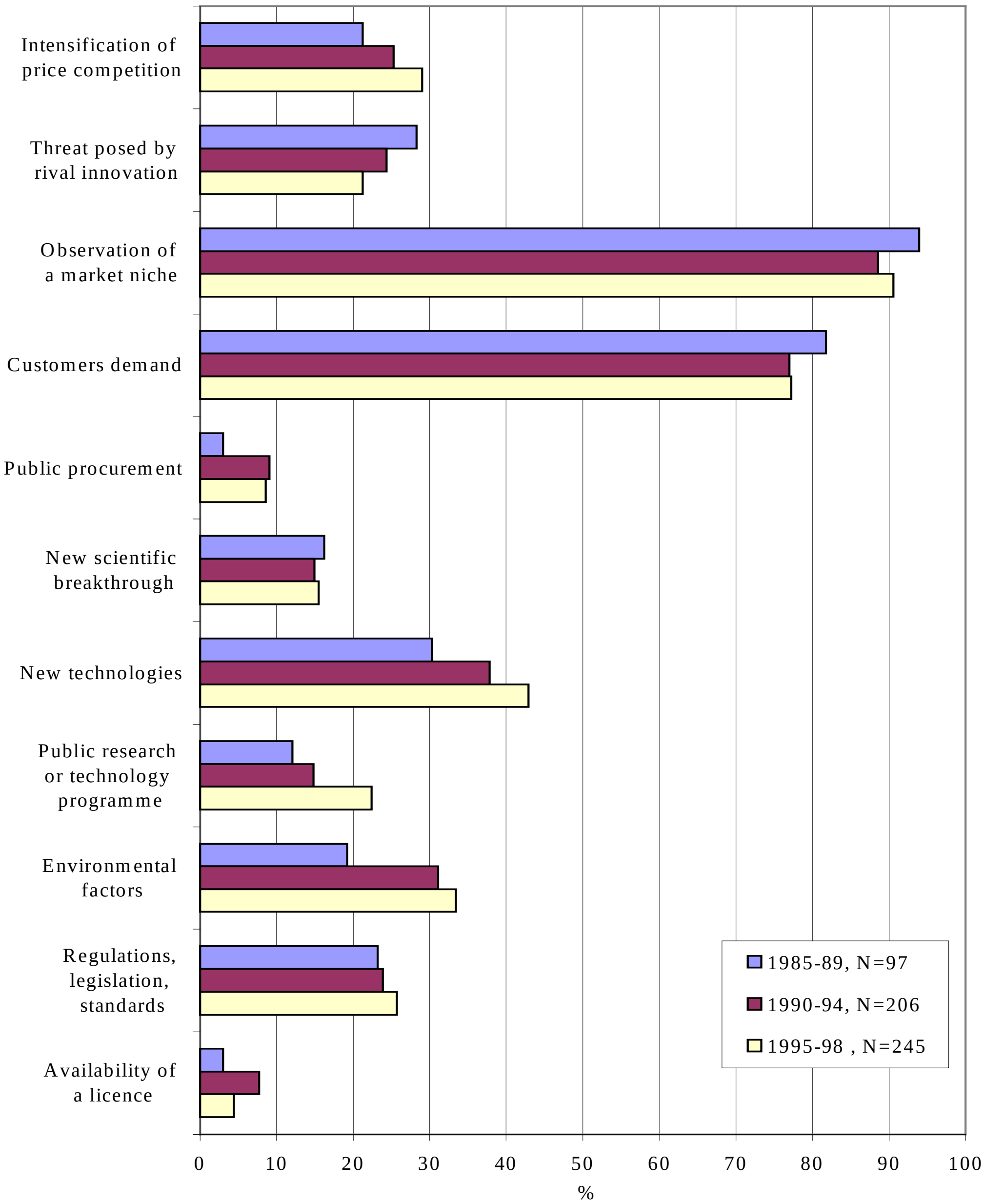

Figure 3. Changes in factors regarded as important for the origin of innovations over time.

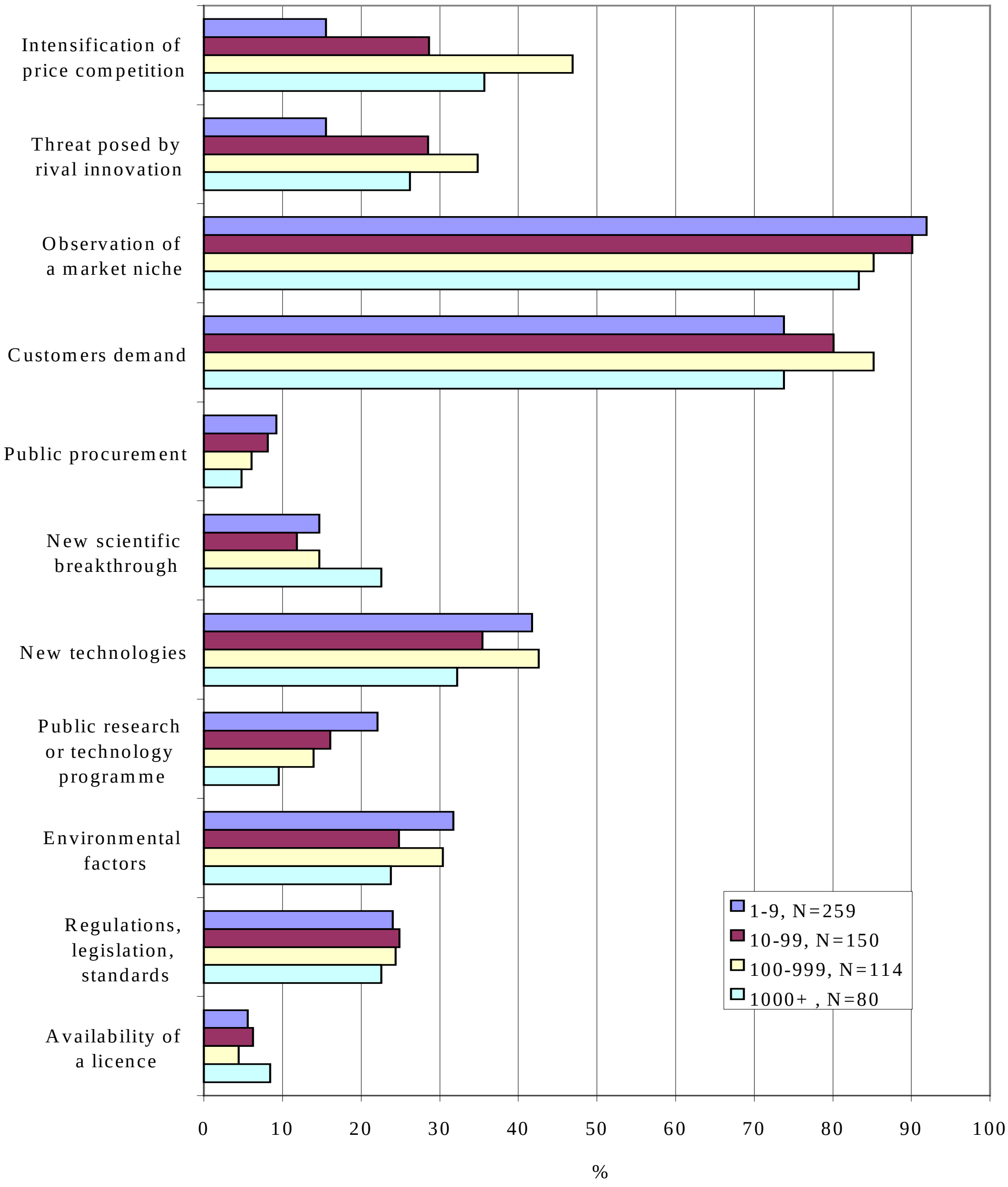

Figure 4. Factors regarded as important for the origin of innovations across firm size groups.

The observation of a market niche and customer demand remain stable over time. For competition-related factors, there is an increase in the intensification of price competition, while the importance of the threat posed by rival innovation gradually decreases as we move from the 1980s to the 1990s. More significant changes occur in the importance of public research or technology programmes, new technologies and environmental factors, all of which show an increase in importance over time.

The share of respondents regarding public research or technology programmes as important for the origin of innovations almost doubles between 1985-89 and 1995-98. One explanation for this is the fact that the number of technology programmes has increased since 1980s, becoming a central instrument of technology policy. The importance of both new technologies and environmental factors increases considerably between 1985-89 and 1990-94 and remains more stable after that.

The observation of market niche decreases in importance for bigger firms, while the opposite is true for firms of up to 100-999 employees. For the relatively less important factors, the intensification of price competition and the threat posed by rival innovation also increases with firm size of up to firms with over 1000 employees. Another interesting observations is that the importance of new scientific breakthrough is more important for the origin of innovations in firms with over 1000 employees. Public research or technology programmes are more important in small firms compared with larger ones, but there is no clear pattern for the importance attributed to new technology across the different size groups.

3.3.2 Collaboration

We distinguished between domestic and foreign collaborative partners to obtain a better picture of the nature of the networks connected to the innovation processes. We also included a question on the role that a public research or technology programme had played in collaboration.

An overwhelming majority of the innovations have been developed in some kind of collaboration, irrespective of industry. The extent of collaboration ranges from 77 per cent in foodstuffs to 91 per cent in software, the average being 87 per cent. Across the firm size groups, the extent of collaboration remains very similar irrespective of firm size. In table 11 we sum up the overall importance of different collaborative partners for those innovations that have involved collaboration.

Table 11. The importance of different collaborative partners in the development of innovation.

Collaborative partners N = 558 [1]N = 281 (only firms belonging to a concern)	Very important %	Important %	Minor importance %	Not important %	Total %
Firms of the same corporation[1]	10	23	17	49	100
Domestic customers	28	38	15	19	100
Foreign customers	17	31	19	33	100
Domestic consultants	3	12	18	66	100
Foreign consultants	1	5	12	81	100
Domestic subcontractors	8	26	22	45	100
Foreign subcontractors	4	14	15	67	100
Domestic universities	12	21	21	46	100
Foreign universities	2	5	12	81	100
VTT	8	14	19	59	100
Other domestic research institutes	3	8	17	73	100
Foreign research institutes	1	8	11	80	100
Domestic competitors	1	3	14	82	100
Foreign competitors	2	6	15	77	100

The most important partners in developing an innovation are customers. In all, about two thirds of the respondents regard domestic customers as important or very important while foreign customers are perceived as relatively less important. Domestic subcontractors, domestic universities and the Finnish Technical Research Centre (VTT) follow. Overall, domestic partners are judged more important than foreign ones. This is particularly apparent in the case of consultants and universities. For firms belonging to a group of companies, collaboration with other group firms is regarded as important or very important in 33 per cent of the innovations.

Again the low number of observations in combination with the large number of collaborative partners renders a sectoral viewpoint difficult and hence we have to stick to the firm size groups and the time periods. Figure 5 summarises how the importance of collaboration partners has changed over time, while figure 6 takes the viewpoint of firm size. Again, we add up the share of respondents regarding particular collaborative partners as important or very important into a combined class. For the sake of clarity, we talk about important factors when we refer to this combined class. Moreover, we do not make a distinction between domestic and foreign partners.

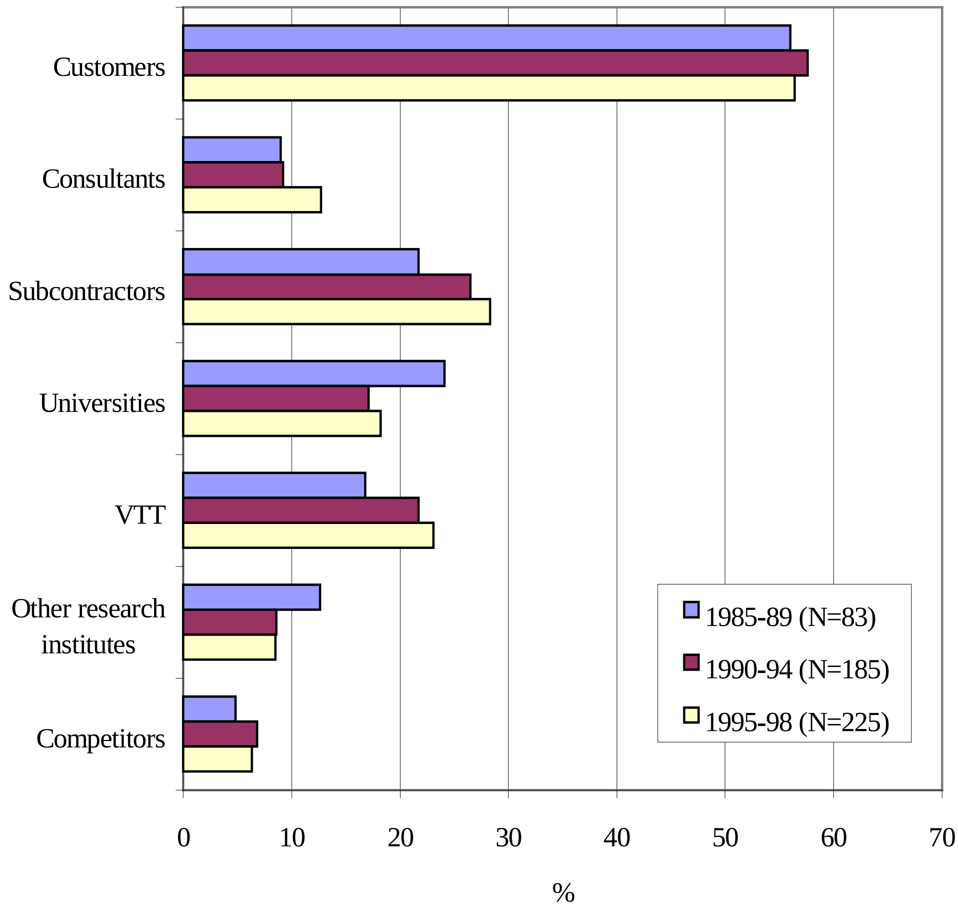

Figure 5. Changes in the importance of collaborative partners over time.

According to figure 5, no major changes have occurred in the importance assigned to customers over time. In the case of consultants and subcontractors in particular, a slight increase is detectable. Likewise, VTT has steadily increased in importance from 17 per cent in the first period to 23 per cent in the third period. Meanwhile the universities and other research institutes have experienced a relative decline in importance.

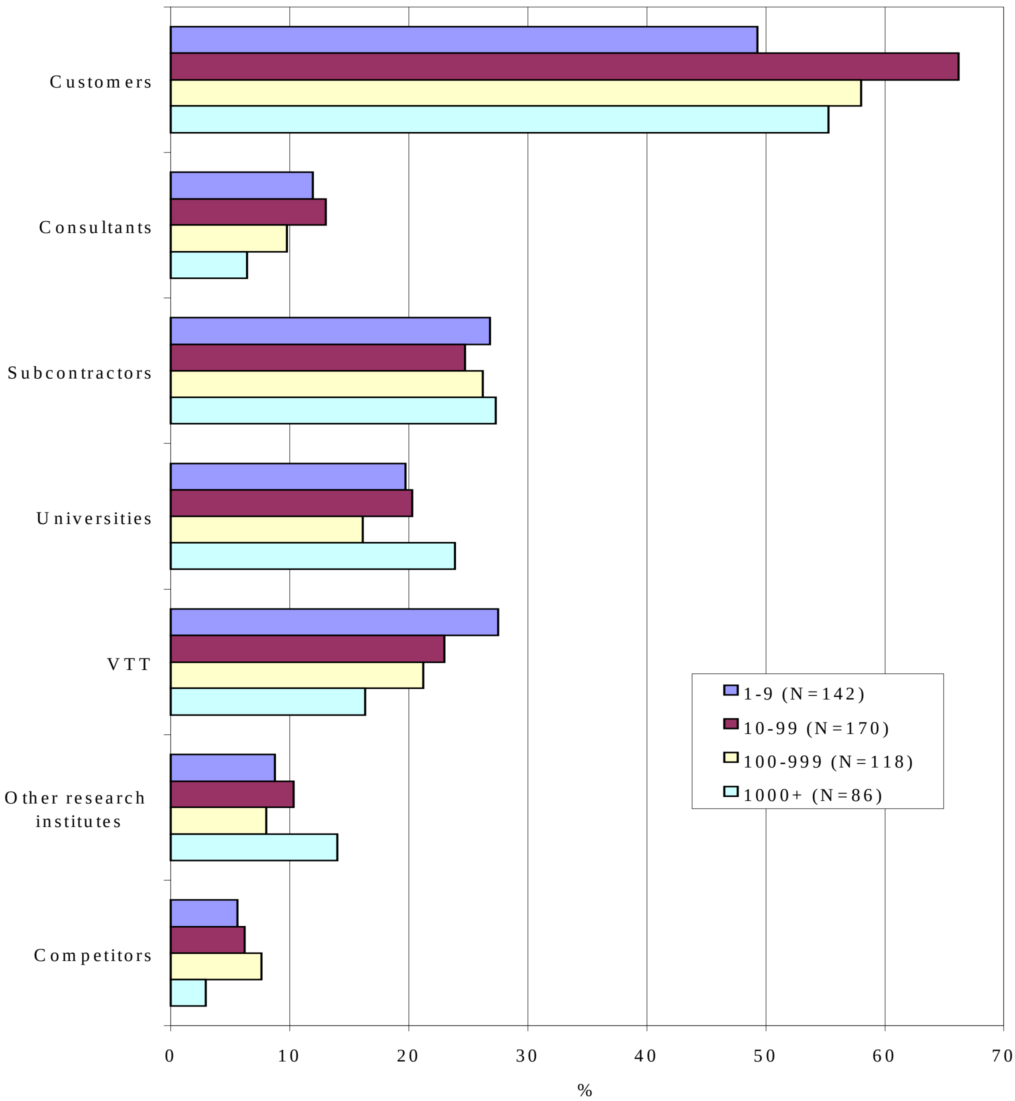

Figure 6. The importance of collaborative partners across firm size groups.

The importance of customers is pronounced for firms with 10-99 employees, but rather invariant across the other firm size groups. The importance of subcontractors is also invariant across the firm size groups, whereas the importance of VTT and consultants decreases as firm size grows. Universities are equally important for smaller firms with 1-9 and 10-99 employees, but their importance seems to vary quite significantly for the larger firms. Both universities and other research institutes are relatively more important collaborative partners for firms with over 1000 employees.

Before turning to the role that public technology programmes have played in collaboration, it should be noted that collaboration was related to a programme in 25 per cent of the innovations. Approximately 80 per cent of these programmes consisted of a Tekes programme. In table 12, we present the share of innovations which involved a programme during collaboration across the firm size groups and the time periods.

Table 12. Share of innovations which involved a technology programme during collaboration across the firm size groups.

Firm size group	1985-98		1985-89		1990-94		1995-98	
	N	%	N	%	N	%	N	%
ALL	505	25	88	17	197	23	220	30
1-9	151	31	10	10	58	29	83	35
10-99	177	27	37	24	71	23	69	32
100-999	101	16	24	8	37	16	40	20
1000+	76	22	17	18	31	19	28	29

From the overall results covering the years 1985-98 it is clear that the importance of a public technology programme for collaboration decreases as firm size grows. For firms with 1-9 employees, a technology programme has been important for collaboration for 31 per cent of the innovations, while the share drops to 22 per cent in the largest firm size group with over 1000 employees. Over time, there is an increase in the importance of public technology programmes for collaboration across all firm size groups. Moreover, when compared with the averages, this increase has been relatively greater over time for smaller firms compared with larger firms.

3.3.3 Summing up

Market-driven factors are the main one's contributing to the origin of innovation across all firm size groups and time periods. The large importance assigned to the observation of a market niche and customer demand suggests that in the Finnish context the origin of innovation is primarily market-driven rather than science- or technology-driven. Nonetheless, across the firm size groups and time periods we see some interesting differences in the relatively less important factors.

The importance of competition-related factors is greater for bigger firms, suggesting that smaller firms innovate relatively less due to competitive pressure compared with the larger firms. Smaller firms innovate relatively more often as a response to the observation to a market niche. Moreover, smaller firms appear to be more dependent on public research or technology programmes when they innovate, while the largest firms are better at harnessing scientific breakthroughs or research.

Over time, the importance of price competition has increased for the origin of innovations, while the importance of the threat posed by rival innovations has declined. This is interesting, since it might suggests that the locus of competition is shifting, perhaps as a result of changes in industry life cycles. This observation would nonetheless demand more elaborate analysis than has been possible here. The increasing importance over time of new technologies and public research or technology programmes might be interrelated phenomena, due to the overall increase in both private and publicly funded R&D. The growing importance of environmental factors probably reflects an overall awareness of environmental issues in industry.

The origin of innovation and collaboration are determined by each other, since collaborative partners often provide crucial inputs for the innovation process. Our results confirm the importance of collaboration for innovation once more, since an overwhelming majority of the innovations has involved some kind of collaboration irrespective of industry and firm size. Apart from the importance that both domestic and foreign customers play as collaborative partners, it seems that innovation networks still have a relatively strong domestic orientation. Domestic subcontractors are more important than foreign ones. The same is true for universities and research institutes, including VTT. However, this should not be interpreted to mean that innovation-related networks are mainly domestic since we do not know to what degree foreign partners have taken part in the innovation processes. A more appropriate conclusion could be that firms appropriate the most important external knowledge inputs to innovation from domestic customers, subcontractors, universities and research institutes, while more peripherial knowledge enters from foreign sources.

Generally speaking, our analysis of changes over time indicates that the relative importance of subcontractors and VTT is increasing slightly, while the opposite seems to be true for universities. No significant changes are apparent in the case of customers, the most important collaborative partner. It also seems to be the case that the customers are, more or less, equally important across all firm size groups, while consultants and VTT are relatively more important collaborative partners for smaller and middle-sized firms. If we add to this the results concerning technology programmes, it appears that they have been particularly important for involving small firms in collaboration and have often involved VTT as a partner. Larger firms regard universities and other research institutes as more important. Overall, the importance of technology programmes for innovation has increased, again reflecting the growth of public R&D.

3.4 Public funding of innovations

Above, we discussed the role of public research and technology programmes in connection to collaboration. Apart from this, the survey also had a question on the importance of complementary public funding for the development of the innovations and the importance of funding from different public organisations (see section 7 in the questionnaire).

3.4.1 Distribution of public funding

To start off, we asked the respondents whether they had received public funding for the development of the innovation. This enables us to look at changes over time, and at the distribution of public funding across industries and firm size groups. In table 13 we present the distribution of the share of innovations which have received funding across industries.

Table 13. Share of innovations receiving public funding across industries.

	N	% with public support
ALL	619	68
Mining and quarrying	3	100
Foodstuffs	29	28
Textiles and clothing	7	57
Wood products	8	50
Pulp & paper	24	50
Printing and publishing	4	75
Oil, chemicals, rubber, plastics	55	67
Other non-metallic mineral products	7	71
Basic metals, fabricated metal products	37	86
Machinery and equipment	113	58
Electrical and optical equipment	96	77
Transport equipment	18	72
Other manufacturing, recycling	9	67
Electricity, gas and water supply	6	67
Construction	10	40
Wholesale and retail trade	47	68
Software	54	74
Architectural and engineering activities	45	84
Research and development	9	100
Other services	32	72
Holding companies	6	67

In all, 68 per cent of the innovations have received public funding. The share of funding has increased from 56 per cent during 1985-89, to 69 per cent in the period 1996-98. However, across industries the differences are more pronounced. Innovations originating from the metals and metal product industries, electrical and optical equipment industries, software and architectural and engineering activities received higher shares compared average, while the foodstuffs, pulp & paper, and machinery and equipment industries received shares below average. Particularly interesting is the very low share of innovations receiving public funding in the foodstuffs and pulp & paper industries. Unfortunately, a more detailed comparison and identification of trends over time is not worthwhile due to the limited number of observations across industries at this stage of the project. Instead we turn to the distribution of public funding across the firm size groups and over time in table 14.

Table 14. Share of innovations receiving public funding across firm size groups.

Firm size group	1985-98		1985-89		1990-94		1995-98	
	N	%	N	%	N	%	N	%
ALL	511	67	89	55	200	69	222	70
1-9	153	81	10	50	60	88	83	80
10-99	177	73	37	62	71	78	69	74
100-999	102	47	25	36	37	49	40	53
1000+	79	53	17	71	32	38	30	60

From the overall results covering the years 1985-98 it is clear that innovations originating from the smaller firms have received more support compared with the bigger firms. Over 70 per cent of the firms with 1-9 or 10-99 employees have received public funding for the development of innovations, while the share drops to around 50 per cent for the bigger firms. Over time there is an increase in shares of public funding, but this increase is rather erratically distributed across the different firm size groups. In fact, the only clearly rising shares are detectable for the biggest firms with over 1000 employees although the innovations from these firms receive relatively less public support compared with the smaller firms.

3.4.2 Importance of different funding organisations

If the innovation had received public funding for its development, there was a follow-up question on the importance that the respondent assigned to funding provided by the different public organisations. As options we included the most important domestic players, Tekes, the Ministry of Trade and Industry (MITI), Sitra, and Finnvera[6], and the Nordic Industrial Fund and the EU as the foreign organisations. Table 15 presents the overall results for only those innovations that

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[6] Finnvera was formed in 1999 through the merger with Kera, a regional actor, and the State Guarantee Board.

have received public funding and have been commercialised since 1985, in order to control for the fact that e.g. Tekes was established in 1983 and that the EU's research policy became relevant for Finland in the late 1980s.

Table 15. The importance of funding from different public organisations.

Funding organisation N=367	Very important %	Important %	Minor importance %	Not important %	Total %
Tekes	43	27	14	17	100
MITI	11	19	16	54	100
Sitra	5	6	3	86	100
Finnvera	8	10	10	72	100
Nord. Industrifonden	1	0	1	99	100
EU	0	3	6	91	100
Other	0	3	6	91	100

The significantly greater importance assigned to domestic organisations is explained by the fact that firms simply have received relatively much more funding for the development of innovations from these organisations, compared with the foreign ones. Altogether 70 per cent of respondents rate support from Tekes as very important, corresponding to over 40 per cent of all innovations covered by the survey. One third of the respondents regard the MITI as an important funder for their innovations. The corresponding figures for funding from Finnvera and Sitra are correspondingly lower, with Finnvera being the more important of the two. The limited importance assigned to funding by the foreign organisations probably results from the small role played by those organisations for overall funding.

When we look at changes over time, the only noteworthy observation is the relative increase in importance of EU-funding, reflecting Finland's closer ties to the EU. However, in this context it should be noted that strict comparisons of the importance of different organisations are difficult to make. This is because our focus on innovations rather than the firm-level might imply that certain organisations receive a higher score due to the fact that they are more focused on financing R&D-projects

rather than firm start-ups or supporting overall business strategies of firms. In particular, the role of Tekes might be overestimated.

Bearing the above consideration in mind, we turn to the importance of funding from different public organisations across firm size groups. This is presented in figure 7. In the figure we include only the domestic funding organisations and add up the share of respondents regarding the organisations funding as important or very important into a combined class. For the sake of clarity we talk about important organisations when we refer to this combined class.

According to the figure, funding by Tekes is regarded as most important in all firm size groups, although there is a slight and gradual decline as we move towards the biggest firm size group with over 1000 employees. The importance of funding by all the remaining organisations also decreases as firm size grows, and especially so for Finnvera.

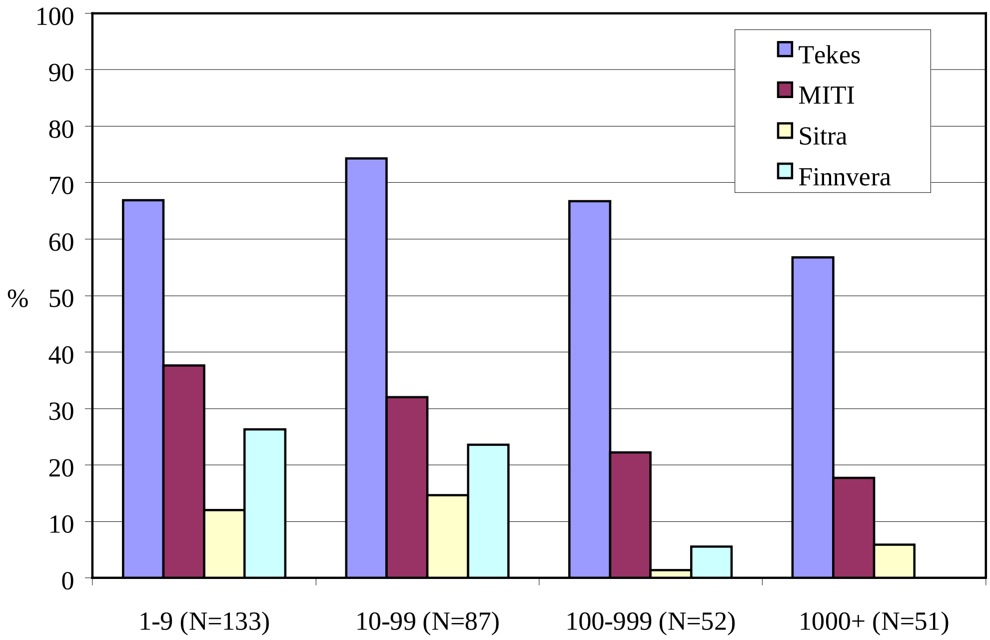

Figure 7. The importance of public funding of different organisations across firm size groups.

3.4.3 Summing up

The large majority of the innovations have received public funding, and this share is on the increase when comparing developments in the 1990s with those of the 1980s. This reflects the overall increase in R&D funding in Finland during the 1990s in particular. The distribution of funding across industries nonetheless appears to be quite uneven, the details of which cannot be investigated in greater detail due to the limited number of observations. Across the firm size groups the results are more robust, indicating that innovations originating from smaller firms have more often received public funding compared with innovations from bigger firms. The share of funding has increased more or less equally across all firm size groups.

A comparison of the importance that funding from particular public organisations plays is tricky, since our innovation-centred survey might discriminate against organisations more focused on providing funding for start-up or the overall business strategies of firms, while funding focused more on R&D-projects might be overrepresented. Taking this into account, it might not be so surprising that Tekes emerges so clearly the most important funder, followed by MITI, Finnvera and Sitra.

The general impression is that the foreign organisations play a rather negligible role for funding innovations, although an increase in importance of the EU is evident. Across the firm size groups, the importance of all funding organisations decreases as we move from the smaller firms to the bigger firms. The smaller firms identify MITI and especially Finnvera as relatively more important organisations. This is expected, since Finnvera is a regional actor, funding small firms and small-scale entrepreneurial activity.

3.5 Development times of innovations

In the survey we asked the respondents to indicate the years of major phases in the innovation's development cycle, including the year of basic idea, first prototype, commercialisation, break-even point and first exports (see section 5 in the questionnaire). In cases where commercialisation or exports had not yet occurred, the respondent was asked to indicate this.

3.5.1 From basic idea to commercialisation

The year of basic idea is considered to indicate the year when the first initiative for the development of the innovation was voiced. The year of commercialisation marks the year when the innovation entered the market on a larger scale than that of a mere prototype. Table 16 presents the time taken for the innovations to develop from the year of basic idea to commercialisation across industries.

Table 16. Time from basic idea of the innovation to commercialisation across industries.

Industry	N	Same year %	1-2 years %	3-5 years %	6-9 years %	10+ years %	Total %
ALL	610	6	44	32	12	6	100
Mining and quarrying	-	0	0	0	0	0	0
Foodstuffs	29	14	48	21	17	0	100
Textiles and clothing	7	0	86	0	14	0	100
Wood products	8	0	63	38	0	0	100
Pulp & paper	22	18	36	32	9	5	100
Printing and publishing	4	25	50	25	0	0	100
Oil and chemicals, rubber and plastics	53	2	34	30	13	21	100
Other non-metallic mineral products	7	0	43	43	14	0	100
Basic metals, fabricated metal products	37	11	41	35	11	3	100
Machinery and equipment	113	5	51	31	8	4	100
Electrical and optical equipment	97	2	44	34	12	7	100
Transport equipment	18	17	39	28	11	6	100
Other manufacturing, recycling	8	13	25	63	0	0	100
Electricity, gas and water supply	6	0	17	17	50	17	100
Construction	10	0	50	40	0	10	100
Wholesale and retail trade	47	4	43	32	19	2	100
Software	54	11	56	24	6	4	100
Architectural and engineering activities	44	5	41	41	7	7	100
Research and development	9	0	33	11	44	11	100
Other services	31	3	32	48	10	7	100
Holding companies	6	0	50	17	33	0	100

Close to 50 per cent of all innovations develop from the year of basic idea to commercialisation in less than 2 years, while the remaining innovations typically require 3-5 years for commercialisation. Once we move beyond 5 years, the share of innovations requiring more years for commercialisation drops quite rapidly.

From a sectoral viewpoint these type of figures give some further indication of the rate of renewal. Firms in software commercialise innovations at the fastest rate. Close to 70 per cent of the innovations from the software industry are commercialised in less than two years compared with the average of 50 per cent. The foodstuffs industry also shows rather rapid commercialisation times. Firms in the machinery and equipment, pulp & paper, metal and metal products industries commercialise innovations on par with the average distribution. Commercialisation times are relatively higher in the oil, chemicals, rubber and plastics industries. Commercialisation times are also surprisingly long in the electrical and optical equipment industry compared with the average.

Table 17. Time from basic idea of the innovation to commercialisation across firm size groups.

Firm size group	N	Same year %	1-2 years %	3-5 years %	6-9 years %	10+ years %	Total %
ALL	578	6	45	32	11	7	100
1-9	159	6	45	33	12	4	100
10-99	198	9	45	29	12	5	100
100-999	129	2	48	32	11	8	100
1000+	92	5	40	33	9	13	100

Across the firm size groups (table 17), there are no major divergences, with the exception that commercialisation times are relatively longer for innovations from firms with over 1000 employees compared with other firm size groups. This is particularly clear if we look at the share of innovations with development times longer than 10 year. This share increases as firm size grows.

3.5.2 From commercialisation to exports

The year of exports indicates when the innovation entered foreign markets and became exportable on a larger scale than merely as a prototype. Before turning to analyses of the time taken for innovations to become exportables, we present the share of innovations which have become exportables across the firm size groups in table 18. In the table we also present the share of innovations for which data on the commercialising firm is not available (NA) to get the complete picture, irrespective of the size of these firms.

Table 18. The share of innovations which have become exportables across firm size groups.

Firm size group	N	Not exportable %	Exportable %	Total %
ALL	633	30	70	100
NA	45	49	51	100
1-9	162	40	60	100
10-99	201	27	73	100
100-999	133	23	77	100
1000+	92	17	83	100

On average 70 per cent of the innovations are exportables, while 30 per cent have not reached the export markets. Across the firm size groups there is a clear tendency for larger firms to export a large share of innovations. 60 per cent of the innovations from firms with 1-9 employees are exportables. The corresponding share for innovations from the largest firms with over 1000 employees is 83 per cent and well above average. Moreover, the share of innovations becoming exportables for which we do not have firm data is somewhat higher, perhaps indicating that these are deceased firms.

Tables 19 presents the time taken from the year of commercialisation to exports across industries, while table 20 presents the time across the firm size groups only for those innovations which have become exportables.

Table 19. Time from commercialisation of the innovations to exports.

Industry	N	Same year %	1-2 years %	3-5 years %	5+ years %	Total %
ALL	438	46	40	8	6	100
Mining and quarrying	1	0	100	0	0	100
Foodstuffs	13	23	54	15	8	100
Textiles and clothing	5	60	40	0	0	100
Wood products	3	33	33	33	0	100
Pulp & paper	15	73	13	7	7	100
Printing and publishing	2	100	0	0	0	100
Oil and chemicals- rubber and plastics	42	55	33	5	7	100
Other non-metallic mineral products	7	14	57	14	14	100
Basic metals- fabricated metal products	29	31	38	14	17	100
Machinery and equipment	97	42	50	6	2	100
Electrical and optical equipment	86	58	36	4	2	100
Transport equipment	10	60	10	20	10	100
Other manufacturing- recycling	3	33	67	0	0	100
Electricity- gas and water supply	2	0	0	100	0	100
Construction	4	25	50	25	0	100
Wholesale and retail trade	32	41	50	9	0	100
Software	34	41	35	9	15	100
Architectural and engineering activities	26	35	35	12	19	100
Research and development	4	50	25	25	0	100
Other services	18	44	56	0	0	100
Holding companies	5	80	20	0	0	100

Close to 90 per cent of all innovations have become exportables in less than 2 years from commercialisation, and close to 50 per cent achieve this in the same year that they are commercialised. Again, the share of innovations requiring longer times to become exportables drops rapidly once we move beyond five years from commercialisation. Less export-oriented industries, such as the foodstuffs industry, suffer from a particularly limited number of observations. Overall, however, no major divergences across industries are identifiable. The expectation is innovations originating from the metal and metal products industries, which show relatively longer times taken to become exportables. For oil and chemicals, rubber and plastics, wholesale and retail the opposite is true.

Table 20. Time from commercialisation of the innovations to exports across firm size groups.

Firm size group	N	Same year %	1-2 years %	3-5 years %	5+ years %	Total %
ALL	420	46	41	8	6	100
1-9	96	45	43	8	4	100
10-99	146	38	47	8	8	100
100-999	102	53	34	9	4	100
1000+	76	55	33	7	5	100

Again the divergences across the firm size groups are quite small (table 20). This time firms with 10-99 employees are the exception. The share of innovations becoming exportables in the same year that they are commercialised is lower in this firm size group compared with the others, while the share of innovations becoming exportables within 1-5 years grows. Also, there is an increase in the share of innovations which become exportables in the same year that they are commercialised as firm size grows.

3.5.3 From commercialisation to break-even

The final viewpoint is the time taken from commercialisation to break-even. This needs some clarifying discussion, since the share of innovations which have not yet reached break-even point is rather large in our survey. In practice, the problem emerges when an innovation is commercialised sometime in the late 1990s; here it is probable that the break-even point had not been achieved by the time of the survey. The share of innovations that have reached break-even across the firm size groups is presented in table 21. Again we also include innovations for which data on the commercialising firm are not available (NA).

Table 21. The share of innovations that have reached break-even across the firm size groups.

Firm size group	N	No Break even %	Reached Break even %	Total %
ALL	633	40	60	100
NA	45	67	33	100
1-9	162	46	54	100
10-99	201	38	62	100
100-999	133	33	67	100
1000+	92	29	71	100

Overall, only 60 per cent of the innovations have reached break-even. When we look at the different firm size groups, it is the innovations from the larger firms which relatively more often reach break-even than the smaller firms. The share of innovations reaching break-even in the firms with over 1000 employees is 71 per cent compared with 54 per cent for firms with 1-9 employees. Referring to the discussion above, we cannot deduce that those innovations which have not reached break-even have not been commercially viable since they may do so in the future, out of reach for our survey. The high share of innovations which have not reached break-even in cases where firm data are missing again suggests that these might be deceased firms.

Moreover, the interpretation of exactly what constitutes the break-even point of an innovation did give rise to some confusion amongst the respondents. It can therefore only be considered a very rough approximation of the year that the innovation returned a profit. With these reservations in mind, the time taken from commercialisation to break-even is presented across industries in table 22, respectively across the firm size groups in table 23 only for those successful innovations that have reached break-even already.

Table 22. Time from commercialisation of the innovations to break-even across industries.

Industry	N	Same year %	1-2 years %	3-5 years %	5+ years %	Total %
All	379	22	46	21	11	100
Mining and quarrying	-	0	0	0	0	0
Foodstuffs	19	37	32	26	5	100
Textiles and clothing	4	25	75	0	0	100
Wood products	4	25	50	25	0	100
Pulp & paper	13	15	69	0	15	100
Printing and publishing	1	100	0	0	0	100
Oil and chemicals, rubber and plastics	33	27	36	24	12	100
Other non-metallic mineral products	6	33	17	33	17	100
Basic metals, fabricated metal products	25	24	32	28	16	100
Machinery and equipment	73	22	52	19	7	100
Electrical and optical equipment	69	19	39	26	16	100
Transport equipment	11	18	36	36	9	100
Other manufacturing, recycling	2	0	50	50	0	100
Electricity, gas and water supply	1	0	100	0	0	100
Construction	6	50	50	0	0	100
Wholesale and retail trade	33	24	61	9	6	100
Software	35	20	54	20	6	100
Architectural and engineering activities	20	15	50	20	15	100
Research and Development	1	0	0	100	0	100
Other services	19	11	53	16	21	100
Holding companies	4	0	26	50	25	100

Of the innovations that have reached break-even, as many as 22 per cent did so within the same year of commercialisation. 46 per cent reached break-even within 1-2 years of commercialisation. The innovations originating from the pulp & paper, the machinery and equipment and the software industries generated profits the fastest if we look at the share of innovations generating profits within two years of commercialisation. On the other hand, profits are returned relatively slower in the oil, chemicals, rubber and plastics industries, the metal and metal products industries, and the electrical and optical equipment industry.

Table 23. Time from commercialisation of innovations to break-even across firm size groups.

Firm size group	N	Same year %	1-2 years %	3-5 years %	6-9 years %	10+ years %	Total %
ALL	367	22	46	21	9	2	100
1-9	88	27	40	24	6	3	100
10-99	125	23	46	21	8	2	100
100-999	89	17	52	19	9	3	100
1000+	65	17	48	22	14	0	100

Again the results are rather invariant across the firm size groups (table 23). Nonetheless, if we only look at the innovations which take over 6 years to reach break-even after commercialisation, the share of innovations doing so increases slightly as firm size grows. 14 per cent of the innovations of firms with over 1000 employees return profits after 6 year or more, compared with 9 per cent in the case of firms with 1-9 employees.

One way to control for subjective judgements as to what constitutes the year of break-even for an innovation, is to cross-compare the time taken for the innovations to develop from the year of basic idea to commercialisation with the time taken for the same innovations to reach break-even after commercialisation. This provides insights into how commercialisation times correlated with the time taken to return profits of innovation. This cross-comparison is presented in table 24.

Table 24. Time from commercialisation to break-even point by development time.

Development time	Time from commercialisation to break even point					
	N	1 year or less %	2 years %	3-4 years %	4+ years %	Total %
ALL	377	52	16	17	15	100
1 year or less	105	65	15	11	10	100
2 years	99	48	24	20	9	100
3-4 years	108	46	14	20	20	100
4+ years	65	48	11	19	23	100

The results suggest that the time needed to reach the break-even point correlates positively with the time taken to commercialise the innovations. Innovations that have been commercialised in less than 3 years also return profits quicker compared with those innovations that have longer commercialisation times. There are some obvious reasons for this. For example, longer commercialisation times increase expenditures to develop innovations, whereby profits are also more difficult to return quickly. Nonetheless, there might also be technology- or industry-specific factors that could be interesting to look at in greater detail than has been possible in this report.

3.5.4 Summing up

Overall, close to 50 per cent of the innovations develop from the year of the basic idea to commercialisation in less than two years. Altogether 70 per cent of the innovations have become exportables, and close to 90 per cent of these become exportables within two years of commercialisation. This gives a rather positive picture of the commercial and export potential of Finnish innovations, even though generalisations are difficult to make since we do not know how these innovations have fared on the export markets.

More interesting is that the share of innovations which have reached break-even and returned profits drops to 60. Of the innovations which have reached break-even, almost 50 per cent have done so within 1-2 years of commercialisation. Moreover, innovations with shorter commercialisation times also return profits quicker compared with innovations that take 4 years or more to reach commercialisation. Nonetheless, in this context account should be taken of the fact that the break-even is analytically somewhat ambiguous and that the data are incomplete for the more recently commercialised innovations.

The results are inconclusive across industries, since the number of observations is limited and varies significantly depending on the viewpoint taken. Overall, it seems to be the case that innovations from the foodstuffs industry, the pulp & paper and software industries are commercialised relatively faster than other industries, and also return profits relatively more quickly. On the other hand, it is surprising that in the electrical and optical equipment industry both the time taken to commercialise innovations and return profits are relatively longer. One might assume that these results would change somewhat if Nokia had received better coverage in the survey. Also, it is apparent that innovations from the oil, chemicals, rubber and plastics industry have longer commercialisation times and return profits more slowly. This is largely explainable by the fact that pharmaceuticals in particular have significantly different development profiles compared with other type of innovations. Better data on the longstanding competitive position of the innovations on the markets would pave the way for more robust conclusions on the commercial success of the innovations.

Across the firm size groups the results are more robust in the sense that the divergences are relatively small. Firm size does not seem to be as important as the industrial context for development times and profitability of innovations. Nonetheless, it seems that the largest firms with over 1000 employees commercialise innovations at a slower pace, even though they turn them into exportables relatively more quickly compared with the smaller firms. It might be the case that these innovations are more complex, but once commercialised have a better point of departure for exports due to greater resources that the larger firms possess e.g. in terms of retailing and marketing.

3.6 Commercial significance of innovations

Apart from the exportability and break-even of the innovations, we also tried to get a rough idea of the commercial significance of the innovations in terms of their contribution to the total turnover and exports of the commercialising firm. We asked the respondent to assess how the commercial significance changed over time during the period 1996-98, and also expectations until 2001 (see section 9 in the questionnaire).

Before turning to the analyses we should take two things into account. First of all, the commercial significance is directly dependent on when the innovation was commercialised. Secondly, it is clear that the commercial significance of the innovations is a function of firm size. For a small firm, a single innovation can account for a large share of turnover and exports, whereas the situation changes very significantly when we move towards the bigger firm size groups.

For our analyses this implies that we have to control for the effect that the year of commercialisation of the innovations has for the results. We do this by only including innovations commercialised after 1994, taking into account that a majority of our innovations reached break-even within two years of commercialisation. With respect to firm size the above considerations also implies that our interest should mainly be on the smaller firms and changes occurring in these size groups. This also makes a comparison across industries analytically uninteresting, since the results are directly dependent on the firm size structures in the different industries.

3.6.1 Commercial significance in 1998

We begin by examining the contribution of innovation to the firm's turnover in 1998. In table 25 we present the contribution of innovation to the turnover of the commercialising firm. In table 26 we present the contribution to exports. We asked the respondents to approximate the shares according to a rough scale of 0 per cent, between 1-5 per cent, 5-25 per cent, 25-50 per cent and 50 per cent or more.

Table 25. Contribution of innovation to the firm's turnover in 1998 across firm size groups.

Firm size groups	N	Contribution to turnover					
		0 %	1-5%	5-25%	25-50%	>50%	Total %
ALL	220	9	29	25	8	29	100
1-9	82	4	10	18	7	61	100
10-99	72	13	36	25	8	18	100
100-999	41	10	41	37	10	2	100
1000+	25	12	48	32	8	0	100

As expected, the contribution of innovation to the turnover diminishes as firm size grows. 61 per cent of the innovations originating from the firms with 1-9 employees account for over 50 per cent of the turnover, and this share drops rapidly when mowing towards the bigger firm size groups. In the bigger firm size groups the share of innovations accounting for 0 per cent or 1-5 per cent of turnover increases correspondingly. The relatively large share of innovations, which account for 0 per cent of turnover in the case of the bigger firms reflects the fact that some innovations are either of very negligible significance to these firms or that product life cycles are shorter. On average, the majority of innovations account for some 1-25 per cent of turnover.

Table 26. Contribution of innovation to the firm's exports in 1998 across firm size groups.

Firm size groups	N	Contribution to exports					
		0 %	1-5%	5-25%	25-50%	>50%	Total, %
ALL	205	35	19	15	7	24	100
1-9	72	36	6	7	1	50	100
10-99	68	37	25	10	9	19	100
100-999	40	30	25	30	13	3	100
Over 1000	25	32	32	28	8	0	100

In table 26 a similar tendency is evident, with 50 per cent of the innovations originating from the smallest firm size group accounting for over 50 per cent of exports. Innovations from the bigger firms account for correspondingly less exports. On the other hand, smaller firms have a relatively higher share of innovations that account for 0 per cent of exports. This is in line with the results in chapter 3.6.3, which indicated that the share of innovations from smaller firms, which are not exportables is lower compared with the larger firms.

3.6.2 Commercial significance - trends in 1996-98

In table 27, we present the trends in the contribution of innovation to the firm's turnover during 1996-98 across the firm size groups and in table 26 the trends in the contribution of exports. We asked the respondents to approximate the trends and to distinguish between increasing, stable or decreasing contribution.

Table 27. Contribution of innovation to the firm's turnover in 1996-98 across firm size groups.

Firm size groups	N	Contribution to turnover			
		Has increased %	Stable %	Has decreased %	Total %
ALL	212	81	16	3	100
1-9	82	82	16	2	100
10-99	66	76	20	5	100
100-999	39	87	13	0	100
1000+	25	84	12	4	100

The contribution of innovation to turnover does not seem to be affected by the size of the firms. Most innovations across all firm size groups have increased their contribution to turnover and the share of innovations that have decreased their contribution to turnover is negligible.

Table 28. Contribution of innovation to the firm's exports 1996-98 across firm size groups.

Firm size groups	N	Contribution to exports			
		Increased %	Stable %	Decreased %	Total %
ALL	175	67	29	5	100
1-9	84	63	35	2	100
10-99	45	60	29	11	100
100-999	35	83	17	0	100
1000+	11	73	18	9	100

Again the observations are similar when looking at the contribution of innovation to exports. Most innovations have increased their contribution to exports irrespective of firm size. Compared with turnover, an interesting difference is the quite clearly declining share of innovations which have upheld a stable share of exports when moving towards the larger firm size classes.

3.6.3 Commercial significance - expectations until 2001

Finally, we examine the expected contribution of innovation to the firm's turnover and exports until 2001. In table 29 we present the expected contribution of innovation to the firm's turnover across the firm size groups. Table 30 depicts the expected contribution to exports.

Table 29. Expected contribution of innovation to the firm's turnover until 2001 across firm size groups.

		Expected contribution to turnover			
Firm size groups	N	Will increase %	Stable %	Will decrease %	Total %
ALL	215	86	10	4	100
1-9	106	88	8	4	100
10-99	54	85	9	4	100
100-999	42	81	14	5	100
1000+	13	85	8	8	100

The respondents' share high expectations of the future potential of the innovations. According to the table, over 80 per cent of all innovations, irrespective of firm size groups, are expected to increase their contribution to firm's turnover.

Table 30. Expected contribution of innovation to the firm's exports until 2001 across firm size groups.

		Expected contribution to exports			
Firm size groups	N	Will increase %	Stable %	Will decrease %	Total %
All	193	83	13	4	100
1-9	91	86	12	2	100
10-99	50	80	12	6	100
100-999	39	79	18	3	100
1000+	13	85	8	8	100

With respect to export expectations, more or less similar results emerge. Most innovations are expected to increase their contribution to exports irrespective of firm size. Across the board, the share of innovations expected to attain a stable contribution to exports is slightly higher compared with turnover, however.

3.6.4 Summing up

In this chapter we have analysed the commercial contribution of innovation to the firm's total turnover and exports in 1998. We restricted the analysis to innovations commercialised after 1994, to control for the fact that the year of commercialisation has direct implications for our analysis. This meant that the number of observations drops quite significantly and generalisations are difficult to make. Moreover, the results are a direct function of firm size, whereby the results across industries are uninteresting since they depend directly on the differences in the underlying firm size structures.

As expected, innovations originating from the smaller firms account for a larger proportion of the turnover and exports of these firms compared with the larger firms. We also obtain additional confirmation for the observation that the share of innovations becoming exportables is lower for smaller firms compared with the larger firms. On average, the majority of the innovations investigated in this chapter account for some 1-25 per cent of turnover, while 35 per cent account for 0 per cent of exports.

When we look at developments in 1996-98, there do not seem to be any significant differences across the firm size groups. Most innovations have increased their contribution to turnover and exports, even though the share of innovations maintaining a stable contribution to exports seems to decrease as firm size grows. Overall, the respondents share high expectations of the contribution of innovations to the firm's turnover and exports in the future. Interestingly, the same holds true for all firm size groups, perhaps indicating that this optimism is also evenly distributed across different industries.

4 Concluding discussion

4.1 The survey results

The main focus of this report has been on the descriptive analysis of the survey results. The response rate of 64 per cent provided us with a relatively large number of observations at this stage of the project with potential for generalisations. Moreover, the structure of the survey data roughly corresponds to the structure of the whole data in terms of years, industries and firm size groups, and also the distribution of patenting. The main issues covered in the survey related to the nature of innovations and the innovation processes. Specifically, we studied the role of different collaborative partners and technology programmes in the development of innovations, the importance of public support, development times and the commercial significance of the innovations.

Overall, it seems that the survey has covered significant innovations since two thirds of the innovations are regarded as entirely new to the firms and approximately 50 per cent of these are also considered now to the global markets. Across industries there seems to be a rough demarcation line differentiating between the nature of innovation in R&D-intensive industries and the service sector on the one hand (the electrical and optical equipment industries, machinery, oil, chemicals, rubber and plastics industries, software, architectural and engineering activities) and on the other hand more traditional industries such as foodstuffs industry, pulp & paper, metal and metal products industries. Firms in the former group of industries more often introduce innovations regarded as entirely new to the firms and the markets, they more often require knowledge about the commercialisation of core technologies, are of the more generic type in terms of usage in other industries and more often receive public support during their development. The latter group of industries relatively more often develop minor improvements (incremental innovations) through the development of process technology and the combination of different components and modules. Moreover, they receive less public support.

Our conclusions across the firm size groups often come out as quite robust. Smaller firms more often quite naturally introduce innovations that are entirely new from their point of view, even though they might not be new to the global markets. Smaller firms require more knowledge about the commercialisation of core technology when they innovate, and the observation of market niche and public research programmes is more important for the origin of innovation. This contrasts in particular with the largest firms. The largest firms draw on a more diversified knowledge base. They harness scientific research to a greater extent and regard collaboration with universities and research institutes as relatively more important. Moreover, competition based on prices is less often the incentive for smaller firms to innovate, and they depend more on VTT and Tekes programmes during collaboration for the development of the innovations. These might be interpreted positively in the sense that smaller firms appear as focused both in terms of competencies and market orientation, and have the capacity to harness expertise originating from the VTT and Tekes programmes. However, if we also consider that the share of innovations becoming exportables and reaching break-even is lower for the smaller firms, alternative interpretations are also possible. It might, for example be the case that the smaller firms are overly dependent on external expertise and the national environment. They might have special problems in commercialising the innovations and returning profit promptly. Overall, the dynamics of these new, small, firms should demand closer investigation. Our data seems to be interesting and useful for this.

The importance of market driven factors such as market niche or customer demand for the origin of innovations is quite evident. This holds true irrespective of firm size, but we might see some interesting differences across industries once we have achieved better coverage by sector. Over time we see some changes in the relatively less important factors. In particular, there is an increase in the importance of public research or technology programmes, new technologies and environmental factors. Another robust conclusion concerns the importance that has been assigned to collaboration irrespective of industry and firm size. Again, the market is the most important setting. Two thirds of the respondents mention collaboration with customers as most important, followed by subcontractors, domestic universities and VTT. An interesting finding is also that domestic partners are regarded as more important than foreign ones. This suggests/confirms that domestic networks still dominate despite globalisation. This is especially interesting, since our data covers the development of innovations as the very strategic core of firm activity. Hence, we suggest that external knowledge input from foreign sources might be more peripheral for the development of innovations compared with the domestic sources.

Development times appear to be quite invariant with respect to firm size. Overall half of the innovations have been brought to market in less than two years from the basic idea. Virtually all have been developed in less than five years. The majority of innovations reaching exports and break-even do so within two years of commercialisation. Nonetheless, our conclusions on these points require some considerations since we have to account for the fact that 30 per cent of the innovations have not become exportables and 40 per cent have not reached break-even. The interpretation of exactly what constitutes break-even in the minds of the respondents might also be ambiguous. Across industries, innovations from the foodstuffs industry, the pulp & paper industry and the software industry stand out as those with rapid development times - they are commercialised faster than average and also return profits quicker. Perhaps surprisingly, the opposite is true for the electrical and optical equipment industry. However, the results also relate to the nature of market dynamics and product life cycles across industries rather than solely to the degree of novelty and other characteristics of the innovations.

As expected, the contribution of innovation to turnover decreases with firm size. For firms with less than 10 employees, a recently commercialised innovation accounts for some 50 per cent of the turnover and exports of the firm. The majority of innovations covers 1-25 per cent of the firm’s turnover. Looking at the years 1996-98, the innovations have increased their contribution to both the firm’s turnover and exports across all firm size groups. The share of innovations with growing contribution to turnover and exports exceeds 80 per cent. Only a negligible number of innovations account for decreasing contribution to firm performance. The same holds for future expectations, which are very optimistic. Hence, the overall impression that one gets is that the turnover and export potential of the innovations covered by the survey are favourable. Nonetheless, it is important to stress that these recently commercialised (we used the cut-off point of 1994 for these analyses) innovations might be success stories in the early phases of their product life cycles, while less significant innovations might have been more poorly covered by the survey. Indeed, a better approximation of the commercial significance would be an important follow-up to the work done so far.

4.2 General points and considerations

Apart from the survey results, the structure of the whole data and our methodology more generally raises some general points and considerations with implications for the use of innovation indicators and further in-depth research based on our data.

The fact that the number of innovations increases steadily up until a drop-off point in 1996 - reflecting a two-year lag in the identification of innovations - suggests that our methodology has been consistent from one year to the next. The absolute number of innovations is relatively low, compared with other similar studies made abroad that have typically been cross-sectional studies covering one or a few years (see e.g. Acs & Audretsch 1990, Kleinknecht & Bains 1993, Santarelli &

Piergiovanni 1996). One explanation is that we probably have applied stricter criteria in identifying innovations, both in the literature reviews and the use of expert opinion. Moreover, we have been especially alert in assessing the domesticality of the innovations. Unfortunately more detailed comparison with other similar studies is difficult due to the context-specificity of the definition of innovations and the fact that data collection is typically not based on standardised methodologies such as the CIS.

The definition of innovations is of course not clear-cut. Our starting point was to emphasise the technological novelty of the innovations, since a judgement on the commercial significance of the innovations was beyond our ability. Moreover, we have included innovations that can be considered new to the firms while they might or might not have been new to the global markets. We thus assume that we have captured changes in the underlying competencies of the firms, as reflected in the way in which they innovate across industries, firm size groups and changes over time. Generally speaking, the insights that we have gained speak against traditional Schumpeterian distinctions between product innovations and process innovations. In fact, many innovations are difficult to categorise as either product innovations or process innovations, since they are often complex bundles incorporating process innovation, product innovation and intangible characteristics related to service concepts and design. Also, process innovation often aims at directly enhancing the performance characteristics of product innovations, not least in the traditional industries. One example is the metal products or pulp & paper industry, where developments of process technology is often a prerequisite for the introduction of a new product to the market.

The large number of software-related innovations is worthy of some further discussion and in-depth studies at subsequent stages of the project. There are many potential reasons explaining the dominance and also the growth of software-related innovations in our data. It is clear that the definition of an innovation is trickier to apply in the case of software since many products evolve as relatively minor changes to previous products alongside the upgrading of operating systems and the like. Nonetheless, the large share of software-related innovations in our data also reflects real structural changes in industry. They might also be related to the increasing software content of industrial products, and the emergence of Nokia-related firms.

In addition to software-related innovations, an interesting feature of the whole data is the large share of other types of innovations originating from the service sector.

Hence, analyses of innovation in the service sectors should increasingly account for the fact that a considerable share of the output in fact appears to be tangible rather than intangible services. The richness of our data seems to offer particularly interesting avenues for further research that would better incorporate qualitative differences of innovations than has been possible in this first report.

The distribution of innovations across firm size classes also gives rise to some noteworthy observations. In particular, the relatively larger share of innovations commercialised by the small firms with less than 9 employees suggests that the role of these microfirms for innovation should receive more attention. Again, further in-depth study is needed on the origin and evolution of these small firms, and the commercial significance and exportability of the innovations. However, it seems to be the case that our methodologies are particularly effective in identifying new small firms, that these are relatively often innovators, and that they are not sufficiently included in analysis using patent data and firm-level surveys, such as the CIS. Thus, our data are particularly interesting for studying industrial renewal processes involving new start-ups.

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Palmberg, C & Toivanen, H. 1999. Innovation and technological change in Finland - some first results of the Sfinno-project. Paper presented at the Nordic Workshop on Industrial and Technological Change, 24-26 November in Kolmården.

Appendix 1: The questionnaire

[Graphics]

FINNISH INNOVATION

Name of respondent

Address

CONFIDENTIAL

Please return by *dd.mm.yyyy*

ID number

1. Background information

The questionnaire concerns the innovation mentioned below and the firm commercialising it. Some of the information is pre-completed; please correct it if necessary.

Name of the innovation

Description of the innovation

[VTT Group for Technology Studies logo]
[Contact information]

2. Firm commercialising the innovation in 1998

Firm name

Firm registration number

Is the firm

Independent ☐

Parent company of a group ☐

Other part of a group ☐

Name of group

Domicile of group's parent company   Finland ☐

Other country, which?

Has any other firm been responsible for the development or commercialisation of the innovation at some earlier time?

If so, which firm/firms and when?

Name of firm	Period

3. Characteristics of the innovation

The time at which the innovation was first brought to market is the reference point for assessing the degree of novelty.

From the perspective of the commercialising firm, the innovation is in terms of its technological content or characteristics

Entirely new ☐

A significant improvement ☐

A minor improvement ☐

The innovation is new

On the Finnish market ☐

On the global markets ☐

Which of the following alternatives best describes the knowlege associated with the innovation's development ?

Productisation of a particular core technology ☐

Development or combination of different types of components or modules ☐

Development of production methods ☐

Productisation of service concepts ☐

Other type, what? ________________ ☐

Are or will other firms be using the innovation?

Yes ☐

No ☐ If so, in which of the following industries?

Agriculture, forestry and fisheries	☐	Transport equipment	☐
Mining of minerals	☐	Other industry, recycling	☐
Food, beverages and tobacco	☐	Electricity, gas and water supply	☐
Textiles, apparel, leather, footwear	☐	Construction	☐
Wood and wood products	☐	Trade, hotels, restaurants, etc.	☐
Pulp and paper	☐	Transport	☐
Publishing and printing	☐	Telecommunications	☐
Chemicals, rubber, plastics, oil	☐	Financial and insurance services	☐
Glass, ceramic products, concrete	☐	Data processing services	☐
Basic metals, metal products	☐	Technical services	☐
Machinery and equipment	☐	Other services	☐
Electrotechnical products	☐		

4. Patenting

Has a patent application been submitted for the innovation?

Yes ☐

No ☐

If yes, in the name of which firm/unit or person ?

____

Which of the following patenting authorities have <u>granted</u> patents for the innovation?

Finland ☐

EPO ☐

USA ☐

Japan ☐

Other, which ? ________________ ☐

5. Commencement of innovation development and the main stages of the development work

Starting dates for the different stages of the innovation's development

	Year	Not yet started
Basic idea proposed		
Development stage began		
First prototype made ready		
Commercialisation began		☐
Exports began		☐
Innovation exceeded the profitability threshold	____	☐

How significant were the following factors for the origin of the innovation?

	Not important	Minor importance	Important	Very important
Intensification of price competition	☐	☐	☐	☐
Threat posed by rival innovation	☐	☐	☐	☐
Observation of a market niche	☐	☐	☐	☐
Customers demand	☐	☐	☐	☐
Public procurement	☐	☐	☐	☐
New scientific breakthrough (what? ____	☐	☐	☐	☐
New technologies (which? ____	☐	☐	☐	☐
Public research or technology programme	☐	☐	☐	☐
Environmentalal factors	☐	☐	☐	☐
Official regulations, legislation, standards	☐	☐	☐	☐
Availability of a licence	☐	☐	☐	☐
Other factor (what? ____	☐	☐	☐	☐

6. Research and development (R&D)

Has development of the innovation involved intramural R&D?

Yes ☐

No ☐

7. Importance of public funding for the innovation's development

Has public support been obtained for the innovation's development?

Yes ☐

No ☐

If yes, please assess the importance of the following sources of funding for the financing of the innovation.

	Not important	Minor importance	Important	Very important
Technology Development Centre (Tekes)	☐	☐	☐	☐
Ministry of Trade and Industry	☐	☐	☐	☐
SITRA	☐	☐	☐	☐
Regional Development Fund (Kera)	☐	☐	☐	☐
Nordiska Industrifonden	☐	☐	☐	☐
EU	☐	☐	☐	☐
Other,which? ______________	☐	☐	☐	☐

8. Collaboration associated with the innovation's development

Has collaboration with other parties taken place at any stage in the innovation's development ?

Yes ☐

No ☐

If yes, please assess the importance of the following partners

	Not important	Minor importance	Important	Very important
Firms belonging to the same group	☐	☐	☐	☐
Domestic customers	☐	☐	☐	☐
Foreign customers	☐	☐	☐	☐
Domestic consultants	☐	☐	☐	☐
Foreign consultants	☐	☐	☐	☐
Domestic subcontractors	☐	☐	☐	☐
Foreign subcontractors	☐	☐	☐	☐
Domestic universities	☐	☐	☐	☐
Foreign universities	☐	☐	☐	☐
VTT	☐	☐	☐	☐
Other domestic research institutes	☐	☐	☐	☐
Foreign research institutes	☐	☐	☐	☐
Domestic competitors	☐	☐	☐	☐

Foreign competitors	☐	☐	☐	☐
Others, who? ____________	☐	☐	☐	☐

Has a public technology programme been important as regards collaboration associated with the innovation's development ?

	Yes			No
Tekes programme	☐	(which one ?	______________)	☐
Other programme	☐	(which one ?	______________)	☐

9. Economic importance of the innovation

Economic importance for the commercialising firm

The innovation's share of the commercialising firm's turnover and exports in 1998

	0 %	1-5%	5-25%	25-50%	>50%
Share of turnover	☐	☐	☐	☐	☐
Share of exports	☐	☐	☐	☐	☐

Development of the innovation's share of turnover and exports, 1996-1998

	Grown	Remained unchanged	Fallen
Turnover	☐	☐	☐
Exports	☐	☐	☐

Development outlook for the innovation's share of turnover and exports, 1999-2001

	Expecte d to grow	Expected to remain unchanged	Expected to fall
Turnover	☐	☐	☐
Exports	☐	☐	☐

Any notes or additional comments (e.g. about problems concerning the innovation's development)

Appendix 2: List of journals reviewed*

NAME OF JOURNAL	ISSUES PER YEAR / YEARS COVERED	SECTORAL COVERAGE / FOCUS
Aromi	9-10 / 1985-98	Foodstuffs
Energia	10 / 1985-98	Energy technology
Forum för teknik och ekonomi	10-11 / 1998	Broad coverage of Finnish industry
Hyvä Suomi	6 / 1994-98	For the promotion of Finnish products
Insinööriuutiset & Tekniikka ja talous	150-160 & 52-53 / 1985-98	Broad coverage of Finnish industry, biased towards the engineering industries
Jäte ja ympäristö	5-6 / 1985-98	Waste disposal and environmental technology
Kehittyvä elintarvike	6 / 1985-98	Foodstuffs
Kemia-Kemi	10 / 1985-98	Chemicals
Konepaja & Metallitekniikka	12 / 1985-98	Metals, engineering
Logistiikka	10 / 1994-98	Logistics
Pakkaus	12 / 1985-98	Packaging industry, including machinery
Paperi ja puu	10-11 / 1994-98	Pulp & paper
Puumies	10 / 1985-98	Mechanical wood products
Sähkö ja Tele	10-11 / 1985-97	Telecommunications
Tekniikan näköalat	5 / 1985-98	For the promotion of Finnish technology
Tekstiilit	10 / 1994-98	Textiles
Tietotekniikan tuoteuutuudet	6 / 1985-97	IT
Tietoviikko	45 / 1985-98	Software

* We kindly acknowledge the help of our student assistants: Adam Tulos, Miikka Virtaharju, Petri Rytkölä and Ville Walden.

Appendix 3: List of large firms*

NAME OF FIRM / CONCERN	PRINCIPLE FIELDS OF ACTIVITY
Ahlström	Pulp & paper and related machinery
Cultor	Foodstuffs, enzymes
Farmos / Orion	Pharmaceuticals, diagnostics
Fiskars	Houseware goods and machinery
Instrumentarium	Medical equipment
Kemira	Chemicals
Kone / Kone Elevator	Elevator systems
Labsystems	Medical equipment
Leiras	Pharmaceuticals
Lännen Tehtaat	Foodstuffs
Metra	Engineering and machinery
Neste / Fortum	Chemicals, energy
Nokia	Telecommunications
Outokumpu	Metal products
Partek	Construction equipment
Raisio	Foodstuffs, fertilisers
Rauma-Repola	Pulp & paper machinery, engineering
Sonera	Telecommunications
Tampella/Tamrock/Kvaerner Pulping	Engineering, pulp & paper machinery
UPM-Kymmene	Pulp & paper
Valmet	Pulp & paper machinery and automation
Wärtsilä/Kvaerner Masa Yards/ Wärtsilä Diesel	Machinery, engineering
Metsäliitto, Rautaruukki, Stora Enso**	

* We kindly acknowledge the help of Petri Rytkölä and Jyrki Kiviniemi.

** These firms have not been included at this stage of the project

Appendix 4: List of tables.

Appendix 5: List of figures.

Working Papers

No. 1 *Miettinen Reijo and Loikkanen Torsti*, Teknologiapolitiikasta yritysten teknologiastrategioihin (From technology policy to company technology strategies). Espoo 1993.

No. 2 *Numminen-Guevara Sirkka*, Katsaus teknologiaohjelmien arviointiin (Review of the evaluations of national technology programmes). Espoo 1993.

No. 3 *Kivisaari Sirkku and Lovio Raimo*, Suomen elektroniikkateollisuuden merkittävien innovatiivisten liiketoimintojen menestyminen 1986-1992 (Success of the major innovative businesses in the Finnish electronics industry 1986-1992). Espoo 1993.

No. 4 *Miettinen Reijo*, Methodological issues of studying innovation-related networks. Espoo 1993.

No. 5 *Numminen-Guevara Sirkka*, Yhteenveto VTT:n tutkimusohjelmien arvioinneista (A summary of the evaluations of VTT's research programs). Espoo 1993.

No. 6 *Hölsä Tuomas*, Ulkomaiset T&K-yksiköt Valmetin paperikoneteollisuudessa ja Ahlströmin konepajateollisuudessa 1983-1993 (Foreign R&D units in Valmet paper machinery and Ahlstrom engineering industries 1983-1993). Espoo 1994.

No. 7 *Halme Kimmo and Ahola Eija*, Pkt-yritykset ja innovaatioiden tukijärjestelmä Suomessa (SME's and innovation support system in Finland). Espoo 1994.

No. 8 *Ahola Eija and Halme Kimmo*, Innovaatiotoiminta pkt-yritysten strategiana (Innovations as a strategy for the SME's). Espoo 1994.

No. 9 *Luukkanen Harri*, Ulkomaiset teollisuusyritykset ja niiden tutkimustoiminta Suomessa 1984-1991 (Foreign industrial firms and their R&D in Finland 1984-1991). Espoo 1994.

No. 10 *Hölsä Tuomas*, Suomalaisten suuryritysten ulkomainen T&K-toiminta. (Foreign R&D of Finnish multinational corporations). Espoo 1994.

No. 11 *Halme Kimmo*, Uudet yritykset biotekniikkasektorilla 1994 (New firms in the biotechnology sector 1994). Espoo 1994.

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No. 13 *Miettinen Reijo*, Sosiologian ja toiminnan teorian näkökulma teknologiatutkimukseen (A sosiological and activity theoretical approach to technology studies). Espoo 1994.

No. 14 *Kivisaari Sirkku*, Management of continuity and change in Finnish health care technology: the Datex and Polar Electro cases. Espoo 1995.

No. 15 *Miettinen Reijo*, Finnish biotechnology innovations in the 1980s and the 1990s: A preliminary study on innovative activity of the Finnish biotechnology sector. Espoo 1995.

No. 16 *Kuisma Mika*, Pölypäästöistä kasvihuoneilmiöön: energiantuotantoon liittyvien ilmansuojeluliiketoimintojen kehityksestä ja kehitysmahdollisuuksista Suomessa. (From local dust emissions to global warming: the development and potential of the Finnish air pollution control and air quality measurement business and their relation to energy sector). Espoo 1995.

No. 17 *Lievonen Jorma*, Teknologia ja työllisyys (Technology and employment). Espoo 1995.

No. 18 *Ahola Eija and Siivonen Timo*, VTT tuotekehittäjänä. Kertomus automaattisen sivuntaitto-ohjelmiston kehittämisestä VTT:ssä (Product development at VTT: the case of automated paper making system). Espoo 1995.

No. 19 *Kuisma Mika*, Kasvihuonekaasut Suomen energian tuotannossa: haasteita uuden teknologian kehittämiselle (Green house gases in the Finnish energy production: challenges for the new technology development). Espoo 1995.

No.20 *Luukkainen Sakari*, Toimialan arvoketjun rakenteen ja kehitysdynamiikan vaikutus suomalaisen tietoliikenneteollisuuden kansainväliseen kilpailukykyyn vuosina 1990-1995 (Value chains in Finnish telecommunications industry). Espoo 1996.

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No. 32 *Kortelainen Sami, Kivisaari Sirkku & Saranummi Niilo*, Uusi teknologia kohonneen verenpaineen hoidossa (New technology in the treatment of high blood pressure). Espoo 1998.

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No. 34 *Mika Kuisma*, Teknologian siirron ja kaupallistamisen nykytilanne Suomessa (The present state of technology transfer and commercialisation in Finland). Espoo 1998.

No. 35 *Jorma Lievonen*, Tekniikan mahdollisuudet - erikoistapauksena televiestintä. (Technological opportunities - case telecommunications). Espoo 1998.

No. 36 *Jorma Lievonen*, Innovaatiot ja infrastruktuurit. Esimerkkinä internet-innovaatiot (Innovations and infrastructures. Internet innovations as an example). Espoo 1998.

No. 37 *Ahti Salo*, Kokemuksia teknologian arvioinnista: kasvigeenitekniikka ravinnontuotannossa (Experiences in technology assessment: plant genetics in food production). Espoo 1998.

No. 38 *Eija Ahola and Sini Molin*, Keksintöjen kiihdyttäjä: Keksintösäätiön toiminnan arviointi. Espoo 1998.

No. 39 *Ville Räsänen*, Internationalization of R&D in Finnish Multinational Companies 1993-1998. Espoo 1998.

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No. 41 *Christopher Palmberg, Ari Leppälahti, Tarmo Lemola and Hannes Toivanen*, Towards a better understanding of innovation and industrial renewal in Finland - a new perspective. Espoo 1999.

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Industrial innovation in Finland - first results of the Sfinno-project

The process of industrial renewal is essential for economic growth and well-being. At the core of this process is the commercialisation of innovations. Hence, a better understanding of industrial renewal processes essentially depends on a better understanding of the development and commercialisation of innovations in their entrepreneurial context.

This report presents first results of an on-going research project called Finnish Innovations (Sfinno). The broader aim of the project is to provide both a deeper and more comprehensive understanding of technological and structural change in the Finnish industry through analyses of conrete innovation output. For this purpose we have built a unique database containing detailed data on some 1600 Finnish innovations commercialised during the 1980s and 1990s. In this report we discuss the structure and coverage of our database, and analyse the results of a large survey that we have undertaken as a part of the project. The survey contains data on the nature, origin, development and commercial significance of the innovations. We analyse the survey data across industries, over different firm size groups and time periods.

Our methodologies and results provide new micro-level insights into industrial renewal and the nature of innovations and innovation processes in Finnish industry. Moreover, our focus on innovation output rather than indirect indicators, such as R&D and patents, or firm-level surveys, contributes to the discussion on the use and limitations of innovation indicators.