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How innovative is Norwegian industry? An international comparison

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1. Introduction

How does Norwegian innovation performance compare with other countries, especially with respect to small firms? This report explores this question, using data from the Community Innovation survey for 1992. We look at two broad issues. Firstly, we explore R&D performance, where we try to go beyond R&D expenditure, into a wider look at R&D collaboration, types of partner and so on. Secondly, we look at new product innovation, exploring patterns of sales from different categories of new products. The analysis looks across industries, and then across different firm-size categories.

The report is not simply descriptive. It asks a very basic analytical question, as follows. In explaining differences in innovation performance (either participation in R&D, for example, or sales of new products) what are the respective effects of industry, nationality and firm size? To what extent, for example, are differences in innovation performance an effect of the industries which are being examined (and hence to what extent are differences in national performance an effect of the industrial structure?) To what extent are they an effect of firm size: that is, the distribution of activity across firm-size categories? And to what extent are they an effect of nationality, of the fact that we are looking at different nations, with different "national innovation systems"? We use analysis of variance techniques to look at these issues.

In what follows, we show that Norway is by no means less innovative than similar economies. Where there are differences to be explained, we show that in general national characteristics are not particularly important. What matters is the industrial structure and size of firms; the latter is particularly important, and in the Norwegian case this suggests that policymakers must consider the performance of small firms if they seek to improve overall innovation performance.

The remainder of the report is organised into six sections. Section 2 addresses problems with international comparisons, and section 3 discusses further some methodological issues. Section 4 addresses the occurrence of R&D activity within the firms, and whether this activity is permanent or occasional. In section 5 we focus on R&D collaboration, with a breakdown by type of partner for co-operation. Section 6 brings in the results of innovation, as measured by share of sales consisting of new or changed products. Some concluding remarks are provided in section 7.

2. Problems (and solutions) in international comparisons

International comparisons of rates of innovation and technological change are key problems both for innovation policymakers and for analysts concerned with economic performance and economic growth. The reason for international comparisons is usually to “benchmark” economic performance, since it is frequently unclear what the relevant standards of performance ought to be (at a national or regional level). This leads to international comparisons as a method of assessment, and it is very common in policy discussion to find comparisons between productivity levels, or output growth rates, or investment rates, or R&D intensities used as a basis for judging economic performance. In the recent EU *Green Paper on Innovation Policy*, for example, innovation performance in Europe is assessed very critically, on the ground that European overall R&D intensity is lower than that of Japan and the USA, and its rates of patenting are lower.

But there are often problems in making such comparisons. The basic problems are of three kinds. Firstly, there may be no relevant indicators for making comparisons. For example, there are no direct measures of innovation performance which can be used to compare the US, Japan and Europe (let alone to compare advanced countries with less-developed countries). Secondly, there are usually more or less sharp differences in industrial structure, which affect how different indicators should be interpreted. For example, countries with industrial structures based on activities where patents are not relevant for appropriability have low patenting rates; so comparisons of patenting rates must take account of such differences in structure and underlying technology. Finally, there are statistical issues, which are often very important and equally often neglected: differences in data collection methods between countries can have important consequences for the resulting indicators.

Against this background, this report has two distinctive features. Firstly, it is based on comparable indicators both of a key innovation input, and more importantly, compare on the basis of a quantifiable innovation output. Secondly, it is based on data which tries in particular to correct for statistical differences and problems.

3. Some methodological issues

This report presents some international comparisons based on the “Community Innovation Survey” (hereafter referred to as CIS), undertaken by Eurostat and DG-XIII of the European Commission in 1993. Figures relate to the year 1992. The survey covered most of the EU countries and some countries outside - among them Norway - collecting information on a wide range of indicators relating to innovative activity in industrial firms.

For several reasons, however, the results of the CIS exercise are not immediately or completely comparable across countries. The main reason for this is that the samples vary in size and methodology.[1] In addition, the way some of the questions are put or defined may vary somewhat among the national surveys. For such reasons not all of the questions in the survey are suited for international comparison. To overcome this, it is first of all necessary to adjust for sample biases, and secondly to focus on a limited number of strictly comparable indicators. In this report, sample biases have been corrected by careful scaling to national totals.. This has been a co-operative process. The data has been compiled through a collaborative project involving national experts in six countries where the CIS data are fairly comparable - all except one are relatively small countries. The six countries are Norway (N), The Netherlands (NL), Denmark (DK), Ireland (IE), Austria (A) and Germany (G).

The actual scaling was performed by national experts, adopting an appropriate procedure depending on the original sample method used. In the Norwegian case, figures are scaled up on the basis of numbers of firms covered in each stratum. The strata used equals those presented in the tables following, covering 102 cells in 17 industries and 6 size classes. Within each cell figures are scaled by the inverse of the rate of coverage of the total number of firms in the population. In doing this, we have treated those not in the sample, and those not responding, in the same way. This is correct if the non-respondents are not different from those responding. A separate survey by Statistics Norway of non-respondents indicated that this seems reasonable, but with a question mark for the smaller firms. For this reason, and because the coverage of the smallest firms (5-9 employees) was particularly low, this size class is left out of the analysis.

An alternative method for scaling would be to use the share of total number of employees or share of total sales covered in each stratum, instead of number of firms. The main reason for not doing so was difficulties within Statistics Norway in reconstructing the correct population of firms at the time the sample was drawn. This problem was present for a small number of the 102 strata cells, but was more acute when measuring number of employees or sales than when counting number of firms. There is in fact not much difference between the scaling methods based on sales, employment or number of firms when aggregating to broad categories as in this report. We therefore feel confident that our results are reliable and representative for

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[1] These issues are discussed in D. Archibugi et al, **, Evaluation of the Community Innovation Survey, First Phase** , European Commission: Luxembourg, 1995.

the Norwegian industry (that is, for firms with more than 9 employees) - given the limitations of the total sample size.

The focus of the analysis is on R&D activities and results of the innovation process, measured by the share of sales consisting of new or changed products. Comparisons are done at industrial level, with industries split into more or less homogenous groups of activities. The grouping differ somewhat from the standard classification used by for example OECD, and reflects the interests of the Dutch researchers who initiated this co-operation.[2] The main point, however, is that the industries defined are fairly homogenous. This allows the comparison of more or less the same kind of activities across countries with a dataset that is more comparable than has previously been available for this kind of indicators.

Finally , the data are also broken down by size classes. This helps us to evaluate the old question in innovation analysis of whether large or small firms are more innovative, and to compare companies of equal size among the different countries.

[2] The co-operative work was initiated and co-ordinated by Professor Alfred Kleinknecht at Vrije Universiteit Amsterdam, the Netherlands.

4. R&D activities: permanent vs intermittent

In this section we compare the occurrence of R&D activities between firms across the different countries, along with an indicator of whether the R&D activity is permanent versus more occasional. How does the occurrence of R&D vary across industries and firm sizes?

We might expect the occurrence of R&D activity to be more likely in large firms than in small ones, since large firms generally have more resources available for R&D, and are able to cover the costs from a larger volume of sales.[3] In addition, large firms generally operate on more than one product line, allowing for potential economies of scale and scope in utilising the results from R&D. The data is consistent with this view. A size effect can be seen in the lower part of table 1A, where the share of R&D performing firms, with few exceptions, increases with the size classes of companies. This is true for *all* the countries in the comparison. In general, the shares of R&D performing firms are at comparable levels among the countries in all size classes. It seems, though, that the Austrian firms perform somewhat better than the others for all but the smallest size class. Norway, in particular, ends up in the middle of the distribution for all the size classes. One should remember, however, that the problems of industrial structure which we referred to above is present here. The distribution of firms between different industries within each size class is not the same in each country. Occurrence of R&D of course differs with which industry we are studying. Differences among the countries in the mix of industries within each size class might therefore cause varying levels of R&D performing firms within each size class.

Looking at the different industries, the variance in the tendency to perform R&D is obvious among different industries in the same country. For Norway, for example, only 10 % of the firms in the textile industry are R&D performers, whereas 67 % are R&D performers within office machinery and communication technology. But it is not necessarily the same industries which are high or low performers in different countries. There is in general relatively large differences among the countries when comparing identical industries. These differences may be caused by differences in the size distributions of firms in the same industries in different countries. But one would also expect this to mirror differences in innovative performance among the firms.

Comparing Norway to the other countries, there is no clear picture of being generally better or weaker than the others. In general, the occurrence of R&D activity in Norwegian industries is for the most at a comparable level with the other countries. There seems to be a relatively high score on the Norwegian part in “agricultural and forestry machinery, other special purpose machinery and domestic appliances”, and “motor vehicles, aircraft and spacecraft” (low number of observations). Comparably weaker performance is found in “textiles and wearing apparel”, “fabricated metal

[3] This is of course the classic argument associated with Joseph Schumpeter, but it remains a strongly debated proposition.

products excl. machinery and equipment", "machinery for production and use of mechanical power, machine tools" (low number of observations), "electrical machinery and apparatus", "medical, precision and optical instruments" and "other transport equipment".

Table 1A.Percentages of firms which have some R&D activities, by industry and size classes (number of employees)

Industry	**NACE**	**N**	**[3]NL**	**DK**	**IE**	**[4]A**	**G**
Mining, oil and gas extraction, energy and water supply	10-14, 40-41	[2]29	33	48	[1]24	[1]39	9
Food and beverages, tobacco	15, 16	23	33	25	16	30	10
Textiles, wearing apparel	17-18	10	18	16	27	30	26
Wood and wood prods, pulp and paper, publishing and printing	20-22	16	11	21	16	46	7
Petroleum refining, chemicals, rubber and plastic prods	23-25	40	40	60	37	69	48
Other non-metallic mineral prods	26	29	34	36	32	48	23
Basic metals	27	43	20	44	[1]42	58	33
Fabricated metal prods excl machinery and equipment	28	14	21	36	17	58	31
Machinery for prod and use of mechanical power, machine tools	29.1, 29.4	[1]29	38	42	29	[1]75	52
General purpose machinery, weapons and ammunition	29.2, 29.6	[1]34	41	38	33	[1]54	48
Agricultural and forestry machinery, other special purpose machinery, domestic appliances	29.3, 29.5, 29.7	66	35	56	31	71	53
Office machinery and computers, radio, tele and communication	30, 32	67	42	80	55	[1]83	71
Electrical machinery and apparatus	31	39	61	44	52	67	50
Medical, precision and optical instruments	33	30	47	71	36	[1]67	63
Motor vehicles, aircraft and spacecraft	34, 35.3	[1]60	34	25	40	[1]56	45
Other transport equipment (excl air and space)	35 excl 35.3	17	22	20	[1]41	[1]50	45
Furniture, other manufacturing	36	[1]24	10	13	38	53	27
Size classes							
10-19		11	9	NA	20	11	27
20-49		22	19	26	21	25	28
50-99		40	38	42	27	48	24
100-199		45	48	53	45	60	43
200-499		57	60	33	52	72	55
>=500		69	66	59	52	90	78

[1] Less reliable because of low number of observations
[2] Weighting disturbed by the inclusion of one very big firm
[3] There is a slight over-estimation for The Netherlands compared to other countries because of a difference in the questionnaire
[4] Covers the year 1990 (all other countries 1992)

It is possible to check which of the breakdowns - that is by industry or by size of firm - gives the best explanation of the variance in tendency to perform R&D. This is done by an analysis of variance, reported in table 1B. A similar exercise is carried out for all the tables in this report. To do this, we treat all the entries in the table as observations on the variable "share of firms being R&D-performers". The data collection is viewed as obtaining one single value for each industry in each country (upper part of table 1A), or one single value for each size class in each country (lower part of table 1A). This is of course not exactly what happened during the collection; instead, the numbers are weighted means of a large number of observations for each cell. But since we don't have detailed information on all the underlying observations, this is the only way to investigate what are actually the decisive factors for explaining the variance in the observed shares.

The method works by computing a total mean value for all the cells in the table. Then the (squared) deviation from this mean is computed for each cell. This give a total sum of deviation from the total mean. Next step is to sum up the reduction in deviation that is obtained when knowing which industry (country) each observation relates to, keeping country (industry) constant. This sum of deviation explained by the model is compared to the total sum of deviations. By computing the rate of explained deviation to total deviation we get the R^2 measure. Dependent on the number of observations (number of categories in each table) it is also possible to compute a F-value and a level of significance for the relationship. In this way we can decide which of the breakdowns in the tables that give the best explanation of the variance in the indicator under study. Results are shown in Table 1B below:

Table 1B. Analysis of variance

Model	**DF**	**R^2**	**F**	**Pr > F**
Share by industry | country	16/85	*0,52	5,73	0,0001
Share by country | industry	5/96	*0,22	5,36	0,0002
Share by size class | country	5/29	*0,81	25,29	0,0001
Share by country | size class	5/29	0,05	0,31	0,9028

What table 1B shows, is that the tendency to perform R&D is clearly dependent on which industry you are in. This is shown in the first line in the table, where we let industry group vary, keeping nationality constant. The R^2 is 0,52 and highly significant with a F value for the model of 5,73. For such a F value to come about by chance, the probability is smaller than 0,0001 - in other words rather unlikely.

This is not the whole explanation, however. As can be seen from line two in table 1B, also the variation in nationality when keeping industry constant can significantly explain some of the variation in the tendency to perform R&D. This relationship is not as strong as for the industry variation, though, with a R^2 of 0,22.

Looking now at the different size classes (third line in table 1B, relating to the lower part of table 1A), size is a very important and highly significant explaining factor for the tendency to perform R&D (R^2 =0,81). The other way round, letting nationality vary while keeping size constant, give no contribution to explaining the variance.

In sum, the analysis shows that industry and size are the most important factors for explaining variance in the national tendency to perform R&D. Nationality has some explanatory power when controlling for industry. But as this relationship vanishes when controlling for size classes, one might expect the influence of nationality to reflect differences in size distributions of firms in different countries. It is also likely that differences in size distributions within industries is a contributing factor in the explanatory power given to industry belonging in this analysis.

Table 2A. Percentages of R&D performers which have permanent (not occasional) R&D, by industry and size classes (number of employees)

Industry	NACE	N	NL	DK	IE	A	G
Mining, oil and gas extraction, energy and water supply	10-14, 40-41	[2]27	83	[1]38	[1]60	na	79
Food and beverages, tobacco	15, 16	72	79	71	74	na	64
Textiles, wearing apparel	17-18	40	74	81	73	na	90
Wood and wood prods, pulp and paper, publishing and printing	20-22	44	61	48	61	na	64
Petroleum refining, chemicals, rubber and plastic prods	23-25	66	85	73	81	na	81
Other non-metallic mineral prods	26	92	54	65	56	na	64
Basic metals	27	73	51	51	[1]75	na	91
Fabricated metal prods excl machinery and equipment	28	81	54	62	59	na	69
Machinery for prod and use of mechanical power, machine tools	29.1, 29.4	[1]37	94	94	69	na	95
General purpose machinery, weapons and ammunition	29.2, 29.6	[1]24	72	50	69	na	76
Agricultural and forestry machinery, other special purpose machinery, domestic appliances	29.3, 29.5, 29.7	57	71	36	88	na	90
Office machinery and computers, radio, tele and communication	30, 32	82	79	90	81	na	85
Electrical machinery and apparatus	31	66	64	65	67	na	91
Medical, precision and optical instruments	33	46	84	70	87	na	90
Motor vehicles, aircraft and spacecraft	34, 35.3	[1]17	59	[1]29	67	na	61
Other transport equipment (excl air and space)	35 excl 35.3	50	56	[1]77	[1]50	na	92
Furniture, other manufacturing	36	[1]49	73	69	58	na	92
Size classes							
10-19		54	56	na	64	na	85
20-49		53	65	56	64	na	69
50-99		52	72	58	76	na	83
100-199		76	79	74	75	na	86
200-499		93	81	69	91	na	92
>=500		86	85	91	96	na	97

[1] Less reliable because of low number of observations
[2] Weighting disturbed by the inclusion of one very big firm

A neglected issue in R&D is the extent to which firms have permanent activity in this area. Turning to the R&D performers, we might expect their R&D activity to be fairly permanent. The reasons for this might include the sunk costs involved in building up a R&D capacity, hiring researchers, and generally building up competencies in the areas relevant for, and often at the core of, the firms' operations. In addition to this it is frequently argued that knowledge builds up in a cumulative way, which might suggest that continuous R&D would confer benefits on firms. These arguments are not supported by the data, however, looking atTable 2A above. Surprisingly small shares of companies consider their R&D activity to be permanent in many industries; moreover examples of low permanent R&D shares are found in all countries. As with the occurrence of R&D, the share of R&D performers with permanent R&D seems to increase with firm size, as one would expect. For Norway in particular, the shares are comparatively low among the small and medium sized firms (less than 100 employees). Just above half of these firms consider their R&D activity to be permanent. Among the larger firms, Norwegian firms are more at the level found in other countries.

Of the 17 industries specified, the Norwegian ones score relatively low on permanent R&D in 11 industries, compared to the other countries. This must be considered a drawback, if cumulativeness and adjustment costs in such activity are taken into account. The large share of small and medium sized companies in Norway may be one of the reasons for this - a group of firms mainly lower on permanent R&D in all countries.

Consulting the analysis of variance (table 2B), the indication is that belonging to a particular industry does not seem to affect the tendency to perform R&D as a permanent activity. Instead, nationality adds significantly to explaining the variation, but with a relatively modest R^2 of 0,24. Controlling for size class adds much more to the explanation, with a highly significant R^2 of 0,62. When keeping size constant the contribution of nationality vanishes - indicating that the nationality effect reported above might be spurious and in reality dependent on differences in the size distribution of companies in different countries. The effect of size is intuitive in the sense that larger firms in general operates on a larger scale also in R&D, and they are often involved in many different projects simultaneously. For R&D to be permanent in such a situation is more likely than when only one project is undertaken at the time - with more limited costs for starting up or closing down the activity.

Table 2B. Analysis of variance

Model	**DF**	**R^2**	**F**	**Pr > F**
Share by industry | country	16/68	0,25	1,44	0,1511
Share by country | industry	4/80	*0,24	6,48	0,0001
Share by size class | country	5/23	*0,62	7,57	0,0002
Share by country | size class	4/24	0,19	1,45	0,2491

5. R&D collaboration

In this section we take a closer look at an important aspect of R&D among the R&D performers, namely the extent to which the firms tend to co-operate with others on R&D. This is a somewhat neglected aspect of R&D, but it appears to be very important, since one of the more robust relationships in the CIS data is that firms which undertake collaboration have higher shares of innovative products in their output mixes. Here we look at R&D co-operation in terms of types of partners There are four categories of partners:

- domestic public partners
- domestic private partners
- foreign public partners
- foreign private partners

Research institutes are classified as public partners, even if the legal status of some of them may be private. Institutional structure in the different countries will of course influence how this question is answered. To co-operate with a public domestic partner, there must exist someone to co-operate with. We don't believe this to be a major problem, however, since the classes used are so broad. Even if there are no research institutes, universities are classified in the same group and might be a partner for co-operation. For this reason, however, when explaining variance we would expect the importance of nationality to be higher for this indicator than for the others.

As with the previous indicators, this measure of co-operation only records the occurrence of co-operation, regardless of its scale. Therefore large firms tend to be more involved in co-operation as measured here, as is clear from the last part of the tables 3A-6A. The size effect seems, however, to be of somewhat less importance in co-operation compared to the occurrences of R&D activity. This might be due to the fact that many countries support research institutes explicitly to meet the needs of small and medium sized firms. In the Norwegian case, the size effect is nevertheless strong. A larger share of Norwegian firms in the three biggest size groups are co-operating with domestic public partners than in any of the other countries. Among the smallest firms, Norwegian ones tend to cooperate less than in the other countries.

In a large number of the Norwegian industries, firms seem to be co-operating with domestic public partners to a lesser extent than in the other countries. Particularly low shares are found in “general purpose machinery, weapons and ammunition”, and “wood and wood products, pulp and paper, publishing and printing”. This kind of co-operation seems to be of greater importance in the industries “petroleum refining, chemicals rubber and plastic products“, “basic metals”, “agricultural and forestry machinery, other special purpose machinery, domestic appliances”, and “medical, precision and optical instruments”.

As expected, nationality has a significant influence on the occurrence of co-operation with domestic public research partners - when controlling for industry. This most likely reflects differences in the availability of research institutions with whom to co-operate with. The effect is relatively modest, though, with an R^2 of only 0,28. The strongest influence is found when comparing different size classes, keeping nationality constant. For this relationship the R^2 is 0,63 and highly significant. Controlled for size, nationality does not seem to have any influence. In sum, therefore, size of the companies seems to be the most important explaining factor behind variations in co-operation with domestic public partners, but with some national variation when controlling for industry.

Looking at co-operation with domestic **private** partners (table 4A), we see the same kind of size effect as for the public partners. Again, this is more pronounced for Norway than for the other countries. In general, the occurrence of this kind of co-operation seems to be somewhat higher in Norway than in the other countries. The shares of companies with this kind of co-operation are generally higher than the shares having public partners. This is particularly true for the smaller companies, indicating perhaps a failure to achieve the policy objective of reaching smaller firms through public support to research institutes in Norway.

Across countries in the comparison, variations in the tendency to cooperate with domestic private partners among the different industries are large. In the Norwegian case, such co-operation seems to be of particularly minor importance in the “textiles and wearing apparel”-industry and in “motor vehicles, aircraft and spacecraft”. It seems to be of relatively large importance in “petroleum refining, chemicals, rubber and plastic products”, “basic metals”, and “fabricated metal products excl. machinery and equipment”.

Using analysis of variance to test which of the breakdowns have the largest explanatory power, there is only a very weak effect of nationality controlling for industry (R^2 =0,12). There is no effect of industry affiliation when controlling for nationality. Larger, and significant, effects are found when comparing different size classes controlling for nationality (R^2 =0,40), and when comparing countries controlling for size (R^2 =0,43). It seems, therefore, that nationality is of importance for the tendency to co-operate with domestic private partners, but that this effect is related to the size distribution of firms in the different countries. Size of companies is clearly an important determinant for this kind of co-operation.

*Table 3A. Percentages of R&D performing firms which collaborate on R&D with **domestic public partners**, by industry and size classes (number of employees)*

Industry	NACE	N	NL	DK	IE	A	G
Mining, oil and gas extraction, energy and water supply	10-14, 40-41	[2]30	68	62	[1]40	[1]36	44
Food and beverages, tobacco	15, 16	23	24	26	25	36	44
Textiles, wearing apparel	17-18	18	12	9	6	32	3
Wood and wood prods, pulp and paper, publishing and printing	20-22	9	21	21	17	28	13
Petroleum refining, chemicals, rubber and plastic prods	23-25	50	31	43	20	56	16
Other non-metallic mineral prods	26	20	21	29	22	36	25
Basic metals	27	73	5	36	[1]13	79	40
Fabricated metal prods excl machinery and equipment	28	36	26	29	26	61	30
Machinery for prod and use of mechanical power, machine tools	29.1, 29.4	[1]12	9	48	6	[1]33	40
General purpose machinery, weapons and ammunition	29.2, 29.6	[1]2	24	35	15	[1]85	26
Agricultural and forestry machinery, other special purpose machinery, domestic appliances	29.3, 29.5, 29.7	55	19	32	12	56	26
Office machinery and computers, radio, tele and communication	30, 32	15	29	36	32	[1]60	40
Electrical machinery and apparatus	31	35	19	55	17	39	22
Medical, precision and optical instruments	33	51	46	50	26	[1]46	35
Motor vehicles, aircraft and spacecraft	34, 35.3	[1]15	25	[1]44	25	[1]44	16
Other transport equipment (excl air and space)	35 excl 35.3	22	12	35	[1]0	[1]100	32
Furniture, other manufacturing	36	[1]8	9	13	4	9	22
Size classes							
10-19		12	17	na	17	[1]46	na
20-49		15	17	25	14	23	na
50-99		37	27	33	14	25	14
100-199		50	23	41	23	39	17
200-499		63	35	36	32	37	27
>=500		78	56	71	44	75	45

[1] Less reliable because of low number of observations
[2] Weighting disturbed by the inclusion of one very big firm

Table 3B. Analysis of variance

Model	DF	R^2	F	Pr > F
Share by industry | country	16/85	0,25	1,80	0,0437
Share by country | industry	5/96	*0,28	7,60	0,0001
Share by size class | country	5/27	*0,63	9,03	0,0001
Share by country | size class	5/27	0,18	1,21	0,3323

*Table 4A. Percentages of R&D performing firms which collaborate on R&D with **domestic private partners**, by industry and size classes (number of employees)*

Industry	NACE	N	NL	DK	IE	A	G
Mining, oil and gas extraction, energy and water supply	10-14, 40-41	[2]39	91	0	[1]80	[1]0	46
Food and beverages, tobacco	15, 16	28	41	45	26	16	29
Textiles, wearing apparel	17-18	3	26	37	6	32	10
Wood and wood prods, pulp and paper, publishing and printing	20-22	34	57	25	26	23	43
Petroleum refining, chemicals, rubber and plastic prods	23-25	52	43	36	20	25	34
Other non-metallic mineral prods	26	38	34	51	22	24	35
Basic metals	27	66	7	57	[1]13	31	47
Fabricated metal prods excl machinery and equipment	28	54	47	42	24	40	30
Machinery for prod and use of mechanical power, machine tools	29.1, 29.4	[1]25	30	68	13	[1]67	36
General purpose machinery, weapons and ammunition	29.2, 29.6	[1]24	30	51	39	[1]39	29
Agricultural and forestry machinery, other special purpose machinery, domestic appliances	29.3, 29.5, 29.7	33	28	40	18	23	29
Office machinery and computers, radio, tele and communication	30, 32	17	43	61	24	[1]0	29
Electrical machinery and apparatus	31	27	36	39	30	17	23
Medical, precision and optical instruments	33	46	60	59	23	[1]46	39
Motor vehicles, aircraft and spacecraft	34, 35.3	[1]9	66	[1]29	0	[1]44	37
Other transport equipment (excl air and space)	35 excl 35.3	22	23	40	[1]0	[1]100	54
Furniture, other manufacturing	36	[1]15	22	26	4	3	17
Size classes							
10-19		18	39	na	26	[1]0	na
20-49		32	38	32	17	13	na
50-99		39	34	45	12	29	28
100-199		59	40	53	21	14	20
200-499		70	46	43	30	23	30
>=500		72	68	63	44	40	49

[1] Less reliable because of low number of observations
[2] Weighting disturbed by the inclusion of one very big firm

Table 4B. Analysis of variance

Model	**DF**	**R^2**	**F**	**Pr > F**
Share by industry | country	16/85	0,17	1,05	0,4124
Share by country | industry	5/96	*0,12	2,62	0,0289
Share by size class | country	5/27	*0,40	3,64	0,0121
Share by country | size class	5/27	*0,43	4,03	0,0074

Now turning to co-operation with **foreign** partners, the shares of co-operating firms are generally lower. This is particularly true for co-operation with foreign public partners (table 5A). One possible reason might be that such a technological infrastructure primarily is constructed to support national needs, and therefore is less accessible to foreigners; this would be consistent with recent arguments - for example by Pavitt and Patel - that globalization in technology creation is an overstated phenomenon.[4] It would also be consistent with arguments - for example by Archibugi and Pianta - that technological specialisation at national level remains very important, and that European economies do not have similar technological bases.[5]

For many industries, no foreign co-operation is recorded at all - particularly among Norwegian firms. No Norwegian firms with less than 50 employees reported any such co-operation in this survey. For the other countries in the comparison, this share is also low. Among the lager firms, the Norwegian shares are at the same order of magnitude as for the other countries in the comparison. The smallest shares are generally found for the largest country, Germany. This might be attributed to the existence of a larger number of potential partners in a large country, compared to what is found in smaller countries.

Looking at the different industries, shares vary somewhat in all countries, but are generally relatively low. Some industries seem to be more oriented towards this kind of co-operation in all countries. They are “petroleum refining, chemicals, rubber and plastic products”, basic metals”, and “medical, precision and optical instruments”.

[4] See for example Patel, P. and Pavitt, K., “The nature and economic importance of national innovation systems”, **STI-Review**, No. 14, 1994, pp. 9-32.

[5] D. Archibugi and M. Pianta, **The Technological Specialization of the Advanced Countries** (Dordrecht: Kluwer) 1993.

*Table 5A. Percentages of R&D performing firms which collaborate on R&D with **foreign public partners**, by industry and size classes (number of employees)*

Industry	NACE	N	NL	DK	IE	A	G
Mining, oil and gas extraction, energy and water supply	10-14, 40-41	[2]19	6	0	[1]40	[1]0	12
Food and beverages, tobacco	15, 16	4	4	12	17	16	5
Textiles, wearing apparel	17-18	3	2	9	2	10	1
Wood and wood prods, pulp and paper, publishing and printing	20-22	1	2	2	7	7	0
Petroleum refining, chemicals, rubber and plastic prods	23-25	18	12	16	11	25	4
Other non-metallic mineral prods	26	4	2	31	4	16	1
Basic metals	27	11	5	20	[1]13	30	10
Fabricated metal prods excl machinery and equipment	28	0	2	8	4	17	1
Machinery for prod and use of mechanical power, machine tools	29.1, 29.4	[1]0	4	17	0	[1]33	4
General purpose machinery, weapons and ammunition	29.2, 29.6	[1]0	4	9	0	[1]23	5
Agricultural and forestry machinery, other special purpose machinery, domestic appliances	29.3, 29.5, 29.7	5	9	5	6	15	3
Office machinery and computers, radio, tele and communication	30, 32	0	3	13	7	[1]20	3
Electrical machinery and apparatus	31	9	4	0	0	11	1
Medical, precision and optical instruments	33	15	10	26	8	[1]19	5
Motor vehicles, aircraft and spacecraft	34, 35.3	[1]8	7	[1]0	8	[1]22	5
Other transport equipment (excl air and space)	35 excl 35.3	0	5	35	[1]0	[1]0	9
Furniture, other manufacturing	36	[1]0	3	0	0	6	7
Size classes							
10-19		0	0	na	3	[1]0	na
20-49		0	2	6	4	0	na
50-99		5	6	9	3	14	1
100-199		20	7	12	9	8	1
200-499		17	10	14	22	12	4
>=500		31	19	53	30	41	11

[1] Less reliable because of low number of observations
[2] Weighting disturbed by the inclusion of one very big firm

The analysis of variance (table 5B) reveals that industry affiliation is not of any importance for this indicator - controlled for nationality. Instead, nationality seems to have a relatively weak, but significant, effect (R^2 =0,23). This effect vanishes, though, when controlling for size. Size itself is the most decisive factor as measured, with nationality kept constant. R^2 rates at 0,67 and is highly significant, confirming the impression from the previous tables that size is the main determining factor for R&D co-operation - no matter what kind of co-operation is studied. Of course, there may be other determining factors not included in the analysis - with an R^2 of 0,6-0,7 there is still a lot of variation to be explained. But that have to be left aside for the moment.

Table 5B. Analysis of variance

Model	**DF**	**R^2**	**F**	**Pr > F**
Share by industry | country	16/85	0,19	1,21	0,2782
Share by country | industry	5/96	*0,23	5,73	0,0001
Share by size class | country	5/27	*0,67	10,82	0,0001
Share by country | size class	5/27	0,12	0,73	0,6103

When it comes to co-operation with **foreign private** partners, the picture is more fuzzy (table 6A). For Norway, the shares of co-operating firms are lower for all size classes when compared to co-operation with **domestic** private partners. This is not true for all the other countries. As the situation is more or less the same in the Netherlands and Germany, Danish, Irish and Austrian firms tend to cooperate more with foreign private partners than with domestic private partners. The reason for this is hard to establish. There is no clear tendency to suggest that any of these countries are generally more co-operative than the others, except that Germany seems to be particularly low on all the kinds of co-operation specified.

Looking again at the different industries, variation is large. Four industries seems to be more oriented towards this kind of co-operation than the others. They are “petroleum refining, chemicals, rubber and plastic products”, “basic metals”, “medical, precision and optical instruments”, and “motor vehicles, aircraft and spacecraft”. Among the Norwegian industries, co-operation with a foreign private partner seems to be of particular importance for “agricultural and forestry machinery, other special purpose machinery, domestic appliances”. Particularly low on this kind of co-operation are the Norwegian industries “textiles and wearing apparel” and “office machinery and computers, tele and telecommunication”.

*Table 6A. Percentages of R&D performing firms which collaborate on R&D with **foreign private partners**, by industry and size classes (number of employees)*

Industry	NACE	N	NL	DK	IE	A	G
Mining, oil and gas extraction, energy and water supply	10-14, 40-41	[2]23	35	9	[1]80	[1]51	17
Food and beverages, tobacco	15, 16	26	13	40	33	18	10
Textiles, wearing apparel	17-18	3	17	31	14	42	8
Wood and wood prods, pulp and paper, publishing and printing	20-22	20	31	24	26	10	14
Petroleum refining, chemicals, rubber and plastic prods	23-25	30	54	48	31	48	22
Other non-metallic mineral prods	26	26	12	34	33	16	9
Basic metals	27	35	27	93	[1]25	25	22
Fabricated metal prods excl machinery and equipment	28	23	21	28	26	32	18
Machinery for prod and use of mechanical power, machine tools	29.1, 29.4	[1]12	19	63	6	[1]67	20
General purpose machinery, weapons and ammunition	29.2, 29.6	[1]18	23	26	31	[1]62	15
Agricultural and forestry machinery, other special purpose machinery, domestic appliances	29.3, 29.5, 29.7	51	17	47	12	24	17
Office machinery and computers, radio, tele and communication	30, 32	5	43	61	32	[1]60	19
Electrical machinery and apparatus	31	32	16	42	33	28	15
Medical, precision and optical instruments	33	15	39	46	31	[1]27	25
Motor vehicles, aircraft and spacecraft	34, 35.3	[1]13	36	44	42	[1]67	30
Other transport equipment (excl air and space)	35 excl 35.3	5	8	40	[1]0	[1]100	18
Furniture, other manufacturing	36	[1]15	13	17	8	[1]12	14
Size classes							
10-19		12	8	na	19	[1]15	na
20-49		16	19	32	17	14	na
50-99		32	26	33	26	23	10
100-199		46	36	54	38	24	8
200-499		45	44	49	54	26	22
>=500		55	67	71	41	48	32

[1] Less reliable because of low number of observations
[2] Weighting disturbed by the inclusion of one very big firm

The analysis of variance confirms again the same broad picture as we have found before (table 6B): Industry affiliation has no significant influence, but nationality is of some importance. This nationality effect vanishes when controlling for size, indicating that size of companies is the single most important variable in the analysis of co-operation. The R^2 of size controlling for nationality is 0,58 and highly significant.

Table 6B. Analysis of variance

Model	DF	R^2	F	Pr > F
Share by industry | country	16/85	0,15	0,97	0,4990
Share by country | industry	5/96	*0,24	6,10	0,0001
Share by size class | country	5/27	*0,58	7,33	0,0002
Share by country | size class	5/27	0,26	1,86	0,1348

6. New product sales

Measuring outputs and results of the innovation process has always been difficult. Nevertheless it is essential to be able to assess outputs in order to address the important policy design - simply because one needs to know how the different policies seem to work. In the OECD Innovation Manual, and in the CIS survey for most countries, a new indicator is developed. This seeks to estimate the share of sales stemming from new or changed products. This indicator of course focuses on only one aspect of innovation - product innovation - and leaves out other aspects such as organisational change and process innovation. The reason is straightforward: that product innovation seems to be more easily operationalised and measured. This choice therefore does not imply that product innovations are more important than the other kinds of innovation; simply that they are more amenable to measurement.

To measure newly introduced or changed products, one has to define the period within which the change has taken place. That choice has serious implications, mainly because firms of different size are thought to have different behaviour. Large firms operating in many product lines are likely to have introduced a change in at least one of the products even if the period is relatively short. They are therefore recorded as “innovative”. Smaller companies may also improve their products - continuously or intermittently (as and when needed). If the latter is the case, and if the time of introduction falls outside of the registration period, many of these companies will be recorded as “non-innovative”. The same problem of choosing the “right” period applies to firms in different industries. In some industries - like electronics - the life cycle of each product generation is relatively short. The likelihood of catching such a firm innovating is high, even with a short registration “window”. In other industries, like metallurgy or even pharmaceuticals, product life is generally much longer, and the need to innovate at short time intervals is smaller. The new products measure is therefore suitable for comparing firms within the same industry or with equal size, but not for comparing across different industries.

In the CIS survey, the time horizon was set to three years. The Austrian numbers below refer to a period of five years - with, therefore, a share of innovative companies expected to be higher than for the other countries.

A related definitional problem concerns what it means to be “new”. In the CIS survey the definition of “newness” leaves out minor changes or adjustments and purely aesthetic changes; it relates to incremental or radical changes in the performance characteristics of products. Furthermore, there is a distinction between products “new to the firm” and products “new to the sector”. The latter is thought of as something completely new - not known to or applied by anyone in the industry before. But even if a product is known in the industry, but introduced for the first time in one particular firm, it represents an innovation to that firm. Below we present how the industries perform on these two indicators in different countries. We include both a measure of the mere occurrence of changed products, and a measure of the actual share of sales consisting of innovations ‘new to the firm’ and ‘new to the sector’.

Table 7A shows the shares of firms having any changed products at all - new to the firm. As with the occurrence-measures presented earlier, the shares tend to rise with company size. This is basically true for all the countries in the comparison. Comparing firms in the different size classes, the shares tend to be somewhat lower in Norway than in the other countries essentially for all size classes. It is actually remarkable that in Norway, 45 % of the firms with 500 employees or more have not introduced any changed products over a three year period. In the other countries this applies to 20-33 % of the larger firms. The explanations may be found in market conditions (market power or other kinds of failure) or in the kinds of products involved - basic and/or standardised products with small scope for improvements. One would expect process- or organisational innovation to be of importance in such cases, as a means of reducing production costs.[6] Unfortunately no such measure is available in the CIS data.

For the smaller companies the shares of innovators are considerably lower than for the larger - down to 13-35 % for companies with less than 50 employees. To the extent that these firms survive over time, there must either exist markets for more or less unchanging products - probably serving well defined market niches with particular and stable needs - or we would expect high turnover of firms (high exit rates). As discussed above, the observation window used (3 years) may exclude some of the smaller companies, if their innovation is discontinuous. However as noted above another phenomenon may also be in effect that can explain the low shares of innovating small firms: entry and exit of firms. Every year a large share of existing firms disappear, by closing down or being merged with other firms. At the same time, a large number of new firms are being established. We suspect that there is a large share of non-innovators among the ones closing down. And we expect there to be many new products being produced by the newly established firms. The successful newly established firms have essentially three options: To keep on innovating and survive as an independent firm, to be bought out by another firm (and hence the production may survive even if the firm disappears), or to keep on producing an unchanging product as long as possible, before closing down. The unsuccessful will of course have to close down.

There is well-known empirical support for high entry and exit rates in previous studies of small firms. At present, however, no study has linked innovation data with entry-exit data. We see this as a fruitful way forward in tracking the dynamics of industrial innovation.

Although the shares vary considerably among industries, one must conclude that it is true for a relatively large share of companies in most industries that a large share of firms are not innovative. Comparing Norwegian industries with the other countries, the general impression is that Norway lags in most industries. The differences discussed above when comparing firms in different size classes among countries, seem to be a widespread phenomenon rather than concentrated in one or a few industries.

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[6] The classic discussion of this transition from product innovation to cost-reducing process change remains W. Abernathy and J. Utterback, “A Dynamic Model of Product and Process Innovation”, **Omega**, Vol 3, 1975, pp.639-56.

Table 7A. Percentages of firms which have some sales of innovative products ('new to the firm'), by industry and size classes (number of employees)

Industry	NACE	N	NL	DK	IE	A	G
Mining, oil and gas extraction, energy and water supply	10-14, 40-41	[2]26	31	39	na	na	14
Food and beverages, tobacco	15, 16	23	37	25	na	na	16
Textiles, wearing apparel	17-18	26	28	36	na	na	46
Wood and wood prods, pulp and paper, publishing and printing	20-22	12	27	25	na	na	18
Petroleum refining, chemicals, rubber and plastic prods	23-25	44	57	66	na	na	58
Other non-metallic mineral prods	26	29	44	45	na	na	26
Basic metals	27	38	22	57	na	na	34
Fabricated metal prods excl machinery and equipment	28	18	27	44	na	na	45
Machinery for prod and use of mechanical power, machine tools	29.1, 29.4	[1]34	47	39	na	na	77
General purpose machinery, weapons and ammunition	29.2, 29.6	[1]34	46	53	na	na	68
Agricultural and forestry machinery, other special purpose machinery, domestic appliances	29.3, 29.5, 29.7	71	46	73	na	na	85
Office machinery and computers, radio, tele and communication	30, 32	56	58	88	na	na	69
Electrical machinery and apparatus	31	30	53	61	na	na	61
Medical, precision and optical instruments	33	30	51	71	na	na	70
Motor vehicles, aircraft and spacecraft	34, 35.3	[1]71	56	46	na	na	36
Other transport equipment (excl air and space)	35 excl 35.3	12	21	25	na	na	34
Furniture, other manufacturing	36	[1]36	16	24	na	na	46
Size classes							
10-19		13	20	na	na	na	35
20-49		24	30	35	na	na	35
50-99		36	52	46	na	na	39
100-199		45	59	58	na	na	49
200-499		59	61	43	na	na	57
>=500		55	72	67	na	na	80

[1] Less reliable because of low number of observations
[2] Weighting disturbed by the inclusion of one very big firm

A more formal investigation into the determinants of the differences observed is presented in the analysis of variance in table 7B. Even if we can see a relatively weak performance of Norway on this indicator compared to the other countries, nationality is not a significant explanatory factor comparing all the countries - neither when controlled for industry nor size. The decisive factors seems to be which industry you belong to, and the size of the company - both highly significant relationships with R^2 as high as 0,62 and 0,81 respectively. This fits well with what we have said earlier: The need to innovate, probably resulting from differences in the life cycle of products, varies considerably among industries, and the mere occurrence of innovation is strongly dependent on the size of the firm - as we see it, because innovation may occur in one of many different product lines.

Table 7B. Analysis of variance

Model	**DF**	**R^2**	**F**	**Pr > F**
Share by industry | country	16/51	*0,62	5,24	0,0001
Share by country | industry	3/64	0,09	2,08	0,1119
Share by size class | country	5/17	*0,81	14,93	0,0001
Share by country | size class	3/19	0,08	0,55	0,6515

Turning now to the shares of sales being changed products (new to the firm, of those firms having new products), do we still observe the same weak performance of Norway, probably with similar explanatory factors?

In general, Norway performs in line with the other countries on this variable, even if the larger firms still are somewhat behind. We interpret this to mean that even if a smaller share of Norwegian companies are innovative measured by new product sales, those that are innovative are not lagging behind comparable firms in other countries. This is by and large true also when comparing single industries, even if a few (particularly basic metals) are relatively low in the comparison. For quite a few industries the higher share of all countries is found in Norway.

The strong size effect recorded on most indicators, and in particular for the occurrence of new to firm sales, is not present for share of sales being new products. For two countries, Norway and Germany, the highest share is in fact found for the smallest size class. It seems reasonable to conclude that a smaller share of small firms are innovative compared to the larger ones, but among those being innovative, the small firms are doing well relative to their size.

When interpreting this table, one must keep two limitations in mind: Firstly, that in terms of total sales of products new to the firm, the larger firms are dominating. This is because of their domination in total sales. Secondly, only innovative firms are included in this comparison. Since a much lower share of the smaller firms are innovative than of the larger ones, the share that new products make up of *total* sales (in innovative and non-innovative firms) is much smaller in small firms than in larger firms. Therefore the larger firms are the most important in terms of volume of innovative output in the single industry or the single country. But as is known from other studies, growth in employment comes mainly in smaller firms, while larger firms are stagnant or declining. In that perspective small firms, and in particular the innovative ones, are important resources to build upon for the future.

Table 8A. Shares of products 'new to the firm' in 1992 sales of those firms which have products new to the firm, by industry and size classes (number of employees)

Industry	NACE	N	NL	DK	IE	[2]A	G
Mining, oil and gas extraction, energy and water supply	10-14, 40-41	25	22	na	na	[1]23	36
Food and beverages, tobacco	15, 16	45	32	48	na	20	34
Textiles, wearing apparel	17-18	33	39	[1]47	na	49	43
Wood and wood prods, pulp and paper, publishing and printing	20-22	22	27	24	na	30	30
Petroleum refining, chemicals, rubber and plastic prods	23-25	27	31	27	na	32	51
Other non-metallic mineral prods	26	24	28	[1]23	na	28	31
Basic metals	27	10	15	[1]27	na	20	33
Fabricated metal prods excl machinery and equipment	28	44	28	29	na	25	42
Machinery for prod and use of mechanical power, machine tools	29.1, 29.4	[1]40	29	[1]32	na	[1]33	37
General purpose machinery, weapons and ammunition	29.2, 29.6	[1]44	46	31	na	[1]42	49
Agricultural and forestry machinery, other special purpose machinery, domestic appliances	29.3, 29.5, 29.7	64	43	34	na	34	58
Office machinery and computers, radio, tele and communication	30, 32	56	47	37	na	[1]46	77
Electrical machinery and apparatus	31	52	43	29	na	41	46
Medical, precision and optical instruments	33	56	42	38	na	[1]49	51
Motor vehicles, aircraft and spacecraft	34, 35.3	[1]31	46	[1]38	na	[1]43	60
Other transport equipment (excl air and space)	35 excl 35.3	46	36	[1]40	na	[1]10	36
Furniture, other manufacturing	36	[1]46	39	[1]41	na	50	66
Size classes							
10-19		46	29	na	na	22	57
20-49		35	33	35	na	29	48
50-99		36	34	31	na	35	46
100-199		40	36	36	na	35	40
200-499		37	34	30	na	38	42
>=500		26	36	28	na	37	45

[1] Less reliable because of low number of observations
[2] Figures relate to innovative products introduced during the last **five** years

The absence of size effect on share of sales new to firm comes clearly through also in the analysis of variance (table 8B). There is no explanatory power stemming from the size variable controlling for nationality, but a relatively strong and significant effect of nationality across size groups. Also when keeping industry constant the nationality effect is positive and significant, but of marginal magnitude. Instead, industry affiliation is an important determinant for the share of sales being products new to firm. As with the mere occurrence indicator (table 7), this must be attributed to differences in technological opportunity and/or varying life cycles in the different industries.

Table 8B. Analysis of variance

Model	**DF**	**R^2**	**F**	**Pr > F**
Share by industry | country	16/67	*0,52	4,46	0,0001
Share by country | industry	4/79	*0,14	3,26	0,0158
Share by size class | country	5/23	0,03	0,14	0,9810
Share by country | size class	4/24	*0,55	7,46	0,0005

Tables 9 and 10 below are parallel to tables 7 and 8, but this time looking at products new to the sector. This is, in other words, a kind of innovation which can be considered more radical than what is products new to the firm (and hence might be known by others in the same industry).

Looking at Norway in particular, comparing with the other countries where data is available, performance is very good. In all size classes, the Norwegian shares are the larger in the comparison, even if the differences are not very large (table 9A). Turning to the different industries, the good performance of Norwegian firms applies to a range of industries, and is not limited to one or two outstanding performers. Nevertheless there are industries where the Norwegian performance seems to be relatively - and absolutely - weak. That applies to wood-based industries (5%) and transport equipment other than air and space (10 %). But these are industries with a low performance in all the countries included.

Table 9A. Percentages of firms which have some sales of innovative products ('new to the sector'), by industry and size classes (number of employees)

Industry	NACE	N	NL	DK	IE	A	[3]G
Mining, oil and gas extraction, energy and water supply	10-14, 40-41	[2]20	17	0	na	na	1
Food and beverages, tobacco	15, 16	17	12	9	na	na	3
Textiles, wearing apparel	17-18	13	3	19	na	na	11
Wood and wood prods, pulp and paper, publishing and printing	20-22	5	10	5	na	na	6
Petroleum refining, chemicals, rubber and plastic prods	23-25	29	24	40	na	na	16
Other non-metallic mineral prods	26	22	10	27	na	na	4
Basic metals	27	29	12	13	na	na	9
Fabricated metal prods excl machinery and equipment	28	11	7	19	na	na	7
Machinery for prod and use of mechanical power, machine tools	29.1, 29.4	[1]32	16	19	na	na	40
General purpose machinery, weapons and ammunition	29.2, 29.6	[1]30	21	27	na	na	22
Agricultural and forestry machinery, other special purpose machinery, domestic appliances	29.3, 29.5, 29.7	49	23	28	na	na	34
Office machinery and computers, radio, tele and communication	30, 32	46	24	50	na	na	26
Electrical machinery and apparatus	31	24	15	35	na	na	17
Medical, precision and optical instruments	33	20	20	44	na	na	31
Motor vehicles, aircraft and spacecraft	34, 35.3	[1]35	10	10	na	na	16
Other transport equipment (excl air and space)	35 excl 35.3	10	13	18	na	na	4
Furniture, other manufacturing	36	[1]22	4	10	na	na	7
Size classes							
10-19		9	8	na	na	na	5
20-49		15	10	13	na	na	4
50-99		25	18	23	na	na	18
100-199		31	19	30	na	na	19
200-499		39	27	22	na	na	32
>=500		52	34	33	na	na	47

[1] Less reliable because of low number of observations
[2] Weighting disturbed by the inclusion of one very big firm
[3] The German figures are too low compared to the other countries, because incrementally improved products are excluded

As can be seen, nationality does contribute somewhat to explaining the variance when controlling for industry, but this is a very weak relationship (table 9B). What seems to matter is industry affiliation, along with size. As with the previous measures of occurrence, the size effect is clearly present for this indicator. The R^2 is up to 0,81 and highly significant when controlling for nationality, whereas there is no effect at all of nationality when controlling for size. This is in line with what we found for products new to the firm, and the remarks made in that regard also apply here.

Table 9B. Analysis of variance

Model	**DF**	**R^2**	**F**	**Pr > F**
Share by industry | country	16/50	*0,56	4,00	0,0001
Share by country | industry	3/63	*0,15	3,84	0,0136
Share by size class | country	5/17	*0,81	14,87	0,0001
Share by country | size class	3/19	0,08	0,56	0,6453

The last indicator included in this study is the share of sales being products new to the industry. Unfortunately, only three of the countries in the comparison could supply this kind of data. Starting with the size effect again, the strong positive relationship between occurrence of sales of products new to the sector, and size, is no longer present (table 10A). Rather, for Norway and the Netherlands, the effect is more the opposite, with the smallest firms performing particularly well in Norway. Due to the unclear picture for Denmark, this effect is not significant in the analysis of variance (table 10B). Rather there is a significant, but moderate, effect of nationality when controlling for size. Looking at Norway in particular, shares are the largest or at the same level as for the other countries in all but the largest size class.

The variation in the shares among different industries is relatively moderate - for Norway from 5 % (basic metals) to 34 % (instruments). In general, Norwegian industries seems to perform on a reasonable level compared to Denmark and the Netherlands. In the analysis of variance, neither industry affiliation nor nationality adds to the explanation of the variance in the recorded shares of new product sales. This is in contrast to what we found for products new to the firm. A reason for this is the small differences among the industries, leaving little variation to be explained, along with the fact that we only have observations for three countries.

Taking the statistics seriously, the analysis nevertheless shows that industry affiliation has no systematic influence when controlling for nationality. Nationality matters when equal size classes are compared. But the limited number of observations included make this conclusion far more uncertain than for the other indicators.

Table 10A. Shares of products 'new to the sector' in 1992 sales of those firms which have products new to the sector, by industry and size classes (number of employees)

Industry	NACE	N	NL	DK	IE	A	G
Mining, oil and gas extraction, energy and water supply	10-14, 40-41	17	11	na	na	na	na
Food and beverages, tobacco	15, 16	30	5	18	na	na	na
Textiles, wearing apparel	17-18	29	4	[1]31	na	na	na
Wood and wood prods, pulp and paper, publishing and printing	20-22	8	9	[1]9	na	na	na
Petroleum refining, chemicals, rubber and plastic prods	23-25	13	5	15	na	na	na
Other non-metallic mineral prods	26	12	9	18	na	na	na
Basic metals	27	5	47	[1]9	na	na	na
Fabricated metal prods excl machinery and equipment	28	26	12	15	na	na	na
Machinery for prod and use of mechanical power, machine tools	29.1, 29.4	[1]18	14	[1]26	na	na	na
General purpose machinery, weapons and ammunition	29.2, 29.6	[1]9	15	22	na	na	na
Agricultural and forestry machinery, other special purpose machinery, domestic appliances	29.3, 29.5, 29.7	27	24	17	na	na	na
Office machinery and computers, radio, tele and communication	30, 32	15	16	24	na	na	na
Electrical machinery and apparatus	31	19	16	[1]37	na	na	na
Medical, precision and optical instruments	33	34	9	15	na	na	na
Motor vehicles, aircraft and spacecraft	34, 35.3	[1]23	25	[1]19	na	na	na
Other transport equipment (excl air and space)	35 excl 35.3	21	9	[1]22	na	na	na
Furniture, other manufacturing	36	[1]28	26	[1]12	na	na	na
Size classes							
10-19		38	18	na	na	na	na
20-49		17	13	18	na	na	na
50-99		30	11	23	na	na	na
100-199		20	10	18	na	na	na
200-499		16	8	16	na	na	na
>=500		17	12	25	na	na	na

[1] Less reliable because of low number of observations

Table 10B. Analysis of variance

Model	DF	R^2	F	Pr > F
Share by industry | country	16/33	0,22	0,57	0,8872
Share by country | industry	2/47	0,05	1,35	0,2704
Share by size class | country	5/11	0,36	1,21	0,3651
Share by country | size class	2/14	*0,43	5,18	0,0207

7. Concluding remarks

In this report we have presented international comparisons of selected innovation indicators, based on the European CIS survey. Figures have been scaled to national totals to overcome differences in sampling methods and response rates, thereby making them comparable across countries. In effect, this is probably the most consistent information available at this time for European comparisons of innovation activities.

The focus of the analysis has been R&D activities, and outputs of innovation, measured by share of sales consisting of new or changed products. Comparisons are made at the level of industrial subgroups, keeping the activity within each group as homogenous as the numbers of observations allow us to. In addition firms have been examined according to size, measured by number of employees. This allows us to investigate national differences in innovative activities, to compare innovation in firms of different size, and to study how innovation varies among industries. By use of analysis of variance we have also assessed the question of which factor seems to explain the larger part of variation in the observed indicators. In particular, we have discussed which of the variables industry affiliation, size and nationality are the most influential in shaping the level of innovative performance.

In general, industry affiliation and size seem to be decisive factors for innovative performance. But this varies with the indicator under study, and will be qualified below. Nationality seems to have less influence in most cases, but are of importance in particular when focusing on R&D collaboration.

Even if nationality does not add significantly to explaining the variation among all countries, one can compare one country with the others to see whether this single country performs better or worse than the others. We have kept this in mind for Norway, and the general impression is that the Norwegian performance is in line with what is found for the other countries in the comparison. It seems that the share of Norwegian firms having new or changed products (new to the firm) in their sales is somewhat lower in Norway than in the other countries, but that those firms being innovative perform comparably well. This suggests that extending the range of innovative firms in Norway might be a fruitful policy goal.

There are of course large variations among different industries in how they perform. This is due to differences in underlying technology, in technological opportunity and in the life cycle of products. Detailed comments on how different industries perform is beyond the scope of this report, but the interested reader can compare the performance of single industries across countries on the different indicators. The overall impression is that most Norwegian industries perform on a comparable level with the other countries, and that this result is not triggered by one or two outstanding performers. At the overall level, this should be seen as a relatively positive evaluation of innovation in Norwegian industry.

Turning in more detail to the different indicators, industry affiliation contributes significantly to explaining variation in the share of R&D-performing firms, the share of firms having new products in their sales, and the share of sales being products new to the firm. It has no effect on the tendency to perform R&D as a permanent vs. more occasional activity, nor on R&D co-operation.

“Size of firm” is important for all the indicators measuring the mere occurrence of an activity. In general, the larger the firm-size category, the higher the share of innovative activity . This is not true, however, when it comes to measuring share of sales from new products among the group of innovating firms. For this variable - among this restricted group of firms - size has no significant effect. Rather, for some countries, among them Norway, the smaller firms are more innovative than the larger ones. Thus being innovative depends positively on size, but once innovative, performance relative to size is at least as good in the smaller firms.

Nationality as an explaining factor seems to matter for the share of sales being new products, when comparing equal size classes. For R&D co-operation nationality also matters - industry affiliation does not - which may suggest that national infrastructures are important, but the coefficients are generally small.

Can we see any scope for policies aimed at improving innovation performance based on this analysis? As long as the Norwegian performance in general seems to be in line with what is found in other countries, the answer could simply be no. However, innovation is now seen as the key to future success, and even to the survival of firms. As this is realised, we must expect all our competitors to do their best to strengthen innovation in their country, leaving no room for rest. We have seen that a smaller share of Norwegian firms have new products in their sales, even if the innovative ones seem successful. Here there are obviously scope for improvements.

Also, individual industries are lagging systematically behind even if the overall picture is reasonably good. A differentiated effort to improve performance in particular industries might therefore be needed. The challenge is twofold: Firstly, one must make sure that the large industries in terms of employment, value added and exports are competitive. Secondly, one must be active in the new and upcoming industries - possibly accounting for a major part of production in the future. With limited resources, the two goals may conflict.

Looking at the shares of innovative firms, measured by any of the indicators, one is struck by the fact that there is always a considerable share of non-innovators or of unchanged products. This suggest that there is room for improvements, simply by trying to raise the share of innovating firms. For example, 31 percent of the large firms, and 89 percent of the smallest ones, are not performing R&D in Norway. Depending on size again, between 41 and 87 percent of firms are not having any new or changed products in their sales. Even with the note made earlier in mind, on the importance of entry and exit of firms in the innovation process, these shares seem to be high. Interpreted this way, the analysis points in the direction of inclusion into the innovation system of a larger share of companies. The scope for growth is probably the largest among the smaller firms, whereas the effect in terms of saving workplaces is larger among the larger firms. The exact policy to accomplish this will have to depend on more detailed analysis of the whole innovation system, and in particular on the spread and development of competencies, technologies, and entry and exit of firms. That must be left aside for future analysis.

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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.