ESPOO 2005

VTT WORKING PAPERS 24

A comparative micro-level analysis of innovative firms in the CIS Surveys and in the VTT's Sfinno Database

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Statistics Finland & VTT Technology Studies

ISBN 951–38–6574–6 (URL: http://www.vtt.fi/inf/pdf/)
ISSN 1459–7683 (URL: http://www.vtt.fi/inf/pdf/)

JULKAISIJA – UTGIVARE – PUBLISHER

VTT, Vuorimiehentie 5, PL 2000, 02044 VTT
puh. vaihde 020 722 111, faksi 020 722 4374

VTT, Bergsmansvägen 5, PB 2000, 02044 VTT
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Technical editing Marja Kettunen

Published by

Series title, number and report code of publication

VTT Working Papers 24
VTT–WORK–24

Author(s)
Lehtoranta, Olavi

Title

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Abstract

This paper examines what has happened to innovative firms before the commercialisation of an innovation and after it. Large firms are a different story altogether, for which reason they are not considered here. Small and medium-sized innovative firms are often created just a few years before an innovation is commercialised. Usually an invention has a longer history, which can be linked to some other company, to the predecessor of the commercialising firm or to a completely different company or research institute.

It was found that domestic patents precede the commercialisation of an innovation by an average of 1 to 2 years and EPO patents by 0 to 1 year. After an innovation, the turnover and employment of the SMEs often grow for a few years depending on the general business situation. The innovations successful for the original commercialising firms can be clearly detected and they were examined in more detail in a case study covering fifty SMEs.

The paper also studies whether the innovators and innovations included in the CIS Surveys differ in their characteristics from those included in the VTT's Sfinno Database. The main difference in these data are that in the CIS Surveys a company can be classified as innovative on the basis of relatively loose criteria. In the Sfinno Database a company is defined indirectly innovative according to whether it has introduced some key product innovation to the market. Notwithstanding the differences of the CIS Surveys and the Sfinno Database and considering the fact that some CIS Surveys have been supplemented with a selective panel of small firms and that certain subjectivity has been difficult to avoid in compiling Sfinno, the data used produce surprisingly logical and consistent results.

Keywords
innovative firms, CIS Surveys, Sfinno Database, micro-level comparison

Activity unit
VTT Technology Studies, Kemistintie 3, P.O.Box 1002, FIN–02044 VTT, Finland

ISBN	Project number
951–38–6574–6 (URL: http://www.vtt.fi/inf/pdf/)	P2SU00143

Date	Language	Pages
February 2005	English	59 p. + app. 14 p.

Name of project	Commissioned by
Dynamic Patterns of Innovative Activities among Finnish Firms	National Technology Agency of Finland Tekes, Ministry of Trade and Industry KTM

Series title and ISSN	Publisher
VTT Working Papers 1459–7683 (URL: http://www.vtt.fi/inf/pdf/)	VTT Information Service P.O. Box 2000, FIN–02044 VTT, Finland Phone internat. +358 20 722 4404 Fax +358 20 722 4374

Contents

1. Introduction

The empirical study of innovations and innovation activities is, in a way or another, based on observations, on the collection of information – by means of surveys, case studies or in other ways. The approaches that are used in these kinds of innovation studies are quite diverse. Researchers have their freedom to define and delimit the phenomenon they want to examine. The definition of innovation or innovativeness can be broad – likewise the number of activities and actors being under consideration can be large. In each case, the object of interest defines what will be examined and how.

The advantages of the multifaceted or many-voiced research are evident. One can impugn the conventional lines of thought, concepts and "regularities". The science will learn and proceed, hopefully also accumulate and get linked interdisciplinarily.

Another way for the accumulation of knowledge is the collection of the so-called institutionalised or standardised data, i.e. information that is collected according to the definitions and methods currently agreed upon. This concerns especially the Community Innovation Surveys (CIS Surveys) of the European Union but also the approach followed in building VTT's Database on Finnish Innovations (Sfinno).

There are two established methodologies for the above-mentioned innovation surveys, the subject and object approaches. The subject approach refers to the Schumpeterian "subject of industrial renewal', i.e. firms that develop and introduce innovations. The object approach refers to innovations, i.e. the Schumpeterian "objects of industrial renewal". In the subject approach, the survey unit is a firm, whereas in the object approach data are collected directly at the level of individual innovations.

Even the institutionalised data can seldom be unchangeable in time. When understanding about a phenomenon changes, the commonly agreed concepts and definitions also transform, at least slightly. Or when the operating environment alters, the information to be collected also changes – or at least it should change. However, the information to be collected is often required to be comparable over years or across countries. This requirement is in fact in conflict with the change demands of information and the solution could be balancing between these contradictory requirements.

The definitions of innovations and the scope of innovation activities have not remained the same in all Innovation Surveys carried out in Finland. The first survey (1991 Innovation Survey) related only to industrial product and process innovations and incremental product improvements. Later on a question on service sector innovations was added to the survey, and it was also asked whether firms had any ongoing product development projects. On the whole, the CIS Survey is a company-centred inquiry estimating the share of innovative firms and their scope of innovation activities, although it requests to name one's collaboration activities and sources of innovation, i.e. questions are also made on some qualitative issues. The main results of the CIS Surveys are the numbers of innovating firms, quantities of innovation activities and budgets, turnover resulting from new and improved products, and reasons why firms innovate, the sources of information and the barriers they face. The CIS Surveys mostly describe technological innovations, also for some service industries – not organisational or managerial innovations, and in this sense they rather serve technology policy than innovation policy extended in the direction of social sciences.

When compared with the data examining innovativeness gathered by researchers, the most essential differences may lie in that the CIS Surveys have a relatively strict definition for innovations, while innovation activities are defined fairly loosely. To be innovative it suffices that the firm has said it has research and product development for example in project form or has ordered product development inputs from others. Some firms reply, however, that they do not have any actual product development activities, but are just working on some developing. In this respect the responses vary. This is apparent for example from that when information is asked about innovation activities in connection with the R&D survey, a different picture appears about the share of firms engaged in innovation activities than from CIS Surveys. This share is influenced not only by the different sample design but also by that innovativeness is bound more to R&D in the former survey.

This report aims to examine what kinds of (SME) firms are innovative, what is their background and development like and what has happened to them before and after the commercialisation of the innovation. The research data used are the VTT Sfinno Database and all Innovation Surveys conducted in Finland and other statistical databases and administrative register data. These extensive data allow for a relatively detailed examination of firm demographic events, firm acquisitions, personnel mobility, firm growth, etc.

The data sets used in this study are as follows:
Database of Finnish Innovations (Sfinno) from VTT Technology Studies, 1985–1998

Several R&D Surveys and Community Innovation Surveys (1991, 1996, 1998, 2000) conducted at Statistics Finland,

Business Register data from Statistics Finland, 1982–2000
Register based data on groups of firms, 1995–2000 excluding 1996
Register based data on mergers of firms

Regional Employment Register data from Statistics Finland, 1988–1999

Register based data on the education and work experience of employees, 1987–1999

Register induced data on the mobility of highly educated employees, 1988–1999

Register induced data on start-ups and spin-offs, 1990–2000

Data on Foreign Ownership of firms (FATS database) from Statistics Finland, 1994–2000

Patent Register data from the National Board of Patents and Registrations, 1985–1999

All patent applications filed in Finland, with the European Patent Office (EPO) and

All patents granted in the US

Firm level R&D Collaboration data from the National Technology Agency of Finland (Tekes), 1993–2000

Data on Firm Acquisitions from the Magazine Talouselämä, 1993–1999

From these data sets we are able to draw information on Finnish innovations and innovators (understood as firms), on their patenting and collaborating behaviour, on mergers and acquisitions, and on the inflow and outflow of highly educated employees. All register based data and data on firm acquisitions as well as data on Tekes funded collaborating firms are treated as total data. The Sfinno, CIS and R&D data sets are samples. The firm level R&D stock is also compiled and is based on the extrapolation of a firm's in-house R&D expenditures extracted from the union of all R&D samples over the 1985–2000 time period.

A central object of interest in this report is how the innovations and innovators of the Sfinno Database and the CIS Surveys differ from one another, that is, how innovation activities are described through the innovation database and the CIS Surveys (the nature of innovations, characteristics of innovators). Even though the CIS Surveys and the Sfinno Database describe the same phenomenon and cover the same industries they seem to produce somewhat different results (Leppälahti 2000).

The aim of this paper is to make a micro-level comparison of the innovations and commercialising firms, and especially the SMEs, included in the union of all CIS Surveys conducted in Finland, and the innovations and commercialising firms included in the Sfinno Database. We do not conduct any aggregate statistical comparison of these surveys. The latter comparison is performed by Leppälahti (Leppälahti 2000). The study is not restricted to the manufacturing sector but is confined, due to data availability reasons, to the latter part of the 1990s.

Case studies of the most successful innovative SMEs are also conducted here and some findings of these studies are given in Section 5. A more in-depth description of the 25 innovative growth firms (a half of the target group of the high growth firms included in the innovation surveys and databases) will be published as a separate report. It includes descriptions of the most successful Finnish innovative SMEs in the 1990s measured by growth of turnover and personnel.

In the conclusion it is discussed whether these data (both the CIS Surveys and the Sfinno Database without its recent extensions) could be used to respond to the question whether any changes can be detected in firms' innovation activities in the 1990s and especially at the end of that decade.

2. Innovation surveys and concepts

2.1 Statistics Finland's Innovation Surveys

J. Schumpeter made a clear distinction between inventions, innovations and imitations. According to Schumpeter an invention is an idea, a sketch or a model for something. Innovations are those inventions that have been commercialised on the market by entrepreneurs, while imitations are innovations that have been copied by others. Schumpeter also made the basic distinction between incremental innovations and radical innovations in terms of their socio-economic effects. Product vs. process innovations referred to the competition in price vs. in productivity. Incremental vs. radical innovations referred to the degree of novelty and nature of innovation process. (Schumpeter 1934)

Process innovations primarily yield productivity gains and affect competition. Product innovations open new markets, out-compete older products and thus are often assumed to affect more directly firms' competitive position on the market. A process innovation might be carried out in order to make conventional products more efficiently. Moreover, a product innovation in one sector might be a process innovation in another sector. It is also clear that product innovations predominate in the early stages of development in specific industries.

The minimum requirement for innovation is that it is new to the firm, either completely new or significantly improved. The identification of innovation and related activities is in the subject approach left to the subjective judgment of the firms. Among innovators the degree of novelty is further evaluated by distinguishing product innovations that are new to the market. The most important output indicator for technological innovations is the proportion of sales due to technologically new or improved products.

The definition of innovation does not differentiate innovations achieved through one's own development effort from those that are adaptations or imitations. Another problem with the ”new to the firm” condition are firms that are established during the reference period, as they are innovators by definition. In the Innovation Surveys the reference period is three years prior to the base year of the survey.

The Innovations Surveys conducted at Statistics Finland use essentially the concept of technological product and process innovation defined in the Oslo Manual (OECD, 1992, 1997). The 1991 Innovation Survey (CIS1) was conducted by using the same methodology as in the first wave of the Community Innovation Survey, although Finland did not participate in the EU Survey. The target population comprised manufacturing firms with at least 10 employees. For firms with at least 100 employees the survey was a census, while a stratified random sample by size class and industry was performed for firms with 10 to 99 employees.

The 1996 Innovation Survey (CIS2) was the Finnish contribution to the second wave of the CIS. The survey was extended to cover some services industries in addition to manufacturing. A similar sampling method was applied as in the 1991 survey for firms with at least 10 employees.

The core questions about product and process innovation were annexed to the 1998 R&D Survey. We call this survey the 1998 Innovation Survey (CIS2.5). The wordings of the definitions were similar to the 1996 Innovation Survey, except that product and service innovations were combined, thereby making the innovation concept wider than in the 1996 Survey. The sample design was slightly different from the one used in the two previous surveys. The majority of firms was included on the basis of the R&D expenditure they had reported in earlier R&D Studies. Stratified random sampling then covered the rest of the population.

In the 2000 Innovation Survey, the wording for the definition of innovation was changed, as the word 'technological' was left out. As in the CIS2.5 the frame was divided into panel and sampling frames. The panel frame included all firms with over 10 employees that reported innovation activities in the 1996 and 1998 Innovation Surveys and the research sector firms. Stratified random sample was made in the sampling frame where the strata used were the size category of the firm's personnel and industry. The response rate of the survey remained at 50 per cent. Defective responses were imputed using the 2000 R&D Survey, earlier Innovation Surveys and the mean, median or mode values in a sampling stratification.

2.2 The Sfinno Database

The Sfinno Database, compiled by the VTT Technology Studies, contains basic data on individual innovations and firms that have commercialised these innovations. This includes such as the product group of the innovation, the year of commercialisation and the sector of the commercialising firm.[1] It also contains data on the origin and diffusion of the innovation, R&D collaboration, public support and the commercial significance of the innovation.

The Sfinno Database without its recent extensions comprises technological innovations commercialised during the 1985-1998 period. The focus in the Sfinno Database is on product innovations because the in-house process innovations are not feasible with the object (innovation-centred) approach. The service sectors are covered incompletely: the nature of innovation in services would require a broader definition of innovation.

[1] The technological class of innovations is based on the International Patent Classification (IPC) system and reveals the underlying technology that is embodied in the innovation. The name and description of the innovations do not typically provide information on the underlying technology.

The definition of innovation in Sfinno is based on the definition provided by the Oslo Manual (OECD 1977). Innovation is an invention that has been commercialised on the market by a business firm or equivalent. The innovation has to be a technologically new or significantly improved product compared with the firm's previous products. The Sfinno Database only includes innovations that are commercialised by a firm registered as domestic, i.e. operating in Finland.

There are three sources of innovation identification in the Sfinno Database: expert opinions, a review of trade and technical journals and a review of annual reports of large firms. Most of the innovations in the Sfinno Database (two thirds) were identified by literature reviews of 18 Finnish trade and technical journals covering the years 1985-1998, 16 per cent were discovered with the use of expert opinions and nine per cent came from the annual reports of large Finnish firms. The rest of the innovations (9%) were from miscellaneous written sources (Palmberg et al. 2000).

The share of significant innovations

In the Sfinno Database innovation has been defined as economically and technologically significant if it has created a new market or product concept within the industry (Hyvönen 2002). However, in order to be significant an innovation does not have to be commercially successful. The significance assessment was undertaken through the method of expert opinions, and the following categories were used: 1=not known, 2=not significant, 3=significant, 4=very significant.

Significant innovations are more oriented towards global markets than non-significant innovations. The knowledge base behind the innovation is usually the development of components and core technology. Significant innovations are more complex in their nature and more generic compared with non-significant innovations.

There were 236 significant innovations (17%) and 1,119 non-significant innovations in the comparison. The share of significant innovations is highest among the largest companies (Hyvönen 2002). Only 11 per cent of significant innovations were commercialised by firms with less than 10 employees.

The share of high complexity innovations

The assessment of the complexity of innovations is based on the degree to which they involve the combination of different types of components or modules. The underlying assumption is that higher complexity innovations also involve more complex knowledge bases in terms of the integration of a greater range of different types of technologies compared with lower complexity innovations. The distribution of high complexity innovations by sector coincides with the distribution of radical innovations especially in the case of the instruments and chemical sector (in pharmaceuticals). In this assessment the following categories were used: 1=low complexity, 2=medium-low, 3=medium-high, 4= high complexity.

Low complexity innovations clearly dominate within the small firm size classes, while large firms are more inclined to develop high complexity innovations. Correspondingly, small firms have to focus on radical innovation in a limited number of technologies and market niches.

The share of radical innovations

A radical innovation is defined as an innovation that is entirely new to the firm and the global market. An incremental innovation is merely an improvement compared with the previous products of the firm. An assessment of whether an innovation is incremental, radical or merely a product differentiation is a difficult one. In some cases the respondents have reported the degree of novelty - from the firm's perspective. Assessing the degree of novelty is particularly tricky in the case of new firms, when the viewpoint of the firm is taken, as by definition these are always innovators despite the fact that their products might be differentiation, pure imitations or adaptations of existing innovations (Palmberg et al. 1999, p. 40).

It has been assessed that some 50 per cent of all innovations covered by the Sfinno survey are radical. The other half of the innovations are 'incremental technological product innovations new to the firm'(Palmberg 2002b).[2] Radical innovations are more common especially in the R&D-intensive chemicals, and instruments sectors, while incremental innovations dominate in the less R&D-intensive traditional metal, metal products and foodstuffs sectors. The methodology used in Sfinno aims at the exclusion of product differentiation.

The tendency for small firms to introduce radical innovations is clear from the viewpoint of the distribution of incremental/radical innovations by firm size classes. Their share is higher in the R&D-intensive sectors characterised by science and technology-based innovations. Small firms face a need to become engaged in radical innovations more frequently. In the largest firm size class, incremental innovations predominate. Hence, large firms appear to rely on the commercialisation of the incremental variations of certain core technologies. Among large firms, the share of innovations induced by price competition and rival innovations is presumably larger. The software sector has a very clear dominance of incremental innovations. On the

[2] A separate survey has been conducted to some 1,500 firms among the innovators in the Sfinno Database. The shares of radical as well incremental innovations refer to this number of firms.

other hand, the software sector is also characterised by many small and young start-up firms that almost by definition are involved in new activities.

One robust result in the innovation studies based on the Sfinno Database is that both radical and high complexity innovations are associated with scientific breakthroughs and new technologies. These types of innovations also involve to a significant extent collaboration with universities and research organisations. They are also associated more frequently with public funding. About 60 per cent of all innovations in the Sfinno survey involved R&D funding, while some 25 per cent of all innovations involved participation in public technology programmes. The more frequent involvement of software innovations in public technology programmes is also clear from the figure above (Palmberg 2002b).

Difficulties in the identification of innovations and innovators

A generic technology or new production method may generate an array of new products, in which case the identification of only one concrete innovation is difficult. There is also the problem of different generations of incrementally developed products. In addition, products, processes and services are sometimes intervened and the innovation is actually a system, an integrated and complex package of product and process innovations that is customised to the customer (Palmberg et al. 1999, p. 39).

Another problem lies in the identification of the commercialising firm. As pointed out by Leppälahti (2000, p. 15), it can be problematic to establish which firm, or firm structure, at which point in time, should be linked to an innovation. According to Klein (1992), few innovations can be assigned to a specific firm. In the Sfinno database, the most recent firm (its Business ID) is defined as the innovator as a rule. However, this causes problems when linking the data, because a more recent ID that was assigned to the innovation did not perhaps exist at the time of the commercialisation. The reason for changes in the ID code of a firm is usually in its structural change.[3]

[3] In this study the Sfinno Database information on the original commercialising firm of the innovation, more exactly its ID code, was retraced to around 100 enterprises, that is, one third of the examined group (292 firms) In the original Sfinno data, the IDs of commercialising firms were fixed according to the year 1999, irrespective whether this ID existed for earlier years.

3. On innovative activities and changes in them

3.1 Factors affecting new patterns of innovative activities

Innovative activities here refer to an activity (a) the target of which is to develop a new or remarkably improved product to markets, or (b) the target of which is to develop and introduce a new or remarkably improved production process. According to the Oslo manual (OECD 1997), innovation activities are broken down into (i) intramural research & experimental development, (ii) acquisition of R&D (extramural R&D), (iii) acquisition of machinery and equipment, (iv) acquisition of other external knowledge, (v) training, (vi) market introduction of innovations, and (vii) design and other preparations for production/deliveries.

The propensity to innovate was interpreted here in the Schumpeterian way as the propensity to introduce an innovation to the market. The commercialisation year of an innovation was used as a signal that the firm in question had commercialised an innovation that year, i.e. was an innovator. It should be noted that in the CIS Surveys innovative firms are firms which declared that they had ongoing or aborted innovative activities or had ordered innovation inputs from others. In Sfinno, innovating firms are those that have commercialised an innovation.

For comparison purposes, we utilise this latter definition for the CIS Surveys as well, i.e. we define that in the CIS Surveys innovating firms are firms that have commercialised an innovation.

The most basic indicator of innovative activity in the CIS Survey is whether the firm has introduced any (technologically) new or significantly improved products or processes which were new to the firm, whether such an introduction is still running or whether its has been abandoned. All firms with successful product and process innovations and/or with (abandoned or) running innovation processes are considered as innovative.

In the CIS Surveys, innovation expenditures include all expenditure related to the scientific, technological, commercial, financial and organisational steps that are meant to lead to the implementation of technologically new or improved products and processes. In this project we have examined most of these steps, but only by means of administrative and statistical data files. We are, however, in a rare situation where we can examine many of these factors simultaneously by using large databases. In addition, we went behind those phenomena, and zoomed in on certain firms, their innovation projects and types of innovations in the case studies of the project.[4]

[4]About the results of the case studies, see Section 5.

The aforementioned questions have been discussed in Section 4 and concluded in Section 6. It should be repeated here that our point of departure concerning these questions is a micro-level comparison (the level of firms, the samples of firms or individual innovations), not aggregate statistics. Aggregate data can also be very helpful in providing information on the changing patterns of innovation activities. As an example of these, we refer to the work of Hollenstein (2001) where he identifies five different innovation styles for the Swiss services sector:

Innovation styles according to Hollenstein (2001)

1. Science-based, network-integrated high-tech firms, endowed with highly qualified staff, high R&D intensity and favourable market and technological opportunities.
2. Re-oriented, outward-looking developers with a highly skilled staff, high investment in IT, and favourable market conditions.
3. Market oriented, inward-looking incremental developers, product and process innovations that have a high IT content, but incremental in nature, where networking is weakly developed.
4. Cost-reducing, value chain oriented process innovators, whose innovation inputs are IT and innovation-related follow-up investments, where the networking structure is predominantly value chain based.
5. Low-profile, inward-looking innovators, with marginal innovation performance, weak demand, strong price competition, low appropriability and innovation opportunities. The innovation style is based on adoption of innovation generated elsewhere.

Sectoral patterns of innovation

Various studies suggest that inter-industry differences in technology variables such as research intensity, patenting or innovation counts used as proxies for innovation output are more significant than inter-firm differences in the same industry for differences in innovativeness and patterns of innovation over industries (Coombs et al. 1987, Malerba & Orsenigo 1996). Explanations for differences in sectoral patterns of innovation are primarily captured in the concept of technological regime or technological paradigm, which have been developed by Nelson & Winter (1977), Dosi (1982, 1988) and Malerba & Orsenigo (1993, 1997), among others.

Malerba & Orsenigo concluded that systematic differences in the patterns of innovation can be found in the three main technological families: chemicals, electronics and mechanical industries. In chemicals and electronics large firms dominate, whereas mechanical industries have a pervasiveness of the entry of new small firms. According to Malerba and Orsenigo technological regime is a combination of (1) technological opportunity, (2) appropriability conditions (the possibilities of protecting innovations), (3) cumulativeness (the relationship between current innovative activities and new innovations) and (4) the nature of the knowledge base of the technology (see Palmberg et al. 1999, p. 22).

Different sectors are characterised by different dynamics in terms of product life cycles and the related nature of competition. In addition, the logic of innovative activity is different in the process-intensive sectors (pulp and paper, metal products, chemicals) and produces technologically less visible innovations, albeit with a higher degree of embodied process technology. Also, journals reporting on traditional industries like pulp and paper, metals, construction, textiles and foodstuffs tend to focus on generic technologies, techniques and concepts in those sectors. The application of criteria for defining technological innovations is also more difficult in these sectors, where technological intensity in the traditional meaning is lower (Palmberg et al. 1999, p. 46).

Generally taken, there is a relatively clear distinction between innovations originating from the R&D intensive electronics, chemicals, instruments and software and the traditional and less R&D-intensive machinery, metals, metal products, foodstuffs and forestry-based sectors. In the R&D-intensive sectors, innovations tend to be science and technology-based. In the traditional sectors, innovations tend to be induced by competition, as well as regulations and environmental issues. Moreover, collaboration appears to be relatively less important.

The studies based on the literature-based methodology have primarily focused on the cross-sectional analysis of the relative contribution of small firms vs. large firms, different types of innovations, the sectoral distribution of innovations, and intersectoral innovation flows. A particular extensive study in this field is Acs & Audretsch (1990). The overall conclusion they arrive at is that small firms play a key role in the process of technological change, especially in R&D-intensive high-technology industries. Small firms generate much of the turbulence in terms of entry, growth and exits, which is crucial for employment growth, competition and industrial renewal (see Palmberg et al 1999, p. 35).

The relationship between business cycles and the patterns of innovative activity have been studied by Geroski & Walters (1995), for example. They utilised the SPRU innovation database and concluded that very few firms could be considered persistently innovative. Rather, the distribution of patents and significant innovations was dispersed over many firms, and turbulence in the introduction of innovations to the market was high.

The 1990s have witnessed the emergence of new firms, especially in the fields of electronics, software and biotechnology. From innovation theory the following hypothesis on the changing patterns in innovation activity can be conducted:

1. Patterns have changed from isolated patterns to networked patterns, or more patterns have emerged.
2. Collaboration is pervasive but the intensity and patterns of collaboration are country-specific.
3. Different sectors have different propensities to collaborate with customers and suppliers.
4. The size of firms matters. Larger firms are often nodes in interactive networks.
5. Previously supplier-dominated innovations are now more demand-driven in consumer markets**.** In Pavitt's taxonomy firms are divided into supplier-dominated, specialist suppliers, scale intensive and science-based firms. Supplier-dominated firms are not intensive producers of new technology. (Pavitt 1984)
6. SMEs are typically more market-oriented in their innovation behaviour.
7. Organisational innovations are more important. Innovation in mature clusters is often non-technological, e.g. focusing on management and organisational practices.
8. Firms that are most successful in pioneering new products may not be the first movers. They may be firms that have the complementary assets required to market or distribute the product.

It has been stated that different clusters have different innovation patterns and that the determinants of innovation performance have changed. Innovation performance depends on the scope and efficiency of knowledge transactions among firms, research institutions and the human resources involved. However, increased knowledge flows should not be seen as a substitute for the growth in knowledge endowments such as investments in human capital or R&D.

Human capital is becoming critical to innovation performance. Competition for and mobility of tacit knowledge is of increasing importance. The mobility of research personnel across the industrial-academic divide is a key mechanism for knowledge transfer and inter-organisational learning. Companies cannot rely on a single source of knowledge but rather engage in various activities for acquiring knowledge.

More competitive markets force firms to innovate more often.[5] They also force firms to engage in networking and collaboration to respond to the wider diversity and

[5] This does not, however, concern all firms, because firms have different positions in the innovation networks.

specialisation of knowledge. High-levels of interdependency between firms translate into important market-based knowledge flows. The role of business transformations for innovation has increased. The business strategy is often based on substantial R&D investment. This is especially so in knowledge-intensive companies. The strategy can also be based on the application of existing technology (process innovators). Innovation occurs in traditional industries and in established companies, but it flourishes most profusely among new, technology-based firms (NTBFs). These are high-risk ventures, started from research institutions or large firms, and many remain small or even fail altogether.

3.2 Focus in this research project: changes in innovative activities

A number of different patterns can relate to various dimensions of innovative activities. A question can be posed: Are certain dimensions of innovative activities nowadays more frequent or more intensively used than earlier? This question also relates to the resources used for the activity or the results obtained by the activity.

Patterns can be found in terms of the selected collaboration partners. To what extent successful collaboration history matters? There is also the question: to collaborate or not, i.e. to rely on one's own R&D activities.

Here the collaboration behaviour of innovating companies as they are represented in the Finnish CIS Surveys is considered (Ebersberger et al. 2002). Three cross-sectional analyses that can be compared over time are used. The results show that the likelihood of collaboration is positively influenced by the level of the diversity in R&D activities. In addition, the probability of collaboration of services sector firms increases over time. Vertical collaboration is strongly influenced by experienced bottlenecks in the knowledge domain. Instead, non-vertical collaboration seems not to have been influenced so much by the gaps in the knowledge. For both the vertical and non-vertical collaboration the relevance of economic hampering factors on the collaboration is quite a recent phenomenon.

Acquiring public funding to resource the R&D efforts can also be seen as an innovative activity. A key question in the context of public funding is whether it has an impact on firms' success of innovative activities. Does public funding have an impact on firms' generation of innovative output?

We have also studied whether different categories of innovators having different returns to innovation can be found. Can we, for example, notice the changing positions of firms within the population of firms?

4. Event histories of innovative firms – comparison of CIS and the Sfinno Database

4.1 Basic observations from the matched datasets

We classify here Sfinno firms according to their innovation intensities over time to three categories: **intensive innovators, persistent innovators and innovators with one innovation**[6]. Furthermore, we divide each of these categories according to their patenting intensity to four categories: intensive patent applicants, persistent patent applicants, occasional patent applicants and non-patenting firms. Moreover, three different categories of patent applicants have been distinguished: firms that have filed patent applications in Finland, those that have filed with the European Patent Office (EPO), and firms for which patents have been granted in the US.

Firms that have commercialised five or more innovations during the 1980–1999 period are here called intensive innovators.[7] Firms that have commercialised more than one but less than five innovations during this period are called persistent innovators. And finally, firms that have commercialised one innovation during this period are called occasional innovators or innovators with one innovation.

It is easy to characterise the most intensive innovators. Most of them are large firms. But how to characterise the less intensive innovators or innovators with one innovation? What kind of firms are they? In the analysis following this introductory description the main interest is focused on this last category.

Innovators with an innovation in 1996

The follow-up of persistent innovators and innovators with one innovation over years can be made by cohorts. As an example, we can consider all the innovators that have commercialised an innovation in 1996 according to the Sfinno Database. The focus here is on what has happened to these companies before the year 1996 and how they can be characterised before and after this year.

There are 79 companies that are followed here. Eleven (14%) of them have filed patent applications intensively or persistently before 1996. It is unclear whether these companies are really occasional innovators. Therefore they will be considered separately in the following.

In all, 33 (42%) of these innovators with one innovation are included in a CIS sample as innovators. In addition, 22 (28%) of them have R&D activities according to the

[6] Non-innovating firms are not included in Sfinno

[7] If we use the 1985-1999 period we get approximately the same results.

combined R&D surveys before the commercialisation. These both groups include all the eleven patenting firms mentioned above except one. When we exclude these 11 companies, we observe that there are still 25 companies among these small innovators that are subsidised by Tekes before the commercialisation. It means that almost a half of them have been customers to Tekes before the introduction of an innovation.

We could therefore set a hypothesis for the innovators with one innovation that being the customer to Tekes increases their propensity to commercialise an innovation afterwards. It seems that the data on the in-house R&D or patenting behaviour of these companies does not correlate with their Tekes customership. This observation may, however, result from the fact that the R&D activities of the smallest firms are unknown in R&D surveys. In addition, only quite a few of the smallest companies have applied for patents. This may explain why the patenting behaviour does not correlate with their R&D collaboration subsidised by Tekes.

Three of these companies under consideration (N=79) have been targets in acquisitions before the commercialisation, five after it. We can further observe that 25 (almost one third) of these companies have closed down according to the Business Register. This closing down means here that their IDs are not existing anymore in the register a few years after the introduction of an innovation. About six of these vanished companies have been purchased by other companies. About a quarter of the small innovators that have commercialised an innovation in 1996 and that were subsidised by Tekes were closed down within seven years. These observations based on registers recordings will, however, give only a faint clue to what has really happened to these companies. We will return to this question later. Next we will have a closer look at the event histories of the innovators with one product innovation by considering all their commercialising years simultaneously.

Sfinno firms (N=878) linked with other data sets

About **40** per cent of occasional innovators and **70** per cent of persistent innovators have in-house R&D activities according to the unweighted R&D samples. About the same percentages of occasional and persistent innovators (i.e. 40% and 70% respectively) have filed patent applications in Finland.

These percentages are not much affected even if we consider all the patenting activities, i.e. also applications filed with the EPO and patents granted in the US. It seems that the previously known in-house R&D activities and patenting activities do not give any anticipating signal for the future market introduction of an innovation for the majority of occasional innovators. But this information or the previous innovation behaviour in general seems to do so for persistent innovators. It is perhaps safe to argue that the propensity to innovate is higher among companies that have innovated already earlier.

The aforementioned percentages for occasional and persistent innovators can approximately be reached again when comparing the Sfinno and CIS data sets over time. Almost **40** per cent of the occasional innovators and **70** per cent of the persistent innovators of the Sfinno Database are included as innovators in the union of CIS samples comprising the innovators and non-innovators of the 1991, 1996, 1998 and 2000 CIS Surveys.

In all, **36** per cent of occasional innovators and **60** per cent of persistent innovators are included in the Tekes data on collaborative innovators. The Tekes data on publicly subsidised collaborating firms include most of all innovators that have only one innovation in the Sfinno database, and innovators that are not included in the Sfinno database.

Almost a half (45%) of the Tekes firms are included at least once in a CIS Survey as innovators. This also suggests that most of the Tekes firms are small innovators that are not included in the Sfinno Database or in the CIS Surveys.

Quite remarkable shares (13–14%) of intensive and persistent innovators are potential spin-offs from larger companies. What is also interesting, these innovations have quite seldom been developed by the spin-offs but rather by their predecessors, their parent companies. When studying the impacts of firms' age and size on the propensity to innovate, this should be taken into account.

Eight per cent of innovators with one innovation are potential spin-offs. The corresponding share for all start-ups varies around 10 per cent in the 1990s. In the group of intensive innovators almost **70** per cent are purchasers and almost **80** per cent are targets in acquisitions. This strongly suggests that business restructuring is an inseparable part of intensive innovation activities.

Slightly more than eight per cent of occasional innovators and one third of persistent innovators have purchased other companies in the 1990s. About eleven per cent of occasional innovators and somewhat fewer than one third (29%) of persistent innovators have been targets in firm acquisitions.

R&D performing firms (N=1,986) linked with other data sets

About **80** per cent of firms that have in-house R&D activities have never introduced any visible innovations to the market according to the Sfinno database. When they have commercialised an innovation they have done so once rather than persistently.

More than **60** per cent of the R&D performing firms are included in a CIS Survey at least once and most of them have responded that they have introduced product or process innovations or have abandoned or ongoing R&D projects. Only quite a small number of firms (9%) have responded that they do not have at the moment any of the aforementioned activities.

About **40** per cent of the R&D firms are included in the Tekes data on collaborative firms. It should be noted, however, that here the number of R&D firms includes several companies that do not exist simultaneously. The total stock of R&D performing companies in any year is smaller than the number of all R&D performers in R&D surveys over years.

Slightly more than one fifth (22%) of the R&D performing firms have filed patent applications intensively. The percentages of persistent and occasional patent applicants are lower. Firms that have filed a patent application will most likely do so in the future, too.

Twelve per cent of R&D firms are potential spin-offs from larger companies and this rate clearly exceeds the average share of spin-offs among start-ups in Finland in the 1990s. About fourteen per cents of R&D firms have purchased other companies and almost one fifth of them have been targets in acquisitions.

Firms that have filed patent applications (N=3,599) linked with other data sets

Almost **30** per cent of intensively patenting companies are included in the Sfinno Database, more than a half of them belong to the group of occasional innovators. On the other hand, as seen in Table 1.2 (Appendix), about **60** per cent of innovators with one innovation have not filed any patent applications. The same percentage is valid for R&D activities, too. As seen in Table 3.2 (Appendix), R&D activities are not known for about **60** per cent of occasional patent applicants. As mentioned before, it seems that patenting and in-house R&D activities cannot be used as anticipating signals for the future innovation commercialising behaviour of occasional innovators – and here of the occasional patent applicants.

It follows from this that intensively and persistently patenting companies should be treated as special cases among occasional innovators. Their propensity to introduce an innovation to the market is probable higher than that of the other innovators with one innovation.

Almost **60** per cent of the intensively patenting firms have in-house R&D activities. This percentage can be even higher because R&D samples do not have information on the R&D activities of all the patenting firms.

Intensive patent applicants can be characterised by their activity in the US patent markets. Over half of the intensive patent applicants have received a patent in the US.

The same figure for the persistent patent applicants is only 17 per cent. Occasional patent applicants have almost never been granted a patent in the US, and we can assume that they have almost never applied for a patent in the US.

About a half of intensive patent applicants and a quarter of persistent patent applicants are included in the CIS Surveys as innovators. The same figures concerning the Sfinno Database are about 30 and 10 per cent.

Almost **40** per cent of intensive patent applicants are included in the data on Tekes-funded companies. As seen in Table 3.5 (Appendix), the focus among the publicly funded companies lies more on the occasionally and persistently patenting and innovating companies than intensively patenting and innovating companies in terms of the numbers of companies.

Intensively patenting firms are more often spin-offs from larger companies than less-intensively patenting firms. The share of purchasers and even more so the share of targets in acquisitions is highest among intensively patenting firms.

Firms included in the CIS Surveys (N=5,166) linked with other data sets

The majority of CIS innovators are not included in the Sfinno Database indicating the fact that the majority of innovators have not introduced any major product innovations into the market. The largest group of CIS innovators included in Sfinno are innovators with one innovation: about 10 per cent of all the CIS innovators belong to this category.

One can assume that most of the CIS innovators are occasional innovators (in terms of major innovations). As seen in Table 1.1 (Appendix), almost **40** per cent of occasional innovators in the Sfinno Database have in-house R&D activities. The same holds true for all CIS innovators: about **40** per cent of them have in-house R&D activities.

About **30** per cent of CIS innovators have filed domestic or other patent applications. This share is smaller than the corresponding share of patenting firms among occasional innovators in the Sfinno database. This finding also supports the view that CIS innovators are above all occasional innovators.

Around 37 per cent of CIS innovators are included in the Tekes data on collaborating firms. About 10 per cent of CIS innovators are spin-offs from larger companies. We can thus observe that the samples of R&D firms include relatively more spin-offs (12% in Table 2.6, Appendix) than the samples of CIS firms in the 1990s.

Twelve per cent of CIS innovators have purchased other companies, the corresponding figure for R&D firms is 14 per cent. About 18 per cent of the R&D firms and 16 per cent of all Sfinno firms and 13 per cent of CIS innovators have been targets in acquisitions.

Firms included in the 1991, 1996 and 2000 CIS data linked with other data sets

Occasional innovators are the largest group in the CIS1 Survey (N=858) after the firms that are not included in the Sfinno database. This is even more so in the CIS2 Survey (N=1,989). The CIS3 Survey (N=1,637) has almost the same share of occasional innovators included in Sfinno than the CIS1 Survey (9.6%).

More than a half (52%) of the CIS1 innovators have in-house R&D activities. This share has steadily decreased from the CIS1 Survey to the CIS2 Survey and from the CIS2 to the CIS3, where the share of CIS innovators having in-house R&D activities is 47 per cent.

It should be kept in mind that these shares do not represent the population of innovators. They are unweighted figures based on the comparison of the separate longitudinal data sets, which comparison is the aim of this introduction. In addition, one should notice that an increase in the share of "R&D activities not known" innovators in the CIS3 Survey should be understood in relation to information given by the R&D Surveys. The in-house R&D activities of innovators are, of course, known in the CIS data itself.

About **44** per cent of the CIS1 innovators have filed patent applications. The corresponding figure for the CIS2 innovators is 37 per cent and for the CIS3 innovators 34 per cent. These figures correspond closely to the shares of patenting firms among the occasional innovators in the Sfinno Database (**43**%).

In all, 26 per cent of the CIS1 innovators are included in the Tekes data on collaborating firms comprising the years 1993–2000, the same figure for the CIS2 Survey is 31 per cent and for the CIS3 Survey 38 per cent. The increase in the share of Tekes firms, from the CIS2 Survey to the CIS3 Survey, emerges from the increasing panel shares of innovative firms in the CIS Surveys.

Not surprisingly, only about 5 per cent of the CIS1 innovators are spin-offs from larger firms. The same figure for the CIS2 Survey is 11 and 14 per cent for the CIS3 Survey. The real increase in the number of spin-offs over years is not equal to this amount; part of the increase comes from the increased statistical noise in the register-based identification of spin-offs.

Conclusions from the preliminary considerations

In this introductory analysis we first of all separated the intensive, persistent and occasional innovators. In addition, the occasional innovators that have filed patent applications intensively or persistently (N=224) were treated separately. The intensively patenting firms can also be characterised by their patenting in the US. Most of the innovators included in the Sfinno Database are innovators with one major innovation. This is even more so in the combination of all CIS Surveys and in the Tekes data.

4.2 The Sfinno Database

Distribution of innovators

The performance of innovators, counted as the number of product innovations per firm, is highly skew. In the Sfinno database:

- Three per cent of innovators introduced 20 per cent of innovations,
- 15 per cent of innovators introduced 25 per cent of innovations, and the vast majority,
- 82 per cent, introduced 55 per cent of innovations and only one (known) innovation per firm.

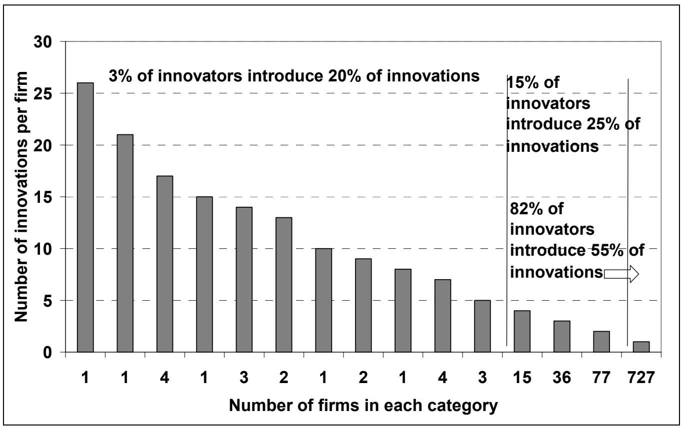


Figure 1. Number of innovations per firm in certain categories, the Sfinno Database.

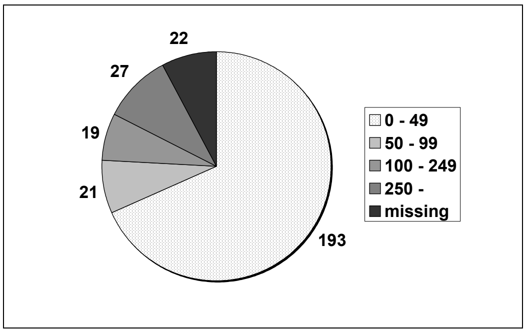
The distribution of patenting firms by the number of patent applications is even more skew than the number of innovations: three per cent of applicants have applied for **60** per cent of patents and **90** per cent of applicants for five patents at the highest.

Innovators with one (known) product innovation

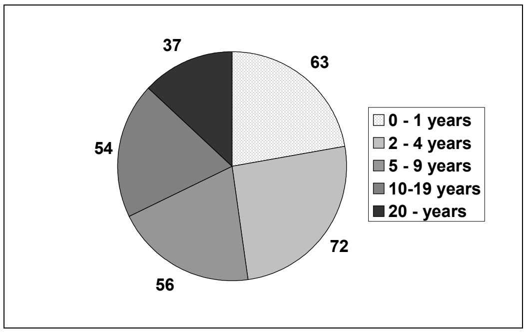
Before its recent extensions, the Sfinno Database contained a total of 794 firms.[8] Of them 664 were firms with one innovation and 130 firms had commercialised several innovations. Of the last mentioned 22 had commercialised its first innovation after 1995. This group is too small for separate analysis. The following study concerns only such firms that have only one innovation in the Sfinno Database in 1995 or after it. Restricting to the latter half of the 1990s is necessary due to the limited availability of other data. The study includes information on turnover, age and firm acquisitions for 282 firms, on other variables for 292 firms.

Age at the time of commercialisation

A fairly substantial share (63 firms or 22%) of the analysed 282 firms had entered the market along with the commercialisation of an innovation. According to the Business Register, their age in the year of commercialisation was 0 to 1 years. Seventy-two firms (26%) had come to the market 2 to 4 years before commercialisation. Thus nearly one half (48%) of the examined Sfinno firms have entered the market less than five years before the commercialisation of the innovation. However, it should be considered here that the age calculated from the year when the firm is recorded in the tax authorities' register is often shorter than the real age of these firms.



Age



Number of personnel

Figure 2. Innovative firms (N=282) in the Sfinno Database with one product innovation, breakdown by age & by the number of personnel.

In the year of commercialisation 56 firms (20%) were aged 5 to 9 years and 54 (19%) were 10 to 19 years. The remaining 37 (13%) were 20 years old or older in the year of commercialisation. Of the innovative firms 22 were potential corporate spin-off firms. Their median age was 5 in the year of commercialisation.

[8] Here the examination concerns only such firms in the Sfinno Database whose Business ID and first year of business are known and that have commercialised an innovation after 1985.

Size at the time of commercialisation

Most (193, 68%) of the Sfinno firms with one known innovation employed fewer than 50 persons in the year of commercialisation, while the groups of 50–99, 100–250 and 250- employees each had around 20 to 27 firms (7–10%). It still needs to be emphasised that this distribution does not describe the size distribution of all Sfinno firms but only of those that are known to have commercialised a product innovation only in one year in 1995 or after it.

Over 90 per cent of the firms in the study are SMEs because firms with missing information on the number of personnel (in the Business Register) are small firms that have just started operation.

According to Palmberg (2002a), a surprisingly large share of innovations originate from the smallest size groups covering firms with fewer than 100 employees (here 48 per cent of the innovations). This is also confirmed by firm-level innovation surveys, where a growing share of innovations is observed to have originated from the smallest firms.

Industrial sector at the time of commercialisation

In Sfinno, the largest share of innovations is concentrated on the machinery sectors, but also on the electronics, metals and metal products. A relatively large share of innovations originating from the software sector can also be detected. These firms tend to be smaller and more technology-oriented in their innovative activities compared with firms in the manufacturing industries (Toivanen 2000).

The large and growing share of software innovations originating from small firms, both in the software and other sectors, points towards a new pattern of innovation where the software content of innovation in manufacturing is increasing and providing new innovation opportunities across all sectors (Pentikäinen et.al. 2002).

The largest share of innovation in Sfinno is commercialised by high-medium technology firms. Almost 50 per cent of the significant and non-significant innovations belong to high technology, 40 per cent of the significant and 27 per cent of the non-significant to low technology and 10 per cent of the significant and 25 per cent of the non-significant to KIBS (Hyvönen 2002). A non-insignificant share of the innovations has their origin in the more traditional metals, metal products, foodstuffs and forestry-based sectors.

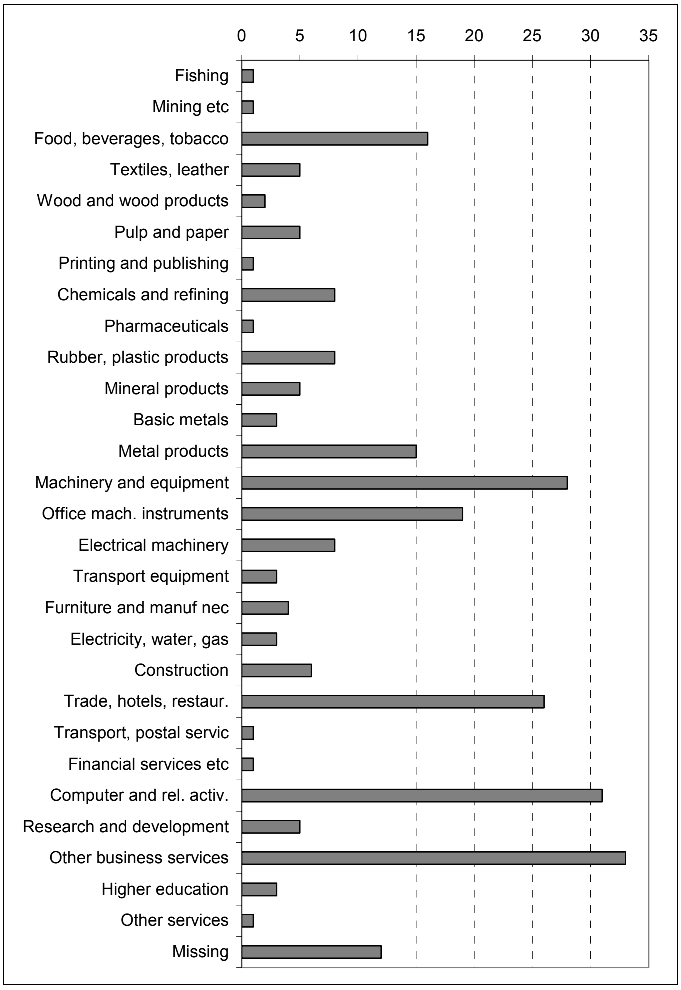


Figure 3. Innovative firms in the Sfinno Database with one product innovation (N=282), breakdown by industry.

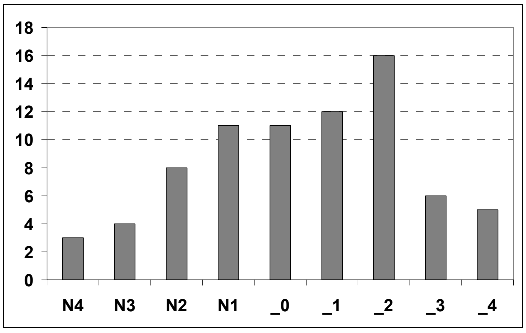
Survival of firms

Only one of the examined product innovators (out of 282) had ceased operation by the year 2001 without being acquired by anyone. According to the Trade Register data even it had merged with another company in 1999. The criterion used here for acquisition was the mobility of personnel from one firm to another. If over 50 per cent of firm 1's personnel move from firm 1 to firm 2, firm 2 is defined as having acquired firm 1. If this share is close to 100 per cent, it may be the same or nearly the same firm, but with a changed Business ID. Some big companies have changed their Business IDs when they get listed in the stock exchange and make some corporate arrangements in that connection. Then they cannot exactly be considered as the same firm anymore. In the examined group of firms there are hardly any of such big corporations.

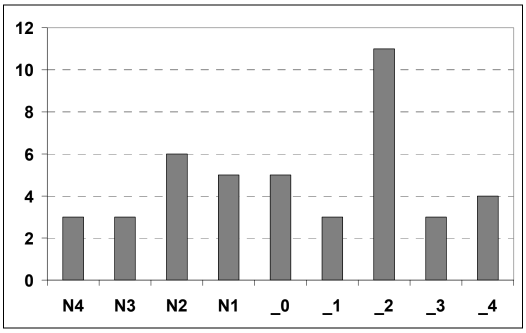
Firms as targets in acquisitions

According to the Talouselämä magazine information on firm acquisitions, 35 (12%) of the examined 292 product innovators were targets in acquisitions of majority shareholding, in a total of 43 separate transactions. (In the CIS data this figure was 10%). The firms acquired included only those aged under five years, of which 28 were one year old and seven two or three years old.

Similarly as for the innovators based on the CIS data, the innovators included in the Sfinno data are mostly firms that are targets in firm acquisitions a couple of years after the innovation was introduced to the market. This rise in activity can be explained by that the firm self wants to be acquired by others or that information on the firm's promising innovation is already on the market at this stage.



Acquisitions



Acquirers

Figure 4. Innovative firms in the Sfinno Database with one product innovation (N=292), the number of acquisitions & acquirers around the commercialisation year _0.

Firms as acquirers

When the information in the Talouselämä magazine is combined with the Business Register data it is found that in the examined period (t-4,..,t+3) nine per cent of product innovators (25 innovators, in total 71 times) were acquirers of majority shareholding in firm acquisitions. Small and medium-sized innovative firms purchased the highest numbers of other firms two years after they commercialised a new product innovation. This observation indicates that the introduction of an innovation to the market involved some corporate arrangements, such as establishment of a new firm and purchase of another firm's business activity or part of it into this new company. Acquirers also include a few potential spin-off firms, when the criterion used for spin-offs is that used in the Nås et al. report (2003).

Receptions

When examining mergers based on the information of the tax authorities and the National Board of Patents and Registration of Finland the number of receptions (of units received, not necessarily whole companies) is highest a few years before the year of commercialisation, but it is relatively great even in that year. This would indicate that innovative activities are fused to the existing firm or that the merger has an effect on the innovation activities of the firm formed by the merger.

In all, the number of receivers (with receivers' IDs) in the data is 29 in the period in question. The number of receptions (where establishments or other units were moved) is 60 during that period. Several units may be detached from one firm and they can fuse into one or several firms.

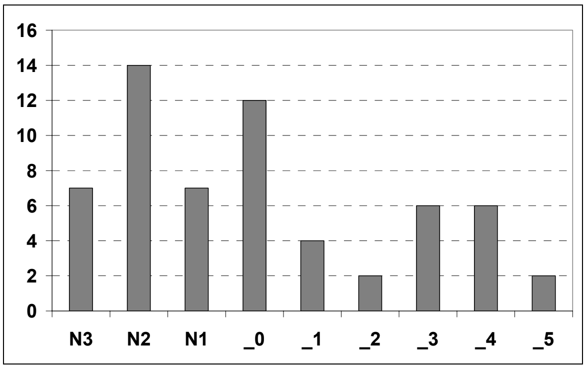
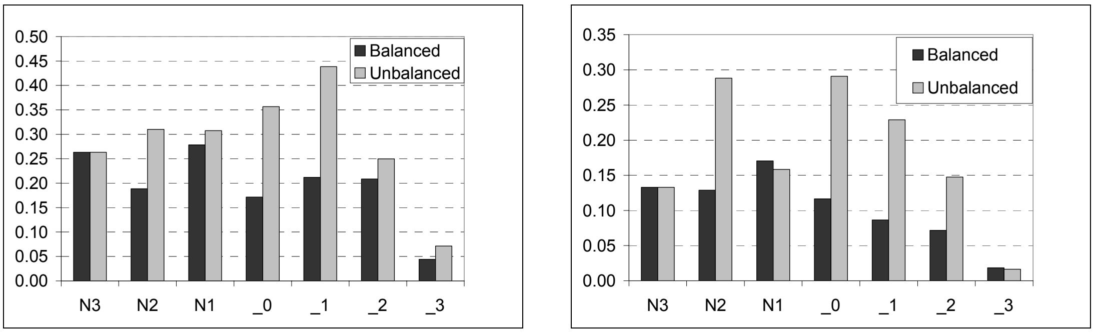


Figure 5. Innovative firms in the Sfinno Database with one product innovation (N=292), the number of merged units around the commercialisation year _0.

Annual growth of turnover

The percentage annual growth of the firm's turnover is understandably highest for new business starts. Because around one half of the studied innovative firms started operation less than five years before their first product innovation, their annual growth of turnover is highest close to the starting years, before the commercialisation of the innovation. For innovators included in the Sfinno Database the firms' average growth of turnover lowers in the year of commercialising the product innovation but differing from the innovators in the CIS data, the average annual growth of turnover does not diminish within a couple of years following the commercialisation. For small innovators participating in new collaboration projects the growth of turnover even accelerates clearly two years after commercialisation.[9]

[9] Balanced panels of innovators are considered here.



Growth rate of turnover **Growth rate of the number of personnel**

Figure 6. Innovative firms in the Sfinno Database with one product innovation (N=282), the average annual growth rates of turnover & number of personnel around the commercialisation year _0.

When trying to separate the growth effect of the innovation from that of the firm start-up, we need to look at the balanced panel of innovators. If firm entries are allowed during the panel years (unbalanced panel), it is found that new innovators have a substantial effect on the average annual growth rate of turnover and that it is clearly highest one year after commercialisation.

Average annual growth rates of the number of personnel have neither accelerated after the commercialisation of the product innovation, as could well have been imagined. In the case of the examined small product innovators only new start-ups (unbalanced panel) bring with them a clear growth impact of employment both a couple of years before commercialisation and in the year of commercialisation and a few years after it.

Tether has also examined the growth diversity among innovative and technology-based new and small firms (Tether 1997) and found out that the distribution of employment creation is highly skewed: a small number of firms are responsible for providing the bulk of the new employment. The mean rate of direct employment creation among innovative and technology-based new and small firms has been modest. Studies in the other European countries have reached similar conclusions. Feeser and Willard (1990) found, for example, that in the US computer industry high growth firms were more likely than slow growth firms to have been established by large management teams and to be exporters. It should be stressed that low growth firms are not necessarily failing firms.

It has been suggested that managerial and marketing competencies distinguish ‘successful’ fast growing companies from their slow growing counterparts. As pointed out by Tether, this kind of ‘barriers to growth’ approach ignores the relationship between the firms and their technology bases. This should not be interpreted as suggesting that the technology base of the firm determines its future growth path. It may rather facilitate the growth. Small firms can often eschew rapid growth because their capabilities and competencies are difficult to acquire.

Pavitt's work suggest that small firms tend to be either supplier dominated, specialist suppliers or more science-based, occasionally and especially during the emergence of a new technological paradigm. Tether provides three broad types of innovative or technology-based new firms: new generic technology-based firms, new, niche market specialist TBFs, and new opportunist design concept-based firms. New generic technologies provide opportunities for the establishment of new firms by individuals with expertise in the emerging technologies. According to Tether, these technologies and the firms participating in their development, tend to undergo a distinct process of evolution.

Innovators with many innovations

As quite credible, the average annual growth rates of turnover are higher for firms having commercialised several innovations than only one innovation. The time profile of average annual growth rates of turnover around the first innovation after 1994 is similar as above: the product innovation does not accelerate the average annual growth rate of turnover compared with the previous years. [10]

However, the average annual growth rate of the number of personnel escalates for these firms in the year of commercialisation and one year before it, the average growth rate being then about 10 per cent a year, while it is for firms with one innovation around 10 to 15 per cent. On average, the personnel increases by 15 per cent a year in firms that have Tekes-funded collaboration projects with other firms or universities. The turnover of these firms also grows faster than that of firms with several commercialised product innovations that are not involved in the R&D collaboration projects. For these firms the number of new collaboration projects reaches its peak in the year t+3 calculated from the first innovation since 1994.

The number of domestic patent applications also grows fairly evenly in this examination group already ten years before the year of commercialisation.

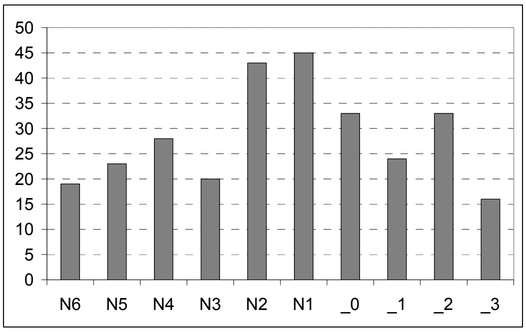
To sum up: What has thus happened before commercialisation of innovation to the Sfinno firms with one innovation, of which over 90 per cent are SMEs? Registers and statistical data disclose the birth mode of the firms (a considerable number are spin-offs of larger firms or research units), rise in recruiting of highly educated personnel and increase in research and patenting activity.

[10] This is probably due to the age and relative small size of the examined enterprises.

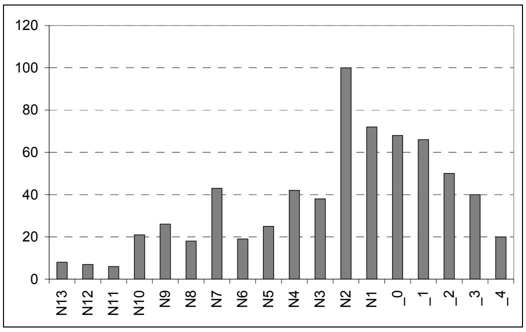
Patenting activities

We now proceed to consider, what happened to these Sfinno firms after the commercialisation. Among the SMEs under examination the number of patents granted in the US starts to grow clearly only after the year of commercialisation, similarly as the number of started Tekes-funded collaboration projects. The number of collaboration projects starts reach its peak around two years after commercialisation but it is high throughout the period (t-1,..t+2).

The peak in the number of domestic patent applications (for those firms that patented in the period (t-4,..,t+3)) is two years before the year of commercialisation but the number of patent applications continued high for two years after it. This corresponds to the average break-even period. After that the patenting activity of these firms with one product innovation falls clearly. This result differs slightly from the result based on the CIS firms, where the peak in the number of domestic patent applications takes place in the assumed year of commercialisation, i.e. in the middle year of the reference period. It would appear that the increased activity of domestic patenting could be used in anticipating commercialisation unless some other firm (changing of the firm into a new one) is the applicant for the patent in the future.



Innovative firms



More than five years old innovative firms

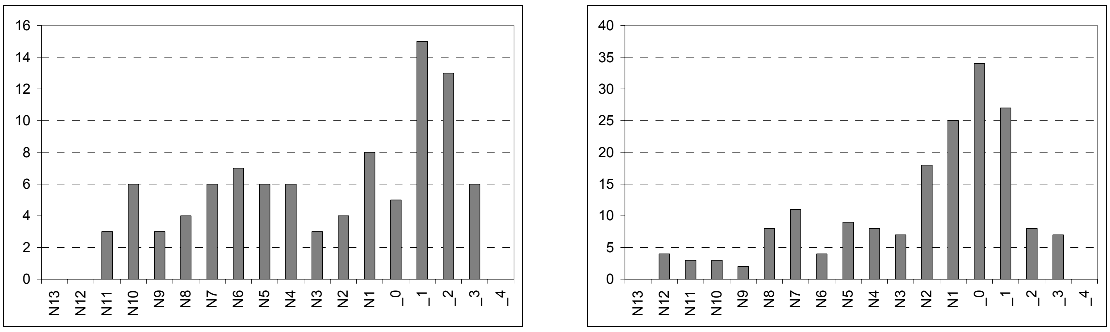
Figure 7. Innovative firms (N=292) & more than five years old innovative firms (N=48) in the Sfinno Database with one product innovation, the number of domestic patent applications around the commercialisation year _0.

If we examine the patenting activity of over five-year-olds innovators (48 SMEs), it can be seen that the number of firms' domestic patent applications grows clearly one year before the commercialisation of the innovation and reaches its peak in the actual year of commercialisation. Can thus the market introduction of the innovation be anticipated by growth in patenting activity? Is it one determinant for commercialisation? This is one of the questions considered in the report by Lehtoranta (2005b).

During the period in question the number of innovators applying for a domestic patent is 98, that is, around one third (34%). These firms have filed a total of 476 patent applications.

The number of EPO patent applications linked to the Sfinno Database by firm also has a clear peak around the year of commercialising the innovation. EPO patents are applied mostly between one year before and one year after the year of commercialisation. Increased activity of EPO patenting may possibly also be used in anticipating commercialisation. In the period (t-4,…,t+3) the number of innovators applying for EPO patent is 49 (17%) and the number of applications is 134.

The number of patents granted in the US probably cannot be used for anticipating commercialisation. Similarly as with innovations based on the CIS data, their peak is one to two years after the year of commercialisation. In the examined group the number of patents granted in the US is 60 and that of firms 28.



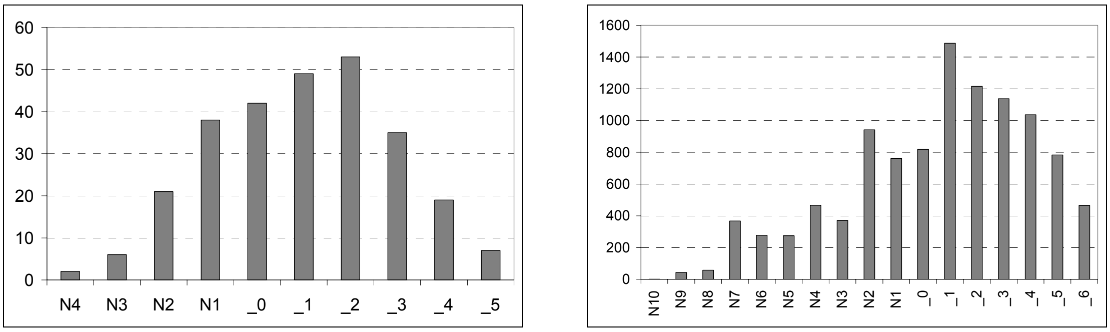
EPO patent applications **Patents granted in the US**

Figure 8. Innovative firms in the Sfinno Database with one product innovation, the number of EPO patent applications & number of patents granted in the US around the commercialisation year _0.

Recruitment activities, collaboration activities

The average recruitment activity (inflow of personnel) grows clearly close to the commercialisation year. Similarly, recruitment of highly educated personnel increases notably. The biggest recruitment activity peaks for product innovators are in the year of commercialisation t and in the year t-2. The inflow of highly educated employees reaches its top level one year after the commercialisation. The number of new collaboration projects attains its peak in the years t+1 and t+2.

The increasing recruitment activity of highly educated personnel to new and especially to new technological firms gives a fairly clear signal of that those firms or new firms to be established around them will commercialise a product innovation in the coming years. However, it may be the case that this innovation is no longer commercialised in Finland. If the firm moves its activity or product development outside Finland, the innovation is evidently not visible as a Finnish innovation in Sfinno and the CIS.



Inflow of highly educated personnel **Number of new starting R&D projects**

Figure 9. Innovative firms in the Sfinno Database with one product innovation, the inflow of highly educated personnel & the number of new starting R&D collaboration projects around the commercialisation year _0.

4.3 CIS Surveys

In the following, we concentrate first of all on firms for which the CIS Surveys have information only on one product innovation[11] over their whole lifetime until the year 2000. The distinction between periods before and after the commercialisation can be more clearly implemented for these firms.

After that we have a short look on companies that have several product innovations over the years in the combined CIS Surveys. It should be noted that all these companies might also have process innovations during the same time periods.[12] Companies having only process innovations are also considered briefly.

The main difference between firms having only one known innovation over years and firms having more than one innovation is that the first-mentioned firms are smaller and younger. In this group there is, however, a certain number of older innovative firms as well.

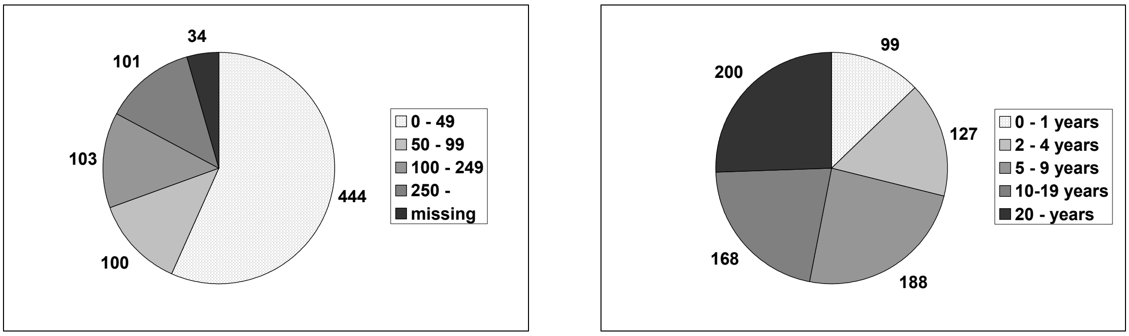
Similarly as in Section 4.2, the main question concerning firms with one known product innovation is what has happened to these companies before and after the commercialisation.

[11] If there are many product innovations in a year, they are interpreted here as one and the same innovation.
[12] CIS Surveys refer to three-year long time periods. The 1998 CIS Survey (CIS2.5) is excluded from the calculations when the numbers of product innovations over years were counted so that there would be no double-counting, due to the fact that the CIS2 and CIS3 Surveys covered partly the same reference years as CIS2.5.

Age at the time of commercialisation

There are 782 innovative firms with one (known) product innovation in the year 1995, 1997 or 1999 included in the examination. Quite a considerable number of them (99 firms, or 13%) had entered the market along with the commercialisation of the innovation (age 0–1 years), while 127 firms (16%) had entered the market 2 to 4 years before commercialisation.

In all, 188 firms (24%) were 5 to 9 years old in the commercialisation year of the innovation, while 168 (21%) were aged 10 to 19. The remaining 200 (26%) were aged 20 or older at the time. It must again be noted that age is here calculated from the year the firm is recorded in the tax authorities' register, not from its actual starting year. The age distribution is presented in the figure below.



Age **Number of personnel**

Figure 10. Innovative firms in the Community Innovation Surveys (CIS) with one product innovation (N=782), breakdown by age & by the number of personnel.

Among CIS firms with one product innovation in 1995 or after it potential spin-offs or outsourced firms[13] number 77, most of them (69) being under five years old in the year of commercialisation. Their average age is around two years in the year of commercialisation. When starting 45 of them had fewer than 100 employees. At least these 45 (20% of under five-year-olds innovators) can be considered as apparent spin-offs of larger companies.

Most of the innovative spin-offs start 3 to 4 years before the commercialisation of the innovation but according to the register entries quite often in the year of commercialisation as well. It is also possible – and quite probable – that the register entry (in most cases the taxation register) is slightly behind the actual starting year.

[13] The Nås et. al. (2003) criterion has been used here.

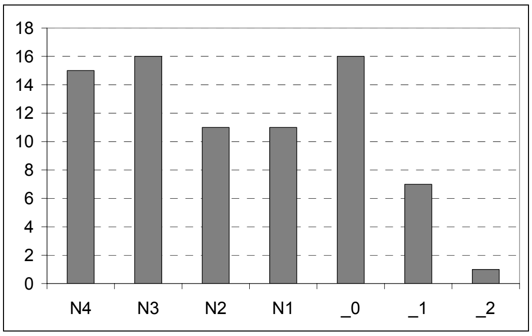


Figure 11. Innovative firms in the Community Innovation Surveys (CIS) with one product innovation (N=782), number of outsourced firms and spin-offs around the commercialisation year _0.

Size at the time of commercialisation

Most (444, 57%) of the CIS firms with one (known) innovation were companies with under 50 employees in the year of commercialisation, while the groups of 50 to 99, 100 to 250 and 250- employees each included around 100 firms (13%). This distribution does not describe the size distribution of all CIS firms but only of those known to have commercialised a product innovation or a product and process innovation only in one year. This condition limits the examination mainly (around 80%) to SMEs.

Industrial sector at the time of commercialisation

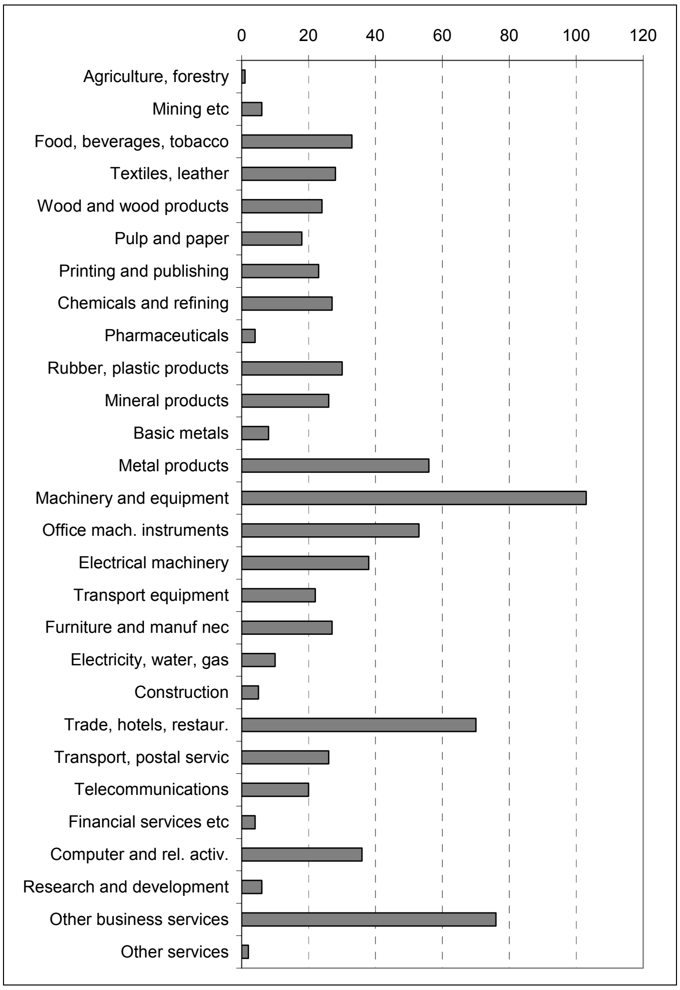


Figure 12. Innovative firms in the Community Innovation Surveys (CIS) with one product innovation (N=782), breakdown by industry.

Survival of firms

Only two per cent of the product innovators under examination (15 firms out of 782) had finished operation by the end of 2001 without being acquired by anyone and four per cent (31 firms) had ended business because of acquisition or because they had been merged to another company. The criterion used here for acquisition has been the mobility of personnel from one company to another: if over 50 per cent of firm 1's personnel move from firm 1 to firm 2, it is defined that firm 2 has acquired firm 1 (successor of firm 1). If this share is close to 100 per cent, it may be the same or nearly the same firm but with a changed Business ID. Some big companies have changed their Business IDs when they get listed in the stock exchange and make some corporate arrangements in that connection. Then they cannot exactly be considered as the same firm anymore. In the examined group of firms there are hardly any such big corporations.

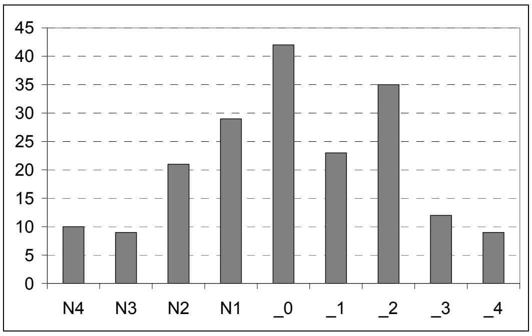
Of dead firms two were aged two years, four between 2 and 4, as were four aged between 5 and 9 years and five were over 10 years old. In total, 15 of the innovators mentioned in the CIS data were dead (19%). Of the purchased firms (most of personnel moved to another firm) in five personnel had moved to another firm in the year of acquisition. One had been purchased at the age of one year, and three while aged 2 to 4 years and six at the age of 5 to 9 years. The rest of the acquired firms were older than 10 years.

One of the dead firms was a potential spin-off firm. Among the purchased firms there were two potential spin-off firms with fewer than 100 employees. They were aged under four years in the year of commercialising the innovation.

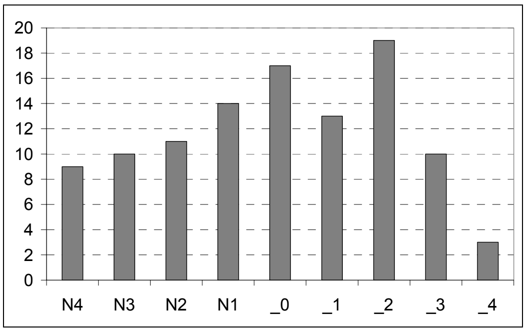
Firms as targets in acquisitions

Ten per cent of the examined product innovators (75 firms outs of 782, a total of 103 times) were targets in firm acquisitions, i.e. in selling of majority shareholding as indicated by the information given by the Talouselämä magazine. Of the firms targeted in acquisitions most (29%) were aged under five years, the same figure (29%) were aged over 20 years, the next most were aged under 5 to 9 years (25%) and the least (17%) were aged 10 to 19.

The activity for being targets in firm acquisitions rises clearly near the year of commercialisation. The highest number firms were targets in firm acquisitions can be found a couple of years after the innovation was introduced to the market. This rise in activity can be explained by that the firm self enters into corporate arrangements or that information on the firm's promising innovation is already on the market at this stage.



Acquisitions



Acquirers

Figure 13. Innovative firms in the Community Innovation Surveys (CIS) with one product innovation (N=782), number of acquisitions & acquirers around the commercialisation year _0.

Firms as acquirers

When the information in the Talouselämä magazine is combined with the Business Register data it is found that in the examined period (t-4,..,t+3) 11 per cent of product innovators (87 innovators, in total 181 times) were acquirers of majority shareholding in the firm acquisitions. Small and medium-sized innovative firms purchased the highest numbers of other firms two years after they commercialised a product innovation. This observation indicates that the introduction of an innovation to the market involved some corporate arrangements, such as establishment of a new firm and buying of another firm's business activity or part of it into this new company. Acquirers also include 13 potential spin-offs, when the criterion used for the spin-offs is that used in then Nås et al. report (2003).

Of the acquiring product innovators nearly one third (27 firms) were aged over 20 years, one quarter (22) less than five years and the remaining 43 per cent were fairly evenly from all the other age groups, the main emphasis being in the youngest ones.

Receptions

The same observation can be made when examining mergers and the number of companies received in them on the basis of the information of the tax authorities and the National Board of Patents and Registration of Finland. Through mergers the number of firms receiving product innovations is highest just in the year of commercialisation.

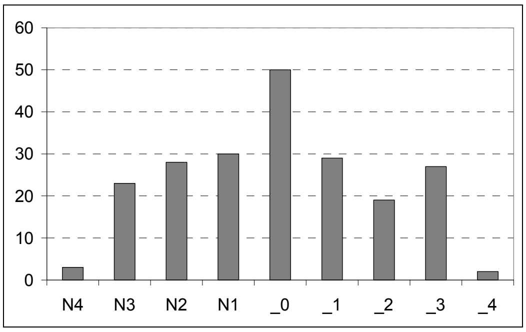
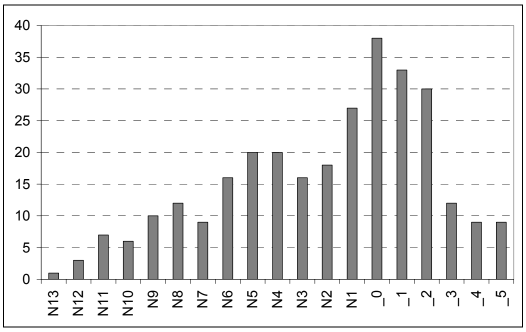


Figure 14. Innovative firms in the Community Innovation Surveys (CIS) with one product innovation (N=782), number of suppliers in mergers around the commercialisation year _0.

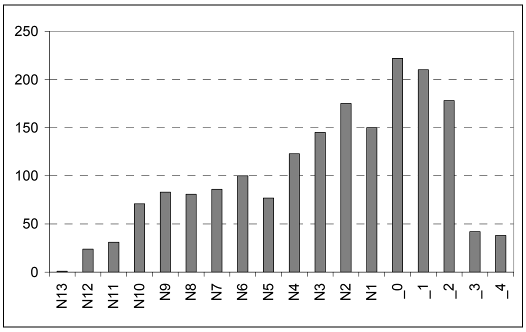
Patenting activity

The peak in the number of domestic patent applications (for the firms patenting in the period (t-4,..,t+3)) occurs in the commercialisation year of the innovation and a few years after it. After that the patenting activity of these firms with one product innovation falls clearly.

If we look at the patenting activity of over five-year-old firms (N=44), it can be seen that the number of the firms' domestic patent applications clearly grows one year before the commercialisation of the innovation, reaching its peak in the year of commercialisation. It can be again asked whether the introduction of the innovation to the market can be anticipated by growth in the patenting activity.



Innovative firms



More than five years old innovative firms

Figure 15. Innovative firms & more than five years old innovative firms in the Community Innovation Surveys (CIS) with one product innovation, number of domestic patent applications around the commercialisation year _0.

In the group examined the number of innovators applying for a domestic patent in the period in question was 200, just around one quarter (25%). These firms have filed a total of 1,245 patent applications in this period. Two thirds, 137, of them are SMEs and their number of patent applications is 480. If we consider only SMEs, the distribution of patent applications around the year of commercialisation is more unclear, possibly partly due to the fact that here the year of commercialisation is defined as the middle year of the reference period.

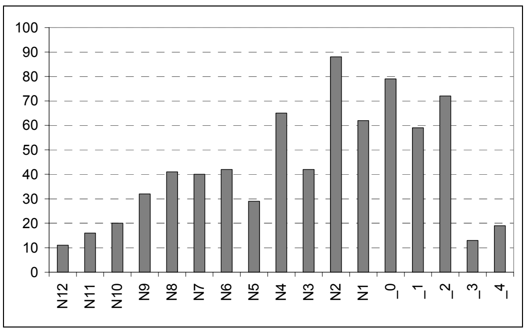
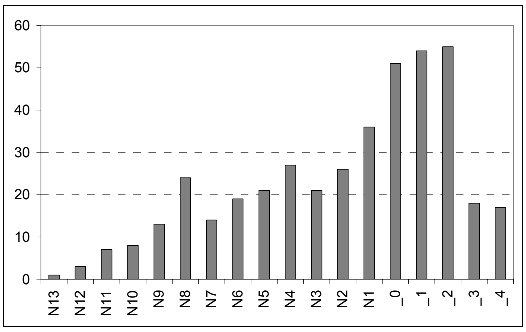


Figure 16. Innovative SME firms in the Community Innovation Surveys (CIS) with one product innovation, number of domestic patent applications around the commercialisation year _0.

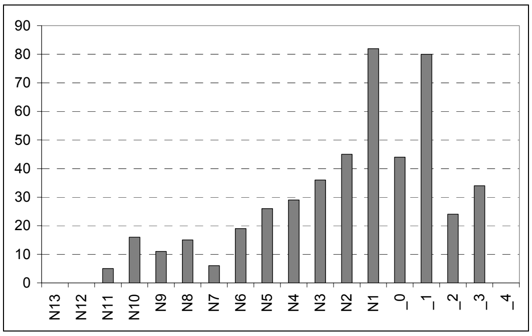
The number of EPO patent applications reaches its peak around the commercialisation year. The highest numbers of EPO patents are applied one year before and one year after the average year of commercialisation.[14] The increased activity of EPO patenting can probably be used in anticipating commercialisation. In the group under examination the number of EPO patent applicants is 95 (12%) and the number of applications is 374 in the period concerned.

In contrast, the number of patents granted in the US probably cannot be used for anticipating commercialisation. Their peak is one year after the year of commercialisation. In the examined group the number of patents granted in the US is 288 and that of firms 66.

The number of patent applications and patents granted does not in fact fall in years t+3 and t+4 as fast as the figures mentioned above led to believe. The low number of patent applications or patents granted in the years in question may be partly caused by that there were no observations yet on all the years mentioned at the time this study was made (problem of truncation). The Figure 18 on CIS2 product innovators with one product innovation in 1995 (= the period 1994-1996) gives a real time profile on the distribution of patents granted in the US to these firms in different years.



Number of EPO patent applications



Number of patents granted in the US

Figure 17. Innovative firms in the Community Innovation Surveys (CIS) with one product innovation, number of EPO patent applications & number of patents granted in the US around the commercialisation year _0.

[14] In the CIS data the reference period is a three-year period, in this study the year of commercialisation is defined as the middle year of the reference period.

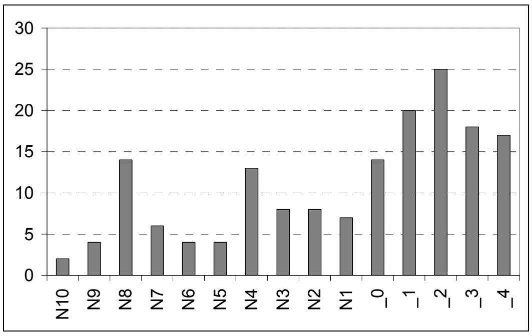


Figure 18. Innovative firms in the Community Innovation Survey CIS2 with one product innovation, number of patents granted in the US around the commercialisation year _0 =1995.

Recruitment activity

The average recruitment activity (inflow of personnel) grows clearly near the commercialisation of the product innovation. Similarly, recruitment of highly educated people increases notably. The biggest recruitment activity peaks for product innovators are in the year of commercialisation t and in the year t-3. The inflow of highly educated personnel reaches its top level in the commercialisation year of the innovation and especially one year after it. The number of new collaboration projects attains its peak in the year t+1 as well.

The increasing recruitment activity of highly educated personnel to new and especially to new technological firms gives a fairly clear signal of that those firms or new firms to be established around them will commercialise a product innovation in the coming years.

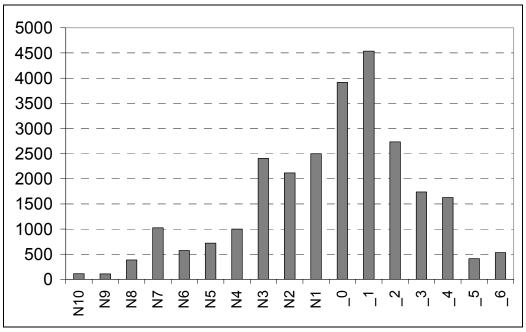
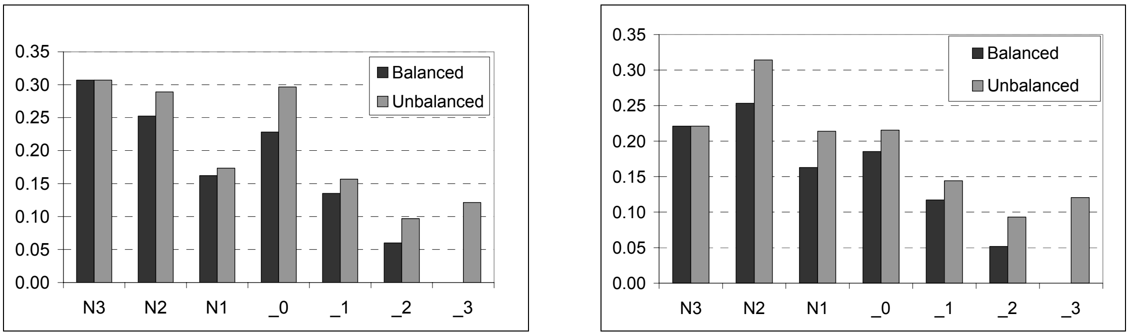


Figure 19. Innovative firms in the Community Innovation Surveys with one product innovation, inflow of highly educated personnel around the commercialisation year _0.

Growth of the company's turnover and personnel (growth dynamics)

The annual growth rate of the firm's turnover is highest for new business starts. Because around one third of the studied innovative firms started less than five years before their first product innovation, their annual growth rate of turnover is highest close to the starting years, i.e. before the commercialisation of the innovation. The firms' average growth rate of turnover is lower in the year of commercialising and it falls further after that.



Product innovation **Process innovation**

Figure 20. Innovative firms in the Community Innovation Surveys (CIS) with one product / process innovation, annual mean growth rates of turnover around the commercialisation year _0.

The same appears not to hold for process innovations: In the year of commercialising a process innovation the firms' turnover grows on average faster than one year before or after the introduction of the innovation. This is particularly evident for firms that commercialised a process innovation but not a product innovation in 1995.

For the above reasons, the average annual growth rate of turnover in the period 4 to 1 years before commercialisation of a product innovation is higher than in the period 0 to 3 years after commercialisation. On average, the turnover of product innovators grows when an innovation is introduced to the market but no acceleration can be seen in this growth rate, rather the opposite. This is clearly visible when we examine the same companies year after year (balanced panel)[15]. If we allow inclusion of new product innovators during the panel years, the average growth rate of turnover will naturally rise distinctly.

A product innovation does not thus, averagely taken (unweighted average), speed up the growth of small innovative firms[16] in the short term but firms are in this respect quite different and an average examination does not do justice to any consideration of changes.

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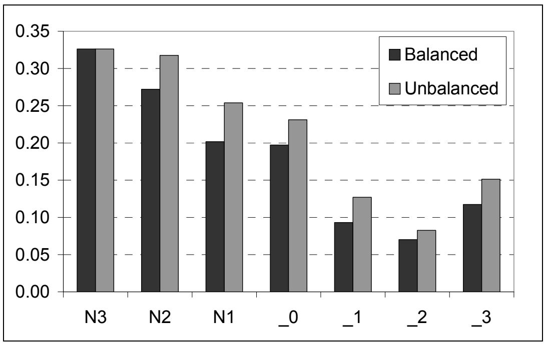
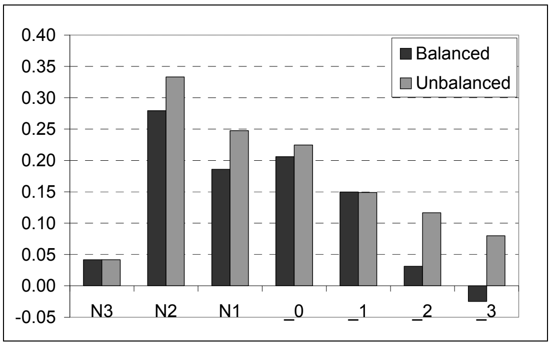
[15] Both unbalanced and balanced panels are built so that firm exits are allowed. Exits are, however, quite rare in the short period under consideration.

[16] Most of the studied firms have fewer than 50 employees.



CIS2 Year _0=1995

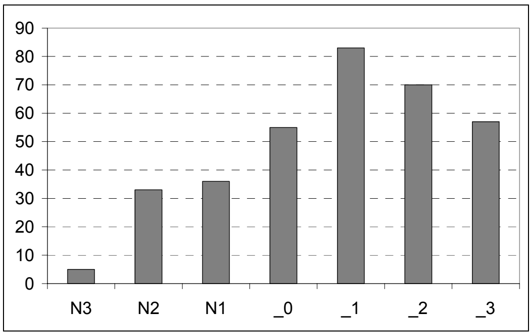


CIS2.5 Year _0=1997

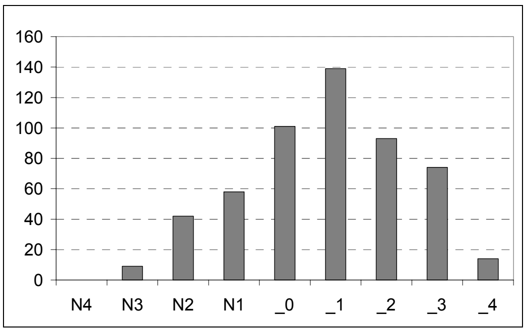
Figure 21. Innovative firms in the Community Innovation Survey CIS2 & CIS2.5 with one product innovation, annual mean growth rates of turnover around the commercialisation year _0.

The examination periods are neither similar as to the image of development they provide. Firms having commercialised their innovation in 1995, which are on average relatively large companies, have increased their turnover in the year of commercialisation as well. This includes fairly strong fluctuations in the volume of turnover on account of recession years and apparent corporate arrangements. The figures mentioned above have been adjusted to describe average organic growth rather than growth through acquisitions: companies whose annual change of turnover is over 5-fold are eliminated from the examination. It is noteworthy that an explanation is not given to all major annual changes in the data, e.g. about acquisitions or mergers.

As evident from the following figure, most of the new Tekes-funded collaboration projects of CIS2.5 innovators were started, on average, one year after the commercialisation of the innovation. The time profile is similar for innovative CIS firms that commercialised a product innovation in 1994 to 1996.



CIS2 Year _0=1995



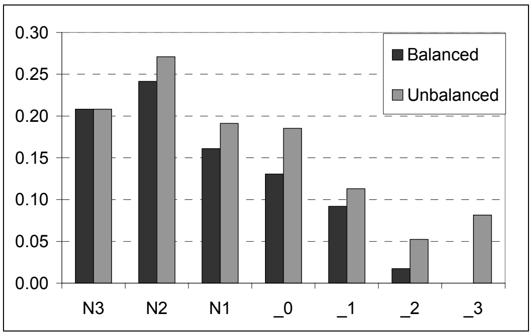
CIS2.5 Year _0=1997

Figure 22. Innovative firms in the Community Innovation Survey CIS2 & CIS2.5 with one produt innovation, number of new starting R&D collaboration projectsaround the commercialisation year _0.

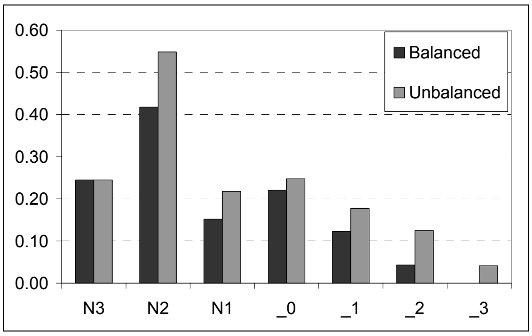
The average annual growth rates of turnover for firms participating in collaboration projects are slightly higher both before and after commercialisation than for non-participating firms. It is to be noted, however, that here no other factors influencing the growth of turnover are taken into account. On average, no acceleration of turnover can be detected after the year of commercialisation.

The average annual growth rate of turnover of potential spin-offs is somewhat intensified in the year of commercialisation of the innovation. High growth rate in the year t-2 is due to the establishing of the spin-off firms. The average age of spin-off firms is around two years in the year of commercialisation.

The average annual growth rates of the number of personnel have neither accelerated after commercialisation of the product innovation, as could have been imagined. The average number of personnel in companies that introduced a product innovation to the market in 1995 had even contracted two years after commercialisation. No corresponding contraction can be seen for those firms that commercialised a product innovation in 1997, where growth was otherwise clearly faster than for those commercialising a product innovation in 1995 or 1999.



Growth rate of turnover



Growth rate of the number of personnel

Figure 23. Innovative spin-off firms in the Community Innovation Surveys CIS with one product innovation, annual average growth rates of turnover & of the number of personnel around the commercialisation year _0.

The average annual growth profile of SME personnel is fairly similar to that of all the firms with one commercialised product innovation included in the study.

Innovators with many innovations

We will last examine whether firms with many commercialised product innovations differ from firms with one innovation. When defining whether the company has commercialised one or several product innovations, information from the CIS2.5 innovation survey concerning the period 1996 to 1998 was not double-counted because the CIS2 survey on the period 1994 to 1996 and CIS3 on the period 1998 to 2000 might have already contained the information on the said period. If the latter surveys did not include the firm under study, the information from the period 1996–1998, i.e. from the CIS2.5 survey will be naturally included.

For firms with several innovations the innovation year t was defined to be the first year after 1994, when the company had introduced a product innovation to the market according to a CIS Survey. The average years of commercialisation for these firms are thus 1995, 1997 or 1999.

In a separate case study it became evident that the above-mentioned firms with one innovation had in several cases launched many other innovations or product families after the innovations based e.g. on fundamental technological breakthroughs. The above firms with one innovation should thus be seen as firms that in the period under review (from the mid-1990s to 2000) were still relatively young, small or for some other reason at the early stage of their journey to innovation.

5. A case study of the fast growing SMEs

In a case study those SMEs and their 'breakthrough innovations' were considered whose mean growth rates in domestic sales turnover were more than ten per cent a year in a three- year period immediately after the innovation and on which there was information in the Sfinno Database or in a CIS Survey. The additional condition for these SMEs is that the turnover of the firm exceeded a limit of FIM one million in the pre-innovation period, and that the turnover increased by at least 50 per cent from the pre-innovation period. The smallest firms are, therefore, not included. The pre-innovation period covered the years t-4,…, t-1 and the post-innovation period the years t+0,…, t+3, where the year t+0 is the innovation year. It is important to notice that data are not necessary existing for all those years when firm-level average turnovers for these both periods were first counted. This means that entries of firms are allowed to take place any year until the year t-1.

There were about 50 of such companies. Their industry breakdown is as follows.

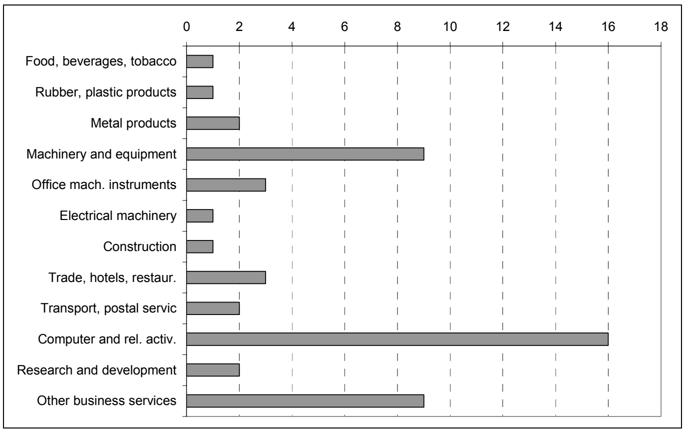


Figure 24. Innovative fast growing SMEs in the CIS Surveys and Sfinno Database at the end of the 1990s (N=50), breakdown by industry.

About one third of these companies are software firms, about one fifth knowledge-intensive services firms in the business services, and one fifth companies in the machinery sector. Quite many of these product innovations included in the Sfinno Database are classified as significant. One striking feature characterising these high growth firms is that most of them belong to the 'new economy' industries. It seems that their products met a strong demand on the market at the end of the 1990s. Many of these firms commercialised a market-first or even a world-first product based on a new technology, mobile technology, data security or data management. Interestingly, there are, however, also some low-tech companies in this group of firms that grew fast almost immediately after the commercialisation of their product or service innovation. The service innovations came mainly from the CIS data.

The case study also reveals that most innovative SMEs have produced several new products and product families after the innovation recorded in the Sfinno Database and there is no mention of the original innovation on the firm's homepages. It is possibly characterised by a shorter life cycle or it has disappeared from the market shortly after its introduction. Here it should be noticed that not all new products necessarily fulfil the definition of innovation. Separating product differentiation or different generations of incrementally developed products from new product launches is, however, a difficult task. Design modifications and imitations are sometimes intervened with the original product launches, too. In fact, an innovation that is new to the firm is quite often to a significant extent based on imitation and adoption to the local or national market (Palmberg et al. 1999).

The case study confirms the observation that the firm commercialising the innovation is often different from the organisation that invented it, and that the firms profiting from innovations are often other than their originally commercialised firms, at least by their Business IDs and thus often by their activity as well. The commercialising company does not often survive many years after having introduced the innovation to the market. It is often sold or merged a few years after commercialisation to some other company or split into new firms. This involves, however, some administrative or survivorship bias. When corporate dynamics (entries, exits, ID changes) increases, it follows that the survival rates of firms and their growth rates and thus also the growth effect of technology easily becomes underestimated if based only on Business IDs.

6. Conclusions

This research report examined what has happened to innovative firms before the commercialisation of innovation and after it. Large firms are a different story altogether, so they are not considered here. Small and medium-sized innovative firms are often created just a few years before an innovation is commercialised.[17] Usually an invention has a longer history, which can be linked to some other company, either to the predecessor of the commercialising firm or to a completely different company or research institute.

The firm commercialising an innovation is often not the inventing organisation. The commercialising firm can be a spin-off or an outsourced company of a larger firm or research institute. Secondly, firms benefiting from innovations are often others than their originally commercialised firms – at least by their Business IDs and thus often by their activity as well. The commercialising company does not often survive many years after having introduced the innovation to the market. It is often sold or merged a few years after commercialisation to some other company or split into new firms. Small companies commercialising product innovations are bought mostly two years after commercialisation.

It was found in the study that domestic patents precede the commercialisation of an innovation by an average of 1 to 2 years, EPO patents by 0 to 1 year and US patents are granted only after commercialisation. It could not be ascertained whether an increase in patenting activity was connected to the innovation in question. Increased patenting activity is not always visible as increased entries of product innovations to the market. Patenting can be linked to a process innovation or a potential future innovator can have been sold before the introduction of the innovation, and it can be difficult to track down the next owner of the innovation.

Those innovators that typically apply for patent have a second peak of patent applications in the late 1990s. This should have indicated a new innovation peak at the turn of the millennium as well. When we look at these firms more closely, we can see that part of them have been transferred to a foreign owner or sold to another firm and therefore this new innovation peak of these companies cannot be seen.

After the innovation, the turnover and employment of the SMEs often grows for a few years depending on the general business situation. It can be seen from the turnover and number of personnel of the innovators that the product innovation does not often produce growth for its original commercialising firms for years, if ever. The innovations successful for the original commercialising firms can be clearly distinguished from this group and they were examined in more detail in the case study.

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[17] Creation here means entry to the Business Register.

It was also examined in the study whether the innovators included in the CIS Surveys differ in their characteristics from those included in the Sfinno Database and if they do, how and what kinds of innovations these different approaches identify. It could be seen that the firm-centred information on innovations in the CIS Surveys was slightly more indefinite than the innovation-centred information in the Sfinno Database. In the CIS Surveys a company can be defined innovative without specifying any particular innovation. This is partly caused by the three-year reference period of the CIS Survey and that even abandoned product development projects are included in the survey.

Looking at the industry breakdowns of innovative firms in the CIS and Sfinno data, no major differences can be discerned between them.[18] There are distinct differences in the innovative firms identified by them but it is difficult to say which data are closer to reality by its industry breakdown because both involve certain selectivity. The Sfinno Database is based particularly for small firms on selective choosing. The innovation data CIS2.5 also includes small firms (small firm panel) that are known to have been engaged in innovation activities.[19] This was also done to a lesser degree for the CIS3 data, which do not include micro firms with fewer than ten employees.

In general, it can be stated that occasional innovators (small innovators) are treated as regular ones in the Sfinno data, whereas occasional innovators are more randomly included in the three-year cross-sectional CIS. In addition, the Sfinno data do not cover all innovative firms. The Sfinno Database includes relatively more firms commercialising product innovations new to the market than the CIS data. The degree of novelty, participation in innovation collaboration or introduction of products new to the market increase the probability that the firm is included in the Sfinno data (Leppälahti 2000). It can be assumed that the Sfinno data cover mainly significant or visible innovations, because the innovations that are only incremental from the firm's viewpoint are also seldom selected by experts or introduced in journals.[20]

In addition to the discrepancies in the number of innovative firms, the different surveys also seem to produce divergent structural results (e.g. in terms of the size of the firms). Furthermore, patent applications and innovations in the Sfinno data seem to be quite closely linked indicating that the share of patent applications is slightly higher in significant innovations than in other innovations.

[18] Here it is a question of non-weighted industrial distribution of small and medium-sized product innovators included in the combination of innovation surveys CIS2, CIS2.5 and CIS3 compared with that of the small and medium-sized product innovators of the Sfinno Database at approximately the same time period (1995-1998). According to Leppälahti (2000), although the general pattern is rather similar, there are some divergences. Large firms, firms located in the capital region and firms belonging to the high technology sector are more likely in the Sfinno data.

[19] The inclusion criterion for micro firms with fewer than 10 employees was the application of R&D subsidies from Tekes (the National Technology Agency of Finland).

[20] On the other hand, Palmberg points out that expert opinions tend to focus on significant innovations, whereas literature-based methodology identifies relatively more small firms and innovations of the incremental kind (Palmberg et al. 2000). Most of the innovations (approximately 1,400) in the Sfinno Database without its recent extension is based on the trade and technical journals.

We can also notice differences over years between innovation concepts, innovation questionnaires and their target groups, and innovation descriptions in the CIS Surveys, possibly reflecting changes in the importance of some types of innovations, some actors in the innovation system (e.g. services firms, foreign-owned companies), some factors in the innovation environment or some ways (e.g. collaboration) to process innovations, broadly speaking changes in innovative patterns. The addition of the word "technological" to the definition of innovation in the CIS2 and CIS2.5 Surveys resulted in a drastically lower proportion of product innovative firms than was the case with the CIS1 Survey.

To sum up: The objectives of the CIS Surveys and Sfinno Database are quite different. The aim of the Innovation Surveys is to estimate, first of all, the volume of firms' innovative activities understood as innovation expenditures in Finland in a way that can be compared with that of the other European countries. Factors hampering or promoting innovation activity are secondary issues in this primary aim. This objective has also directed the sample design of the survey. One criterion in the sample design (for CIS2.5 and CIS3) has been to follow a certain group of firms known to be innovative. These firms were in the sample as a panel. The objective of the Sfinno Database is to collect innovation-specific data on the major innovations in Finland. In the Sfinno data, both expert opinions and literature-based methodology will contain nation-specific characteristics, which hampers international comparability.

The main difference – both by methodology and approach – in these data are in that in the CIS Surveys a company can be classified as innovative on the basis of relatively loose criteria. These criteria are specific for a three-years' period: innovation activities are asked as concerning this period. In the Sfinno Database the company will be defined indirectly innovative according to whether it has introduced to the market some key product innovation. The criteria used are expert opinions or a review of a key innovation in some technical journal. The criteria applied to the Sfinno Database are thus stricter than those criteria given in the framework of the CIS Surveys based on the firms' own responses.

The framework and wording of the CIS Surveys have caused concern to some extent, as have the practical criteria used in compiling Sfinno (particularly separation of product differentiations from new products and product improvements for the company). Due to language differences respondents may understand the same terms differently in different countries. In the last two Innovation Surveys (CIS3 and CIS3.5) made in Finland innovation was no longer specified as a technological innovation, because that word could be understood in different countries more narrowly or more widely. As a result, the CIS3 and CIS3.5 responses include innovations that are new service concepts but not necessarily technologically new.

One issue receiving less attention when planning the national application of the CIS3 was how the framework can itself direct respondents. When questions are made about innovation activities in connection with the R&D Survey, the framework also binds innovation to practising of research and development, and even to the small-scale R&D, and thus it is not as limited to the introduction of a product or a production process to the market as a separate Innovation Survey is. When carried out in connection with the R&D Survey, the Innovation Survey can also possibly provide better international comparability for innovation activities but as concerns introduction of key innovations to the market we depart from an innovation-centred description, that is, such as in the Sfinno Database. As a result, there may be a larger group of innovative companies with a relatively smaller share than before of the innovations new to the market. In such case the number of innovative firms will not necessarily correlate with economic success anymore.

Notwithstanding the differences in the starting points and methodology of the CIS Surveys and the Sfinno Database and considering the fact that some CIS Surveys have been supplemented with a panel of small firms – though the lower limit for including small companies has varied from one survey to another – and that certain subjectivity has been difficult to avoid in compiling Sfinno, the data provide surprisingly logical and consistent results.[21] In the foregoing study the year of commercialisation most often given in both data sets is the year 1997. They thus illustrate the more or less turbulent events around the same boom period.

[21] The annual reports of large firms can be a more subjective source compared with the expert opinion and literature-based sources. In addition, some journals focus more on the underlining technology of the innovations, and others deal with particular product launches, in which case the broader nature of the innovation is difficult to comprehend (Palmberg et al. 1999). In addition, in the Sfinno data a subjective judgment by the respondents concerning the degree of novelty and commercial significance of innovations has been used.

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Appendix

1. Sfinno firms (N=878) linked with other data sets (Tables 1.1 - 1.8)

Table 1.1. In-house R&D performance of Sfinno firms

N Innovators in Sfinno	R&D activities not known in R&D Surveys	Not in house R&D activities	In house R&D activities	Sum	%	R&D activities not known in R&D Surveys	Not in house R&D activities	In house R&D activities	Sum
Intensive	1	0	22	23		4.3	0.0	95.7	100.0
Persistent	18	20	90	128		14.1	15.6	**70.3**	100.0
Occasional	238	211	278	727		32.7	29.0	**38.2**	100.0
Total	257	231	390	878		29.3	26.3	44.4	100.0

Table 1.2. Patenting behaviour of Sfinno firms: Sfinno firms having filed domestic patent applications

N Innovators in Sfinno	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum	%	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum
Intensive	22	1	0	0	23		95.7	4.3	0.0	0.0	100.0
Persistent	56	16	17	39	128		43.8	12.5	13.3	**30.5**	100.0
Occasional	85	108	94	440	727		11.7	14.9	12.9	**60.5**	100.0
Total	163	125	111	479	878		18.6	14.2	12.6	54.6	100.0

Table 1.3. Patenting behaviour of Sfinno firms: Sfinno firms having filed any patent applications

N Innovators in Sfinno	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum	%	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum
Intensive	22	1	0	0	23		95.7	4.3	0.0	0.0	100.0
Persistent	60	19	13	36	128		46.9	14.8	10.2	**28.1**	100.0
Occasional	113	111	85	418	727		15.5	15.3	11.7	**57.5**	100.0
Total	195	131	98	454	878		22.2	14.9	11.2	51.7	100.0

Table 1.4. Comparing the Sfinno and CIS firms over time: Sfinno firms included / not included as innovators in CIS

N Innovators in Sfinno	Not in CIS	No innova-tion in CIS	Product or pro-cess innova-tion in CIS	Sum	%	Not in CIS	No innova-tion in CIS	Product or pro-cess innova-tion in CIS	Sum
Intensive	1	1	21	23		4.3	4.3	91.3	100.0
Persistent	35	6	87	128		27.3	4.7	**68.0**	100.0
Occasional	397	53	277	727		54.6	7.3	**38.1**	100.0
Total	433	60	385	878		49.3	6.8	43.8	100.0

Table 1.5. Number and percentage of collaborative Tekes funded firms among Sfinno firms

N Innovators in Sfinno	Not in Tekes data	In Tekes data	Sum	%	Not in Tekes data	In Tekes data	Sum
Intensive	7	16	23		30.4	69.6	100.0
Persistent	52	76	128		40.6	**59.4**	100.0
Occasional	465	262	727		64.0	**36.0**	100.0
Total	524	354	878		59.7	40.3	100.0

Table 1.6. Number and percentage of spin-offs from larger companies among Sfinno firms

N Innovators in Sfinno	Non spin-offs	Spin-offs	Sum	%	Non spin-offs	Spin-offs	Sum
Intensive	20	3	23		87.0	13.0	100.0
Persistent	110	18	128		85.9	**14.1**	100.0
Occasional	669	58	727		92.0	**8.0**	100.0
Total	799	79	878		91.0	9.0	100.0

Table 1.7. Number and percentage of purchasers among Sfinno firms

N Innovators in Sfinno	Has not purchased other companies	Has purchased other companies	Sum	%	Has not purchased other companies	Has purchased other companies	Sum
Intensive	7	16	23		30.4	69.6	100.0
Persistent	85	43	128		66.4	**33.6**	100.0
Occasional	667	60	727		91.7	**8.3**	100.0
Total	759	119	878		86.4	13.6	100.0

Table 1.8. Number and percentage of targets in acquisitions among Sfinno firms

N Innovators In Sfinno	Has not been a target in an acquisition	Has been target in an acquisition	Sum	%	Has not been a target in an acquisition	Has been target in an acquisition	Sum
Intensive	5	18	23		21.7	78.3	100.0
Persistent	91	37	128		71.1	**28.9**	100.0
Occasional	645	82	727		88.7	**11.3**	100.0
Total	741	137	878		84.4	15.6	100.0

2. R&D performing firms (N=1986) linked with other data sets (Tables 2.1 – 2.8)

Table 2.1. Comparing the R&D and Sfinno firms over time: R&D performing firms included in Sfinno

N R&D performing firms in R&D samples	Inten-sive inno-vators	Persis-tent inno-vators	Occa-sional inno-vators	Not inclu-ded in Sfinno	Sum	%	Inten-sive inno-vators	Persis-tent inno-vators	Occa-sional inno-vators	Not inclu-ded in Sfinno	Sum
No int. R&D	0	20	211	9363	9594		0.0	0.2	2.2	97.6	100.0
Internal R&D	22	90	278	1596	1986		1.1	4.5	14.0	**80.4**	100.0
Total	22	110	489	10959	11580		0.2	0.9	4.2	94.6	100.0

Table 2.2. Patenting behaviour of R&D firms: R&D performing firms having filed domestic patent applications

N R&D performing firms in R&D samples	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum	%	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum
No int. R&D	107	325	545	8617	9594		1.1	3.4	5.7	89.8	100.0
Internal R&D	352	279	233	1122	1986		17.7	14.0	11.7	**56.5**	100.0
Total	459	604	778	9739	11580		4.0	5.2	6.7	84.1	100.0

Table 2.3. Patenting behaviour of R&D firms: R&D performing firms having filed any patent applications

N R&D performing firms in R&D samples	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum	%	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum
No int. R&D	143	368	515	8568	9594		1.5	3.8	5.4	89.3	100.0
Internal R&D	435	277	193	1081	1986		21.9	13.9	9.7	**54.4**	100.0
Total	578	645	708	9649	11580		5.0	5.6	6.1	83.3	100.0

Table 2.4. Comparing the R&D and CIS firms over time: R&D performing firms included /not included as innovators in CIS

N R&D performing firms in R&D samples	Not in CIS	No innova-tion in CIS	Product or pro-cess innova-tion in CIS	Sum	%	Not in CIS	No innova-tion in CIS	Product or pro-cess innova-tion in CIS	Sum
No int. R&D	6071	1987	1536	9594		63.3	20.7	16.0	100.0
Internal R&D	744	170	1072	1986		37.5	8.6	**54.0**	100.0
Total	6815	2157	2608	11580		58.9	18.6	22.5	100.0

Table 2.5. Number and percentage of collaborative Tekes funded firms among R&D firms

N R&D performing firms in R&D samples	Not in Tekes data	In Tekes data	Sum	%	Not in Tekes data	In Tekes data	Sum
No int. R&D	8191	1403	9594		85.4	14.6	100.0
Internal R&D	1212	774	1986		61.0	**39.0**	100.0
Total	9403	2177	11580		81.2	18.8	100.0

Table 2.6. Number and percentage of spin-offs from larger companies among R&D firms

N R&D performing firms in R&D samples	Non spin-offs	Spin-offs	Sum	%	Non spin-offs	Spin-offs	Sum
No int. R&D	8918	676	9594		93.0	7.0	100.0
Internal R&D	1757	229	1986		88.5	**11.5**	100.0
Total	10675	905	11580		92.2	7.8	100.0

Table 2.7. Number and percentage of purchasers among R&D firms

N R&D performing firms in R&D samples	Has not purchased other companies	Has purchased other companies	Sum	%	Has not purchased other companies	Has purchased other companies	Sum
No int. R&D	9233	361	9594		96.2	3.8	100.0
Internal R&D	1705	281	1986		85.9	**14.1**	100.0
Total	10938	642	11580		94.5	5.5	100.0

Table 2.8. Number and percentage of targets in acquisitions among R&D firms

N R&D performing firms in R&D samples	Has not been a target in an acquisition	Has been target in an acquisition	Sum	%	Has not been a target in an acquisition	Has been target in an acquisition	Sum
No int. R&D	9074	520	9594		94.6	5.4	100.0
Internal R&D	1622	364	1986		81.7	**18.3**	100.0
Total	10696	884	11580		92.4	7.6	100.0

3. Firms that have filed patent applications (N=3599) linked with other data sets (Tables 3.1 – 3.8)

Table 3.1. Comparing the patenting and Sfinno firms over time: patenting firms included in Sfinno

N Firms that have filed patent applications	Intensive innovators	Persistent innovators	Occasional innovators	Not included in Sfinno	Sum	%	Intensive innovators	Persistent innovators	Occasional innovators	Not included in Sfinno	Sum
Intensively	22	60	113	549	744		3.0	8.1	15.2	73.8	100.0
Persistently	1	19	111	979	1110		0.1	1.7	10.0	**88.2**	100.0
Occasionally	0	13	85	1647	1745		0.0	0.7	4.9	**94.4**	100.0
Total	23	92	309	3175	3599		0.6	2.6	8.6	88.2	100.0

Table 3.2. R&D activities of patenting firms: patenting firms included at least in one R&D sample

N Firms that have filed patent applications	R&D activities not known in R&D surveys	Not in house R&D activities	In house R&D activities	Sum	%	R&D activities not known in R&D surveys	Not in house R&D activities	In house R&D activities	Sum
Intensively	166	143	435	744		22.3	19.2	58.5	100.0
Persistently	465	368	277	1110		41.9	33.2	**25.0**	100.0
Occasionally	1037	515	193	1745		59.4	29.5	**11.1**	100.0
Total	1668	1026	905	3599		46.3	28.5	25.1	100.0

Table 3.3. Number and percentage of patenting firms for which patents have been granted in the US

N Firms that have filed patent applications	Intensive patentors	Persistent patentors	Occasional patentors	Patent not granted in US	Sum	%	Intensive patentors	Persistent patentors	Occasional patentors	Patent not granted in US	Sum
Intensively	110	145	147	342	744		14.8	19.5	19.8	46.0	100.0
Persistently	0	34	157	919	1110		0.0	3.1	14.1	**82.8**	100.0
Occasionally	0	0	50	1695	1745		0.0	0.0	2.9	**97.1**	100.0
Total	110	179	354	2956	3599		3.1	5.0	9.8	82.1	100.0

Table 3.4. Comparing the patenting and CIS firms over time: patenting firms included /not included as innovators in CIS

N Firms that have filed patent applications	Not in CIS	No innovation in CIS	Product or process innovation in CIS	Sum	%	Not in CIS	No innovation in CIS	Product or process innovation in CIS	Sum
Intensively	342	41	361	744		46.0	5.5	48.5	100.0
Persistently	782	57	271	1110		70.5	5.1	**24.4**	100.0
Occasionally	1410	98	237	1745		80.8	5.6	**13.6**	100.0
Total	2534	196	869	3599		70.4	5.4	24.1	100.0

Table 3.5. Number and percentage of collaborative Tekes funded firms among patenting firms

N Firms that have filed patent applications	Not in Tekes data	In Tekes data	Sum	%	Not in Tekes data	In Tekes data	Sum
Intensively	470	274	744		63.2	36.8	100.0
Persistently	861	249	1110		77.6	**22.4**	100.0
Occasionally	1470	275	1745		84.2	**15.8**	100.0
Total	2801	798	3599		77.8	22.2	100.0

Table 3.6. Number and percentage of spin-offs from larger companies among patenting firms

N Firms that have filed patent applications	Non spin-offs	Spin-offs	Sum	%	Non spin-offs	Spin-offs	Sum
Intensively	679	65	744		91.3	8.7	100.0
Persistently	1042	68	1110		93.9	**6.1**	100.0
Occasionally	1664	81	1745		95.4	**4.6**	100.0
Total	3385	214	3599		94.1	5.9	100.0

Table 3.7. Number and percentage of purchasers among patenting firms

N Firms that have filed patent applications	Has not purchased other companies	Has purchased other companies	Sum	%	Has not purchased other companies	Has purchased other companies	Sum
Intensively	626	118	744		84.1	15.9	100.0
Persistently	1048	62	1110		94.4	**5.6**	100.0
Occasionally	1692	53	1745		97.0	**3.0**	100.0
Total	3366	233	3599		93.5	6.5	100.0

Table 3.8. Number and percentage of targets in acquisitions among patenting firms

N Firms that have filed patent applications	Has not been a target in an acquisition	Has been target in an acquisition	Sum	%	Has not been a target in an acquisition	Has been target in an acquisition	Sum
Intensively	598	146	744		80.4	19.6	100.0
Persistently	1024	86	1110		92.3	**7.7**	100.0
Occasionally	1666	79	1745		95.5	**4.5**	100.0
Total	3288	311	3599		91.4	8.6	100.0

4. Firms included in the CIS samples (N=5166) linked with other data sets (Tables 4.1 – 7.8)

Table 4.1. Comparing the CIS and Sfinno firms over time: CIS firms included in Sfinno

N CIS firms	Inten-sive inno-vators	Persis-tent inno-vators	Occa-sional inno-vators	Not inclu-ded in Sfinno	Sum	%	Inten-sive inno-vators	Persis-tent inno-vators	Occa-sional inno-vators	Not inclu-ded in Sfinno	Sum
Non innovat.	1	6	53	2328	2388		0.0	0.3	2.2	97.5	100.0
Innovators	21	87	277	2393	2778		0.8	3.1	10.0	**86.1**	100.0
Total	22	93	330	4721	5166		0.4	1.8	6.4	91.4	100.0

Table 4.2. R&D activities of CIS firms: CIS firms included at least in one R&D sample

N CIS firms	R&D activities not known in R&D Surveys	Not in house R&D activities	In house R&D activities	Sum	%	R&D activities not known in R&D Surveys	Not in house R&D activities	In house R&D activities	Sum
Non innovat.	231	1987	170	2388		9.7	83.2	7.1	100.0
Innovators	170	1536	1072	2778		6.1	55.3	**38.6**	100.0
Total	401	3523	1242	5166		7.8	68.2	24.0	100.0

Table 4.3. Patenting behaviour of CIS firms: CIS firms having filed domestic patent applications

N CIS firms	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum	%	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum
Non innovat.	30	53	102	2203	2388		1.3	2.2	4.3	92.3	100.0
Innovators	298	266	272	1942	2778		10.7	9.6	9.8	**69.9**	100.0
Total	328	319	374	4145	5166		6.3	6.2	7.2	80.2	100.0

Table 4.4. Patenting behaviour of CIS firms: CIS firms having filed any patent applications

N CIS firms	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum	%	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum
Non innovat.	41	57	98	2192	2388		1.7	2.4	4.1	91.8	100.0
Innovators	361	271	237	1909	2778		13.0	9.8	8.5	**68.7**	100.0
Total	402	328	335	4101	5166		7.8	6.3	6.5	79.4	100.0

Table 4.5. Number and percentage of collaborative Tekes funded firms among CIS firms

N CIS firms	Not in Tekes data	In Tekes data	Sum	%	Not in Tekes data	In Tekes data	Sum
Non innovat.	2040	348	2388		85.4	14.6	100.0
Innovators	1739	1039	2778		62.6	**37.4**	100.0
Total	3779	1387	5166		73.2	26.8	100.0

Table 4.6. Number and percentage of spin-offs from larger companies among CIS firms

N CIS firms	Non spin-offs	Spin-offs	Sum	%	Non spin-offs	Spin-offs	Sum
Non innovat.	2181	207	2388		91.3	8.7	100.0
Innovators	2485	293	2778		89.5	**10.5**	100.0
Total	4666	500	5166		90.3	9.7	100.0

Table 4.7. Number and percentage of purchasers among CIS firms

N CIS firms	Has not purchased other companies	Has purchased other companies	Sum	%	Has not purchased other companies	Has purchased other companies	Sum
Non innovat.	2248	140	2388		94.1	5.9	100.0
Innovators	2458	320	2778		88.5	**11.5**	100.0
Total	4706	460	5166		91.1	8.9	100.0

Table 4.8. Number and percentage of targets in acquisitions among CIS firms

N CIS firms	Has not been a target in an acquisition	Has been target in an acquisition	Sum	%	Has not been a target in an acquisition	Has been target in an acquisition	Sum
Non innovat.	2205	183	2388		92.3	7.7	100.0
Innovators	2416	362	2778		87.0	**13.0**	100.0
Total	4621	545	5166		89.5	10.5	100.0

Table 5.1. Comparing the CIS1 and Sfinno firms over time: CIS1 firms included in Sfinno

N CIS1 firms	Inten- sive inno- vators	Persis -tent inno- vators	Occa- sional inno- vators	Not inclu- ded in Sfinno	Sum	%	Inten- sive inno- vators	Persis -tent inno- vators	Occa- sional inno- vators	Not inclu- ded in Sfinno	Sum
Non innovat.	0	2	5	270	277		0.0	0.7	1.8	97.5	100.0
Innovators	13	30	54	484	581		2.2	5.2	9.3	**83.3**	100.0
Total	13	32	59	754	858		1.5	3.7	6.9	87.9	100.0

Table 5.2. R&D activities of CIS1 firms: CIS1 firms included at least in one R&D sample

N CIS1 firms	R&D activities not known in R&D Surveys	Not in house R&D activities	In house R&D activities	Sum	%	R&D activities not known in R&D Surveys	Not in house R&D activities	In house R&D activities	Sum
Non innovat.	70	173	34	277		25.3	62.5	12.3	100.0
Innovators	57	221	303	581		9.8	38.0	**52.2**	100.0
Total	127	394	337	858		14.8	45.9	39.3	100.0

Table 5.3. Patenting behaviour of CIS1 firms: CIS1 firms having filed domestic patent applications

N CIS1 firms	Inten- sive appli- cants	Persis -tent appli- cants	Occa- sional appli- cants	Not filed patent appli- cation	Sum	%	Inten- sive appli- cants	Persis -tent appli- cants	Occa- sional appli- cants	Not filed patent appli- cation	Sum
Non innovat.	7	6	20	244	277		2.5	2.2	7.2	88.1	100.0
Innovators	121	68	62	330	581		20.8	11.7	10.7	**56.8**	100.0
Total	128	74	82	574	858		14.9	8.6	9.6	66.9	100.0

Table 5.4. Patenting behaviour of CIS1 firms: CIS1 firms having filed any patent applications

N CIS1 firms	Inten- sive appli- cants	Persis -tent appli- cants	Occa- sional appli- cants	Not filed patent appli- cation	Sum	%	Inten- sive appli- cants	Persis -tent appli- cants	Occa- sional appli- cants	Not filed patent appli- cation	Sum
Non innovat.	8	9	18	242	277		2.9	3.2	6.5	87.4	100.0
Innovators	135	67	54	325	581		23.2	11.5	9.3	**55.9**	100.0
Total	143	76	72	567	858		16.7	8.9	8.4	66.1	100.0

Table 5.5. Number and percentage of collaborative Tekes funded firms among CIS1 firms

N CIS1 firms	Not in Tekes data	In Tekes data	Sum	%	Not in Tekes data	In Tekes data	Sum
Non innovat.	250	27	277		90.3	9.7	100.0
Innovators	430	151	581		74.0	**26.0**	100.0
Total	680	178	858		79.3	20.7	100.0

Table 5.6. Number and percentage of spin-offs from larger companies among CIS1 firms

N CIS1 firms	Non spin-offs	Spin-offs	Sum	%	Non spin-offs	Spin-offs	Sum
Non innovat.	273	4	277		98.6	1.4	100.0
Innovators	550	31	581		94.7	**5.3**	100.0
Total	823	35	858		95.9	4.1	100.0

Table 5.7. Number and percentage of purchasers among CIS1 firms

N CIS1 firms	Has not purchased other companies	Has purchased other companies	Sum	%	Has not purchased other companies	Has purchased other companies	Sum
Non innovat.	258	19	277		93.1	6.9	100.0
Innovators	494	87	581		85.0	**15.0**	100.0
Total	752	106	858		87.6	12.4	100.0

Table 5.8. Number and percentage of targets in acquisitions among CIS1 firms

N CIS1 firms	Has not been a target in an acquisition	Has been target in an acquisition	Sum	%	Has not been a target in an acquisition	Has been target in an acquisition	Sum
Non innovat.	249	28	277		89.9	10.1	100.0
Innovators	450	131	581		77.5	**22.5**	100.0
Total	699	159	858		81.5	18.5	100.0

Table 5.9. Panel of CIS91 firms: CIS91 firms included in CIS96

N CIS1 firms	Not in CIS2	No innova-tion in CIS2	Product or pro-cess innova-tion in CIS2	Sum	%	Not in CIS2	No innova-tion in CIS2	Product or pro-cess innova-tion in CIS2	Sum
Non innovat.	198	60	19	277		71.5	21.7	6.9	100.0
Innovators	360	88	133	581		62.0	15.1	**22.9**	100.0
Total	558	148	152	858		65.0	17.2	17.7	100.0

Table 6.1. Comparing the CIS2 and Sfinno firms over time: CIS2 firms included in Sfinno

N CIS2 firms	Inten-sive inno-vators	Persis-tent inno-vators	Occa-sional inno-vators	Not inclu-ded in Sfinno	Sum	%	Inten-sive inno-vators	Persis-tent inno-vators	Occa-sional inno-vators	Not inclu-ded in Sfinno	Sum
Non innovat.	1	4	33	1148	1186		0.1	0.3	2.8	96.8	100.0
Innovators	17	39	95	652	803		2.1	4.9	11.8	**81.2**	100.0
Total	18	43	128	1800	1989		0.9	2.2	6.4	90.5	100.0

Table 6.2. R&D activities of CIS2 firms: CIS2 firms included at least in one R&D sample

N CIS2 firms	R&D activities not known in R&D Surveys	Not in house R&D activities	In house R&D activities	Sum	%	R&D activities not known in R&D Surveys	Not in house R&D activities	In house R&D activities	Sum
Non innovat.	13	1064	109	1186		1.1	89.7	9.2	100.0
Innovators	6	411	386	803		0.7	51.2	**48.1**	100.0
Total	19	1475	495	1989		1.0	74.2	24.9	100.0

Table 6.3. Patenting behaviour of CIS2 firms: CIS2 firms having filed domestic patent applications

N CIS2 firms	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum	%	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum
Non innovat.	18	19	50	1099	1186		1.5	1.6	4.2	92.7	100.0
Innovators	132	88	67	516	803		16.4	11.0	8.3	**64.3**	100.0
Total	150	107	117	1615	1989		7.5	5.4	5.9	81.2	100.0

Table 6.4. Patenting behaviour of CIS2 firms: CIS2 firms having filed any patent applications

N CIS2 firms	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum	%	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum
Non innovat.	22	23	49	1092	1186		1.9	1.9	4.1	92.1	100.0
Innovators	159	85	51	508	803		19.8	10.6	6.4	**63.3**	100.0
Total	181	108	100	1600	1989		9.1	5.4	5.0	80.4	100.0

Table 6.5. Number and percentage of collaborative Tekes funded firms among CIS2 firms

N CIS2 firms	Not in Tekes data	In Tekes data	Sum	%	Not in Tekes data	In Tekes data	Sum
Non innovat.	1077	109	1186		90.8	9.2	100.0
Innovators	551	252	803		68.6	**31.4**	100.0
Total	1628	361	1989		81.9	18.1	100.0

Table 6.6. Number and percentage of spin-offs from larger companies among CIS2 firms

N CIS2 firms	Non spin-offs	Spin-offs	Sum	%	Non spin-offs	Spin-offs	Sum
Non innovat.	1091	95	1186		92.0	8.0	100.0
Innovators	717	86	803		89.3	**10.7**	100.0
Total	1808	181	1989		90.9	9.1	100.0

Table 6.7. Number and percentage of purchasers among CIS2 firms

N CIS2 firms	Has not purchased other companies	Has purchased other companies	Sum	%	Has not purchased other companies	Has purchased other companies	Sum
Non innovat.	1091	95	1186		92.0	8.0	100.0
Innovators	668	135	803		83.2	**16.8**	100.0
Total	1759	230	1989		88.4	11.6	100.0

Table 6.8. Number and percentage of targets in acquisitions among CIS2 firms

N CIS2 firms	Has not been a target in an acquisition	Has been target in an acquisition	Sum	%	Has not been a target in an acquisition	Has been target in an acquisition	Sum
Non innovat.	1060	126	1186		89.4	10.6	100.0
Innovators	635	168	803		79.1	**20.9**	100.0
Total	1695	294	1989		85.2	14.8	100.0

Table 6.9. Panel of CIS2 firms: CIS2 firms included in CIS3

N CIS2 firms	Not in CIS3	No innova-tion in CIS3	Product or pro-cess innova-tion in CIS3	Sum	%	Not in CIS3	No innova-tion in CIS3	Product or pro-cess innova-tion in CIS3	Sum
Non innovat.	968	134	84	1186		81.6	11.3	7.1	100.0
Innovators	444	94	265	803		55.3	11.7	**33.0**	100.0
Total	1412	228	349	1989		71.0	11.5	17.5	100.0

Table 7.1. Comparing the CIS3 and Sfinno firms over time: CIS3 firms included in Sfinno

N CIS3 firms	Inten-sive inno-vators	Persis-tent inno-vators	Occa-sional inno-vators	Not inclu-ded in Sfinno	Sum	%	Inten-sive inno-vators	Persis-tent inno-vators	Occa-sional inno-vators	Not inclu-ded in Sfinno	Sum
Non innovat.	2	3	34	670	709		0.3	0.4	4.8	94.5	100.0
Innovators	11	43	89	785	928		1.2	4.6	9.6	**84.6**	100.0
Total	13	46	123	1455	1637		0.8	2.8	7.5	88.9	100.0

Table 7.2. R&D activities of CIS3 firms: CIS3 firms included at least in one R&D sample

N CIS3 firms	R&D activities not known in R&D Surveys	Not in house R&D activities	In house R&D activities	Sum	%	R&D activities not known in R&D Surveys	Not in house R&D activities	In house R&D activities	Sum
Non innovat.	145	502	62	709		20.5	70.8	8.7	100.0
Innovators	104	391	433	928		11.2	42.1	**46.7**	100.0
Total	249	893	495	1637		15.2	54.6	30.2	100.0

Table 7.3. Patenting behaviour of CIS3 firms: CIS3 firms having filed domestic patent applications

N CIS3 firms	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum	%	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum
Non innovat.	14	25	27	643	709		2.0	3.5	3.8	90.7	100.0
Innovators	125	89	89	625	928		13.5	9.6	9.6	**67.3**	100.0
Total	139	114	116	1268	1637		8.5	7.0	7.1	77.5	100.0

Table 7.4. Patenting behaviour of CIS3 firms: CIS3 firms having filed any patent applications

N CIS3 firms	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum	%	Inten-sive appli-cants	Persis-tent appli-cants	Occa-sional appli-cants	Not filed patent appli-cation	Sum
Non innovat.	20	26	25	638	709		2.8	3.7	3.5	90.0	100.0
Innovators	148	85	84	611	928		15.9	9.2	9.1	**65.8**	100.0
Total	168	111	109	1249	1637		10.3	6.8	6.7	76.3	100.0

Table 7.5. Number and percentage of collaborative Tekes funded firms among CIS3 firms

N CIS3 firms	Not in Tekes data	In Tekes data	Sum	%	Not in Tekes data	In Tekes data	Sum
Non innovat.	633	76	709		89.3	10.7	100.0
Innovators	572	356	928		61.6	**38.4**	100.0
Total	1205	432	1637		73.6	26.4	100.0

Table 7.6. Number and percentage of spin-offs from larger companies among CIS3 firms

N CIS3 firms	Non spin-offs	Spin-offs	Sum	%	Non spin-offs	Spin-offs	Sum
Non innovat.	638	71	709		90.0	10.0	100.0
Innovators	799	129	928		86.1	**13.9**	100.0
Total	1437	200	1637		87.8	12.2	100.0

Table 7.7. Number and percentage of purchasers among CIS3 firms

N CIS3 firms	Has not purchased other companies	Has purchased other companies	Sum	%	Has not purchased other companies	Has purchased other companies	Sum
Non innovat.	656	53	709		92.5	7.5	100.0
Innovators	790	138	928		85.1	**14.9**	100.0
Total	1446	191	1637		88.3	11.7	100.0

Table 7.8. Number and percentage of targets in acquisitions among CIS3 firms

N CIS3 firms	Has not been a target in an acquisition	Has been target in an acquisition	Sum	%	Has not been a target in an acquisition	Has been target in an acquisition	Sum
Non innovat.	647	62	709		91.3	8.7	100.0
Innovators	811	117	928		87.4	**12.6**	100.0
Total	1458	179	1637		89.1	10.9	100.0

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ISBN 951–38–6574–6 (URL: http://www.vtt.fi/inf/pdf/)
ISSN 1459–7683 (URL: http://www.vtt.fi/inf/pdf/)