STEP rapport / report **ISSN 0804-8185**

R-01
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1997

Svein Olav Nås and Ari Leppälahti

Innovation, firm profitability and growth

Svein Olav Nås
STEP group
Storgt. 1
N-0155 Oslo
Norway

Ari Leppälahti
Statistics Finland/
Statistics Norway
P.O. Box 8131 Dep.
N-0033 Oslo
Norway

Project financed by the programme 'SMB analyse',
The Research Council of Norway

Oslo, May 1997

STEP group

Studies in technology, innovation and economic policy
Studier i teknologi, innovasjon og økonomisk politikk

Storgaten 1, N-0155 Oslo, Norway
Telephone +47 2247 7310
Fax: +47 2242 9533
Web: http://www.step.no/

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1. Introduction

This study explores relationships between innovative activity, profitability and firm growth in Norwegian industry. It is based on a dataset which merges information from the Norwegian Innovation Survey (that is, the Norwegian component of the *Community Innovation Survey 1992*) with accounting data for a panel of firms for the period 1990 (91) to 1994. This allows us to look at profitability and growth over time in firms engaged in innovative activity in the year 1992, or in firms that introduced new products in the period 1990-92. It also allows for comparisons with firms not involved with innovation in this period. Finally, we can investigate whether profitability in the year preceding our registration of innovative activity seems to have had any effect on the occurrence or level of innovation.

In doing this, we address a central issue in innovation studies, namely the effects of innovation on firm performance. Does it pay off to become involved in innovative activity? What forms do the benefits of innovation take - does innovation enhance short-run profitability, or does it contribute to firm growth, or both or neither?

One important point about innovation is that it is not costless: It requires the creation of tangible and intangible assets which increase production costs; from this perspective, innovating firms will not necessarily be more profitable, but they will be more likely to survive and grow. A second basic argument about innovation and firm performance is that the innovation of new or technically superior products creates temporary monopolies which improve the business performance of firms. However such temporary imperfect competition can clearly be exploited in at least two ways. On the one hand, firms can raise prices on the basis of the performance improvements in the product, and this 'imperfect competition' advantage will lead to improved returns on sales or on assets. Alternatively, firms can hold prices down, leading to more or less sharp improvements in the price-quality ratio of the product, resulting in increasing sales and market shares: in this case profitability (however measured) may not improve via innovation, but innovation will improve the growth performance of the firm.

In this paper we show that the latter is the case: that innovating firms in Norway are not markedly more profitable in terms of rates of return on sales or assets. However they do have much higher rates of growth of sales (which mean also, of course, that the absolute amounts of profit grow faster than in non-innovating firms). The impact of innovation is primarily on market share, not on profit ratios.

Hitherto, questions about returns to innovation have been addressed partly through case studies, partly through theoretical reasoning and also by econometric investigation.

Econometric studies have largely been limited to the returns or productivity effect of one of the components of the innovation costs, namely R&D.[1] Perhaps the best

[1] For an overview of this kind of research, see Mairesse, Jaques and Mohamed Sassenou: R&D and productivity: A survey of econometric studies at the firm level. STI Review, No. 8, April 1991.

known example is Edwin Mansfield's many studies, where rates of return above 20% are found for many firms and industries.[2] This is considerably higher than the average rates of return on ordinary investments. The social returns on R&D are usually even higher, as R&D results tend to spill over to users other than the originators, and it is difficult to appropriate all the gains. Even if these rates differ from industry to industry, and over time, the general conclusion is that R&D investments are profitable in aggregate, but of course not always for each single firm or single project, as the risks involved are usually high.

Since R&D is but one component of the total innovation costs one would expect estimates of returns to this single component to be too high. The innovation survey has shown that, in the Norwegian case, only about 50 % of total innovation costs, including investments, are R&D.[3] These additional costs have to be taken into consideration when estimating rates of return; R&D alone is not sufficient for the results to come about. Activities such as design, test production and other production start-up preparations, along with associated investments must be carried out before a new product or process can be introduced to the market and income starts flowing in. Including the other components will therefore considerably lower the estimated rates of return on the total investment in innovation, compared to the returns on the single component R&D. That is, when the returns are related to the size of the investment. With the data at hand, we are now able to shed some light on the profitability of the whole range of innovation costs.

Similar work has been carried out in Finland with a comparable data set.[4] With a different kind of data set, but with many of the same research themes, profitability of British innovating firms have been studied.[5] Results from these analysis are included for comparisons where appropriate.

Measuring profitability is not an easy task. This is due to the fact that business accounts are to some extent discretionary for firms. In addition, the time profile for profits to be earned varies according to industry, type of product and innovation, market characteristics and so on. This problem is addressed in section 2.2 below. But there is another problem relating to this; firms may choose to postpone earnings in terms of profitability in order to expand their market instead. This opens up the opportunity for higher profits in the future if successful. Such a strategy can be achieved by, for example, lowering prices temporarily in order to expand sales. We suspect that in particular small and medium sized firms may choose this option, in order to obtain the necessary scale of operation for long term survival. In order to

[2] See for example Mansfield, E., J. Rapoport, A. Romeo, S. Wagner and G. Beardsley: "Social and private rates of returns from industrial innovation", in Quarterly Journal of Economics, Vol. 91 (May 1977), pp. 221-240.

[3] See for example Svein Olav Nås, Tore Sandven og Keith Smith: Innovasjon og ny teknologi i norsk industri: En oversikt. STEP report 4/94 and Frengen, Geir, F. Foyn and R. Ragnarsøn: Innovasjon i norsk industri og oljeutvinning i 1992. Statistics Norway, report 95/7.

[4] See Husso, Kai, Ari Leppälahti and Petri Niininen: R&D, innovation and firm performance. Studies on the panel data of Finnish manufacturing firms. Science and technology 1996:3, Statistics Finland. In particular, chapter 4 on innovation activities and firm profit.

[5] See Geroski, Paul, Steve Machin and John van Reenen: The profitability of innovating firms. Rand Journal of Economics, Vol. 24, No. 2, Summer 1993.

check whether such behaviour seems to occur, we have included development in sales as an additional indicator of firm performance.

Innovation is per definition the introduction of something new on the market. This usually involves considerable risk. The risk can be technological - one is not able to achieve the performance expected in the new product or process at the expected cost - or commercial - if the market does not accept the new product to the desired degree or at the prevailing price. As a result, failures are part of the game, and the aggregate results are sums of both successes and failures. For large firms, or society as a whole, that means handling a portfolio of projects where the central outcome is the net effect of successes and failures. For a single small firm the result can be growth and/or profitability, or disaster if a failed project is large relative to the overall size of the firm. Looking at the whole population of firms in an economy, the disaster of one firm is not necessarily a problem, as long as there are enough successes to offset the disasters.

In this study, we mainly apply the perspective of single firms, as we do not have information covering all relevant firms in Norwegian industry. In reality, firms going out of business are part of the picture. It has not been possible, however, to include bankruptcies or firm exit in the analysis - they are simply left of the panel. The reason is that we don't always know the reason for exit. Some may actually be successes, taken over by other companies and therefore ceasing to exist as separate entries. There is therefore both a positive and a negative effect of these omissions, of which it is hard to tell the net effect on the analysis of returns on innovative activity. We have included, however, an analysis of panel dropouts in order to shed some light on this question. And, even if the main focus is the performance of single firms, we sum up the results for different sub classes of firms, thereby constructing "synthetic portfolios" of innovative investments where the net result can be expected to be positive, even if some of the single firms may experience losses.

The report is organised as follows: Chapter 2 discusses data sources and basic concepts - in particular the indicators used to measure innovative activity and firm profitability. In this part we also include a brief analysis of the dropout firms to evaluate if they are different from the ones remaining in the panel. Chapter 3 addresses the question of whether innovative firms are more or less profitable, or faster growing than non-innovating firms, and discusses obstacles to innovation related to problems with financing innovative activity. In chapter 4 we take a closer look at the innovators, investigating whether the level of innovative activity seems to be associated with the level of profitability and sales growth. We compare firms with an emphasis on process versus product innovation, and look at how different kinds of inputs in the innovation process seem to relate to profits and salesgrowth. Concluding remarks are collected in chapter 5.

2. Data sources and basic concepts

The core data source for this study is the Norwegian Innovation Survey (equivalent to the Community Innovation Survey - CIS). To be able to study how innovative activity relates to profitability and other measures of firm performance, Statistics Norway have added ordinary accounting data to the innovation data. To study developments over time, it is necessary to construct a panel where the same firms are followed over time. In doing so, some of the units are lost. This might cause problems for the analysis, since dropouts may represent failures (firms going out of business) as well as successes (where the firm gets bought up by another unit). In this chapter we discuss these issues, starting with an introduction to the CIS and Oslo manual approaches to measuring innovation. Next we present the accounting data, and discuss the important problem of how to measure firm profitability and performance, before proceeding with the more concrete problems of panel construction and an analysis of the dropout firms. Are the dropouts different from those that are kept in the panel in such a way as to disturb the representativeness of the main panel?

2.1 The CIS approach to innovation

The CIS data collection was carried out in 1993 after a joint initiative from EUROSTAT and DGXIII of the European Commission. The actual collection and financing of the effort was left to national authorities, who assigned various subcontractors to do the work. In the Norwegian case, financing came from the Research Council of Norway (NFR) and the employers' association (NHO), and the survey was carried out by Statistics Norway. At the core of this effort was the "CIS harmonised questionnaire", as it was called, including all questions and categories to be used in the survey. [6] With a few exceptions, this questionnaire adapts the first version of the "Oslo manual" - a set of recommendations from OECD regarding collection of innovation data. We will therefore here give a brief summary of the philosophy and methodology behind the Oslo manual.[7]

There are essentially two ways of collecting innovation data: the so called "subject approach", and the "object approach". In the latter approach, a single innovation and its sources and results are studied. In the subject approach, each single firm is studied, including any innovative project it might have. The last approach is chosen for CIS, as recommended in the Oslo manual. The method allows aggregation of activity across industries and countries, and allows international comparison if sampling is done properly. Another advantage is that all innovative activity is included, successes as well as failures. As pointed out above, failures are unavoidable in the innovative process. And lastly, firms without innovative activity are included, allowing for comparisons between those active and those inactive in innovation - a matter of great importance for policy making.

[6] A copy of the questionnaire is included in Appendix B.

[7] Innovation Manual: Proposed Guidelines for Collecting and Interpreting Innovation Data (Oslo Manual). OECD, Directorate for Science, Technology and Industry, Paris 1992.

The Oslo manual relates explicitly to the other manuals in the OECD family of manuals relating to science and technology data. In particular, the Frascati manual on measurement of expenditures for R&D is taken as a starting point. In the Oslo manual definition of innovations costs, the Frascati definition of R&D is included. That means that, in principle, all other innovation costs components specified in the Oslo manual are additional to R&D. In practice, however, it seems difficult for the companies to make this distinction, and results from Frascati and Oslo-type surveys are therefore not compatible. Results show a smaller amount of R&D in innovation surveys than in Frascati-based surveys, making one suspect that non-R&D activity is included in the Frascati-based numbers. On the other hand, one might argue that innovation surveys are new to the firms, with unfamiliar concepts and breakdowns. R&D as a concept, and the concrete surveys, have been around for thirty-five years or so. At the present time there is not much more to do than accept the present numbers and be warned about possible problems with how firms interpret the questions.

There is a general problem of accuracy and reliability when collecting data through survey questionnaires, in particular when the questions do not match readily available data in the firms. This is the case with the innovation survey, as most firms do not keep a record of either innovation inputs or outputs. In effect the answers cannot be treated as accurate measures, but rather as well-informed estimates by the people responsible in the firms. Or, as one might put it, as *indicators* of the activity going on. In addition, there are several questions asking for opinions or more qualitative information about the firm and its activities. Such information is highly dependent upon who the respondent is, and what function he or she has in the organisation. On the other hand, many issues relating to innovation is not available as "hard data", and surveying or interviewing collecting more or less qualitative information is the only possible source. As the same technique has been applied in a series of countries, and most results seem to be relatively consistent across both countries and industries, we believe them to give a reasonable picture of reality.[8]

The data collected through CIS can be divided into these categories: general background information, innovation inputs and innovation outputs, along with more qualitative information on innovation goals, sources of information, technology transfers and obstacles to innovation. All of this information cannot be utilised in this report, but we hope to include most of what we find of relevance to the main question about the relationship between innovation and profitability. Of particular interest are of course the direct costs related to innovation, and their relation to profitability. Costs are broken down into six categories, of which the first is R&D as discussed above. The others are product design, trial production, (training and) tooling up, acquisition of patents and licenses, market analysis (excluding launch costs) and "other costs".[9] In addition, firms are asked to specify total amounts spent

[8] For an evaluation of the CIS approach, see Archibugi, Daniele, P. Cohendet, A. Kristensen and K.-A. Schäffer: Evaluation of the Community Innovation Survey (CIS) - Phase I. EIMS publication No. 11, Luxembourg 1994.

[9] One should be aware that the Norwegian application of this question is somewhat different from this, as "training" is left out, and "patents" is replaced with the term "products".

on investments in machinery and equipment linked to innovation (actual outlay in the year under study).

A new feature in the Oslo manual was the attempt to measure the output of innovative activity directly. As this was the first version of a manual for collection of innovation data, the Oslo manual concentrated on what is thought to be most easily measured; product innovations. Even if the manual generally covers all kinds of innovation except organisational change, it is limited to products on the results side. Concretely, the companies were asked to estimate the share of total sales stemming from products that had been changed over the last few years (in CIS, limited to the last three years). A distinction was also made between major innovations and incremental innovations, by the degree of change in the product. A further distinction was made between products new to the firm, and products new to the industry. This is a direct measure of innovative results, not hampered by for example tax considerations that play a role in making up the accounts. Profits, on the other hand, reported in the accounts, include results from all of a firm's activities, many of which are not related to innovation. Nevertheless, bottom line profits is the goal of most companies, and one should expect to find some correlation between new product sales and profits. This question is addressed later in this report.

2.2 Firm profitability

A central idea behind this study is that there exist some kinds of links between innovative activity and the results achieved by firms in terms of economic outcome. This link is probably bi-directional - that is, economic results may influence innovation, and innovation may affect economic results. We address both these possibilities here, although the effects on economic results are given the larger share of attention. For both approaches, however, it is vital how economic results are understood and measured.

Due to the limited availability of data we have to use financial accounts as the source for indicators of economic results. This is certainly better than what has been available so far, as a linked data set like the one we use has hardly been available anywhere before.[10] However, it is still necessary to consider what we actually measure through the accounts. In this section we present the financial accounts and discuss their interpretation and reliability.

All accounting data are reported due to regulations in Norwegian law. The accounts are generally constructed for purposes other than obtaining true measures of economic performance from a statistical point of view, with their function as a basis for extracting taxes probably being one of the most important. Since economic results are taxed on a yearly basis there is an incentive for firms to report this figure as low as possible every year. Besides, this information helps the firms themselves to keep track of their performance, as well as outsiders such as more or less anonymous investors. Of course, most firms keep track of their performance in more detail in their internal accounting, but such information has not been available to us.

[10] A similar set is available for Finland, see Husso & al., op.cit.

In order to avoid problems stemming from tax-motivated dispositions, we have chosen to use quite simple measures of profit. The first one is simply operating profit, defined as the net difference between sales and ordinary operating costs excluding financial items and depreciation. It is used as a rate, that is, as a percentage of sales.

This measure captures the performance of ordinary production in the companies, regardless of how the results are split between dividend, retained earnings or other expenditures like financial items. One could say it relates to the "technological" aspects of operations; the "pure" manufacturing part of running the firms. Interpreted in this way, operating profits capture the essence of what we are looking for when analysing innovations.

One should note, however, that there are elements in both costs and earnings that are not included in this measure - elements which are necessarily part of any firm's operations. These include dividends paid to the owners of the company - a cost the firm must bear in order to pay for the capital invested; financial costs - also payment for invested capital and other funding by borrowing; and depreciation - the cost of wearing out or using machinery and buildings. The latter is hard to estimate, and in practice it is based on administrative rules which may be an advantage or disadvantage for the firms, but rarely close to the economic reality of "true" depreciation. On the income side there are net gains from financial dispositions or income from selling or renting out part of the firm or its property. As a result of this, firms with a positive operating profit may come out with a negative or considerably lower taxable annual result, or vice versa. The sum, however, is a rather fuzzy picture that demands detailed investigation of each single account. It is not possible for us due to the time and resources available. That is why we have chosen to use the simple measure of operating profit.

Another way of comparing results between firms is to relate earnings to the total assets involved in production - in other words, to the value of capital involved in the firms. We use such a measure as our second indicator for profitability; return on total assets. It is defined as profits exclusive of extraordinary items but including net financial items and depreciation, as a percentage of total assets (rather than total sales, as for operating profit rate). This measure thus includes some of the "fuzzy" items described above. It is included to investigate whether the results are sensitive to the measure of profitability used, so that results can be evaluated using both approaches.

Although the two measures of profitability may indicate different performance levels for individual firms depending on the measure applied, the two are in general highly correlated and they show the same pattern of development for groups of companies in most of our analysis. We interpret this as a sign of robustness in our data which strengthens our confidence in the results.

The third and last measure of performance included is simply the development over time in sales. Expanding the market share is usually a goal for the firms, as a means for subsequent increases in profits. In particular for smaller, and newly established firms, increasing the scale of operation may be given higher priority than short term profits. As market share data are not available to us we simply use total sales as our

indicator. It can be interpreted both as an indicator of success in the marketplace and of the scale of operation.

Before presenting the actual analysis, we must consider some systematic differences between firms that may affect the results. The most important is perhaps differences in technological opportunity between different industries.[11] In some industries, like computers or pharmaceuticals, there are rapid technological changes taking place - partly based on new scientific knowledge that allows new solutions to be applied in innovation. In other industries, many of them mature and long lasting, the technology is quite fixed and the potential for improvement is more limited. This of course affects both the level of investment in innovative activity, the share of new products in sales, the development over time in sales and the profitability of firms. In fact it is not necessarily the case that profits are higher among the most innovative industries - they have to reinvest large parts of their surplus in search of even better solutions. In mature industries, on the other hand, market structure is usually settled and market power and economies of scale comes into play in a different manner. Even among the more dynamic industries there are important differences. Comparing computers and pharmaceuticals we find that the latter may spend up to 10 or 15 years on developing a new generation of drugs, whereas computers are replaced by new models every six moths or so. As a result, the intervals between innovative investments being made until results show up on the balance sheets vary greatly. Thus we must expect differences in the time profile of profitability.

All this makes comparison difficult. Ideally one should always control for industry, but the number of observations available makes this option impossible in many cases. The long time lag for results to show up creates a need for long time series to capture all effects. On the other hand, with a long time lag it is hard to establish a clear relationship between the initial action and subsequent results, as additional factors come into play. Innovation for many firms is a more or less permanent activity, and even if we only have recorded innovative investments for one year, this one observation may be a reasonable indicator of the general level of such activity in the firms over a longer time period. Thus it should be possible to distinguish firms with and without innovation, and firms with different kinds of innovation, to see whether they differ in economic performance, even if the time series is limited.

Summing up this discussion, we must expect a lot of “noise” in the data, reflecting factors we are not able to include in the analysis. Therefore it is unlikely that the relationships we do uncover will be very strong ones. We do think, however, that looking for a relationship between innovation and profitability is worthwhile and necessary, and that our methodology will help us to do so.

[11] For a good discussion of this concept and related terms, see Rod Coombs: Technological opportunities and industrial organisation, in Dosi & al (eds): Technical change and economic theory. Pinter Publishers, London and New York, 1988.

2.3 Description of data

2.3.1 Panel construction

The data of the panel consist of the Norwegian innovation survey 1992 and statistics of financial accounts 1990-94. The aim has been to find a match for the firms which responded in the innovation survey from the statistics of accounts. The gross sample of enterprises in the innovation survey in manufacturing industry was 1 848. The sample was constructed to be representative of total industry. All enterprises with 100 or more employees were included, for enterprises between 5-9, 10-49 and 50-99 the sampling fractions were 20, 30 and 50 per cent respectively. In all, 953 enterprises, or 52 %, responded. The sample covered also mining and quarrying, but industry here refers to manufacturing only, that is NACE classes 15-37.[12]

As for the statistics of financial accounts, there are two main sources of data. First, we have register data based on annual balance sheet figures which firms send to the administrative body ("Brønnøysund-registeret"). The second source is the statistics of accounts survey of Statistics Norway. Statistics Norway data are collected from enterprises by mail survey. The survey in industry covers all enterprises with at least 100 employees. In addition, based on these data, Statistics Norway maintains a panel of large enterprises (100 or more employees) which are considered to have remained identical over time.

The sources of data for financial accounts in the panels are:
1990-94: Statistics Norway's identical enterprise panel (100 or more employees)
1991-94: Those in the panel above, Statistics Norway; others from the register

Thus, we have two panels, 1990-94 for big enterprises and a shorter one, 1991-94 for enterprises without size restriction. As for the contents of the two data, although the extent differs, the definitions of key variables of interest are identical.

The statistical unit is enterprise (a legal unit) which is identified by enterprise code. The linking of different data sets within and between the years under study is done by enterprise code and by checking the name and change in sales. In the case of no match by the code a firm is dropped from the panel. As for the change of sales, only vague criteria have been applied. Annual increases no greater than doubling and decreases less than 50 per cent are allowed. This is to control the fact that despite the same code and name there might have been a major change in the structure or activities of enterprise. However, if the firm is included in the Statistics Norway's identical enterprise panel, it is included in our panel as well, no matter how big a change in sales has been.

A well-known problem with longitudinal data like enterprise panels is attrition. The structure of the economy or individual enterprises is not static. New enterprises are

[12] Details of survey methodology in: Frengen, Geir, Foyn, Frank and Ragnarsøn, Richard (1995) Innovation in Norwegian Manufacturing and Oil Extraction in 1992. Statistics Norway, Reports 95/26. Ragnarsøn, Richard (1994) Innovasjonvirksomheten: Dokumentasjon av innovasjonundersøkelsen 1993. Statistisk sentralbyrå, Notater 94/19.

born, old ones fall into bankruptcy and as a result of reorganisation of activities there may be a split or merger. One way to classify the possible changes is presented in Table 2.1 (see also Struijs and Willeboordse 1995).[13] This section also draws on the experiences gained in the recent corresponding panel survey of Finnish manufacturing industry (Husso, Leppälahti and Niininen 1996). [14]

Table 2.1. The enterprise as a statistical unit, classification of change

Type of change	**Unit's identity retained**
1. No change or a minor change in characteristics	Yes
2. Existence	
2.1 Birth	No
2.2.Death	No
3. Structural change	
3.1 Concentration	
3.1.1 Merger with another	No
3.1.2 Acquisition of a new part	Yes
3.2 Division	
3.2.1 Disintegration	No
3.2.2 Splitting off a part	Yes
3.3 Other structural change	Yes or No

Enterprises included in our panel can be placed into the classes 1., 3.1.2, 3.2.2 or 3.3. These are the cases in which the identity according to enterprise code has been retained. The problem remains, that identity in accordance with the enterprise code may have been retained even though the structure and activities of an enterprise have changed considerably. For example, an enterprise may reorganise its activities by establishing new subsidiary companies which get their own enterprise codes (class 2.1) while the original enterprise code is retained by the parent company (class 3.2.2), which, however, concentrates solely on the management of the new subsidiary enterprises (or interlocking group of enterprises). That is why additional checks are required, which in our case is the proportional change in sales.

2.3.2 Data coverage and panel dropouts

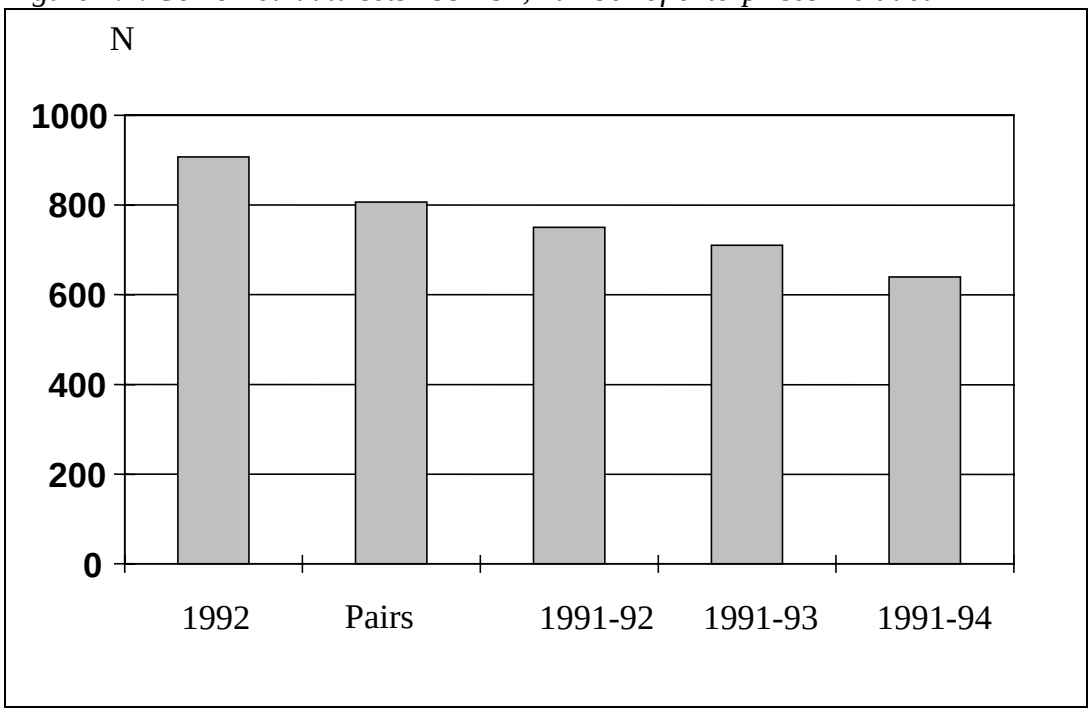
As the innovation survey forms the basis of the panel, the coverage is evaluated in relation to the net sample, i.e. those firms which responded to the innovation survey. That is, problems related to the coverage and representativeness of the innovation survey itself are not considered here. A renewed industrial classification, NACE on 2-digit level, has been used in the construction of the panel and this makes the number of enterprises in some classes as well as in industry total a little different

[13] Struijs, P. & A. Willeboordse, (1995). Changes in populations of statistical units. In Cox, B.G., D.A. Binder, B.N. Chinnappa, A. Christianson, M.J. Colledge & P.S. Kott (eds.): Business Survey Methods, 65-84. John Wiley & Sons, New York.

[14] Husso K., Leppälahti A., Niininen P. (1996) R&D, Innovation and Firm Performance. Studies on the Panel Data of Finnish Manufacturing Firms. Statistics Finland, Science and Technology 1996:3. Helsinki

from the original survey. For manufacturing industry (NACE 15-37), there are 916 observations. Excluding firms with missing code and after deleting a few double codes (an enterprise had split its response to the innovation survey), we have 908 firms to start with (Figure 2.1.). Out of these 85 are lost because of no match between the innovation survey and statistics of financial accounts data by enterprise code in 1992. Controlling for the difference in sales between innovation and accounting data (in this case ±50 % since we have the same year) we are left with 806 pairs of manufacturing firms, 89 per cent of respondents in the innovation survey. Sales control here is to ensure that the response in both surveys refers to the same unit, given the code. Years 1991 and 1993-94 are then added in the way described above, and the final panel consists of 640 enterprises, or 70 per cent of the enterprises in the original net sample. The number of enterprise pairs between the 1990-94 panel of large enterprises and the innovation survey is 145.

Figure 2.1. Combined data sets 1991-94, number of enterprises included



In comparison to the original net sample of the innovation survey, we find for the size class more than 50 employees a slightly higher proportion of innovative firms (Table 2.2.). The coverage of the panel in terms of enterprises retained is lowest with small enterprises. An obvious explanation is that small firms are more likely to face bankruptcy or acquisition by another enterprise than larger ones and consequently the probability of falling out of the panel is higher.

Table 2.2. The coverage of the panel 1991-94, comparison to the original net sample of 1992 innovation survey

	Original net sample	Number of firms in the panel	Coverage of the panel	Proportion of innovative firms (net sample)	Proportion of innovative firms (panel)
Size	N		Percent		
ALL	908	640	70	40	43
1-19	409	268	66	19	20
20-49	157	111	71	39	39
50-99	125	90	72	56	59
100-	217	171	77	71	74

Tables 2.3 and 2.4 present the enterprises of the 1991-94 panel broken down by size, industry and key innovation variables.

Table 2.3 Basic figures of the panel 1991-94 according to the size of firm

Number of firms	Number of firms	No innovations	Innovations	Product innovations	Process innovations	R&D activities
	N					
ALL	640	364	276	188	234	164
1-19	268	214	54	35	38	26
20-49	111	68	43	29	35	21
50-99	90	37	53	40	46	35
100-	171	45	126	84	115	82

Table 2.4 Basic figures of the panel 1991-94 according to industry

NACE	Number of firms	No innovations	Innovations	Product innovations	Process innovations	R&D activities
	N					
ALL	640	364	276	188	234	164
15	102	57	45	28	38	25
16	1	.	1	1	1	1
17	21	14	7	7	6	5
18	8	6	2	2	2	1
19	5	2	3	.	3	.
20	45	34	11	8	11	2
21	18	5	13	8	12	9
22	99	60	39	8	38	12
24	13	2	11	10	11	10
25	15	9	6	5	5	4
26	34	20	14	12	10	10
27	18	7	11	6	10	7
28	71	53	18	11	16	10
29	55	24	31	28	24	21
31	20	9	11	9	9	9
32	9	3	6	6	3	6
33	10	3	7	7	4	7
34	13	5	8	8	4	7
35	43	29	14	9	12	8
36	40	22	18	15	15	10

As can be seen, the analysis cannot be carried out all the way on the NACE 2-digit level. Some industrial classes have to be put together.

In the panel of identical enterprises of more than 100 employees 1990-94, the proportion of innovators is 75 per cent (Table 2.5.), which is in accordance with Table 2.2. In particular, the proportion of process innovators is high. According to number of firms, the largest branches are food, transport equipment and printing and publishing.

Table 2.5. Basic figures of the identical enterprise panel 1990-94 according to industry. Number of firms.

NACE	N	No innovations	Innovations	Product innovations	Process innovations	R&D activities
ALL	145	37	108	70	100	70
15	22	6	16	7	15	8
17	5	1	4	4	3	3
19	1	.	1	.	1	.
20	6	3	3	3	3	1
21	12	2	10	7	10	8
22	19	7	12	3	11	4
24	8	1	7	6	7	6
25	5	1	4	3	4	2
26	8	1	7	5	6	5
27	9	.1	8	4	8	5
28	5	1	4	2	4	3
29	9	2	7	6	6	5
31	6	.	6	5	5	5
32	1	.	1	1	1	1
33	3	.	3	3	2	3
34	5	.	5	5	4	5
35	16	10	6	3	6	3
36	5	1	4	3	4	3

In Table 2.6 we take a closer look at the panel dropouts. Out of 823 enterprises for which a match between innovation and accounting data were found in 1992, 640 are retained in our panel while 183 firms fall out. The largest group of dropouts consist of firms for which the change in sales has been out of the limits allowed.[15] The remaining 76 enterprises were tracked down in the enterprise register. These have been classified into two groups; “ceased” and “new code”. Ceased means that firms has closed down its activities, in most cases due to bankruptcy. New code is somewhat more complicated, it includes for example cases in which a firm has merged with another or those in which a firm has disintegrated and its activities have continued in new companies. From the point of view of technology studies, it would be interesting to know, for instance, if a small firm has been acquired by a larger one because of its know-how in technology, which would imply that the small firm has in fact been successful in its innovation activities even though it has discontinued. However, this kind of analysis has not been possible here.

[15] The limits are set to annual doubling or reduction by 50 % or more.

Table 2.6. The panel 1991-94 and the panel dropouts according to their characteristics in 1992

	N	Employees	Proportion of innovators	Operating profit	Return on total assets
		mean	%	median (%)	median (%)
In panel	640	112	43	4,2	10,0
Dropout in all	183	142	33	2,3	5,2
Ceased	48	74	21	2,4	8,7
New code	28	141	43	2,9	6,9
Change in sales	107	170	36	1,9	3,6

As was found earlier, enterprises included in the panel have a higher proportion of innovators than dropouts. They also have clearly higher profits, as indicated by operating profit ratio and return on total assets. For the dropouts, the firms which have closed down activities are smaller than average and consequently have a lower proportion of innovators. Firms which drop out because of the change in sales are on average bigger, they have lower profits and the proportion of innovators is a little lower than among those remaining in the panel. Interestingly, in the group 'new code' the proportion of innovators is relatively high (even accounting for the average size). As explained above, this group can include successful innovators even though they have dropped out of the panel.

3. Do profit rates differ between innovators and non-innovators?

3.1 Innovation output and the rate of profit 1990-94

The question we deal with here is whether the profit rate of innovators (firms that reported product or process innovations for the period 1990-92) and non-innovators differ in our two panels. Profits are indicated by OPR (operating profit ratio) and ROTA (return on total assets). As we know, the profit rate of a firm can vary considerably from one year to another. Because the focus here is on the effects of innovation, we will exclude the most extreme fluctuations from time series, which apparently are due to other, more short-term factors than innovation activities. Thus, in order to be included in the analysis, the profit rate of a firm has to fulfil limits ±30 for OPR and –30,+50 for ROTA each year. This restriction is used throughout Chapter 3. This has no really big effect - for OPR 10 firms, or 1,6 per cent, fall outside the limits. Corresponding figures for ROTA are 21 firms or 3,3 per cent. Even after cutting off the outliers the distributions of profit rates remain skewed. This is why median is used instead of mean. However, where the number of observations is greater, for instance when looking at industry total, median and mean are very close to each other. Further, the figures presented are 'unweighted', i.e. each firm contributes with its median, independent of the volume of profit or loss. We first take a look at the development of profits at total industry level.

Figure 3.1 Average operating profit ratio (median) 1991-94 according to innovation activities, all industry

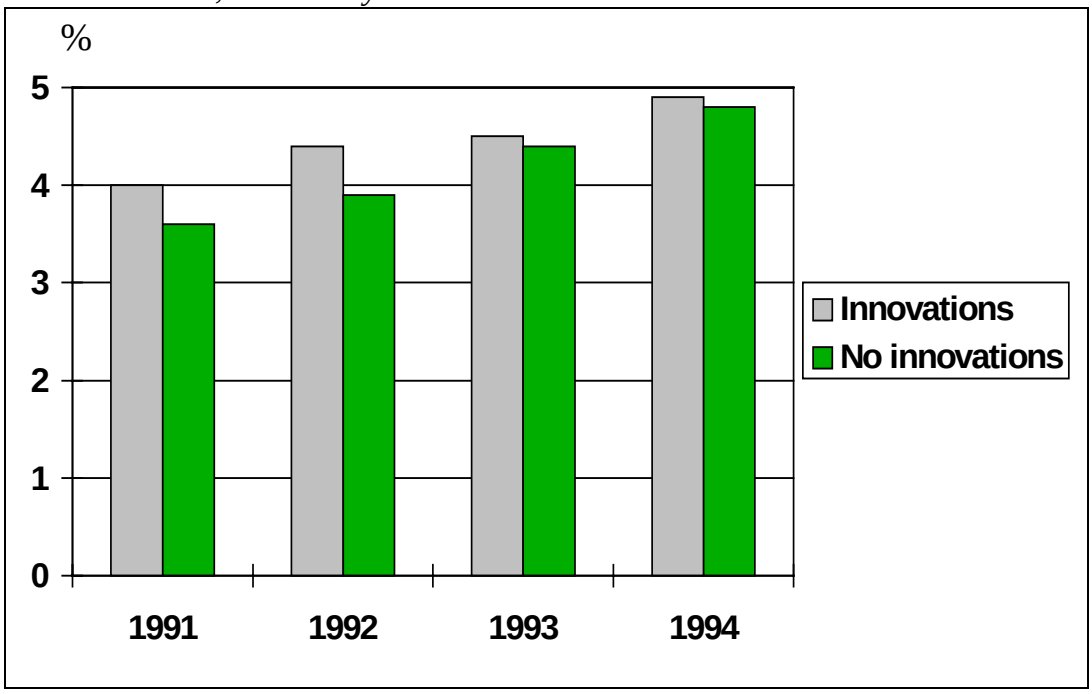
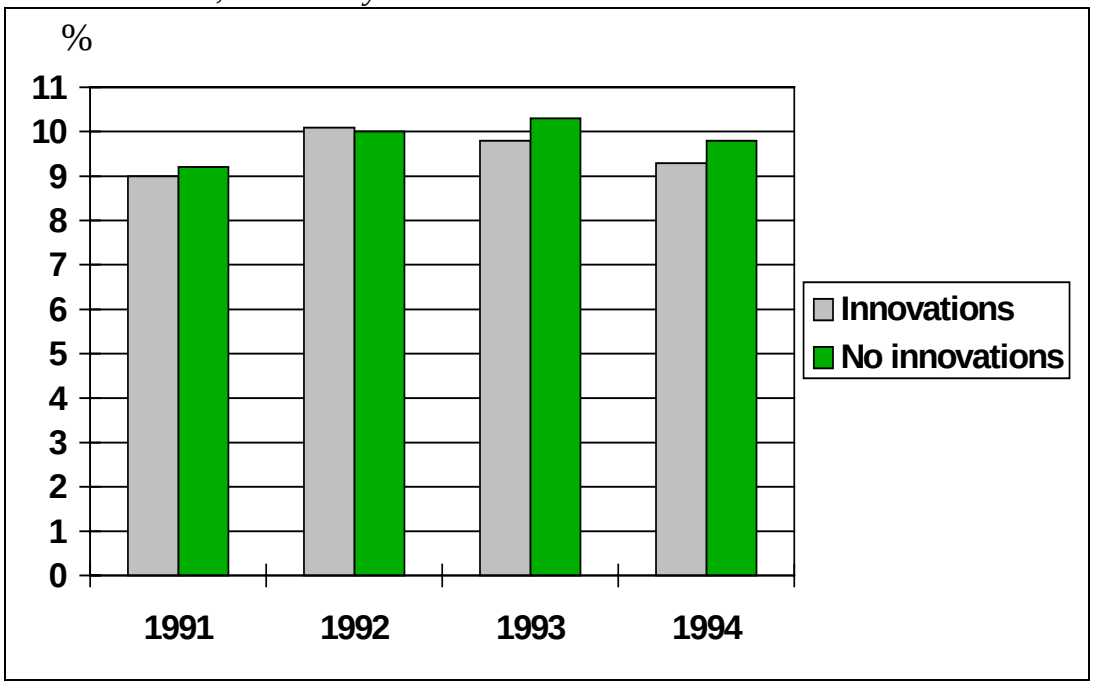


Figure 3.1 presents the OPR in the 1991-94 panel. As can be seen, the profits of innovators are somewhat greater until 1993, when any significant difference

practically disappears. Figure 3.2 shows the corresponding development for ROTA. It is immediately clear that measured by this indicator, there is no difference between the two groups. Thus, for the industry total, innovation output does not have an impact on profitability in our panel.

Figure 3.2 Return on total assets (median) 1991-94 according to innovation activities, all industry



Although innovations seem to have little or no effect on profit level in the industry as a whole, we will still pursue the usual breakdowns such as firm size and main economic activity. We first tackle the effect of firm size, using the identical enterprise panel of Statistics Norway. This covers enterprises with more than 100 employees and is one year longer than our panel for all enterprises. Figures 3.3 and 3.4 present developments in OPR and ROTA respectively. The conclusion is quite obvious: except for 1993 (especially with ROTA, somewhat less with OPR) innovators show consistently higher profits. Further, for the OPR, the difference grows considerably in 1994.

Figure 3.3 Operating profit ratio (median) large enterprise panel 1990-94 according to innovation activities, industry

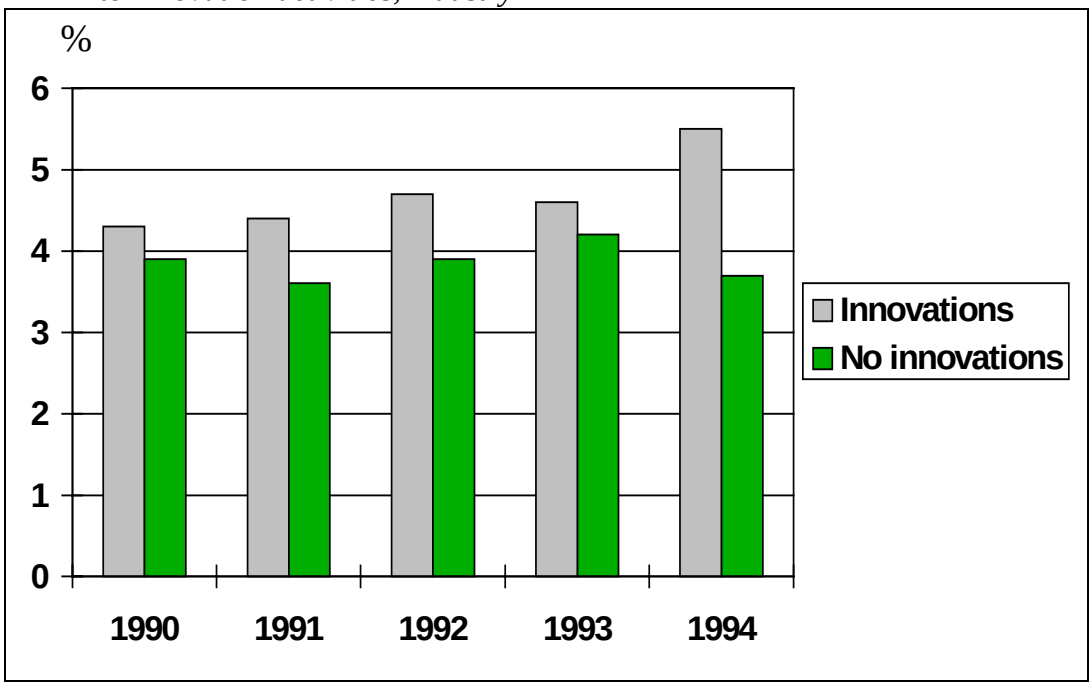
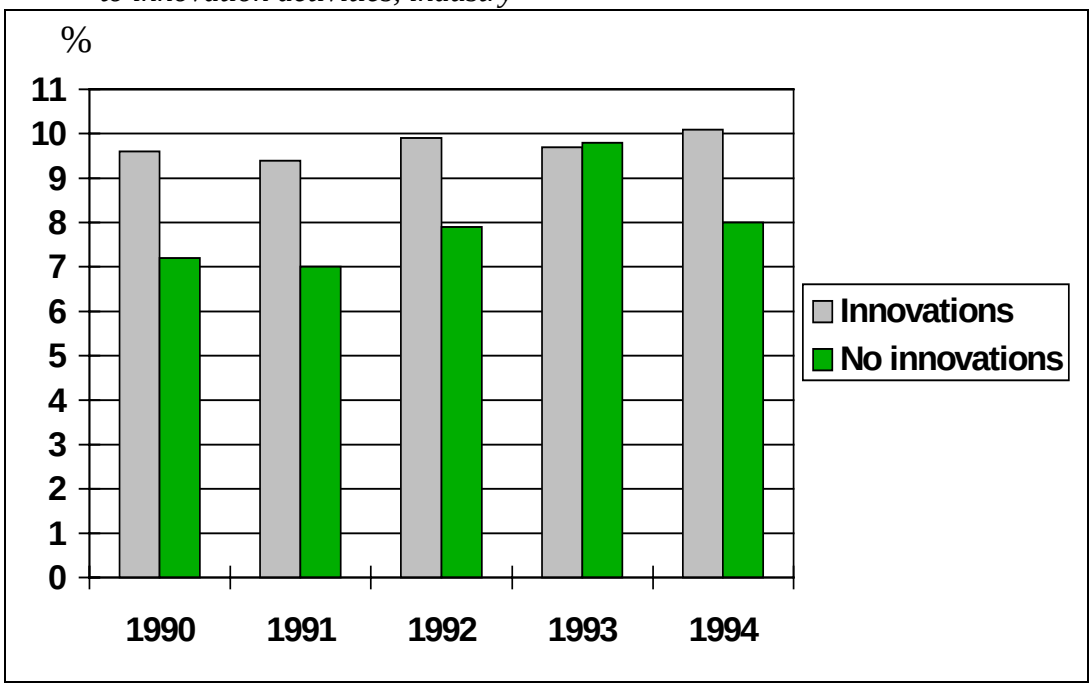


Figure 3.4 Return on total assets (median) large enterprise panel 1990-94 according to innovation activities, industry



The profit levels for other size groups are shown in Tables 3.1 and 3.2. Considering both OPR and ROTA, the results for size groups 1-19 and 20-49 are inconclusive. No systematic difference between innovators and non-innovators can be found. The group 50-99 employees, however, follows much the same pattern as the large enterprise panel. Further, it seems that the difference in favour of innovators increases with time. Thus, the results suggest that innovation output, firm size and profit are related in such a way that among firms with more than 50 employees, innovators show greater profit than non-innovators. With small enterprises on the

other hand, profit rate seems to be more or less independent of firms' innovation activities. This may, however, be a result of selectivity, too. For example, unsuccessful small enterprises fall out of the panel because of bankruptcy while successful ones may be bought by larger enterprises. Thus, the group of small firms is - to a greater degree than large firms - in a state of flux due to entries and exits, a factor which cannot be handled by panel. This could be one reason why we are not able to detect permanent difference in profitability between innovators and non-innovators.

Table 3.1 Operating profit ratio (median) 1991-94 according to innovation activities and size, firms with less than 100 employees

	Size					
Year	1-19		20-49		50-99	
	Innovation	No Innovation	Innovation	No innovation	Innovation	No innovation
1991	4,4	3,5	3,0	3,8	3,4	3,1
1992	4,1	3,8	3,9	3,7	4,8	4,1
1993	3,8	4,6	4,5	4,7	4,9	3,0
1994	5,0	5,5	4,1	3,6	4,9	2,7
	(n=51)	(n=212)	(n=42)	(n=68)	(n=52)	(n=37)

Table 3.2 Return on total assets (median) 1991-94 according to innovation activities and size, firms with less than 100 employees

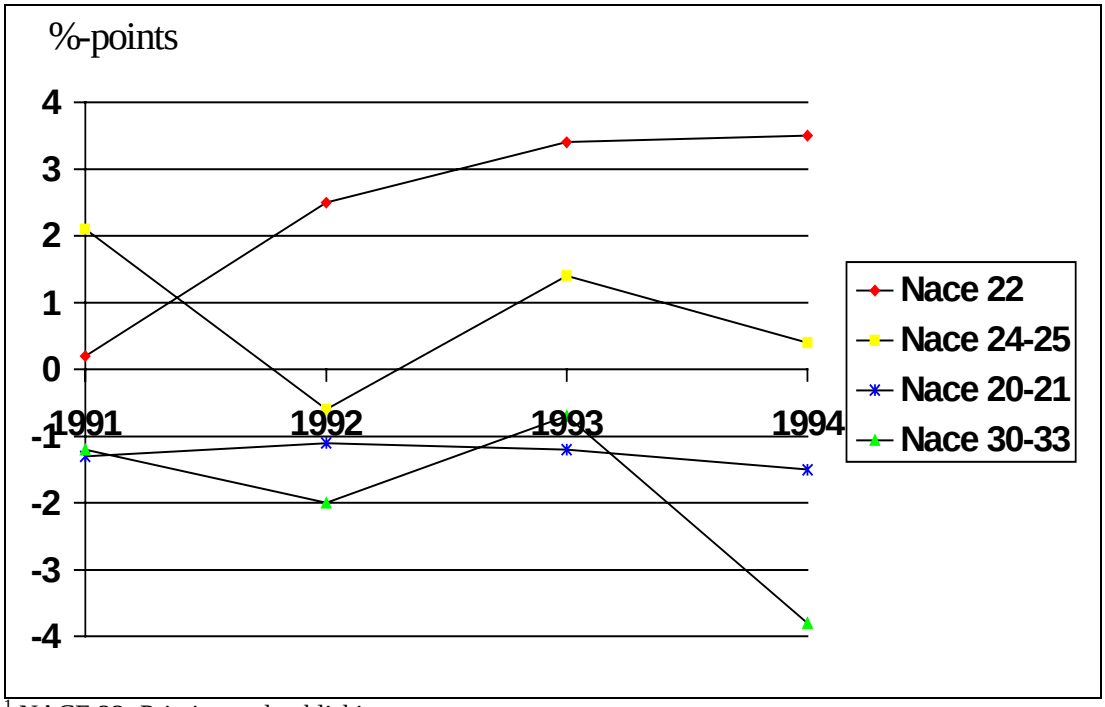
	Size					
Year	1-19		20-49		50-99	
	Innovation	No Innovation	Innovation	No innovation	Innovation	No innovation
1991	11,5	9,3	7,3	8,6	7,5	8,8
1992	11,2	10,2	9,8	9,0	10,3	10,3
1993	11,3	10,6	9,5	10,3	11,3	7,9
1994	11,5	11,8	8,3	8,8	9,6	7,2
	(n=52)	(n=201)	(n=42)	(n=67)	(n=53)	(n=36)

We now turn to the effects of industry by breaking down the data according to industrial classification. Only some selected results are discussed here. Detailed figures can be found in the appendix Table A.1. It should be emphasised that industry level analysis is hampered by skewed distribution of profit variables and the rather small number of enterprises in some industrial classes. The small number of observations also means that controlling for size on the industry level could not be done.

Figures 3.5 and 3.6 present the difference in profit rates between innovators and non-innovators. Positive values mean that innovators have higher profits, while negative values indicate higher profits for non-innovators. Perhaps surprisingly, there is a difference, even increasing over time, in the profit rate in favour of innovators in printing and publishing (NACE class 22). This is traditionally considered a low-tech industry, as measured by R&D intensity or proportion of innovating firms, for instance. In contrast, the electrical equipment and instruments industries (NACE 30-33), in which R&D intensity and proportion of innovators are high, non-innovators show slightly higher profits. The difference with ROTA is not stable, but here again we see an increase in 1994. Other industries in which non-innovators had higher

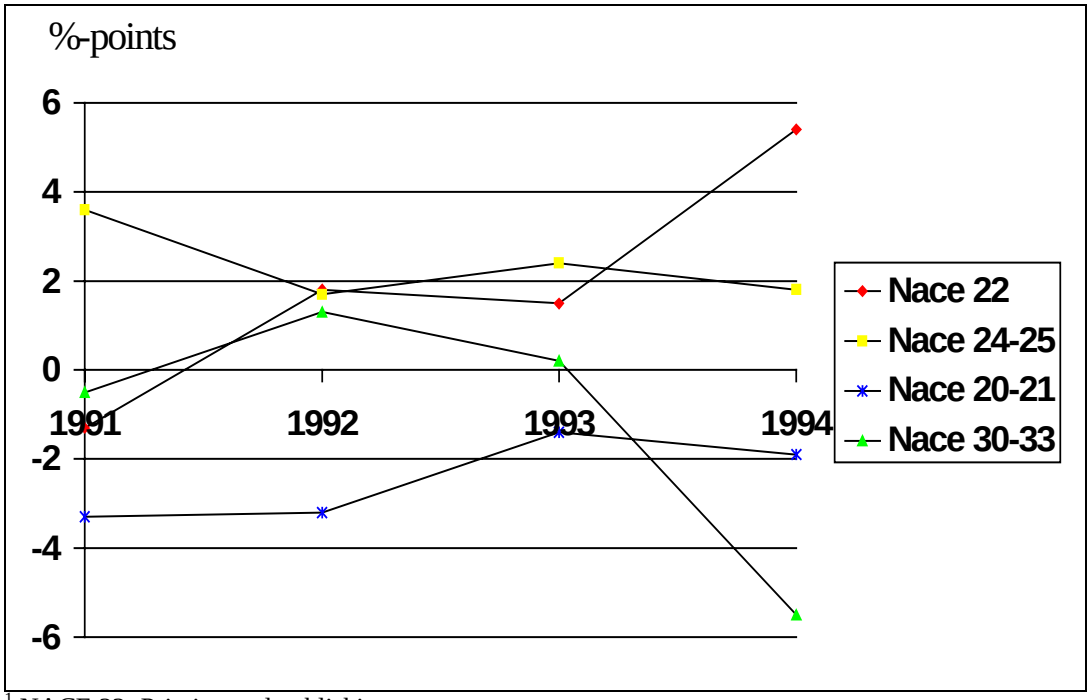
profit rates than innovators were wood, wood products, pulp and paper (NACE 20-21) and textiles and clothing. Greater R&D intensity and profits amongst innovators coincide in the chemical, rubber and plastics industries (NACE 24-25). Innovators also showed somewhat higher profit levels in manufacture of other non-metallic mineral products. Remaining industries showed no marked or constant differences, as for example food (15-16) and metal and metal products (27-28) in the appendix Table A.2.

Figure 3.5 Operating profit ratio (median). The difference between innovators and non-innovators in some industrial classes.[1]



[1] NACE 22=Printing and publishing
NACE 20-21=Wood, wood products, pulp and paper
NACE 24-25=Chemicals, rubber and plastics
NACE 30-33=Electrical equipment and instruments

Figure 3.6 Return on total assets (median). The difference between innovators and non-innovators in some industrial classes.



[1] NACE 22=Printing and publishing
NACE 20-21=Wood, wood products, pulp and paper
NACE 24-25=Chemicals, rubber and plastics
NACE 30-33=Electrical equipment and instruments

Besides the problems of data coverage, there are two further aspects to consider. Firstly, the lag before innovations become profitable is certainly different in different industries. Secondly, intramural R&D is not the only input indicator of innovation activity. One channel of technological diffusion is acquired technology in the form of process innovations developed by another industry. This may well be the case here with printing and publishing. All this makes industry-level analysis complex, even if we possessed more extensive data.

3.2 The development of firm performance

In the previous section we focused on the differences in average profit rates. We now turn to the question of differences in the development of innovators and non-innovators. The first focus is on the persistence of profit rates, i.e. how well profits in the beginning of the period predict the profit rates of following years. Another aspect we take a look at is the development of sales. Although not directly related to profitability, it indicates how successful a firm has been in enlarging its activities. And, of course, it can be assumed that introduction of new products to the market or improvement of production methods will in due course be reflected in an increase in sales.

Profit rate and innovation output may be related in ways other than that innovations simply indicate higher profit. It has been proposed (Geroski, 1993 and 1995)[16] that the performance of innovative firms is more persistent, and that they are less vulnerable, e.g., to cyclical downturns. According to this argument, what matters is the process of innovation which makes firms more flexible when adjusting to external incidents like demand or supply shocks.

The persistence of profit rate has been analysed for our two panels by taking correlations of the first year's profit with the following years' profit rates. Table 3.3 presents the results from the large enterprise panel 1990-94.

Table 3.3 Correlations of OPR and ROTA 1990 with OPR and ROTA 1991-94. Large enterprises panel

OPR

	N	1991	1992	1993	1994
All	142	.59 (**)	.42 (**)	.35 (**)	.31 (**)
Innovations	107	.58 (**)	.46 (**)	.40 (**)	.38 (**)
No innovations	35	.65 (**)	.29	.11	.03

ROTA

	N	1991	1992	1993	1994
All	143	.60 (**)	.35 (**)	.29 (**)	.22 (**)
Innovations	106	.59 (**)	.30 (**)	.23 (*)	.23 (*)
No innovations	37	.59 (**)	.41 (*)	.43 (**)	.19

** p<.01; *.01<= p <= .05

As could be expected, the first year's profit correlates positively with the profits of following years even with the lag of five years. For OPR, the correlation is stronger for innovators than non-innovators. The ROTA conclusions are not so clear; 1992-93 non-innovators have higher correlations but in 1994 there is a difference in favour of innovators.

[16] Geroski, P (1995): Innovations and competitive advantage. OECD, Economic Department Working Papers No. 159.

Geroski, P.; Machin, S. and Reenen J. (1993): The profitability of innovating firms. RAND Journal of Economics, Vol 24, No 2.

Table 3.4 Correlations of OPR and ROTA 1991 with OPR and ROTA 1992-94. Firms with less than 100 employees.

OPR				
	N	1992	1993	1994
All	458	.42	.34	.34
		(**)	(**)	(**)
Innovations	143	.21	.28	.28
		(*)	(**)	(**)
No innovations	315	.51	.37	.36
		(**)	(**)	(**)
ROTA				
	N	1992	1993	1994
All	451	.36	.26	.20
		(**)	(**)	(**)
Innovations	147	.38	.29	.22
		(**)	(**)	(**)
No innovations	304	.35	.25	.19
		(**)	(**)	(**)

** p<.01; *.01<= p <= .05

For smaller firms the panel is one-year shorter. All the correlations are positive and significant. For OPR, non-innovators do have stronger correlations, but the figures for innovators are confusing, with the correlation coefficient increasing slightly after 1992.

The result that there is no difference between the two groups is perhaps not surprising. In order to be able to adequately assess the hypothesis of persistence of profit, longer time series would be required. Besides the usual problem concerning the lags of innovation output, this would help to deal with the impact of short-term economic fluctuations.

With the development of sales there is a striking difference between small and large firms. The change in sales is calculated by setting sales 1991=100 (1990=100 in the case of large enterprise panel). Here each firm weights according to its volume of sales, and thus the overall figures match quite closely to the group of large enterprises. As for the large enterprises (Table 3.5), non-innovators have clearly had more rapid increase in sales in the beginning of the period, but levels of sales start to decrease in 1994. This can be seen also from Table 3.6, in which we have a shorter panel for all enterprises. Interestingly, in the analysis of persistence of profit, the correlation coefficient for the year 1994 dropped as well (Table 3.3. above).

Table 3.5 The development of sales 1990-94 (1990=100, nominal prices) by innovation output. Large enterprise panel.

	N	1991	1992	1993	1994
		Index 1990=100			
All	145	100,3	102,3	104,4	108,9
Innovations	108	98,6	98,7	100,8	107,5
No innovations	37	114,3	132,2	134,8	120,2

Results are more consistent for enterprises with less than 100 employees, with innovators showing constantly faster increase in sales. This is especially the case for size-classes 20-49 and 50-99 employees. The results for small enterprises can be related to the development of profitability in Section 3.1. It was found that for small firms the profit rate between innovators and non-innovators did not differ, either cross-sectionally or over time, while for large firms it did. One way to interpret this is that what matters with innovation for small firms is growth, while for large firms it is return in terms of profits. The importance of growth for small firms is also reflected amongst non-innovating small firms for which the growth of sales has been faster than non-innovating large firms.

Table 3.6 The development of sales 1991-94 (1991=100, nominal prices) by number of employees and innovation output.

Size		N	1992	1993	1994
			Index 1991=100		
All	Innovations	276	100,9	104,2	112,3
	No innovations	364	109,4	108,4	104,2
1-19	Innovations	54	105,1	110,1	120,8
	No innovations	214	101,1	102,4	115,8
20-49	Innovations	43	107,4	116,1	134,5
	No innovations	68	100,1	100,5	109,0
50-99	Innovations	53	104,0	108,6	121,7
	No innovations	37	103,0	97,9	101,9
100-	Innovations	126	100,6	103,6	111,2
	No innovations	45	114,0	113,4	101,9

3.3 Profit and problems of finance as obstacles to innovation

Above, we examined whether innovation output has an impact on profit rates or on firm performance. But we can also put the question the other way around, i.e. does profit have an impact on the propensity of a firm to engage in innovation activities? If a firm is struggling with economic difficulties, indicated by low profit, it may be less inclined to undertake risky projects such as innovation. On the other hand, economic difficulties might be an incentive to start searching for new solutions. The data at our disposal presents a weakness here, namely the time-span covered; the decision to invest in innovation is a matter of the long-term development of a firm and is not likely to be made on the basis of one year's profit alone. In the data

available, innovation output refers to the period 1990-92 and the first year for the profit rate is 1991. However, as we have seen, the profit rates of adjacent years correlate quite strongly, so it is perhaps not misleading to rely on one year's profit data alone.

We can assume that profit rates correlate positively with the possibilities for internal financing of innovation activities. It should be noted that this is a proportional measure, and does not as such indicate the extent of potential internal sources of funds for innovation. In this sense cash flow, the most widely used measure of internal financial capability, may be more accurate. We present some results for cash flow also and define it as net annual result (result after taxes, depreciation and other financial items). Internal financial capability is the traditional explanation for the frequent observation that innovation (or R&D) activities are more common in large enterprises than in smaller ones.[17] The argument is that larger, more diversified firms are better able to bear the risks and uncertainties involved in innovation activities and are less dependent on external debt.

Besides being an indicator of internal financial capabilities, profit rate is likely to be positively correlated with external sources as well. Unfortunately the impact of external sources of finance cannot be dealt with explicitly, due to the lack of data on sources of funding for innovation activities. But profit rate may also be a signal to the providers of risk capital, which is often needed to finance innovation activities which are generally of uncertain outcome.

We can also make use of valuable additional information from the innovation survey, in which respondents were asked about financial barriers to innovation activities. The inclusion of barriers was limited to those which had actually had some impact, i.e. had prevented realisation of at least some innovation activities during 1990-92. Of special interest here is 'lack of appropriate sources of finance' which was rated according to its importance on a scale from 1 (insignificant) to 5 (crucial). We thus have an overview of how firms themselves perceive their financial possibilities for innovation, or in other words, an overview of how far these barriers prevent innovation. The levels of financial problems reported indicate that firms could potentially have introduced a greater number of innovations than they did.

The data we use here is the combined 1991-92 dataset. This is basically larger than our 1991-94 panel (because of attrition), but on the other hand, there is a considerable degree of non-response for the question concerning financial sources. Thus we have 568 responses, which is 83 per cent of the responses in the original net sample. For background information, Table 3.7 presents percentages of responses to the 'sources of finance' obstacle according to importance attached, firm-size and innovation activity. As we might expect, financial barriers are considered to be more important for small firms than large ones. There are no marked differences between innovators and non-innovators. Looking at size-categories we see that a greater share of innovative firms with fewer than 20 employees consider this obstacle to be 'important'. However, there is no difference between innovative and non-innovative

[17] Cohen, Wesley (1995): Empirical Studies of Innovative Activity. In Stoneman, P. (ed.): The Handbook of Economics of Innovation and Technological Change. Blackwell Publishers. Oxford.

firms when we look at the responses ‘important’ and ‘of medium importance’ together. In all, ‘sources of finance’ as a barrier is relevant for both groups; it may have prevented innovation activities (non-innovators) or have limited further innovations (innovators).

Table 3.7 Sources of finance as a barrier to innovation activity by size

	Innovations				No innovations			
Size	N	Not important	Of medium impor-tance	Important	N	Not important	Of medium impor-tance	Important
		Percent				Percent		
ALL	268	52	17	31	300	44	21	34
1-19	47	36	13	51	167	37	25	38
20-49	47	36	28	36	59	41	22	37
50-99	59	49	31	20	35	57	23	20
100+	115	66	8	26	39	69	5	26

In Table 3.8. the importance of source of finance is classified as above and further broken down by variables on innovation output and firm size. Looking at totals, Figure 3.8 is much as expected in the sense that firms which reported financial problems as important barriers to innovation also tend to have lower profit rates. This is true for both innovators and non-innovators as well as for ROTA and OPR. The only exception to this is the group small innovating firms with fewer than 20 employees, for which there is no such connection. In accordance with what we established in Section 3.1, profit rates between innovators and non-innovators do not markedly differ even when classified according to degree of importance. But there is an interesting modification by size. Amongst those firms with less than 20 employees that reported ‘source of finance’ as an important problem, non-innovators have lower profit rates. The size-group 20-49 employees displays a contradictory result, with non-innovators showing higher than average profit rates (there are a few other importance classes with big difference in the profit rate between innovators and non-innovators, but these have only a small number of observations and are very uncertain).

Table 3.8 Profit rates according to innovation output, firm size and importance of sources of finance as a barrier to innovation.

	OPR				ROTA			
	Innovators		Non-innovators		Innovators		Non-innovators	
All	N	%	N	%	N	%	N	%
Not important	136	4,5	132	4,2	139	10,1	131	10,6
Of medium importance	46	3,2	63	3,3	46	7,4	61	9,4
Very Important	82	3,1	103	2,2	81	7,9	101	7,0
1-19								
Not important	17	4,6	61	4,9	17	13,8	60	11,9
Of medium importance	6	3,5	40	3,0	6	10,9	38	9,5
Very Important	23	5,4	64	2,1	23	12,0	62	6,9
20-49								
Not important	16	3,9	24	5,0	17	10,1	24	10,2
Of medium importance	13	3,9	13	2,2	13	7,9	13	7,1
Very Important	17	1,6	22	2,6	17	2,8	22	7,4
50-99								
Not important	28	3,7	20	2,9	29	11,6	20	7,6
Of medium importance	18	1,6	8	6,1	18	4,0	8	13,0
Very Important	12	1,9	7	-0,2	11	5,3	7	5,1
100-								
Not important	75	4,7	27	3,5	76	9,8	27	10,3
Of medium importance	9	6,2	2	8,1	9	8,7	2	16,3
Very Important	30	2,7	10	2,6	30	7,3	10	9,8

The relationship between the importance of 'sources of finance' as a barrier and profit rates can also be analysed by taking simple correlations, although the barrier variable is not strictly continuous, but discrete. Some interesting patterns emerge from the correlations between profit rates, cash flow and problems of funding innovation activities (Table 3.9). Consistent with Table 3.8, the correlations are negative, i.e. the lower the profit or cash flow, the more problems with finding funds. Perhaps the most interesting result can be found in the north-east corner of Table 3.9, where non-innovative firms with less than 50 employees show significant negative correlations for each of the three profitability indicators. With larger non-innovators, profit and problems of finance do not correlate. As for innovators, it is the groups of smallest and largest enterprises in which profits and problems of finance correlate most weakly.

Table 3.9 Correlations of profit rate with 'lack of appropriate sources of finance' as a barrier to innovation. According to innovation output and size

Size	Innovations			No innovations		
	OPR	ROTA	Cash flow	OPR	ROTA	Cash flow
All	-.17	-.17	-.11	-.16	-.21	-.06
p-level	(**)	(**)	( )	(**)	(**)	( )
N	264	266	268	298	293	300
1-19	-.01	-.07	-.16	-.17	-.25	-.20
p-level	( )	( )	( )	(*)	(**)	(*)
N	46	46	47	165	160	167
20-49	-.30	-.34	-.27	-.29	-.29	-.28
p-level	(*)	(*)	( )	(*)	(*)	(*)
N	46	46	47	59	59	59
50-99	-.28	-.24	-.13	-.10	-.24	.08
p-level	(*)	( )	( )	( )	( )	( )
N	58	58	59	35	35	35
100-	-.14	-.15	-.12	-.07	-.05	.01
p-level	( )	( )	( )	( )	( )	( )
N	114	115	115	39	39	39

** = p<.01; * = .01<=p<.05

One way to interpret the results above is to assume that profit rates indicate the internal financial capabilities of firms to introduce innovations, and reported financial problems indicate the motivation to do so. According to this interpretation, negative correlations for small non-innovating firms may indicate that internal financial capabilities have been a relevant factor in preventing innovation activities. As far as large enterprises are concerned, profit rate or cash flow does not seem to have an impact on the financing of innovation. Perhaps the most curious result in Table 3.9 (as can be inferred from Table 3.8, also) is the correlations close to zero for small innovating enterprises. Although 51 per cent of them reported 'sources of finance' as an important barrier, this does not correlate with the profit rate and only weakly with cash flow. One possible explanation is that innovation for the relatively low proportion of small enterprises that introduce innovations in the first place is so crucial that profit rate does not play a decisive role. What matters is the expected future growth of sales. Also, a considerable proportion of them may be newcomers, in which case their products are by definition innovations and subsequently there is no relation to the profit rate.

4. How can we account for differences among innovators?

So far the focus has been on differences between innovators and non-innovators. In this chapter we go on to take a closer look at innovators alone, to investigate whether differences in innovation activity are related to profitability and salesgrowth in firms.

In the first section we compare developments in profits for product- and process innovators. At the outset we would expect that product innovations are more risky, but with greater potential if successful. Process innovations, on the other hand, are more often aimed at cost reductions or more efficient production in already existing lines of production; hence the risk may be smaller, but so may the potential benefit. The second section applies the same analysis to sales growth as the performance indicator. Next we apply an indicator from the innovation survey where firms were asked to state the share of total sales consisting of totally new or changed products over the preceding three year period. Does this measure of innovativeness, which essentially measures the degree of successful innovation, also show up in profits and salesgrowth? Lastly, we look for effects of the amount of innovation inputs, measured relative to the size of firms, on profitability and salesgrowth. Are those firms with large innovation inputs also the more profitable ones?

4.1 Development in profit rates for product- and process innovators

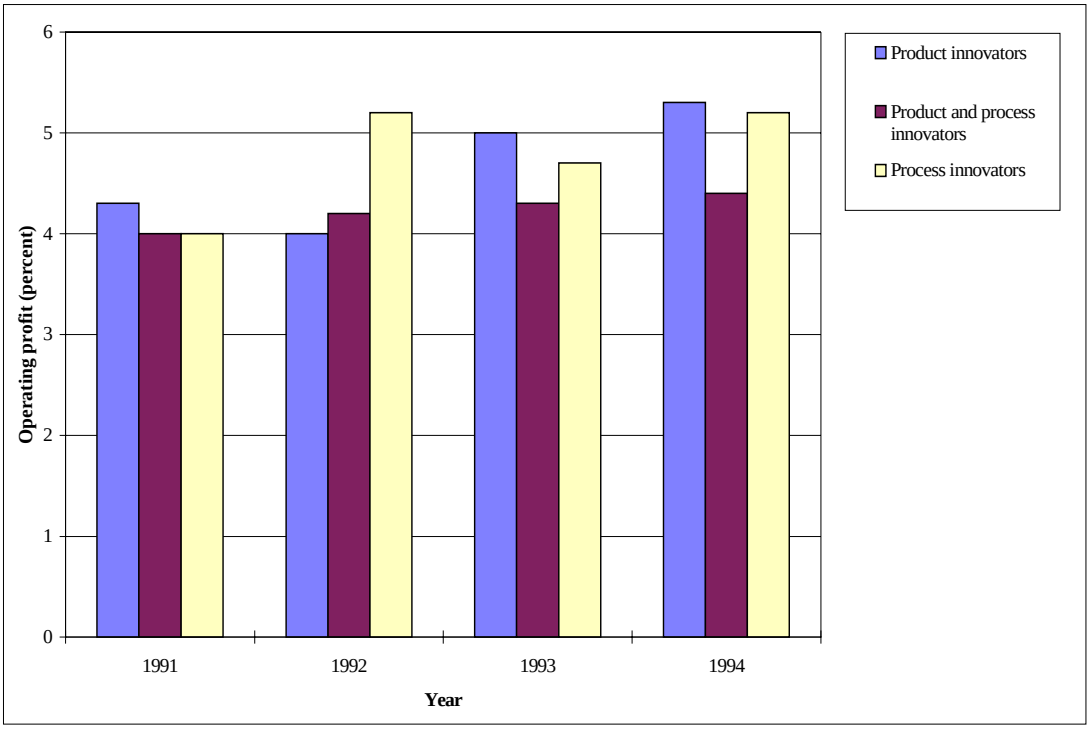
For many firms, product- and process innovation goes hand in hand; a new product may require a new or modified process, and a new or modified process may result in changes to product characteristics. There is a difference, however, between changing or renewing product characteristics, and improving the production process. Changing the production process requires an already existing production, which one wants to improve. Essentially, this can be viewed as a kind of cost reducing operation, where the market for the product being produced is already known. Thus in many cases the risk of such innovation can be considered to be moderate. One can argue that this in many cases might be a defensive action; the triggering experience might be pressures on profit levels by competing firms. Product innovation, on the other hand, includes presenting a new or changed product to the market. This might be a defensive action too, but can also be viewed as an offensive move with future opportunities. In such a situation there might be uncertainties about whether the new or improved product will be accepted. The risk increases, of course, according to the degree of “newness” - which is true of both product- and process innovations.

What would this imply for the observed profit rates or development of sales, if these indicators really reflect what is happening? If it is true that risks are generally greater for product innovation than for process innovation, we would expect greater diversity in the results of product innovators, as some of them will fail due to the higher risks involved. Among process innovators, if risk is generally lower, we would expect to find less variation. Secondly, we would expect the potential profit of successful firms to be greater for product innovators, whilst also showing a longer lag in the

realisation of the profits. It is not necessarily possible to track this in the data, however, as successful and unsuccessful innovations are mixed. This problem is to a certain degree modified in Section 4.3 below, when we introduce the share of new or changed products into the discussion. In a sense, this indicator "isolates" the successful innovations, and thus give us an opportunity to look for a relationship between innovation success and success in terms of profits or growth in sales.

In the CIS survey, firms were asked if they had introduced any new or changed products or processes during the past 3 year period (1990-1992). Just over half the innovative firms included in our panel reported both product- and process innovations (146 firms). 42 firms, or 15 %, reported product innovation alone, and the remaining 88 firms (32 %) reported process innovation alone. Below we compare how the performance of these three groups on our indicators of profit and development in sales.

Figure 4.1. Median operating profit 1991-1994 by type of innovation. Short panel. N=276.



The level of operating profit is not substantially different for product and process innovators and those involved in both types of innovation. As can be seen from Figure 4.1, the difference - at its greatest – lies around 1 percentage point. It seems that growth in profit rates starts somewhat later among product innovators, but that they increase more rapidly once started, compared to process innovators. The minor variations observed here, however, cannot be said to show significant differences. This has also been confirmed by a formal test for each individual year.[18]

[18] Testing for significant differences between groups of firms in this chapter is based on ANOVA (analysis of variance). The method investigates whether the total variance in observed values (that is, the squared deviance from the grand total) can be better explained by introducing the classes or groups under study, taking into consideration the number of observations and the degrees of freedom (number

Even if the median profit rates do not differ, variance within the groups of product-process innovators may be hidden by this measure of central tendency. In Table 4.1 below we present the 1st and 3rd quartiles (Q1 and Q3), the 1st and 9th percentiles and their differences. As we can see, variation between the groups is very small for all the years considered. A formal test also reveals that there are no significant differences in mean deviation from the group medians in any of the years.[19] Thus we must conclude that there are no differences in risk attached to process and product innovation as hypothesised above, the way product-process innovation is recorded here and revealed in profit rates.

Table 4.1. Operating profit 1991-1994 according to product or process innovation. Measures of variance. Short panel.

		N	Median	Q3	Q1	Q3-Q1	P9	P1	P9-P1
OPR91	Product only	42	4,3	7,3	0,6	6,8	9,4	-2,5	11,9
	Both	146	4,0	6,6	1,1	5,5	10,0	-3,1	13,1
	Process only	88	4,0	8,8	1,6	7,2	13,5	-0,6	14,1
OPR92	Product only	42	4,0	7,3	1,4	5,9	9,9	-2,7	12,6
	Both	146	4,3	7,7	2,0	5,7	10,3	-1,2	11,5
	Process only	88	5,2	8,8	5,5	6,3	12,2	0,1	12,3
OPR93	Product only	42	5,0	7,9	1,7	6,2	9,9	-1,7	11,6
	Both	146	4,4	8,0	1,8	6,2	10,4	-1,4	11,8
	Process only	88	4,7	8,6	2,2	6,3	12,5	-0,1	12,6
OPR94	Product only	42	5,3	8,4	3,1	5,3	11,6	1,8	13,4
	Both	146	4,4	7,7	1,9	5,8	12,6	-2,6	15,2
	Process only	88	5,3	9,5	2,0	7,4	14,7	-1,1	15,8

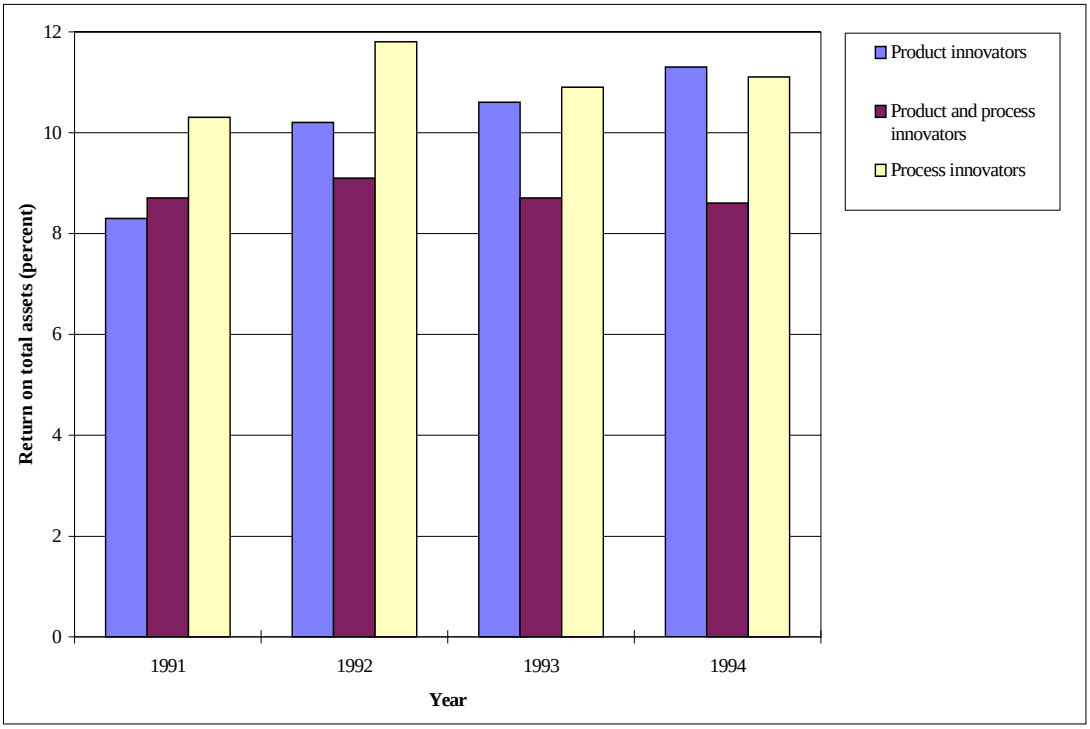
Looking at our second profit indicator, return on total assets, we basically find the same pattern as found for operating profit (Figure 4.2 below). None of the differences between groups are statistically significant[20], but in firms where process innovation is involved the profit rate seems to level off over time, whereas there is a weak but persistent growth over time among the product innovators. This is in line with the hypothesis put forward above, namely that product innovation is in a sense an offensive action, while process innovation is more often of a defensive nature. Thus product innovators have the opportunity to increase market shares and profits, while process innovators to a larger extent defend their position and are thus fighting to maintain existing levels of profit. One must note, however, that the evidence is weak, possibly because the time span covered is too short to reveal any "final" outcome. Obviously, longer time series and more research is needed on this topic.

of categories). The level of significance is set to 95%, that is, we accept that there is a 5 % likeliness that the observed differences might come about by chance.

[19] Tested by ANOVA, see footnote 18.

[20] Tested by ANOVA, see footnote 18.

Figure 4.2. Return on total assets 1991-1994 by type of innovation. Short panel. N=276.



A possible source of error when comparing profits among process and product innovators is the mix of firms of different size or different industry within groups. To control for this, we have broken down the material according to size and industry. Five size classes are used, and profit levels are compared for product and process innovators within the classes. Results are presented in Tables 4.2 and 4.3 below. In general, no clear picture emerges from these tables. There are of course differences in profit levels among firms of different sizes, but in the vast majority of cases, differences among process and product innovators are not significant at the usual 5-percent level, even within size classes.[21] The same is true when controlling for industry (Appendix Tables A.3 and A.4); profit levels do vary between industries, but these variations cannot be better explained when introducing the product-process innovation distinction. We must therefore conclude that the distinction between product and process innovators does not add to explaining variation in profit levels, and that differences either in size of firm or in industry do not change this picture.

[21] Tested by ANOVA, see footnote 18.

Table 4.2. Product-process innovators. Median operating profit 1991-94 (short panel) by size class.

Size class	*Year*	*Product innovators*	*Product and process innovators*	*Process innovators*
1-19	1991	6,1	3,9	3,1
	1992	3,4	2,1	8,3
	1993	4,4	4,4	3,3
	1994	5,6	4,5	5,0
20-49	1991	3,2	3,0	1,9
	1992	5,4	4,0	3,6
	1993	6,2	3,7	4,5
	1994	2,8	4,6	4,1
50-99	1991	2,8	3,5	4,0
	1992	5,9	3,9	5,2
	1993	2,8	6,2	4,5
	1994	6,4	4,8	4,6
100-199	1991	2,6	4,4	4,9
	1992	2,9	5,3	7,1
	1993	4,9	4,1	7,1
	1994	6,1	3,3	8,2
200 +	1991	4,9	4,2	4,7
	1992	4,9	4,7	3,9
	1993	5,7	4,1	3,2
	1994	4,6	5,2	5,2

Table 4.3. Product-process innovators. Median ROTA 1991-94 (short panel) by size class.

Size class	*Year*	*Product innovators*	*Product and process innovators*	*Process innovators*
1-19	1991	16,7	11,2	10,7
	1992	9,2	6,1	13,8
	1993	14,4	10,6	10,8
	1994	16,6	13,2	11,4
20-49	1991	7,4	7,9	6,7
	1992	16,8	9,7	9,8
	1993	15,4	7,5	11,5
	1994	6,6	8,9	5,5
50-99	1991	5,3	7,8	9,8
	1992	11,3	9,5	11,2
	1993	10,6	11,9	9,6
	1994	12,4	8,3	9,2
100-199	1991	8,5	9,4	13,4
	1992	8,0	10,7	13,4
	1993	9,1	7,9	14,7
	1994	11,2	6,8	12,5
200 +	1991	6,6	8,0	12,6
	1992	10,2	9,1	9,6
	1993	10,0	7,8	9,8
	1994	7,8	9,2	10,9

Part of the problem with explaining differences in profit rates between product- and process innovators relates to the timing of obtained results. The time it takes for profits to react to innovative action may differ for product and process innovators, in different industries and for firms of varying size. To investigate this, we have simply computed an average profit level over the four year period under study, as an unweighted average of each firm's profit-to-sales ratio. This measure thus indicates the level of profitability independent of when in the four year period it is earned. Looking at operating profits first (Figure 4.3), we find that the picture is rather fuzzy. However, it seems that there is a rather sharp increase in profit levels for process innovators when firm size increases, up to size class 100-199 employees. Also, when using return on total assets as the profit indicator, process innovators seem to have higher profit levels the larger the firm, but again with an exception for the smallest and largest firms (Figure 4.4). Using this indicator, we also find a persistent drop in profit level for product innovators as firm size increases. It is hard to know how to interpret this. One possibility could be that there is greater chance to succeed with product innovation, rather than process innovation, if you are small - and vice versa for bigger companies.

Figure 4.3. Operating profit. Unweighted average 1991-1994 by type of innovation. Short panel. N=276.

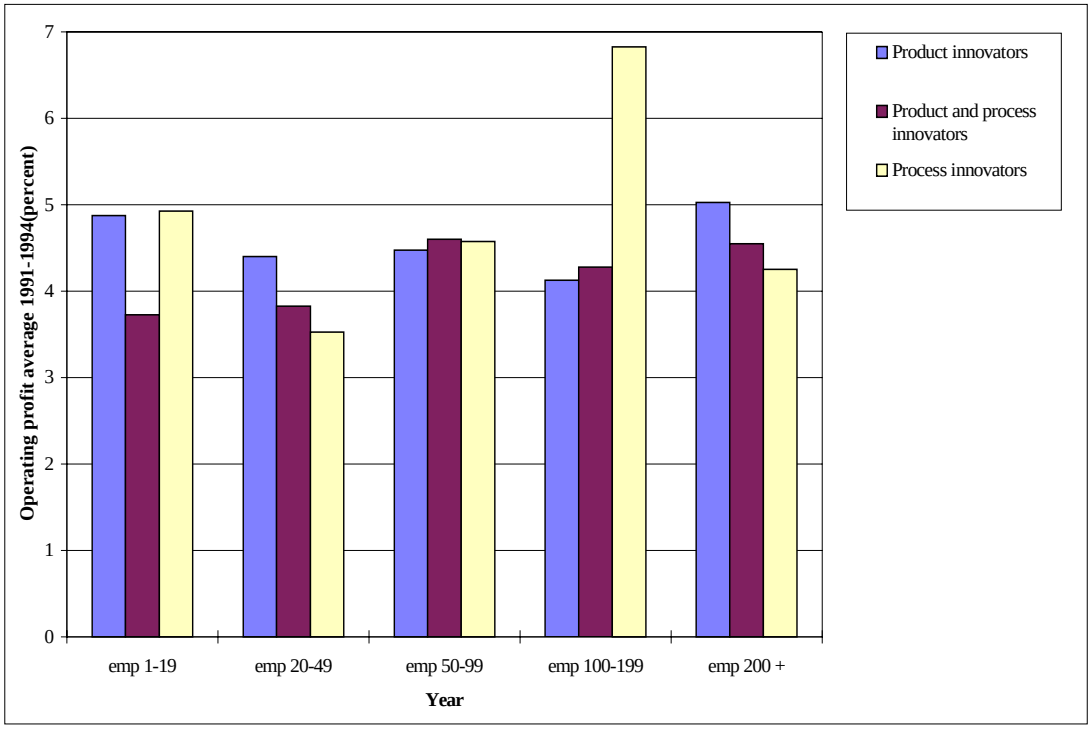
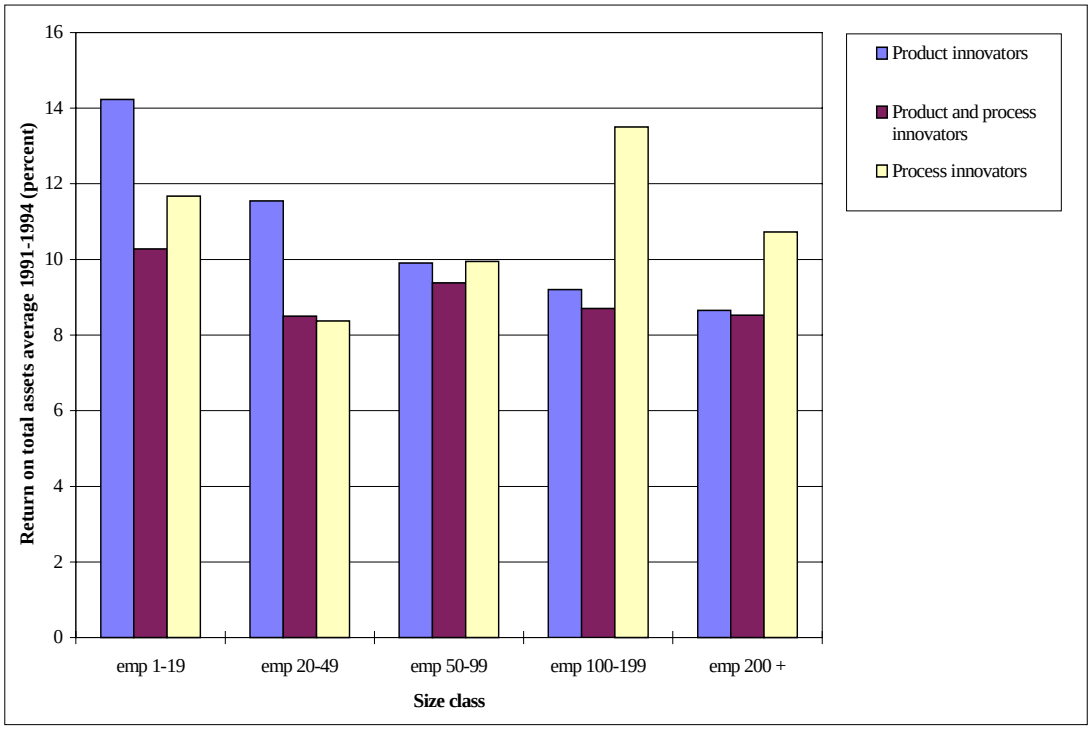


Figure 4.4. Return on total assets. Unweighted average 1991-1994 by type of innovation. Short panel. N=276.



A final topic to be considered when looking at profits for product and process innovators concerns the persistence of profits over time. A significant change in profit level indicates that firms' performances have changed - for better or worse. A persistent level, on the other hand, could be an indication of the ability to cope with changing environments, as argued in Chapter 3. In Table 4.4 we have computed

simple correlations of profit level for the first year and the following years to check this. It appears that the level is somewhat more persistent amongst innovators compared to non-innovators, in particular due to the development in the groups of process innovators. The differences are not large, however.

Perhaps the most striking result is the lack of persistence of profits amongst product only innovators. This could be an indication of higher risks for product innovation compared to process innovation, as discussed above. Single firms may experience significant changes to profits due to the success or failure of innovation, thus leading to a lack of correlation of profit level for the first and subsequent years. If failing and succeeding firms are more or less equally distributed within the group of product innovators (and size classes), this may explain why we have not discovered this type of relationship in the preceding analysis. Also, taking seriously the argument that innovative capacity makes firms able to cope with changing environments, this seems to be more appropriate for process innovation than for product innovation.

Let us add a warning that the number of observations is rather limited in this analysis, particularly for product only innovators. In addition, the arguments for a relationship between persistence of profits and innovative risk is a rather complicated one that needs further discussion. Therefore the conclusions should be treated as suggestions for further research, rather than the final word on these topics.

Table 4.4. Persistence of profits. Correlations of operating profit and return on total assets 1991 with operating profits and return on total assets 1992-1994. Short panel.

	N	1992	1993	1994
OPR				
All	640	.50**	.49**	.39**
Non-innovators	364	.56**	.41**	.33**
Product only innovators	42	.41**	.30	.21
Product and process innovators	146	.35**	.58**	.52**
Process only innovators	88	.66**	.60**	.38**
ROTA				
All	640	.38**	.25**	.18**
Non-innovators	364	.35**	.16**	.18**
Product only innovators	42	.47**	.29	-.07
Product and process innovators	146	.32**	.40**	.26**
Process only innovators	88	.61**	.56**	.19

** p<.01; *.01<= p <= .05

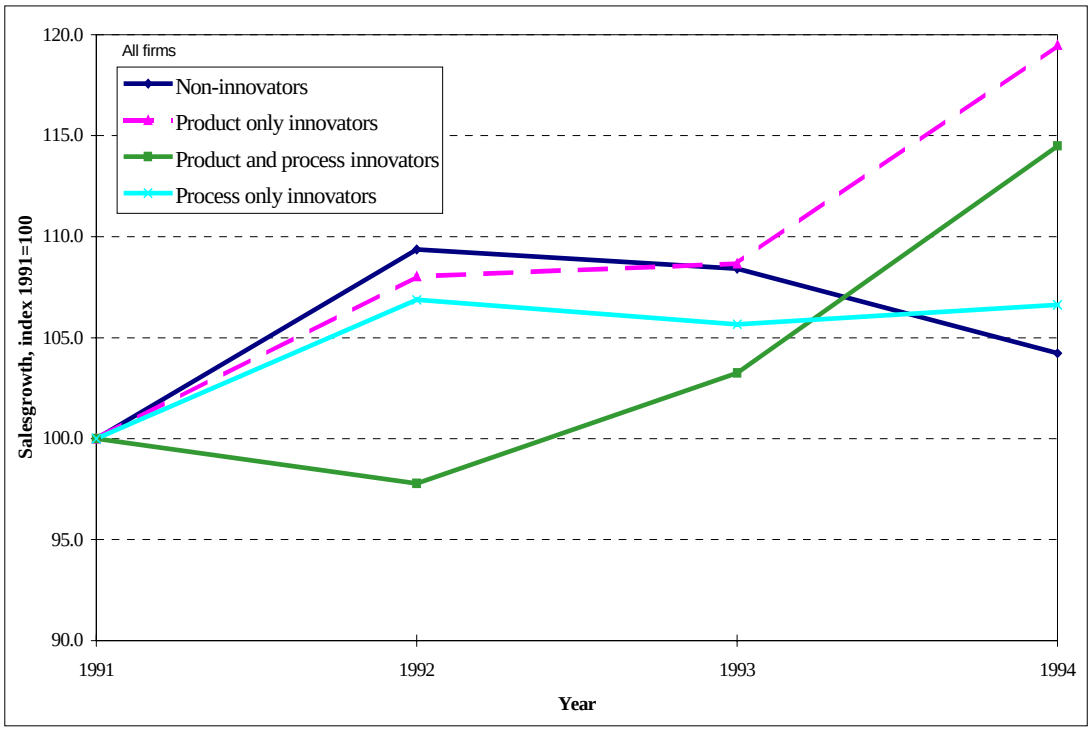
4.2 Development in sales for product and process innovators

So far in this chapter, profit has been treated as the sole objective of firms. Profit may indeed be the final goal, but in the interim, increasing market shares or expanding the market itself may be necessary. The short term, therefore, may see a trade off between profits and market share - via, for example, temporarily lowered prices. Small or newly founded firms in particular may find such trade offs necessary, in order to achieve at least the minimum market size needed for efficient

operations. As market share is not available to us as a variable, we apply the size of total sales as a proxy – on the grounds that increasing sales, in most cases, results from expanding market shares or the market itself.

Development of sales for all firms independent of size is shown in Figure 4.5 below. Sales has been converted into an index set to 100 in the first year under study, namely 1991. The general picture is one of increasing sales over time amongst innovators. Also for non-innovators sales grow the first year, in fact even more than for innovators, but over time non-innovators experience a decline, and innovators seem to grow more quickly. The fastest growing innovators are product only innovators - perhaps due to the more offensive nature of product innovation as discussed above.

Figure 4.5. Development in sales 1991-1994 by type of innovation. Index 1991=100. N=640.



In Figures 4.6-4.10 below, sales development is shown according to firm size. The general picture of greater growth for innovators than for non-innovators is maintained throughout the size classes - and product innovators make up the strongest growing group in all size classes. There are some differences, however. First of all, smaller firms have significantly higher relative growth than larger ones, independent of whether they are product innovators, process innovators or non-innovators. In absolute numbers, of course, growth is greatest for the larger companies, as the bases from which they grow are larger. We will nevertheless interpret the results as a difference in the priorities given to salesgrowth versus profits between smaller and larger companies: smaller companies seem to put more emphasis on growth than larger ones.

Another interesting feature that emerges when controlling for size classes, is that the decline in sales in the second half of the period for non-innovators is entirely due to

the development of larger firms (with 200 employees or more). In the other size classes non-innovators do experience a slower growth than innovators, but we do not find decline as with the larger companies. It is, however, difficult to interpret this without further investigation of this group of non-innovating large companies. It could be suggested that these are companies in traditional industries with economies of scale explaining their size, operating in international markets highly affected by cyclical developments. But that is for future analysis to decide.

Figure 4.6. Small firms (1-19). Development in sales 1991-1994 by type of innovation. Index 1991=100. N=268.

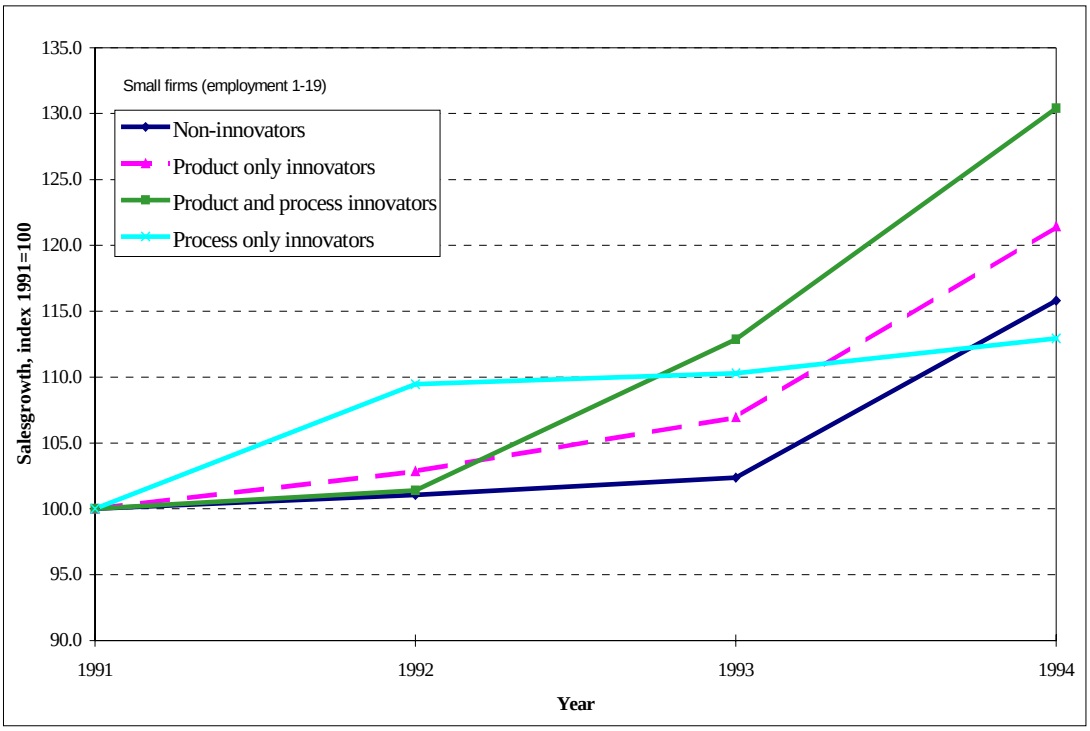


Figure 4.7. Medium sized firms (20-49). Development in sales 1991-1994 by type of innovation. Index 1991=100. N=111.

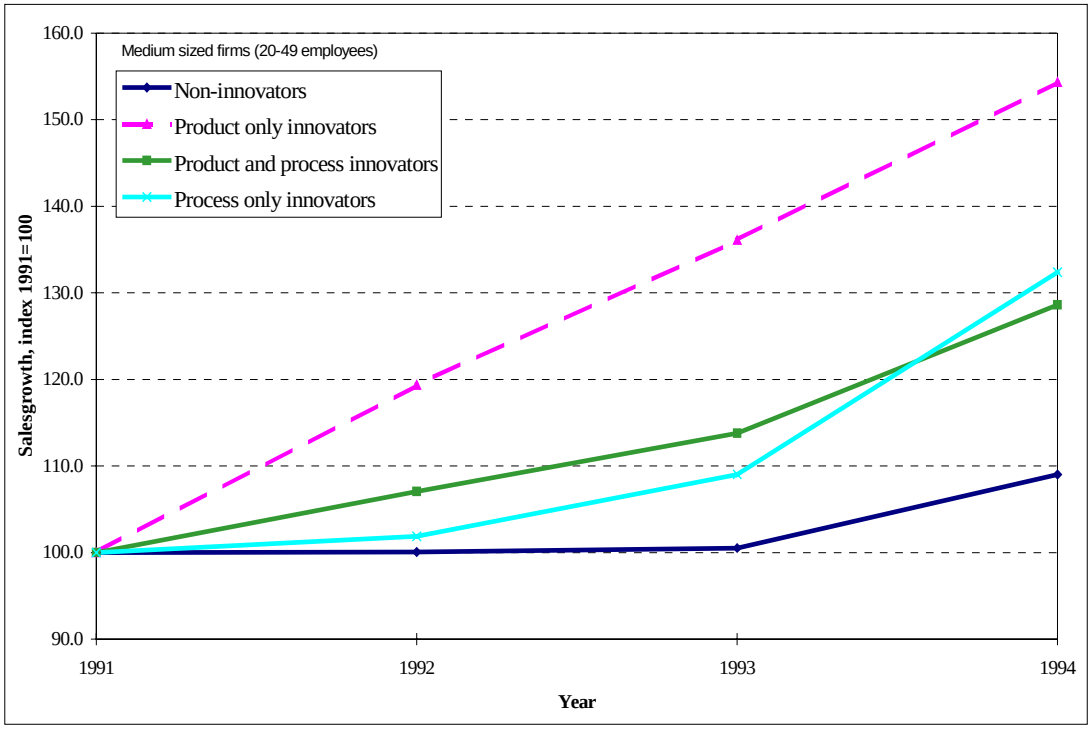


Figure 4.8. Medium sized firms (50-99). Development in sales 1991-1994 for by type of innovation. Index 1991=100. N=90.

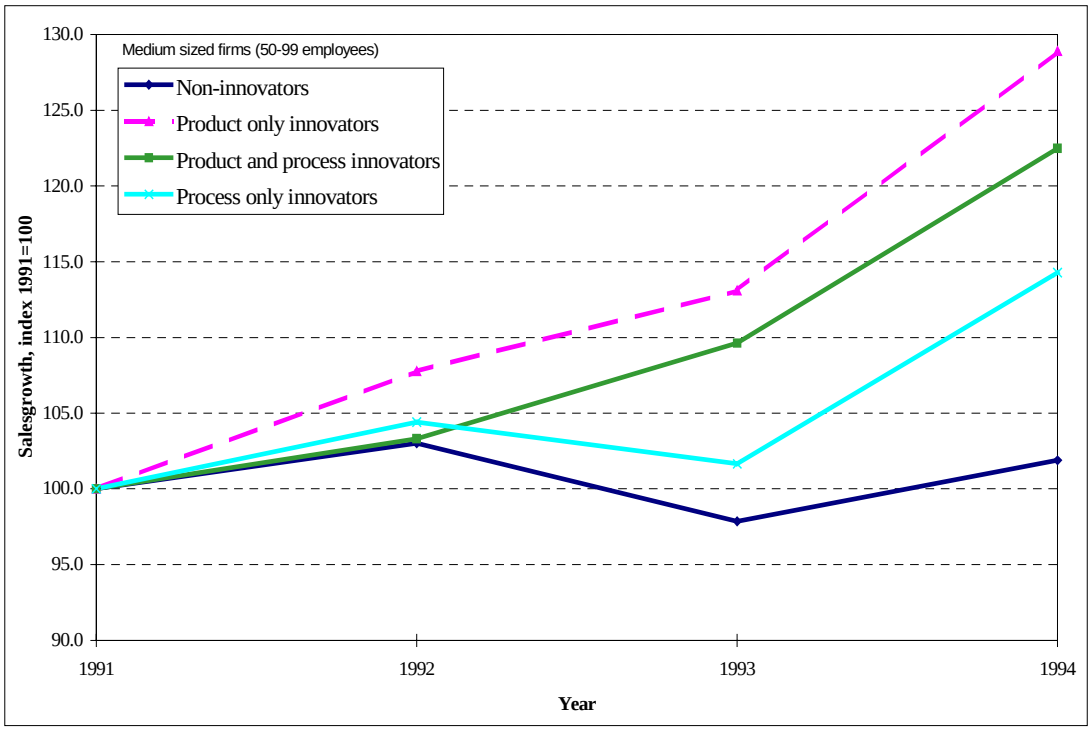


Figure 4.9. Large firms (100-199). Development in sales 1991-1994 for by type of innovation. Index 1991=100. N=89.

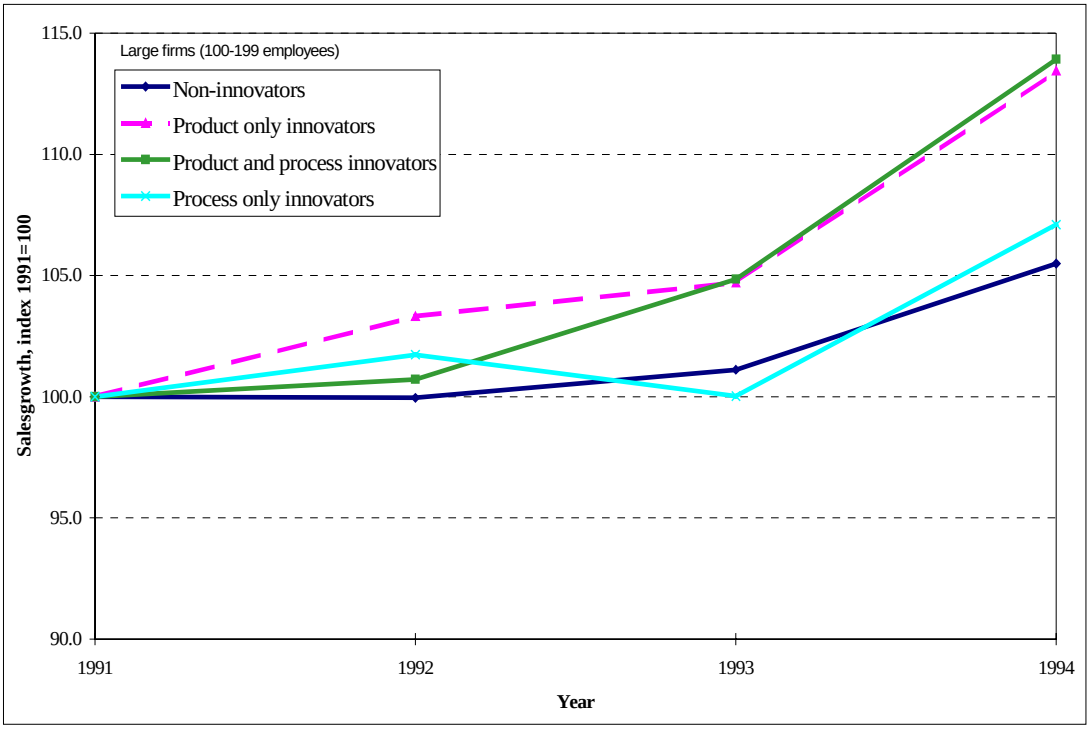
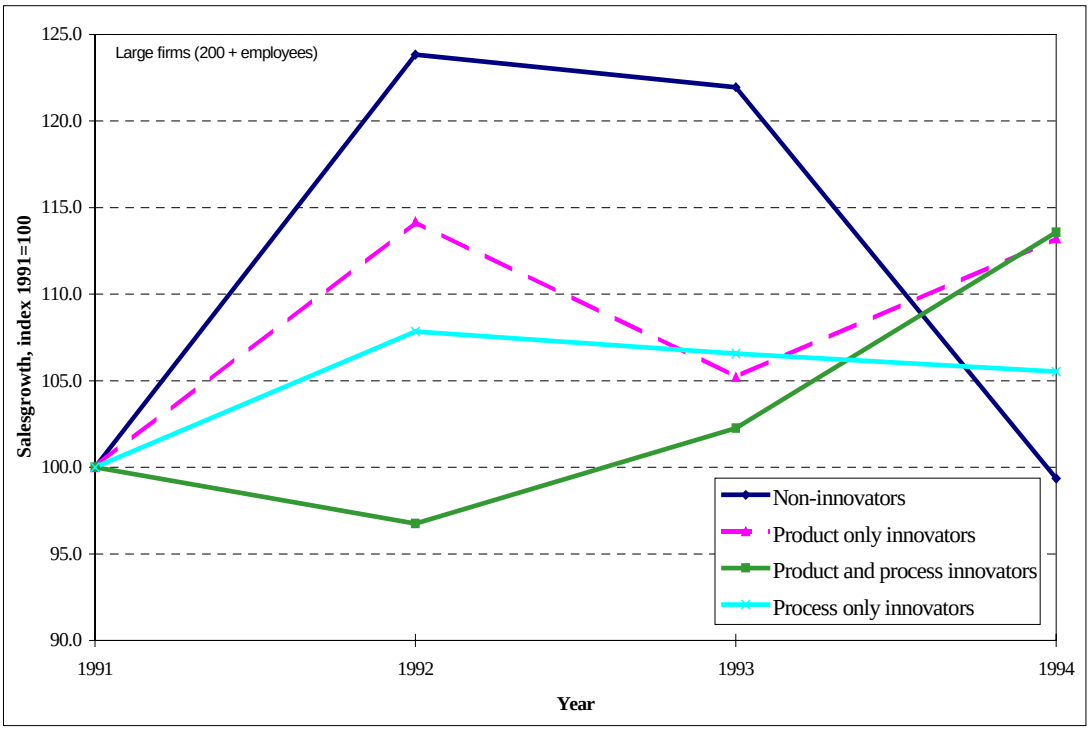


Figure 4.10. Large firms (200+). Development in sales 1991-1994 for by type of innovation. Index 1991=100. N=82.



Having investigated the differences amongst product and process innovators at length above, we do not seem to find any strong evidence that this distinction is of significant importance for developments in profit levels. Profit rates among innovators are seen to grow slowly over time for the period under study, perhaps somewhat more for product innovators than process innovators, but the differences

are not statistically significant. The analysis of persistence of profits suggested the conclusion that there is a somewhat greater degree of uncertainty involved with product innovation compared to process innovation, as profit rates are not correlated over time to the same degree. This suggestion requires further research, however.

When looking at developments in sales, we see that innovative firms grow more than non-innovative ones. In particular, non-innovative large companies have a negative development in sales in the second half of the period under study. Smaller firms are in general seen to grow more in relative terms than larger ones. We conclude our discussion with the suggestion that this is probably due to the priority given to growth in smaller firms, in many cases at the expense of profits in the short term.

4.3 How important are new products for profits?

The CIS approach to measuring the results of product innovation was to ask firms how much of their total sales in 1992 consisted of products that were completely new or significantly improved over the period 1990-92. How does this indicator relate to economic results as recorded in the accounts?

At the outset we would expect there to be a positive relationship, with higher profits among firms reporting a larger share of new products. However, there are many factors that might disturb such a relationship. First of all, profit rates vary according to the industry the firms belong to. So too does the need and opportunity to innovate; in industries with rapid technological change firms have to innovate frequently in order to keep up with the competition. This might in fact contribute to lowering profits, as there is a cost side to innovative activity drawing upon available funds. The opposite might happen in industries with a slower pace of change; if market positions are stable and well defined, profits may be high even if the industry is not particularly innovative in terms of large shares of new products in sales. Another point relates to the timing of results to show up in profits; this problem affects the analysis here in the same way as in the other parts of the report.

Our first approach - to look for a relationship between profits and new product sales, is simply to see whether the numbers are correlated using Pearson’s r. This method looks at correlations on a firm-by-firm basis. Results are reported in Table 4.5 below, broken down by industry. As can be seen, we generally do not find any significant correlations, with only a few exceptions - most noticeable in the food and textile industries. The significant coefficients are positive however, as expected, except for the basic metals industry. A similar analysis controlling for size hardly gives any significant coefficients at all. We must conclude, therefore, that there does not exist any general and simple relationship between the share of new products in sales and profit rates in subsequent years when profits are measured as they are here, and without bringing in additional explanatory variables. Unfortunately, the number of observations in the data set does not allow us to control for size and industry simultaneously.

Table 4.5. Correlations of new products share of sales 1992 with OPR and ROTA 1991-1994 by industry (short panel). Not significant correlations reported as 0.

INDUSTRY	*OPR91*	*OPR92*	*OPR93*	*OPR94*	*ROTA91*	*ROTA92*	*ROTA93*	*ROTA94*
All industries	0	0	0	0	0	0	0	0
Food, beverages and tobacco	0	0	0,45**	0,37*	0	0	0,35*	0
Textiles, wearing apparel, fur and leather	0	0	0,60*	0,85**	0	0	0,58*	0,82**
Wood products, pulp and paper	0	0	0,54**	0	0	0	0,54**	0
Publishing and printing	0	0	0	0	0	0	0	0
Chemicals, rubber and plastics	0	0	0	0	0	0	0	0
Mineral products	0	0	0	0	0	0	0,58*	0
Basic metals, metal products	0	-0,38*	0	0	0	-0,40*	0	0
Machinery and equipment	0	0	0	0	0	0	0	0
Electrical and optical equipment, incl. IT	0	0,45*	0	0	0	0,41*	0	0
Transport equipment	0	0	0	0	0	0	0	0
Furniture, recycling	0	0	0	0	0	0	0	0

** p<.01; *.01<= p <= .05

Even if there is no relationship at firm level, this might be due to additional factors influencing performance within the individual firm. Therefore it may still be possible to identify differences between classes of firms dependent on their level of new product sales. We have constructed such classes for firms with no new products in their sales, firms with a low share (1-25 %) and firms with a high share (more than 25 %) of new products in their sales. The borderline between the high and low categories are somewhat arbitrary, reflecting that 25 % is a rather high share of new or changed products, but on the other hand the number of firms in each group should not be too different. In the sample, 104 (60 %) firms fall within the high category and 68 (40 %) in the low category. 104 firms have no new products. Results are reported in Figures 4.11-4.13 below, including salesgrowth as an additional result indicator.

The first thing we notice is that the profit level among those firms with a high share of new products in sales is always higher than profits for firms with a low share of new products in sales. The same applies to the development in sales. What upsets the picture somewhat, however, is the group of firms with no new products. In general, they seem to perform at the same level as the most innovative firms. This may be a reasonable result, since most of these firms (80%) are process only innovators. Thus they may be successful innovators even if this does not show up in the sales of new products.

A statistical test of differences between the groups in Figures 4.11-4.13 reveals that they are in most cases not significant at the 5 % level.[22] This is, however, to a large extent due to the inclusion of the group with no new products in sales. Also, this test for significance is influenced by where the borderline between the high and low group is drawn. Since we can see a persistently higher performance among those with a high share of new products in sales than among those with a low share, we interpret this to mean that successful innovation - in terms of a larger share of new products in sales - have a positive effect on profits and salesgrowth. This result holds, however, for the average performance of firms, and not necessarily for the

[22] Tested by ANOVA, see footnote 18.

single firm, as demonstrated in the correlation analysis above. This can be paralleled with the management of a portfolio of innovation projects, where it is possible to obtain a positive outcome from the total portfolio, but not necessarily for each single project. This is of course due to the risk involved, and demonstrates the need to be large enough to operate a whole portfolio of projects to increase the possibility for a positive outcome. This is generally possible for larger firms and society as a whole, but of course more difficult for smaller firms. Argued this way, the results can be seen as a demonstration of a rationale for public involvement in supporting, and thus managing, a portfolio of innovation projects.

Figure 4.11. Median operating profit by high (more than 25 %), low (1-25 %) and no (0 %) new products in sales. Short panel. Innovative firms. N=269.

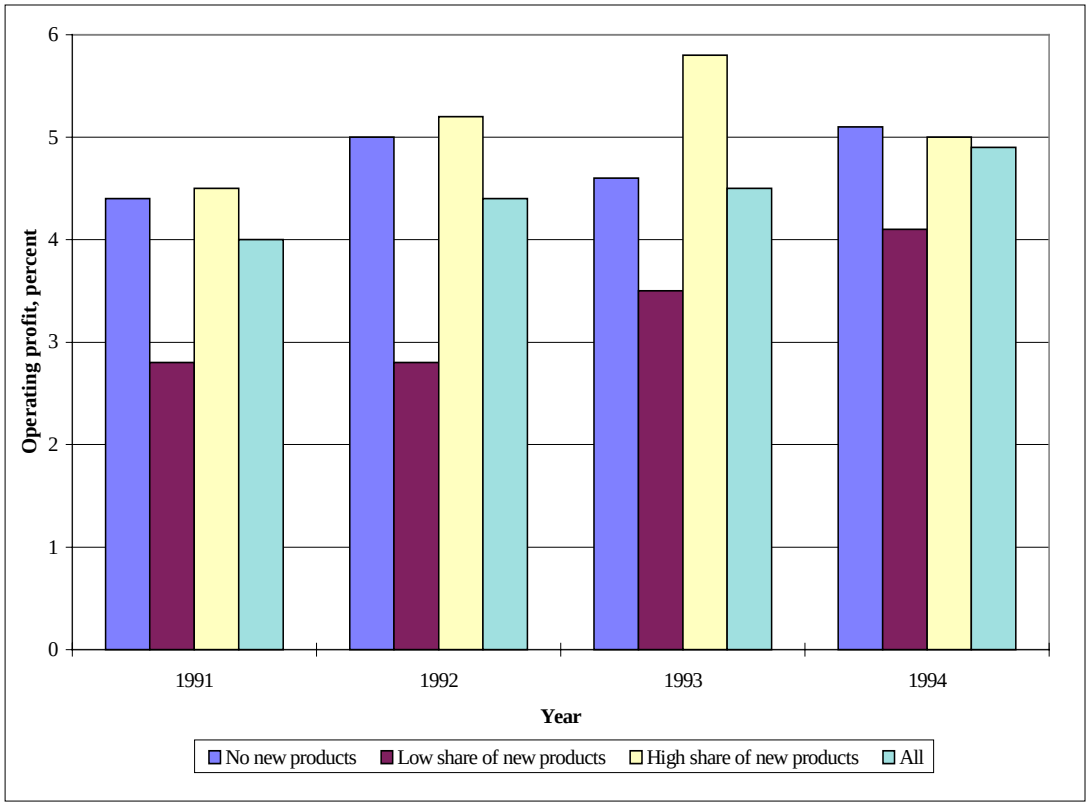


Figure 4.12. Median return on total assets by high (more than 25 %), low (1-25 %) and no (0 %) new products in sales. Short panel. Innovative firms. N=270.

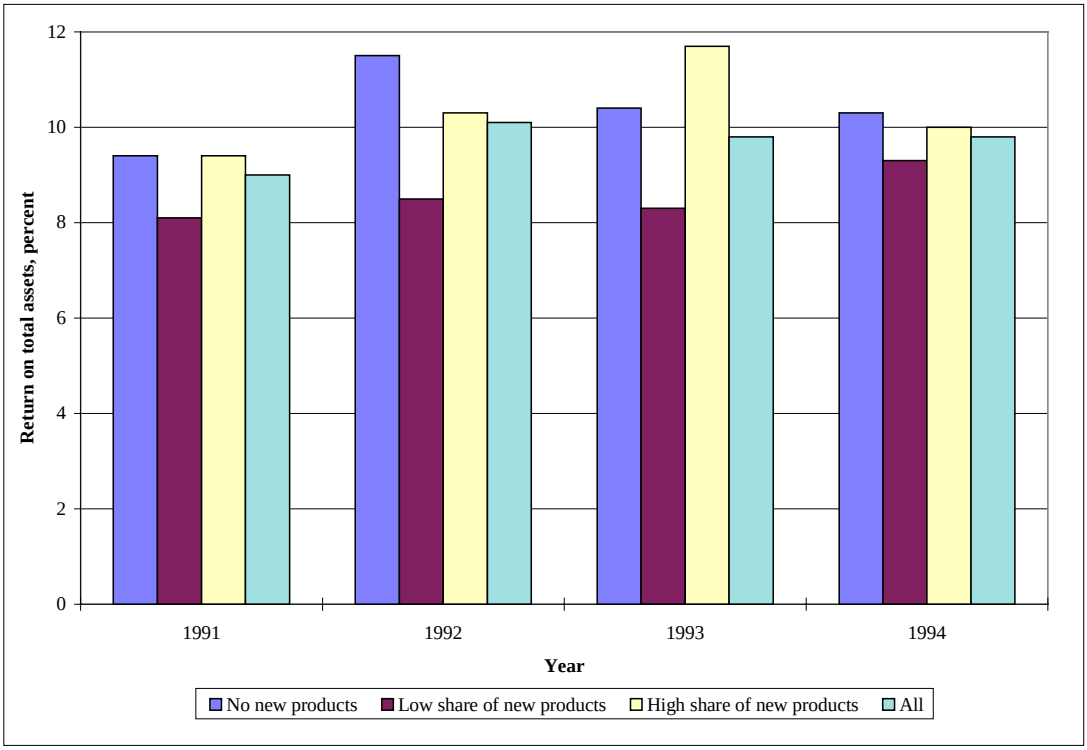
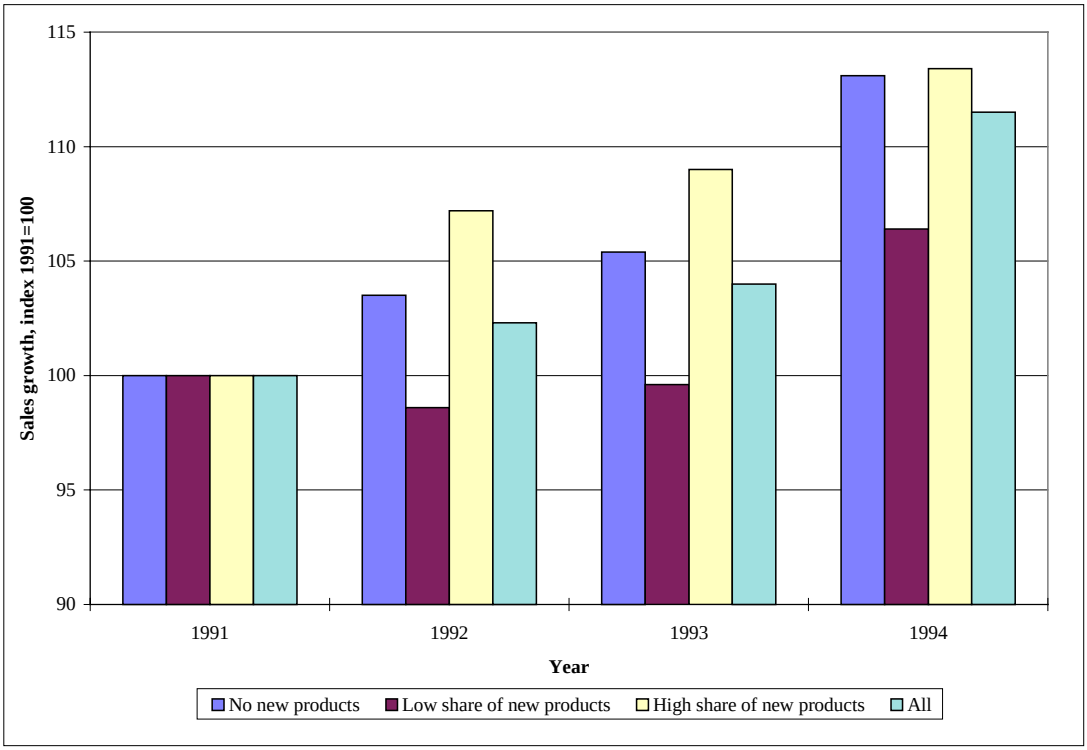


Figure 4.13. Salesgrowth (index, 1991=100) by high (more than 25 %), low (1-25 %) and no (0 %) new products in sales. Short panel. Innovative firms. N=276.



4.4 To what extent are innovation inputs reflected in profits?

So far we have established a relationship between profits or salesgrowth and the degree of innovativeness - measured by share of new products in sales and evaluated for classes of innovative companies. Is there a relationship also with innovation inputs, measured by innovation costs? Again we would at the outset expect such a relationship to be positive, but with the usual factors disturbing the relationship; industry differences, the differences in time lag of results, the riskiness and resulting variance in results among firms, and other factors not included in the analysis. In particular it is a problem that we have innovation costs data for one year only; the ideal would have been the stock of knowledge built up over time, or long-term average values.

Our first approach is the same as in the last section, looking at relations of inputs and profits at firm level using correlation analysis (Pearsons r). All measures used are relative to sales, i.e. innovation costs as a percentage of total sales and profit rates (relative to sales). It turns out that such a relationship at firm level is hard to establish with a reasonable degree of statistical significance, even when controlling for industry, size class or the product-process distinction. Even if most of the significant coefficients are positive, as expected, they are in general few, with small coefficients and in some cases even negative. Results are reported in Appendix Tables A5 and A6.

As in the former analysis, we then approach the problem by constructing classes of firms, depending upon how much they spend on innovation inputs relative to their sales (innovation costs intensity). The rationale for doing this is that even if there is no clear and identifiable relationship at firm level, there may still be differences among the groups of firms investing high or low shares of sales in innovations. We have constructed three classes, with innovation intensities less than 1 including 0 (N=47), 1-4 (N=115) and 4 or above (N=114). These classes are somewhat arbitrary, and the choice of borderlines will affect whether differences are significant. The classes do, however, apply the same borderlines as used by the OECD to classify low, medium and high tech industries based on R&D expenses.

We find no clear difference when comparing the two classes investing most heavily in innovation (see Figures 4.14 and 4.15). Over time the medium class seems to improve its performance relative to the high class, but this difference is not statistically significant.[23] The class of firms with innovation intensity less than 1, on the other hand, performs more weakly than the others for all the years and for both of our two profits measures. These differences are in most cases statistically significant. It seems, then, that profits on average are higher in firms with an innovation intensity above 1 than in firms with an innovation intensity below 1. Ideally, this result should have been controlled also for industry, as the intensity of innovative activity clearly varies between industries. This is not possible, however, as the number of observations is too limited. In fact, all industries are represented in this group of low innovation intensity, but two industries account for around 20 % of the observations each: food, beverages and tobacco, and transport equipment.

[23] Tested by ANOVA, see footnote 18.

If we look at a different sample, and use the long panel data set of large companies from 1990 to 1994, we basically get the same results as for the short panel (Figures 4.16 and 4.17 below). This even applies to the 1990 observation year, two years before the innovative input recorded in this survey. This strengthens our confidence in the findings.

Figure 4.14 Operating profits 1991-94 (short panel) by innovation intensity. N=269.

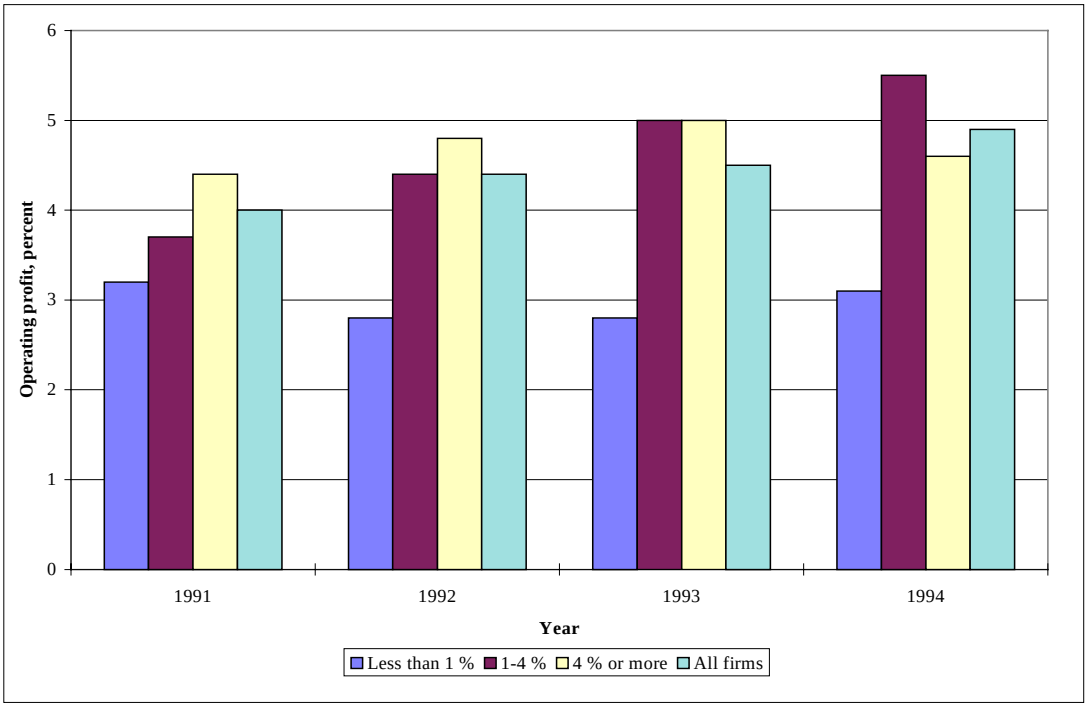


Figure 4.15. Return on total assets 1991-94 (short panel) by innovation intensity. N=270.

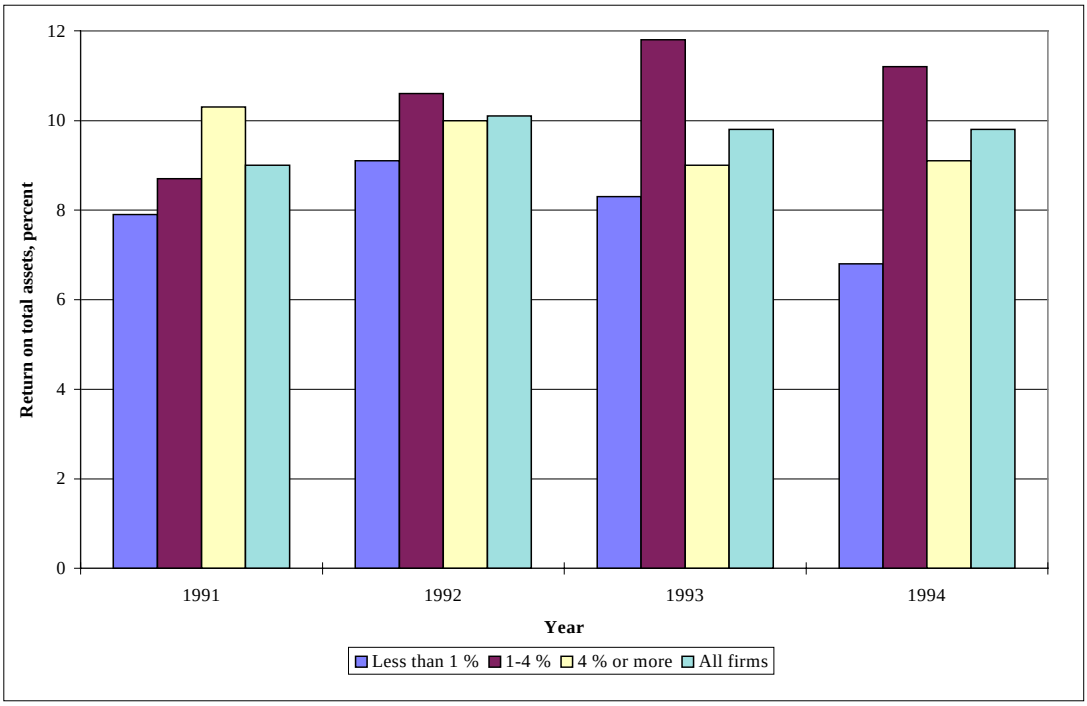


Figure 4.16. Operating profits 1990-94 (long panel) by innovation intensity. N=107.

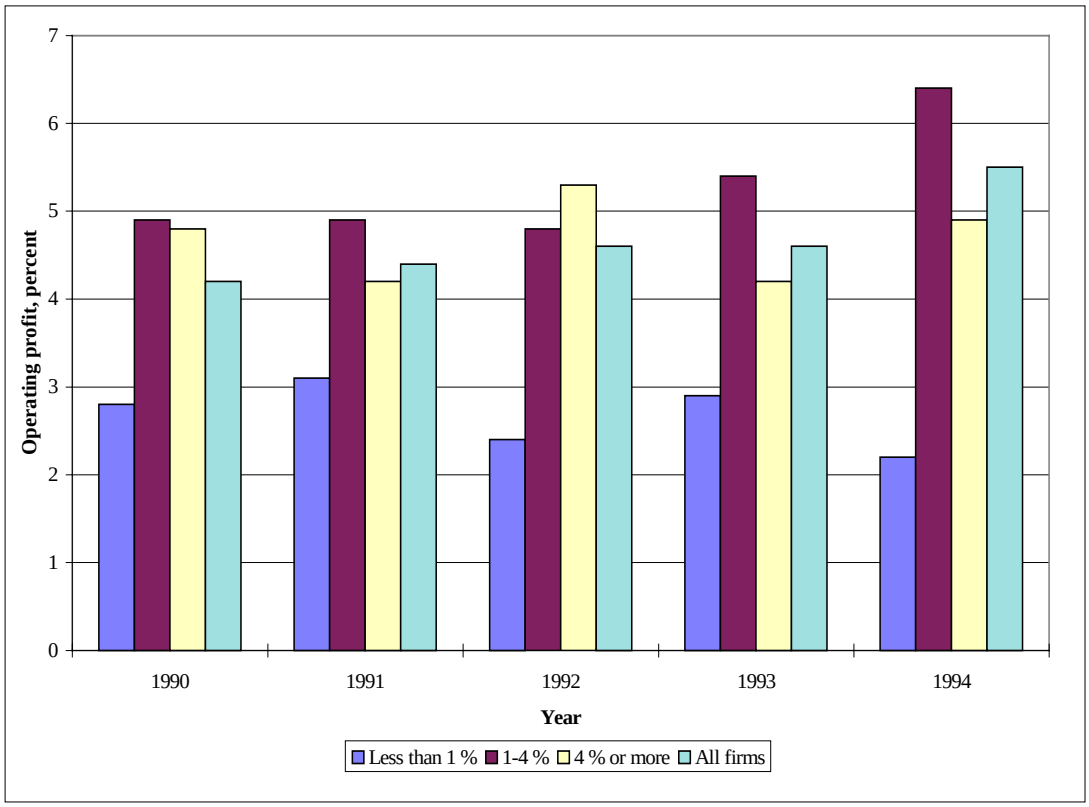
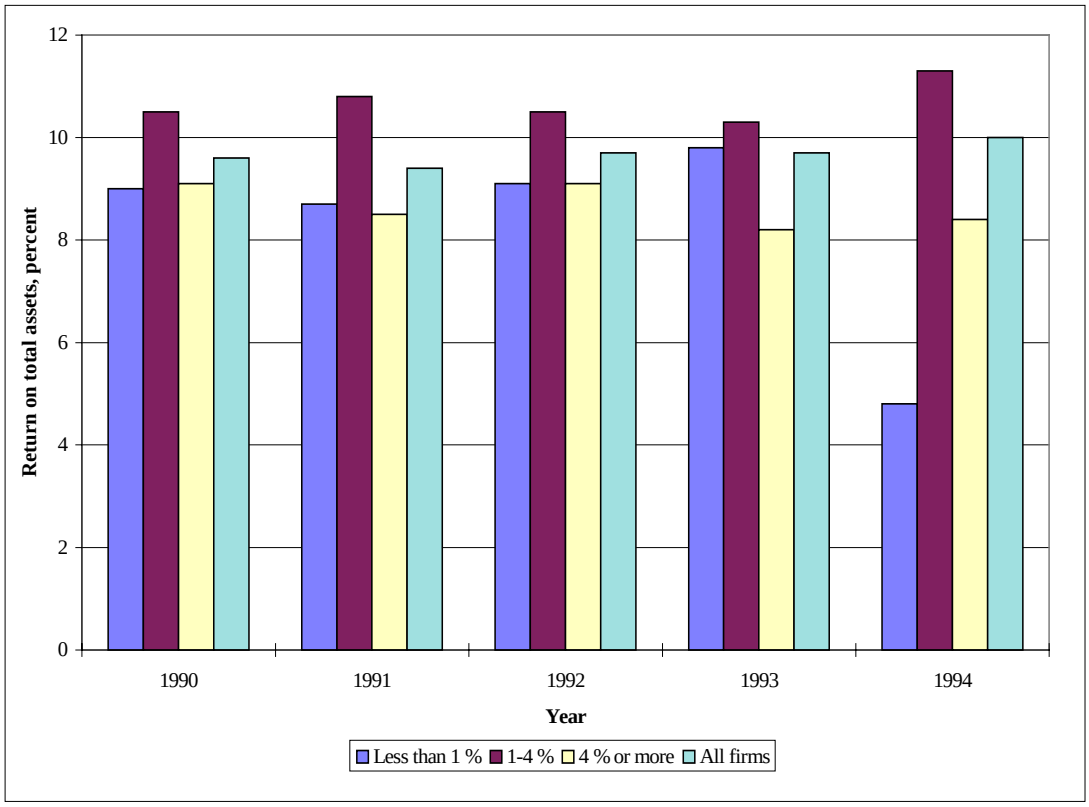


Figure 4.17. Return on total assets 1990-94 (long panel) by innovation intensity. N=106.



The last indicator of performance applied in this study is development in sales. Using the same categories for high, medium and low innovation intensities as above,

developments in sales are compared for the classes over the period 1990/91 - 1994. As can be seen from Figures 4.18 and 4.19 below, the differences between classes are relatively moderate. It is none the less striking how firms with the highest innovation investments seem to outperform the others in both 1993 and 1994. This result holds for both the short panel involving all firms, and the one-year longer panel of large firms. Thus again it appears that innovative firms take out part of the revenue in increasing market shares. Of course, over time this will, most likely, also result in higher profit rates.

Figure 4.18. Salesgrowth 1991-1994 (index 1991=100), short panel, by innovation intensity (N=276)

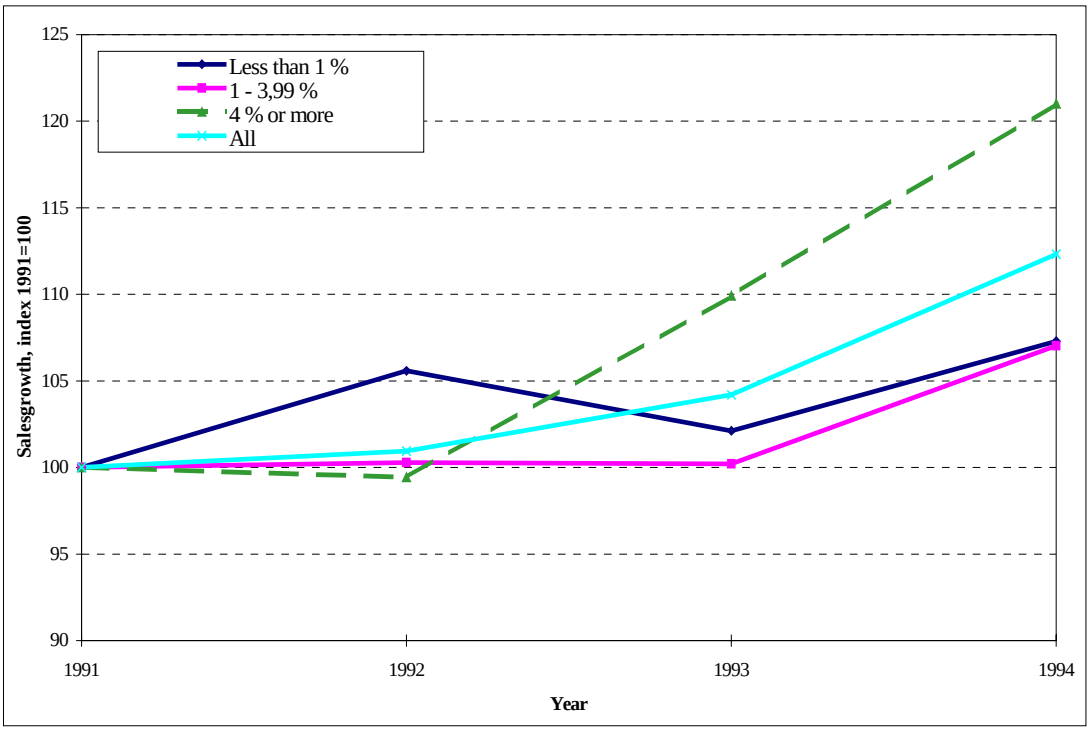
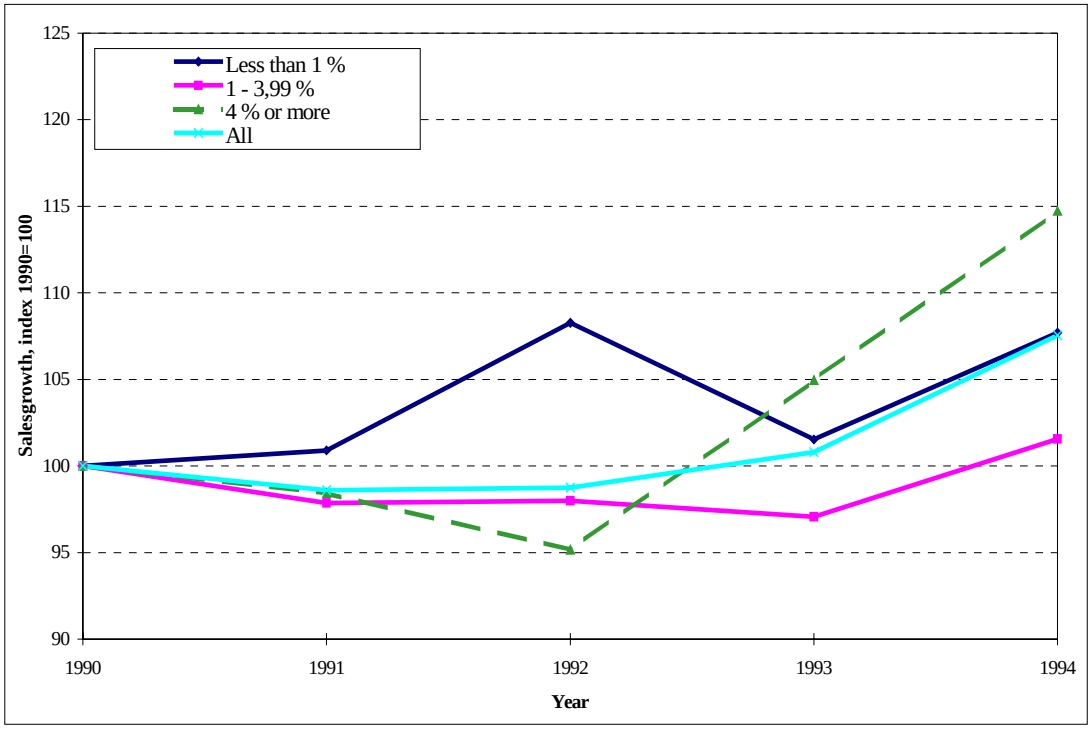


Figure 4.19. Salesgrowth (index 1990=100) 1990-1994, long panel, by innovation intensity (N=108)



5. Concluding remarks

Does it pay off to be innovative? The question is asked over and again by policy makers as well as in private businesses. The answer is not an unambiguous "yes" according to our analysis, but differences do indeed exist. They depend upon who you are; what business you are in and what you are trying to accomplish. This is by and large in accordance with established knowledge in the field, and with our own expectations to the work at the outset. However, we are now able to apply statistical testing to some of the propositions, work that will continue in future efforts both to utilise existing data better and to add new data to the analysis.

For some of the problems considered, the time span covered may be too short. Our data cover innovation expenses recorded for the year 1992 and new products introduced 1990-92, merged with accounting data for the 5-(4)-year period 1990(91)-1994. In all, 640 firms are included in the final matched panel under study.

The number of observations in the data material does not allow us to control for all the relevant variables simultaneously. This problem is particularly strongly felt for analysts studying a small economy like the Norwegian, where the universe of firms under study is limited. Therefore, the particular findings referred to below should not be taken as causal relationships, as underlying variables not included in the particular analysis may be correlated to the variables under study and disturb the picture. For example, there seem to be significant differences between firms of different size, and between firms belonging to different industries. At the same time, the distribution on firm size varies between industries. It is hard to tell which of the two variables is the most important, since they cannot both be included in the same analysis. It is nevertheless interesting and important to establish that such differences do exist, even if we have to leave to future analysis to establish the exact causal relationships.

Our findings are that there are no major and clear-cut differences between innovators and non-innovators, product and process innovators unless additional factors are taken into account; the relationships depend upon factors like firms size, industry, innovative strategy and innovative inputs. Even within industries there are large variations. Thus, for some of the groups of firms we have studied, there do indeed exist differences between firms, both in terms of profit rates and, in particular, in terms of sales growth.

We have investigated whether there are any systematic differences in profit rates and sales-growth between firms of different kinds. The two measures of profitability applied - operating profits and return on total assets - are generally highly correlated, and in most of the analysis they show more or less the same pattern between groups. We therefore refer here to profitability without specifying which measure it refers to. In addition the high correlation strengthens our confidence in the findings.

For Norwegian industry as a whole there are no significant differences in profitability between innovators and non-innovators. This is of course due to the fact that we have a mix of companies from different industries and of different sizes. Controlling for industry reveals that in some industries, namely printing and

publishing, chemicals, rubber and plastics, innovators earn a higher profit, whereas in wood products, pulp and paper, non-innovators do better in terms of profit rates. In other industries there is a change over time in which of the two groups does the best. A breakdown by size shows that among large companies (more than 50 employees) innovators do better than non-innovators, a difference that is persistent over time. This is a confirmation that innovation seems to have a positive effect on profitability.

For smaller firms, however, there is no clear picture. As the results for smaller companies are more vulnerable to problems stemming from panel construction (there are more drop-outs among the smaller companies), one can argue that the analysis of the larger companies is more reliable. In particular for the smaller firms it is therefore preferable to try to bring into the analysis what happens to the drop-out firms.

Another effect that can be observed among the larger companies, and not the smaller ones, is that profits are more persistent over time among innovators than among non-innovators. This seems to support the argument that innovators are less vulnerable to changes in the business environment than non-innovators.

Looking next at developments in sales, we again find a difference in the performance of small and large companies. Among the smaller ones, innovators grow faster than non-innovators. We interpret this as an indication of success, and as a priority given to expanding the scale of operation in smaller companies at the cost of (maybe temporarily) lowered profit rates. Among larger companies sales develop differently: in the first years non-innovators grow faster than innovators, but the growth levels off and the innovators catch up during the last years we have observed (1994).

The innovation survey included questions on factors hampering innovation - among them problems of finance. For the firms, retained profits is an important source of finance for innovation, as credit is hard to get for risky projects. Therefore one would expect there to be a negative correlation between reported problems of finance and profit rate. We do find such a correlation, but not for the larger companies. It is likely that many of the larger companies are in command of such resources that financing innovation is less of a problem than for the smaller ones. Among small and medium sized companies, one could say that where profitability is low, innovation is hampered by lack of appropriate finance that restricts innovative companies from doing more, and keeps non-innovative companies from doing anything at all. This is indeed an argument for a closer assessment - or maybe reassessment - of how public support for innovation is split between large and small companies - without drawing any firm conclusions based solely on this result.

Looking in more detail at the performance of the innovators, we initially made a distinction between firms involved with product innovation only, those in process innovation only, and firms involved with both kinds of innovation. In general, this distinction does not help to explain differences in profitability among firms. This is true even when controlling for size classes and industry. Nor are there any differences in variance in profitability, which we interpret to mean that the riskiness of product and process innovation is not significantly different. There is, however, a lack of persistence of profits among the product only innovators, which might indicate that the risk involved is somewhat higher than for process innovation. This result is, however, uncertain and requires further research. Taking the problem of

timing of results into consideration, we constructed a measure of average profits for the whole time period under study. The picture still remains somewhat fuzzy, but there is an indication that smaller companies seem to do better when involved with product innovation, whereas larger ones do better when involved with process innovation.

Using sales-growth as the performance indicator, we find clearer differences. Innovators grow faster than non-innovators, and the difference increases over time. In particular, firms involved in product innovation grow faster, and growth is generally faster among small innovators than larger ones.

The output-indicator introduced in the innovation survey on share of sales stemming from new or changed products is interesting in itself, but does it entail increased profits or higher sales for the firms? On a firm-to-firm basis we are not able to establish such a relationship; a simple correlation of shares of new products with profit rates hardly show any statistically significant relations at all. This is even true when controlling for industry or size classes. Now, this does not necessarily mean that there is no relationship. As argued in section 4.3 and elsewhere, the riskiness of innovation necessarily brings with it some failures that will disturb the relationship between innovativeness and profitability at the level of single firms. If, on the other hand, we consider groups of firms as representing portfolios of innovative investments, we might be able to observe positive outcomes in each portfolio. Of course, the portfolios constructed here are "synthetic", in the sense that they do not reflect real risk sharing among the firms. From the viewpoint of society as a whole, it may nevertheless bring gains from innovation, even if there are losses to some of the individual firms. The results, of course, are dependent upon how the groups, or "synthetic portfolios" are constructed. We have simply grouped firms according to whether the share of new products in sales is "high" (more than 25 %), "low" (1-25 %) or none at all. Results show a higher profit rate among firms with a "high" share of new products in sales, compared to those with a low share. The same is true for the sales-growth variable. In other words, being innovative in this sense seems to show up also in economic results, but only evaluated for groups, or "portfolios", of innovations. On the other hand, firms with no new products in sales have equally high profits and sales-growth as the highly innovative in terms of new products. This group, however, mainly consists of firms involved with process-only innovation. In this analysis they seem to perform as well as the most innovative product innovators.

Applying the same kind of logic concerning "portfolios" of innovative investments, we finally looked into the relationship between innovative investments and economic performance. Firms are grouped into three categories, according to the level of innovation cost intensity (percentage of total innovation costs of total sales). The groups applied are "high" (4 % or more), "medium" (1-3,99%) and "low" (0-1 %). Results show statistically significantly lower profit rates for the low-intensity group, whereas for the two remaining groups it is not possible to distinguish between them. For the sales-growth indicator there are only minor differences, except that the high-intensity category grow faster from 1992 onwards.

Before leaving this discussion, let us remind the reader of some of the problems encountered in time series analysis involving panel construction. Firms are born and closed down all the time, they are restructured through take-overs and split-offs. This

is part of ordinary business operation, and may be related to innovative strategy, among other things. Including such activity in the analysis is, however, extremely difficult. Firms where this has taken place to any significant degree have been left out of the panel, since we are unable to follow the same units over time. This obviously blurs the picture: some of the closedowns should be counted as losses - possibly due to failed innovation - and some of them as successes, as they may be taken over by other companies to get access to their technology. The activity as such may therefore continue to exist and prosper, but we are unable to follow the unit. The analysis of dropout firms do indicate that such phenomena exist: the 48 firms that ceased to exist (bankruptcy or other kinds of closing down) have a particularly low proportion of innovators: 21 %. Firms with a new identity code, that is firms coded as a part of another firm, have a much higher share of innovators: 43 %. In addition to these, 107 firms dropped out of the panel due to large increases or decreases in sales - indicating that split-offs or take-overs have taken place. These have a quite substantial share of innovators (36 %) and in particular low profitability. In all, construction of the panel resulted in a loss of 22 % of the firms. These are clearly different from those remaining in the panel. We therefore suggest to follow up with a more detailed study of the drop-outs. We will emphasise, however, that the drop-outs include both possible gains and losses due to innovation, so the net effect of leaving them out could be both positive and negative.

Let us emphasise too, that a longer panel in terms of years covered is necessary to address some of the questions related to innovation, profitability and growth. Our first concern relates to the time it takes for results to come about, which requires more years of accounting data. There is, however, a drawback to consider when doing this; the panel construction becomes even more difficult and the number of drop-outs will increase.

The second concern relates to trying to explain the incentives for firms to involve themselves with innovation. If part of the answer to this question is to be found in the accounts, one needs information going further back in time than that available to us in this round.

The most important problem, however, concerns information on the innovative activity itself. So far, we only have information on innovative activity undertaken at one single point in time. Strictly speaking we don't know whether this is an indication of an activity with some degree of permanence or if it is more occasional, even though we expect it to be rather permanent, in particular for larger firms. To solve this problem we must await future innovation surveys. A matter to consider in this respect is whether one should try to re-establish the original sample of firms - to facilitate panel analysis - or draw a completely new sample for reasons of representativeness.

Finally, in our analysis we have shown that it is possible to establish a relationship between innovative activity and economic performance as recorded in accounting data. It is our belief that future analysis using this methodology will bring even more insight into the question of the profitability of innovative activity than we have been able to in this round. Efforts to improve data quality and expand the time series is therefore worth while.

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Appendix A: Additional tables

Table A.1. Operating profit ratio (OPR) according to innovation activities, panel 1991-94. Product or process innovations, OPR between -30 - 30 % each year (data for figures 3.1 and 3.5)

Industry, Nace	YEAR	Inno-vations	Firms	Profit, mean	Profit, std	25% quartile	Profit, median	75% quartile	Range of profit
15-37	91	No	361	3.5	6.2	0.9	3.6	6.6	46.5
15-37	91	Yes	269	4.1	5.8	1.2	4.0	7.3	47.3
15-37	92	No	361	3.7	6.1	1.3	3.9	6.2	53.7
15-37	92	Yes	269	4.6	5.6	2.0	4.4	7.9	56.1
15-37	93	No	361	4.8	5.9	1.5	4.4	7.9	49.6
15-37	93	Yes	269	4.9	5.8	2.1	4.5	8.0	55.7
15-37	94	No	361	4.9	6.8	1.7	4.8	8.4	53.7
15-37	94	Yes	269	5.3	6.2	2.3	4.9	8.4	47.2
15-16	91	No	57	3.6	5.9	0.8	3.3	7.5	32.5
15-16	91	Yes	45	2.6	4.2	1.3	3.1	5.2	20.3
15-16	92	No	57	3.9	4.7	0.7	3.7	5.6	23.6
15-16	92	Yes	45	4.4	3.8	2.1	3.9	6.8	16.1
15-16	93	No	57	5.4	3.8	2.6	5.0	7.0	16.8
15-16	93	Yes	45	4.3	4.1	1.9	4.3	7.2	21.8
15-16	94	No	57	4.3	5.1	1.5	3.7	7.4	30.0
15-16	94	Yes	45	3.3	4.9	1.5	3.3	6.7	27.5
17-19	91	No	22	5.6	6.2	0.9	6.3	9.9	25.5
17-19	91	Yes	12	5.0	3.7	1.7	5.5	7.4	12.6
17-19	92	No	22	4.3	4.7	2.3	3.9	6.2	21.7
17-19	92	Yes	12	4.1	4.3	1.1	4.9	7.1	13.3
17-19	93	No	22	5.1	5.7	3.0	5.7	8.7	25.4
17-19	93	Yes	12	4.4	4.1	1.9	4.0	7.9	13.7
17-19	94	No	22	5.3	7.5	2.2	4.9	8.0	35.9
17-19	94	Yes	12	7.7	6.9	2.7	4.9	13.8	20.8
20-21	91	No	38	3.3	6.0	0.0	3.7	6.5	27.8
20-21	91	Yes	24	1.0	6.7	-0.1	2.4	4.7	31.3
20-21	92	No	38	3.1	5.0	0.6	2.9	5.4	25.4
20-21	92	Yes	24	1.0	5.1	-2.0	1.8	4.1	22.2
20-21	93	No	38	4.0	4.5	1.1	3.3	5.5	23.2
20-21	93	Yes	24	3.0	6.2	-1.5	2.5	6.5	29.1
20-21	94	No	38	6.9	6.1	2.3	5.7	10.4	27.6
20-21	94	Yes	24	5.5	6.0	2.3	4.2	8.7	28.5
22	91	No	59	2.7	5.5	0.7	3.6	5.8	31.6

(continued)

Table A.1, continued

Industry, Nace	YEAR	Inno-vations	Firms	Profit, mean	Profit, std	25% quartile	Profit, median	75% quartile	Range of profit
22	91	Yes	38	4.9	6.6	-0.1	3.8	9.2	30.1
22	92	No	59	3.6	6.0	1.9	4.4	5.9	42.3
22	92	Yes	38	6.6	5.6	2.8	6.9	9.4	28.7
22	93	No	59	4.5	5.5	0.8	3.4	7.9	26.0
22	93	Yes	38	6.4	4.9	2.6	6.8	8.7	25.4
22	94	No	59	4.5	6.2	0.9	3.9	7.1	33.8
22	94	Yes	38	6.6	6.2	4.0	7.4	11.2	26.0
24-25	91	No	11	2.3	6.8	-0.5	2.6	6.3	24.7
24-25	91	Yes	16	5.9	7.2	2.0	4.7	8.9	32.1
24-25	92	No	11	5.7	7.4	0.7	5.8	10.9	26.2
24-25	92	Yes	16	6.9	6.0	3.9	5.2	8.2	25.2
24-25	93	No	11	4.3	8.7	-1.5	4.3	8.4	30.9
24-25	93	Yes	16	6.2	6.1	2.9	5.7	7.1	28.1
24-25	94	No	11	5.1	11.2	-1.0	5.4	13.9	36.2
24-25	94	Yes	16	6.8	6.1	3.8	5.8	9.1	28.3
26	91	No	20	3.1	8.1	0.3	3.0	8.3	34.9
26	91	Yes	14	6.0	5.5	0.7	6.0	9.1	17.7
26	92	No	20	2.4	9.8	1.5	3.9	5.7	40.8
26	92	Yes	14	6.4	6.4	1.3	5.8	12.0	21.2
26	93	No	20	4.3	6.7	0.7	3.4	7.9	28.7
26	93	Yes	14	7.2	7.5	2.8	6.8	14.6	23.2
26	94	No	20	7.4	5.6	3.8	6.6	10.0	19.0
26	94	Yes	14	7.8	5.7	2.9	7.1	11.6	18.9
27-28	91	No	60	3.8	7.5	0.2	4.6	7.2	45.7
27-28	91	Yes	27	3.2	6.9	1.9	4.2	6.3	34.4
27-28	92	No	60	3.5	7.6	-0.2	3.7	6.3	52.1
27-28	92	Yes	27	5.0	3.9	2.1	5.1	7.7	18.8
27-28	93	No	60	5.1	6.9	1.6	5.1	8.3	45.7
27-28	93	Yes	27	5.6	4.4	2.6	5.3	6.8	20.4
27-28	94	No	60	4.4	8.3	0.8	5.6	9.2	46.7
27-28	94	Yes	27	5.7	7.0	3.4	6.4	8.0	32.3

(continued)

Table A.1, continued

Industry, Nace	YEAR	Inno-vations	Firms	Profit mean	Profit std	25% quartile	Profit, median	75% quartile	Range of profit
29	91	No	24	3.5	7.4	0.4	5.1	7.5	36.9
29	91	Yes	31	5.8	4.6	2.9	5.3	8.9	21.6
29	92	No	24	3.0	7.0	-0.7	4.8	7.1	28.9
29	92	Yes	31	4.4	8.4	1.2	5.5	8.9	52.4
29	93	No	24	4.9	6.8	1.8	5.8	7.2	29.7
29	93	Yes	31	5.5	9.5	2.0	4.4	9.7	55.7
29	94	No	24	4.5	8.6	2.3	5.6	9.1	43.1
29	94	Yes	31	5.9	6.3	1.9	4.5	10.5	26.7
30-33	91	No	15	6.2	7.2	3.5	5.2	9.3	30.6
30-33	91	Yes	23	5.3	5.5	1.1	4.4	8.5	20.9
30-33	92	No	15	6.5	5.3	3.2	6.6	9.5	20.6
30-33	92	Yes	23	5.0	3.1	2.6	4.6	6.6	13.1
30-33	93	No	15	7.1	7.7	3.7	5.7	12.5	32.6
30-33	93	Yes	23	5.1	4.4	2.3	5.0	9.3	17.1
30-33	94	No	15	5.7	8.7	1.6	7.8	10.7	33.4
30-33	94	Yes	23	4.4	5.9	2.4	4.0	7.4	29.9
34-35	91	No	33	3.2	3.9	1.9	3.3	5.6	21.0
34-35	91	Yes	21	4.8	3.9	2.1	4.1	7.0	13.9
34-35	92	No	33	4.0	4.8	1.8	3.8	6.2	23.3
34-35	92	Yes	21	3.7	5.2	1.5	4.0	6.7	23.3
34-35	93	No	33	3.5	6.9	1.1	3.5	4.7	44.9
34-35	93	Yes	21	2.7	4.3	1.3	2.7	5.7	17.6
34-35	94	No	33	3.5	5.8	1.8	3.4	6.3	33.4
34-35	94	Yes	21	2.7	6.9	1.6	2.4	6.2	35.0
36-37	91	No	22	2.9	4.1	1.2	2.2	4.5	18.3
36-37	91	Yes	18	2.4	6.3	-2.5	3.1	5.8	23.3
36-37	92	No	22	3.7	3.9	1.7	3.1	6.0	15.8
36-37	92	Yes	18	2.8	6.2	1.2	3.6	7.0	26.0
36-37	93	No	22	5.0	5.0	0.6	5.1	9.2	19.3
36-37	93	Yes	18	3.1	5.7	-0.6	3.7	6.7	21.8
36-37	94	No	22	5.4	4.7	2.4	4.1	8.4	17.6
36-37	94	Yes	18	5.4	6.0	1.8	4.4	9.3	27.2

Table A.2. Return on total assets (ROTA) according to innovation activities, panel 1991-94, product or process innovations, ROTA between -30, +50 % each year (data for figures 3.2 and 3.6)

Industry, Nace	YEAR	Inno-vations	Firms	Profit, mean	Profit, std	25% quartile	Profit, median	75% quartile	Range of profit
15-37	91	No	349	8.8	10.6	3.2	9.2	14.6	65.9
15-37	91	Yes	270	9.4	9.2	4.4	9.0	14.8	67.4
15-37	92	No	349	9.4	9.7	4.8	10.0	15.6	64.8
15-37	92	Yes	270	10.1	8.6	6.1	10.1	14.7	67.0
15-37	93	No	349	10.5	10.1	5.0	10.3	16.1	70.8
15-37	93	Yes	270	10.4	9.3	5.1	9.8	15.2	61.9
15-37	94	No	349	10.5	10.8	4.7	9.3	17.3	76.7
15-37	94	Yes	270	10.1	9.7	4.9	9.8	15.8	66.7
15-16	91	No	54	9.2	9.4	4.9	9.5	14.3	46.2
15-16	91	Yes	45	8.7	8.8	5.0	9.0	14.1	52.2
15-16	92	No	54	9.9	9.3	5.1	10.6	15.6	48.6
15-16	92	Yes	45	11.5	8.0	8.2	11.5	16.1	43.0
15-16	93	No	54	12.9	8.1	7.3	12.1	16.1	43.2
15-16	93	Yes	45	11.7	8.3	7.4	11.8	15.7	50.8
15-16	94	No	54	10.3	9.5	5.1	9.2	18.0	46.6
15-16	94	Yes	45	8.4	11.1	3.7	8.9	14.8	58.9
17-19	91	No	22	11.2	12.0	5.7	10.3	18.1	49.1
17-19	91	Yes	12	10.6	6.9	5.5	10.4	13.5	22.0
17-19	92	No	22	10.3	7.0	6.7	10.7	14.5	29.5
17-19	92	Yes	12	8.3	7.1	3.1	9.8	12.8	22.1
17-19	93	No	22	11.7	12.1	6.2	13.2	18.6	55.8
17-19	93	Yes	12	9.2	7.4	4.1	8.1	14.3	27.0
17-19	94	No	22	12.3	10.3	6.1	13.0	16.5	48.2
17-19	94	Yes	12	14.3	12.3	5.7	8.9	21.9	35.9
20-21	91	No	38	6.3	10.5	0.2	9.3	14.8	48.3
20-21	91	Yes	23	4.7	9.4	1.9	6.0	9.8	39.2
20-21	92	No	38	6.8	8.1	3.1	7.4	11.6	41.6
20-21	92	Yes	23	4.3	9.1	-1.9	4.2	9.9	39.9
20-21	93	No	38	7.9	8.0	3.6	7.3	12.3	44.6
20-21	93	Yes	23	6.0	10.3	-1.9	5.9	11.0	49.5
20-21	94	No	38	12.3	10.0	5.5	11.0	18.0	45.7
20-21	94	Yes	23	9.4	10.4	3.5	9.1	13.3	53.0

(continued)

Table A.2 continued

Industry Nace	YEAR	Inno-vations	Firms	Profit mean	Profit std	25% quartile	Profit, median	75% quartile	Range of profit
22	91	No	53	8.3	10.8	4.4	10.0	13.0	58.1
22	91	Yes	39	9.7	11.3	3.5	8.7	15.2	63.1
22	92	No	53	10.4	10.5	6.4	11.0	17.2	64.8
22	92	Yes	39	13.2	8.6	7.6	12.8	19.7	35.6
22	93	No	53	10.0	8.6	5.0	10.5	15.2	49.0
22	93	Yes	39	13.1	9.7	6.9	12.0	17.4	51.7
22	94	No	53	8.5	7.9	3.7	8.3	12.8	44.4
22	94	Yes	39	11.8	10.2	7.2	13.7	18.5	45.6
24-25	91	No	11	4.8	12.4	2.7	6.4	10.6	49.4
24-25	91	Yes	16	10.5	8.0	5.2	10.0	14.5	27.4
24-25	92	No	11	8.3	12.2	3.2	8.3	17.5	44.3
24-25	92	Yes	16	12.1	5.7	8.4	10.0	15.1	22.4
24-25	93	No	11	7.2	15.2	-2.0	9.8	20.2	52.0
24-25	93	Yes	16	11.8	9.0	4.4	12.2	15.5	34.8
24-25	94	No	11	9.9	20.0	-0.7	10.0	20.4	71.8
24-25	94	Yes	16	12.4	8.1	7.1	11.8	13.5	33.2
26	91	No	20	8.4	11.3	2.7	7.3	16.0	44.2
26	91	Yes	14	10.7	9.3	2.6	9.7	16.1	31.9
26	92	No	20	7.8	13.3	5.6	9.2	14.5	52.0
26	92	Yes	14	11.2	11.4	3.9	9.6	16.0	44.7
26	93	No	20	9.4	9.4	2.5	8.7	16.9	33.2
26	93	Yes	14	10.3	11.4	7.0	9.4	16.6	41.5
26	94	No	20	14.3	9.9	6.1	11.1	20.5	37.0
26	94	Yes	14	11.5	7.0	7.8	10.4	16.9	26.1
27-28	91	No	58	10.5	11.6	2.8	11.7	17.8	55.9
27-28	91	Yes	28	9.4	9.0	6.9	9.7	15.0	46.1
27-28	92	No	58	8.6	9.9	1.0	8.8	15.6	47.9
27-28	92	Yes	28	9.8	6.0	6.8	10.0	12.8	33.8
27-28	93	No	58	10.3	11.0	4.7	9.7	16.1	63.6
27-28	93	Yes	28	10.9	7.0	6.3	10.5	12.7	33.0
27-28	94	No	58	10.5	12.4	2.6	12.3	18.7	61.0
27-28	94	Yes	28	10.6	11.9	6.1	10.2	13.8	58.3

(continued)

Table A.2 continued

Industry Nace	YEAR	Inno-vations	Firms	Profit, mean	Profit, std	25% quartile	Profit, median	75% quartile	Range of profit
29	91	No	22	9.2	12.2	2.8	8.7	16.5	52.8
29	91	Yes	31	10.1	5.7	5.9	9.4	14.4	23.0
29	92	No	22	10.1	10.7	1.7	13.6	16.9	36.8
29	92	Yes	31	9.1	8.7	5.3	9.7	14.9	44.5
29	93	No	22	12.7	12.8	7.3	11.5	19.1	60.2
29	93	Yes	31	9.5	9.6	4.1	9.0	15.8	45.7
29	94	No	22	12.5	11.0	5.8	11.9	19.5	46.3
29	94	Yes	31	8.9	8.3	2.7	6.9	15.3	27.3
30-33	91	No	15	11.9	11.5	6.0	10.1	18.8	46.3
30-33	91	Yes	23	11.2	9.2	4.5	9.6	14.6	36.8
30-33	92	No	15	12.0	9.5	6.6	10.0	21.0	37.1
30-33	92	Yes	23	11.0	6.2	8.4	11.3	13.6	33.0
30-33	93	No	15	12.1	10.8	7.6	11.5	17.6	46.7
30-33	93	Yes	23	12.3	9.0	5.0	11.7	20.4	29.4
30-33	94	No	15	8.7	14.7	3.5	13.5	19.8	52.2
30-33	94	Yes	23	9.0	8.3	5.5	8.0	13.2	36.5
34-35	91	No	34	8.5	7.2	5.0	8.6	13.2	35.3
34-35	91	Yes	21	12.8	9.9	6.0	9.0	19.2	43.4
34-35	92	No	34	11.0	10.4	5.2	10.2	15.6	52.0
34-35	92	Yes	21	11.7	10.8	5.8	11.2	16.4	53.0
34-35	93	No	34	9.1	9.9	3.5	8.9	13.8	47.4
34-35	93	Yes	21	9.1	10.4	3.2	9.4	12.7	49.8
34-35	94	No	34	7.1	10.1	3.3	7.3	12.5	56.1
34-35	94	Yes	21	8.1	7.4	3.4	6.7	12.3	31.0
36-37	91	No	22	6.8	9.3	4.9	5.6	9.3	50.9
36-37	91	Yes	18	6.5	10.2	-3.6	5.8	15.4	29.5
36-37	92	No	22	8.9	6.5	6.2	8.5	14.4	25.3
36-37	92	Yes	18	6.0	10.0	2.9	7.7	10.3	42.2
36-37	93	No	22	11.2	10.8	2.9	11.5	19.6	42.8
36-37	93	Yes	18	6.9	9.4	-0.4	8.0	15.3	31.8
36-37	94	No	22	12.2	10.1	4.9	8.5	20.6	37.5
36-37	94	Yes	18	10.0	7.9	5.1	9.0	16.1	34.1

Table A.3. Product-process innovators. Median operating profit 1991-94 (short panel) by industry. Only categories with at least 3 observations reported.

INDUSTRY	*Year*	*Product innovators*	*Product and process innovators*	*Process innovators*
Food, beverages and tobacco	1991	3,7	3,0	3,7
Food, beverages and tobacco	1992	4,5	3,3	3,9
Food, beverages and tobacco	1993	7,9	5,3	4,1
Food, beverages and tobacco	1994	6,7	3,1	2,1
Textiles, wearing apparel, fur and leather	1991		6,0	6,4
Textiles, wearing apparel, fur and leather	1992		5,4	5,3
Textiles, wearing apparel, fur and leather	1993		5,1	3,2
Textiles, wearing apparel, fur and leather	1994		8,5	2,7
Wood products, pulp and paper	1991		1,6	2,4
Wood products, pulp and paper	1992		1,7	3,1
Wood products, pulp and paper	1993		2,7	2,5
Wood products, pulp and paper	1994		4,0	6,1
Publishing and printing	1991		4,4	3,7
Publishing and printing	1992		3,1	7,3
Publishing and printing	1993		2,2	7,5
Publishing and printing	1994		9,6	6,9
Chemicals, rubber and plastics	1991		3,7	
Chemicals, rubber and plastics	1992		4,6	
Chemicals, rubber and plastics	1993		5,4	
Chemicals, rubber and plastics	1994		5,8	
Mineral products	1991	4,9	5,2	
Mineral products	1992	7,8	3,9	
Mineral products	1993	5,3	5,2	
Mineral products	1994	8,6	3,9	
Basic metals, metal products	1991	3,5	4,5	4,2
Basic metals, metal products	1992	3,6	2,9	6,9
Basic metals, metal products	1993	2,2	5,3	5,5
Basic metals, metal products	1994	4,9	5,7	6,6
Machinery and equipment	1991	6,1	4,6	1,6
Machinery and equipment	1992	3,8	5,5	8,9
Machinery and equipment	1993	5,3	4,2	5,0
Machinery and equipment	1994	9,7	4,3	3,6
Electrical and optical equipment, incl. IT	1991	5,7	3,7	
Electrical and optical equipment, incl. IT	1992	3,7	5,2	
Electrical and optical equipment, incl. IT	1993	5,7	4,0	
Electrical and optical equipment, incl. IT	1994	4,8	2,8	
Transport equipment	1991	4,5	6,2	2,9
Transport equipment	1992	3,8	5,6	3,4
Transport equipment	1993	3,3	3,3	2,7
Transport equipment	1994	2,9	4,9	2,4
Furniture, recycling	1991	-2,5	3,1	12,5
Furniture, recycling	1992	2,9	2,1	5,2
Furniture, recycling	1993	3,8	3,3	4,1
Furniture, recycling	1994	6,4	2,6	9,8

Table A.4. Product-process innovators. Median ROTA 1991-94 (short panel) by size classes.

INDUSTRY	*Year*	*Product innovators*	*Product and process innovators*	*Process innovators*
Food, beverages and tobacco	1991	7,4	8,9	10,1
Food, beverages and tobacco	1992	10,8	12,3	11,1
Food, beverages and tobacco	1993	15,2	12,6	9,5
Food, beverages and tobacco	1994	11,6	10,1	5,7
Textiles, wearing apparel, fur and leather	1991		10,4	15,4
Textiles, wearing apparel, fur and leather	1992		9,8	11,3
Textiles, wearing apparel, fur and leather	1993		9,1	5,7
Textiles, wearing apparel, fur and leather	1994		12,0	8,8
Wood products, pulp and paper	1991		4,7	8,8
Wood products, pulp and paper	1992		4,2	9,9
Wood products, pulp and paper	1993		5,6	8,2
Wood products, pulp and paper	1994		7,4	11,2
Publishing and printing	1991		8,7	8,8
Publishing and printing	1992		6,8	12,9
Publishing and printing	1993		9,0	12,0
Publishing and printing	1994		16,8	13,2
Chemicals, rubber and plastics	1991		7,8	
Chemicals, rubber and plastics	1992		9,5	
Chemicals, rubber and plastics	1993		11,8	
Chemicals, rubber and plastics	1994		12,5	
Mineral products	1991	8,8	7,6	
Mineral products	1992	14,1	6,7	
Mineral products	1993	8,5	8,3	
Mineral products	1994	14,2	8,2	
Basic metals, metal products	1991	8,6	9,4	10,4
Basic metals, metal products	1992	10,6	7,8	12,5
Basic metals, metal products	1993	12,2	10,5	9,8
Basic metals, metal products	1994	12,4	10,1	10,1
Machinery and equipment	1991	13,2	9,4	3,9
Machinery and equipment	1992	6,9	9,7	14,5
Machinery and equipment	1993	9,0	8,4	11,0
Machinery and equipment	1994	19,8	6,5	5,6
Electrical and optical equipment, incl. IT	1991	12,0	8,5	
Electrical and optical equipment, incl. IT	1992	10,1	11,5	
Electrical and optical equipment, incl. IT	1993	12,8	10,7	
Electrical and optical equipment, incl. IT	1994	10,4	6,3	
Transport equipment	1991	7,7	17,6	9,0
Transport equipment	1992	10,2	15,8	8,9
Transport equipment	1993	6,7	8,9	9,8
Transport equipment	1994	5,3	9,5	6,7
Furniture, recycling	1991	-6,4	5,8	17,6
Furniture, recycling	1992	7,4	7,3	9,9
Furniture, recycling	1993	8,0	7,8	8,0
Furniture, recycling	1994	9,6	7,8	13,9

Table A.5. Correlations of innovation inputs 1992 with operating profit, return on total assets and salesgrowth 1991-1994, by innovation types. Short panel.

	N	1991	1992	1993	1994
R&D-INT 1992 with OPR 1991-94					
All	293	-.10	.22**	.09	-.07
Product only innovators	42	.20	-.01	.03	-.08
Product and process innovators	145	-.12	.29**	.13	-.09
Process only innovators	86	.27*	.28**	.28*	.17
R&D-INT 1992 with ROTA 1991-94					
All	293	-.22**	.14*	.06	-.04
Product only innovators	42	.28	.11	.15	-.14
Product and process innovators	145	-.28**	.23**	.10	-.05
Process only innovators	86	.18	.17	.20	.08
INNO-INT 1992 with OPR 1991-94					
All	282	-.00	.17**	.07	-.03
Product only innovators	42	-.02	.07	.03	.01
Product and process innovators	146	.01	.18*	.09	-.05
Process only innovators	87	.03	.18	.08	.04
INNO-INT 1992 with ROTA 1991-94					
All	282	-.10	.09	.01	-.03
Product only innovators	42	.14	.14	.15	.09
Product and process innovators	146	-.13	.13	.04	-.01
Process only innovators	87	.02	.06	-.05	-.05

** p<.01; *.01<= p <= .05

Table A.6. Correlations of innovation inputs 1992 with operating profit, return on total assets and salesgrowth 1991-1994, by size classes. Short panel.

	N	1991	1992	1993	1994
R&D-INT 1992 with OPR 1991-94					
All					
Small firms (1-19 emp)	54	-.71**	.26	-.37**	-.37**
Medium sized firms (20-49 emp)	43	-.04	-.16	-.09	-.06
Medium sized firms (50-99 emp)	53	-.11	-.25	.17	-.45**
Large firms (100-199 emp)	58	-.09	.11	.04	-.16
Large firms (200 + emp)	65	.65**	.59**	.59**	.51**
R&D-INT 1992 with ROTA 1991-94					
All					
Small firms (1-19 emp)	54	-.66**	.21	-.19	-.19
Medium sized firms (20-49 emp)	43	-.03	-.13	.09	-.02
Medium sized firms (50-99 emp)	53	-.13	-.16	.00	-.18
Large firms (100-199 emp)	58	-.05	.17	.13	-.11
Large firms (200 + emp)	65	.32**	.40**	.41**	.23
R&D-INT 1992 with SALES 1992-94					
All					
Small firms (1-19 emp)	54		.05	-.15	-.06
Medium sized firms (20-49 emp)	43		-.13	-.07	-.16
Medium sized firms (50-99 emp)	53		.32*	.48**	.36**
Large firms (100-199 emp)	58		-.06	.12	.12
Large firms (200 + emp)	65		.02	.08	.02
INNO-INT 1992 with OPR 1991-94					
All					
Small firms (1-19 emp)	54	-.50**	.35**	-.29*	-.29*
Medium sized firms (20-49 emp)	43	.04	-.05	.09	.11
Medium sized firms (50-99 emp)	53	.05	-.13	.22	-.33*
Large firms (100-199 emp)	59	-.11	.06	-.07	-.18
Large firms (200 + emp)	66	.35**	.28*	.25*	.20
INNO-INT 1992 with ROTA 1991-94					
All					
Small firms (1-19 emp)	54	-.50**	.24	-.20	-.23
Medium sized firms (20-49 emp)	43	.02	-.14	.00	.06
Medium sized firms (50-99 emp)	53	.05	-.08	.04	-.10
Large firms (100-199 emp)	59	-.11	.06	-.07	-.18
Large firms (200 + emp)	66	.15	.16	.12	.07
INNO-INT 1992 with SALES 1992-94					
All					
Small firms (1-19 emp)	54		.14	-.04	.05
Medium sized firms (20-49 emp)	43		-.17	-.07	.01
Medium sized firms (50-99 emp)	53		.38**	.48**	.36**
Large firms (100-199 emp)	59		-.06	.04	.08
Large firms (200 + emp)	66		.04	.04	-.01

** p<.01; *.01<= p <= .05

Appendix B: Questionnaire

(E.C. Harmonised Innovation Surveys 1992/1993 - Final Questionnaire)

Introduction

This questionnaire is concerned with technological innovation

A *technology* can be interpreted broadly as the whole complex of knowledge, skills, routines, competence, equipment and engineering practice which are necessary to produce a product. A new product rests on a change in this underlying technology

More generally, *innovation* occurs when a new or changed product is introduced to the market, or when a new or changed process is used in commercial production. The *innovation process* is the combination of activities - such as design, research, market investigation, tooling up and so on - which are necessary to develop an innovative product or production process. We are concerned with products and processes which are *new to your enterprise*.

Definitions

New products

In the questionnaire we distinguish two types of product innovation: "significant" and "incremental" innovations. They are defined as follows:

A *significant innovation* is a newly-marketed product whose intended use, performance characteristics, technical construction, design, or use of materials and components is new or substantially changed. Such innovations can involve radically new technologies, or can be based on combining existing technologies in new uses.

An *incremental innovation* is an existing product whose technical characteristics have been enhanced or upgraded. This can take two basic forms. A simple product may be improved in terms of better performance or lower cost, through use of new components or materials. A complex product, consisting of a number of integrated technical sub-systems, may be improved by partial changes to one or more of the sub-systems.

What do we not include as an innovation? We leave out changes which are purely aesthetic (such as changes in colour or decoration), or which simply involve product differentiation (that is, minor design or presentation changes which differentiate the product while leaving it technically unchanged in construction or performance).

New processes

A process innovation is the adoption of new or significantly improved production methods. These changes may involve new equipment or production organisation or both. Process innovations may be introduced in order to make new products, or to increase efficiency with which existing products are produced.

I. GENERAL INFORMATION

Enterprise Structure

Name of Enterprise: .....

Address: .....

Is your enterprise

independent? ☐

part of a group? ☐ if so, is it a . .

"mother" enterprise? ☐

"daughter" enterprise? ☐

"sister" enterprise? ☐

If you belong to a group, what is the country of head office? .....

If there have been any structural changes in the enterprise over the last three years which may affect the comparability of your answers to questions covering 1990-92, please specify:

.....

Number of employees at the end of 1992 (in full-time equivalents): .. ..

The questionnaire is to be filled in for your enterprise. If this is not the case, please state for which part of the group you are responding for, and please read this for 'enterprise" in the rest of the questionnaire: .....

Economic Activities

Enterprise's main field of industrial/commercial activity: .....

NACE code (if available): .....

Turnover in 1992 (in national currency units): .....

Domestic Sales in 1992 (% or in national currency units): .....

Export Sales in 1992 (% or in national currency units): .....

Turnover in 1990 (in national currency units): .....

Domestic Sales in 1990 (% or in national currency units): .. . .

Export Sales in 1990 (% or in national currency units): .....

General Information about Innovation Activities

1.	Has the enterprise developed or introduced any technologically changed *products* (goods or services) during 1990-92?	Yes	☐	No	☐
2.	Has the enterprise developed or introduced any technologically changed *processes* during 1990-92?	Yes	☐	No	☐
3.	Does your enterprise intend to develop or introduce any technologically changed products or processes in the years 1993-5?	Yes	☐	No	☐

INSTRUCTIONS

If the answers given to questions 1. 2. and 3. are all "no", please answer question 12., and fill in the last three lines of the last page before returning the questionnaire.

II. SOURCES OF INFORMATION FOR INNOVATION

INFORMATION
Various types of information are required in the development and introduction of new products and processes. We are interested to know more about where this information is found.

4. Please indicate the importance of the following internal sources, (these include management, production, R&D, sales and marketing functions), and/or external sources of information for your enterprise's innovation activities during 1990-92.

Scale: 1=unsignificant; 2=slightly significant; 3=moderately significant; 4=very significant; 5=crucial

Source of information	1	2	3	4	5
INTERNAL SOURCES:					
- within the enterprise					
- within the group of enterprises					
EXTERNAL MARKET/COMMERCIAL SOURCES.					
- suppliers of materials and components					
- suppliers of equipment					
- clients or customers					
- competitors in your line of business					
- consultancy firms					
EDUCATIONAL/RESEARCH ESTABLISHMENTS.					
- universities / higher education					
- government laboratories					
- technical institutes					
GENERALLY AVAILABLE INFORMATION:					
- patent disclosures					
- professional conferences, meetings, professional journals					
- fairs / exhibitions					
OTHER EXTERNAL SOURCES (please specify):					
-					
-					
-					

III. OBJECTIVES OF INNOVATION

INFORMATION
The main reasons for developing and introducing innovations are being asked about in this question. That is, we are concerned with key factors involved in the decision to innovate. It may be helpful to think of these in terms of the strategy of your enterprise.

5. Please indicate the importance of the objectives of *your* enterprise's innovation activities during 1990-92, according to the following scale: (Please specify other objectives).
Scale: 1=insignificant; 2=slightly significant; 3=moderately significant; 4=very significant; 5=crucial

Objective	1	2	3	4	5
Replace products being phased out					
EXTEND PRODUCT RANGE:					
- within main product field					
- outside main product field					
Increasing or maintaining market share					
CREATING NEW MARKETS:					
- nationally					
- within the European Community					
- in North America					
- in Japan					
- in other countries					
Improve production flexibility					
LOWER PRODUCTION COSTS BY:					
- reducing the share of wage costs					
- reducing materials consumption					
- reducing energy consumption					
- reducing product design costs					
- reducing production lead times					
Reducing environmental damage					
Improving product quality					
Improving working conditions/safety					
OTHER INNOVATION OBJECTIVE (please specify):					
-					
-					
-					

IV. ACQUISITION / TRANSFER OF TECHNOLOGY

INFORMATION
We would like to ask about the channels through which your enterprise gains access to new technology

6. Please indicate whether your enterprise has acquired any new technologies during 1992 in one or more other of the following ways. You can choose more than one possibility. Please include any other relevant acquisitions not listed.

Forms of Acquisition	European			non-European		
	national	E.C.	non-E.C.	U.S.A.	Japan	Other
- the right to use others' inventions (including licences)						
- results of R&D contracted out						
- use of consultancy services						
- acquisition of technology through the purchase of (part of) another enterprise						
- purchase of equipment						
- communication with / specialist services from other enterprises						
- hiring skilled employees						
OTHER (please specify)						
-						
-						

7. Please indicate whether your enterprise transferred any new technologies out of the enterprise in one or other of the following ways during 1992. You can choose more than one possibility. Please specify any other transfers.

Forms of Transfer	European			non-European		
	national	E.C.	non-E.C.	U.S.A.	Japan	Other
- the right to use your inventions (including licences)						
- R&D performed for others						
- consultancy services for other companies						
- transfer of technology through the sale of part of your enterprise						
- sales of equipment						
- communication with other enterprises						
- mobility of skilled employees						
OTHER (please specify)						
-						
-						

INSTRUCTIONS
If you have acquired or transferred any new technology during 1992 and your enterprise is part of a group, please complete Q.8. If not, please go to question 9.

8. Please indicate whether any of the above 1992 acquisitions and transfers of technology took place between the enterprise and a "mother" / "daughter" / "sister" enterprise, by location: (You can choose more than one possibility)

Acquisition / Transfer	European			non-European		
	national	E.C.	non-E.C.	U.S.A.	Japan	Other
- acquisition from "mother" / "daughter" / "sister" enterprise						
- transfers to "mother" / "daughter" / "sister" enterprise						

INFORMATION
Question 9. asks about how your enterprise protects its competitive advantage in new products/processes.

9.a) Please evaluate the effectiveness of the following methods for maintaining and increasing competitiveness of *product* innovations introduced during 1990-92:
Scale: 1=insignificant; 2=slightly significant; 3=moderately significant; 4=very significant; 5=crucial

Method used	Product innovations				
	1	2	3	4	5
- patents					
- registration of design					
- secrecy					
- complexity of product design					
- having a lead time advantage over competitors					

9.b) Please evaluate the effectiveness of the following methods for maintaining and increasing competitiveness of *process* innovations introduced during 1990-92:
Scale: 1=insignificant; 2=slightly significant; 3=moderately significant; 4=very significant; 5=crucial

Method used	Process innovations				
	1	2	3	4	5
- patents					
- registration of design					
- secrecy					
- complexity of process design					
- having a lead time advantage over competitors					

V. R&D ACTIVITY

INFORMATION
R&D is a term covering 3 activities: basic research, applied research and experimental development.
Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. *Applied research* is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective.
Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed towards producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

10 a) Did your enterprise engage in R&D in 1992? Yes ☐ No ☐
b) Does the enterprise perform R&D on a continuous (as opposed to occasional) basis? Yes ☐ No ☐
c) i) What percentage of 1992 R&D was related to *product* innovations? .....%
ii) What percentage of 1992 R&D was related to *process* innovations? .....%
iii) Difficult to group in either category .....%
100 %
d) i) What was the total 1992 R&D expenditure for your enterprise? (in national currency units) .....
ii) Within your total 1992 R&D expenditure, how much did you spend on external R&D services? (in national currency units) .....
e) Does your enterprise plan to undertake R&D in the next three years? Yes ☐ No ☐

11. Did your enterprise have any co-operation arrangements on R&D activities with other enterprises or institutions in 1992? Yes ☐ No ☐
(Such co-operation includes active participation in joint R&D projects with other organisations. It does not necessarily imply that both partners derive commercial benefit from the venture. Pure contracting out work, where there is no active participation, is not regarded as co-operation)
If no, please continue with question 12.
If yes, please specify the type of organisation and country of partner:

Co-operation Partner	location of your co-operation partner:						
	inside Europe				outside Europe		
	Regional	National	E.C.	non-E.C.	U.S.A.	Japan	Other
- clients / customers							
- suppliers							
- "mother" / "daughter" / "sister" enterprises							
- competitors							
- joint ventures							
- consultants							
- government laboratories							
- research institutes							
- universities / higher education							
- industry-operated R&D labs.							
OTHER (please specify):							
-							

VI. FACTORS HAMPERING INNOVATION

INFORMATION
We are interested to find out more about the factors which constitute barriers to innovative success, by either slowing down or stopping an innovative project altogether.

12. If any of the list of difficulties hindered the realisation of innovations in your enterprise during 1990-92, please indicate its relative importance to any of your innovative activities.
Scale: 1=insignificant; 2=slightly significant; 3=moderately significant; 4=very significant; 5=crucial

Barrier	1	2	3	4	5
ECONOMIC FACTORS.					
- excessive perceived risk					
- lack of appropriate sources of finance					
- innovation costs too high					
- pay-off period of innovation too long					
ENTERPRISE FACTORS					
- enterprise's innovation potential (e.g. R&D, design, etc.) too small					
- lack of skilled personnel					
- lack of information on technologies					
- lack of information on markets					
- innovation costs hard to control					
- resistance to change in the enterprise					
- deficiencies in the availability of external technical services					
- lack of opportunities for co-operation with other firms and technological institutions					
OTHER REASONS-					
- lack of technological opportunities					
- no need to innovate due to earlier innovations					
- innovation too easy to copy					
- legislation, norms, regulations, standards, taxation					
- lack of customer responsiveness to new products and processes					
- uncertainty in timing of innovation					

VII. COSTS OF INNOVATION

INFORMATION
We are interested to know more about expenditures associated with innovation in your enterprise. In Part (a) we ask you to estimate total innovation costs, which means the total current expenditures associated with the activities listed in Part (b). In Part (d) we ask for an estimate of the capital expenditure spent on investment in plant, machinery and equipment which you have undertaken in order to introduce new products to the market.

13. a) Estimated total current expenditures on innovation activity in 1992 (in national currency units): .....

b) Please estimate the percentage share of total current innovation expenditures (see 13 (a)) attributable to the following activities:

- R&D	.....%
- acquisition of patents and licences	.....%
- product design	.....%
- trial production, training and tooling-up	.....%
- market analysis (excluding launch costs)	.....%
- other	.....%
	100 %

c) Please estimate the percentage of total current innovation expenditures (see 13 (a)) which was spent on specialist services outside your enterprise (for example, for R&D, patenting, training, design): .....%

d) Estimated total capital expenditure spent on investment in plant, machinery and equipment in 1992, linked to new product innovation (in national currency units): .....

VIII. IMPACT OF INNOVATION ACTIVITIES

INFORMATION

One quantifiable measure of innovation impact is through sales of innovative products. Q.14. asks for the distribution of the enterprise's total sales according to their life-cycle stage. Q.15. further analyses the way the product range has evolved with regard to incremental innovations, as compared to the introduction of completely new product developments, by identifying 3 types of product. Q.16. asks for information about the newness of your product innovation.

14. Please estimate the distribution of the enterprise's sales of its products at the different stages of the product lifecycle in 1992?

Product stage	Turnover	
Introductory		%
Growth		%
Maturity		%
Decline		%
Total 1992 sales	100	%

INFORMATION

In question 15., you are asked to consider the 1992 sales of **all** products manufactured by your enterprise and to distinguish three types of product:

1) products which essentially have remained technologically unchanged during 1990-92 (minor, aesthetic changes should be ignored);
2) products subject to incremental technological changes in 1990-92;
3) significantly changed from a technological viewpoint or newly introduced products during

15.a) How were the enterprise's 1992 *total* sales distributed across these types of products?	
1) products essentially unchanged during 1990-92	%
2) products subject to incremental changes during 1990-92	%
3) products significantly changed or introduced during 1990-92	%
Total 1992 sales	100 %

15.b) How were the enterprise's 1992 *export* sales distributed across these types of products?	
1) products essentially unchanged during 1990-92	%
2) products subject to incremental changes during 1990-92	%
3) products significantly changed or introduced during 1990-92	%
Total 1992 export sales	100 %

16. What percentage of the 1992 sales of your innovative products was new to:	
- the enterprise/group only?	%
- your industry?	%
Total 1992 sales of innovative products	100 %

Name of respondent:	
Job Title:	
Phone no.:	Fax no :

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Storgaten 1, N-0155 Oslo, Norway
Telephone +47 2247 7310
Fax: +47 2242 9533
Web: http://www.step.no/

STEP group

STEP-gruppen ble etablert i 1991 for å forsyne beslutningstakere med forskning knyttet til alle sider ved innovasjon og teknologisk endring, med særlig vekt på forholdet mellom innovasjon, økonomisk vekst og de samfunnsmessige omgivelser. Basis for gruppens arbeid er erkjennelsen av at utviklingen innen vitenskap og teknologi er fundamental for økonomisk vekst. Det gjenstår likevel mange uløste problemer omkring hvordan prosessen med vitenskapelig og teknologisk endring forløper, og hvordan denne prosessen får samfunnsmessige og økonomiske konsekvenser. Forståelse av denne prosessen er av stor betydning for utformingen og iverksettelsen av forsknings-, teknologi- og innovasjonspolitikken. Forskningen i STEP-gruppen er derfor sentrert omkring historiske, økonomiske, sosiologiske og organisatoriske spørsmål som er relevante for de brede feltene innovasjonspolitikk og økonomisk vekst.

The STEP-group was established in 1991 to support policy-makers with research on all aspects of innovation and technological change, with particular emphasis on the relationships between innovation, economic growth and the social context. The basis of the group's work is the recognition that science, technology and innovation are fundamental to economic growth; yet there remain many unresolved problems about how the processes of scientific and technological change actually occur, and about how they have social and economic impacts. Resolving such problems is central to the formation and implementation of science, technology and innovation policy. The research of the STEP group centres on historical, economic, social and organisational issues relevant for broad fields of innovation policy and economic growth.