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FINNISH PATENTING ACTIVITY

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ABSTRACT: This is an analysis of Finnish patenting activity in the period 1963-86, in the light of US patent statistics. The US patents granted to Finland in absolute numbers and related to population as well as the Finnish share in total foreign (non-US) patenting are compared with similar data for Norway, Sweden and Denmark. The gradually livelier Finnish patenting activity reflects the ascending technological level of Finland's industry. - By means of an indicator of revealed technological advantage (RTA) the sectoral pattern of Finnish patenting is also analysed. This indicates a certain polarisation, with relatively large number of industrial branches in positions stronger or weaker (from the point of view of patenting) than the average, and few sectors in between.

KEY WORDS: Patenting, technological level, Finland.

FINNISH PATENTING ACTIVITY

GEORGE F. RAY

Contents:

May 1988

FINNISH PATENTING ACTIVITY

Introduction

To obtain a patent - and particularly to have a patent granted abroad - is costly. Unless the subject of the patent is genuinely original and represents progress in some direction, nobody is likely to spend money and energy in pursuing it. A patent thus constitutes an innovation considered worth promoting and protecting.

It follows that information on Finnish patents granted abroad will reflect the innovative activity of Finnish industrialists, scientists and technologists as embodied in patentable processes or products.

US patents

By far the largest, and probably also the most sophisticated market in the world is that of the United States. US patent statistics can therefore be considered the best source for assessing the patenting activity of any country outside the US. Two factors support this: first, the rigorous examination to which all patent applications are submitted, whether they originate in the US or elsewhere; and secondly, the strong interest of the applicant firms in protecting their technological advances in this most important market.

It was in the early 1960s that economists demonstrated the usefulness of US patent statistics as proxy measures of technological and innovative activity; the number of studies and monographs based on this useful source has recently grown even larger.[1]

The method

The basic statistical material is presented in the three appendix tables, A1, A2 and A3. The first indicates the number of US patents granted to Finnish applicants in the period 1963-86. This long period is divided into four sub-periods. The tables follow the US Patent Classification, which distinguishes 33 sectors altogether.

The second table indicates by sector the Finnish share in the total of all patents granted in the US to non-US patentees. This is important additional information because the number of all (non-US) patents - that is, the propensity to patent - varies significantly across sectors. The table also gives the Finnish share as a percentage of all patents, in all sectors, granted to foreigners in the US.

The third table shows an indicator derived from the material in the previous tables, which is then used as an analytical tool. Following earlier scholars, this indicator is called an index of 'revealed technological advantage', or RTA. It is calculated as Finland's share of US patenting in one sector divided by the Finnish share in all patenting. (Both figures are shown in table A2.) It is a proxy measure of Finland's technological performance relative to foreign competition in one sector compared to overall Finnish technological performance against similar competition, all in the light of patents granted in the US.

The data presented in the three appendix tables are further analysed in two ways:

- overall Finnish patenting activity, extended to a comparison with other Nordic countries (Sweden, Denmark and Norway); and

- the sectoral strengths and weaknesses of Finland in the light of US patents.

Finnish patents in the US

The number of patents granted in the US to Finnish applicants has been rising quite considerably from one five-year period to the next since 1963 (chart 1). In the latest period, 1981-6, the number of patents granted was almost seven times that in 1963-8. This increase compares favourably with the same data for the other three Nordic countries, Sweden, Denmark and Norway, for which the number of patents granted in the US rose by a factor of less than two (table 1.)

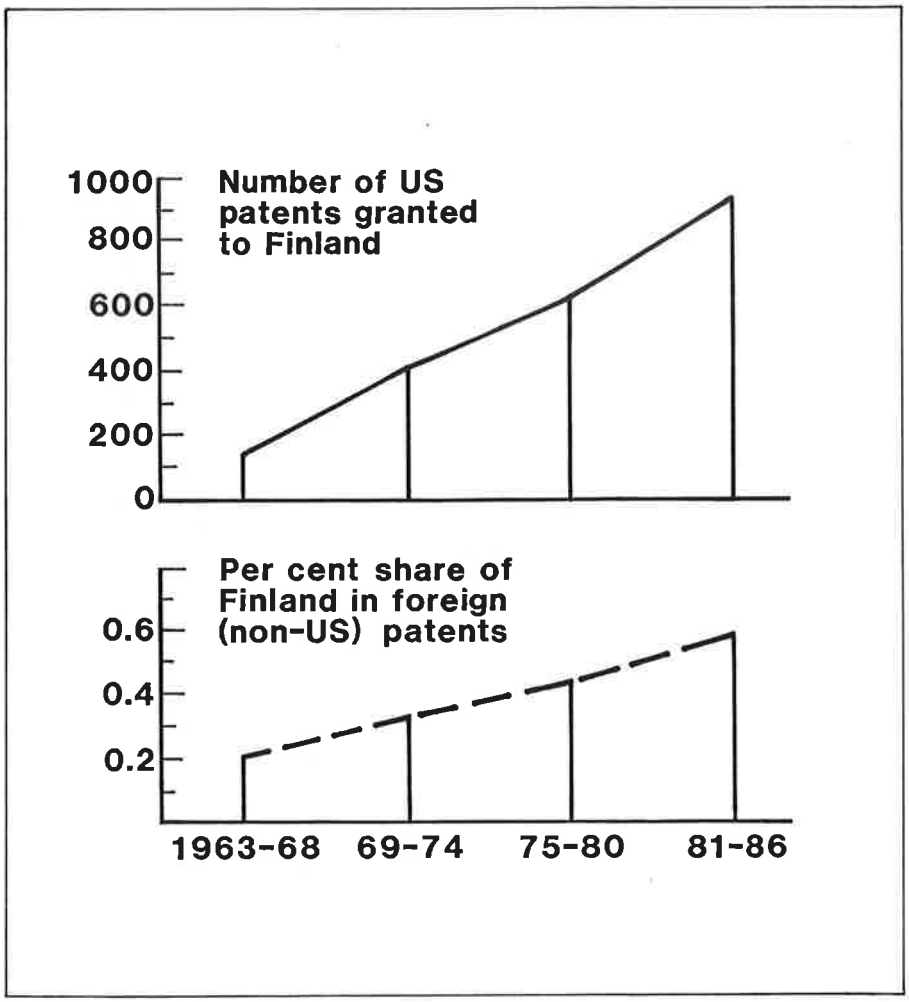
Growth, however, is one thing, and the absolute number of patents is another. The number of Swedish patents is several times as large as the number of Finnish patents (in the latest period five times larger); in the 1960s there were almost four times as many Danish, and twice as many Norwegian, patents as Finnish, but in the 1980s Finns were granted more patents than Danes and/or Norwegians.

Table 1. US patents granted to Finland, Sweden, Denmark and Norway 1963-86

		1963-8	1969-74	1975-80	1981-6
1. Number of patents granted					
	Finland	141	413	635	955
	Sweden	2986	4583	4994	4502
	Denmark	525	951	904	895
	Norway	285	476	560	481
1a 1963-8=1.0					
	Finland	1	2.9	4.5	6.8
	Sweden	1	1.5	1.7	1.5
	Denmark	1	1.8	1.7	1.7
	Norway	1	1.7	2.0	1.7
2. Number of patents per million of (1985) population					
	Finland	29	84	130	195
	Sweden	358	549	598	539
	Denmark	103	186	177	175
	Norway	69	115	135	116
2a Finland=1.0					
	Sweden	12.3	6.5	4.6	2.8
	Denmark	3.6	2.2	1.4	0.9
	Norway	2.4	1.4	1.0	0.6
3. Per cent share in foreign (non-US) patenting					
	Finland	0.20	0.32	0.44	0.57
	Sweden	4.23	3.55	3.46	2.69
	Denmark	0.74	0.74	0.63	0.53
	Norway	0.40	0.37	0.39	0.29
3a 1963-8=1.0					
	Finland	1	1.6	2.2	2.9
	Sweden	1	0.8	0.8	0.6
	Denmark	1	1.0	0.9	0.7
	Norway	1	0.9	1.0	0.7
3b Finland=1.0					
	Sweden	21.1	11.1	7.9	4.7
	Denmark	3.7	2.3	1.4	0.9
	Norway	2.0	1.2	0.9	0.5

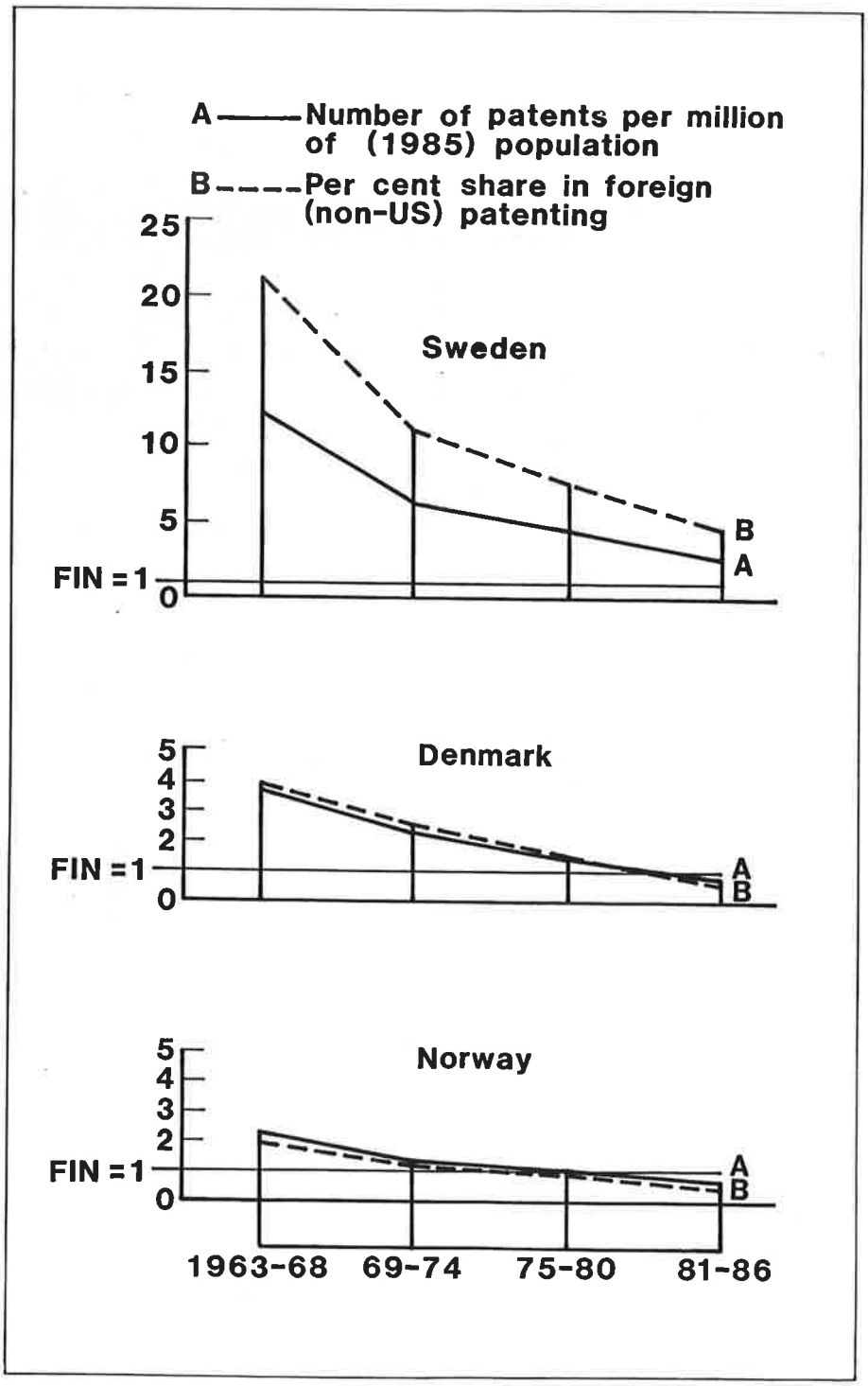
Source: tables A1 to A3 for Finland; SPRU for Sweden, Denmark and Norway.

Chart 1. Finnish patenting in the US, 1963-86



Source: Table 1.

Chart 2. Indicators of Nordic patenting activity, 1963-86 (Index numbers, Finland = 1.0



Source: Table 1.

If allowance is made for the size of the countries' population, a similar picture emerges: in the 1960s there were twelve times as many Swedish patents, almost four times as many Danish and twice as many Norwegian patents as Finnish ones (table 1, block 2); later figures also reflect the more vigorous Finnish patenting activity: by the 1980s the Swedish 'advance' was reduced to under three and the Danish and Norwegian patents had been overtaken by the Finnish figures.

The third part of the table indicates the percentage share of each of the three countries in all patents granted in the US to foreigners. The Finnish share almost trebled, from 0.20 per cent in the 1960s to 0.57 per cent in the 1980s. In the same period the Swedish, the Danish and the Norwegian shares declined. Even so, the Swedish share is still almost five times as large as the Finnish one in the most recent period, but it should be remembered that in the 1960s it was more than twenty times the Finnish level (chart 2). The Danish share, which was four times the Finnish one in the 1960s, is now marginally smaller, whilst the Norwegian share, twice the Finnish one in the 1960s, is now only half the latter (table 1, block 3).

Patents always represent something new, the result of research, development, invention and innovation. The improvement demonstrated by this analysis clearly reflects the strengthening of Finnish industry, the increasing success of its innovative activity and its ascending technological level.

Sectoral pattern

Within this overall performance, certain Finnish industries or sectors have been more successful than others. By means of the indicator of RTA, as defined above, it is possible to distinguish those sectors that have performed better (or worse) than the Finnish average: an RTA index of more than '1' reveals technological advantage of the particular sector over the Finnish average.

In table 2 an analysis of the basic RTA data shown in appendix table A3 is presented. It includes all sectors except those whose number of patents granted is less than five in 1981-6 since the very small number makes their inclusion irrelevant; this reduces the number of sectors from the original total of 33 to 23.

The table classifies the sectors in two ways: horizontally, into sectors with high, medium and low RTAs (high: RTA 1.1 and over; medium: RTA 0.9 to 1.1; and low: less than 0.9), based on their values in the most recent period, 1981-6. Vertically, the classification follows the change in the RTA index from 1969-74 to 1981-6 (the first period, 1963-8, was omitted in view of the very sharp increase in patenting activity from the first to the second five-year period, trebling the number of Finnish patents); here we also distinguish three groups: increasing RTA (a gain in RTA of 0.2 or more), stable, and decreasing (a loss of 0.2 or more). This manner of classification yields altogether nine groups. Among them, the 'best' sectors, with the highest revealed technological advantage, are in the top right-hand box marked 1A, and the 'weakest' sectors those in the

bottom left-hand box marked 3C. (It should be remembered, of course, that all this is based on the US patent statistics and, like all statistics, they have their limitations.)

Table 2. Relative technological advantage (RTA): the Finnish sectoral pattern[a]

1. HIGH (RTA > 1.1)	2. MEDIUM (0.9 < RTA < 1.1)	3. LOW (RTA < 0.9)
A. INCREASING		
1A 01 Inorganic chemicals 09 Non-metallic minerals 12 Chemical, food etc. apparatus [1] 13 Non-electric general machinery 15 Non-electric specialised machinery 21 'Other' transport equiment (b) 23 Mining machinery	2A 08 Plastics and rubber	3A 02 Organic chemicals 07 Drugs
B. STABLE		
1B 11 Metallurgical/mineral processes 16 Metalworking equipment	2B 30 Instruments and controls	3B 14 General industrial electrical apparatus 24 Telecommunications 26 Electrical devices
C. DECREASING		
1C 17 Assembling, material-handling apparatus 31 Miscell. metal products 33 Other n.e.c.	2C nil ∅	3C 04 Chemical processes 10 Food and tobacco 20 Road vehicles and engines 32 Textile, clothing, leather and wood products

Source: Table A3.

(a) The sectoral figures refer to the classification in the appendix tables.

(b) Other than road vehicles and aircraft.

1) Includes pulp and paper making machinery

According to this analysis, the 'best sectors of Finnish industry - with the highest and increasing RTA index - are

	RTA in 1981-6
12 apparatus for chemicals, food, glass, etc. [1]	3.69
23 mining machinery	2.15
01 inorganic chemicals	2.02
21 transport equipment other than road vehicles and aircraft	1.63
16 non-electric specialised machinery	1.46
09 non-metallic minerals	1.26
13 non-electric general industrial equipment	1.12

Other sectors, still with above-average but stable RTA, are

11 metallurgical/mineral processes	1.75
16 metalworking equipment	1.58

whilst the following indicate still relatively high but decreasing RTAs:

17 assembling and material-handling apparatus	1.89
33 'other' n.e.c.	1.27
31 miscellaneous metal products	1.14

In contrast, the 'weakest' sectors, according to this analysis, are those listed in box 3C of table 2, with a low and decreasing RTA index:

04 chemical processes	0.76
32 textile, clothing, leather and wood products	0.74
10 food and tobacco processes and products	0.68
20 road vehicles and engines	0.28

---

1) This sector includes pulp and paper making machinery, which almost totally explains the high figure. Traditionally in this field the Finnish companies have shown a high innovative activity which is compatible with the fact that Finland is the most important supplier of paper making machines on the world market.

It seems justified to add to this latter list those sectors with less than five patents - or none at all - in 1981-6 and which, for this reason, were not included in our analytical table 2:

	Number of patents, 1981-6
03 agricultural chemicals	2
05 hydrocarbons, mineral oils, fuels	0
06 bleaching, dyeing, disinfecting	2
18 nuclear reactors and systems	0
19 power plants	1
22 aircraft	3
25 semiconductors	1
27 calculators, computers, office equipment	4
28 image and sound equipment	3
29 photography, photocopy	1

It is of course quite possible that any one (or indeed several) of the patents granted to this latter group - say, for instance, the sole patent concerning semiconductors - may prove to be the greatest success of all. It is also in principle possible that certain innovations resulting from the research and development in these or other sectors have not been submitted in the US for patent application for some reason or other. Without very thorough and searching investigation, which would obviously far exceed the scope of this paper, these points - and perhaps other questions that may arise - must be left open.

This kind of analysis nevertheless leads to some tentative conclusions which have to be treated with great caution, bearing in mind the above limitations.

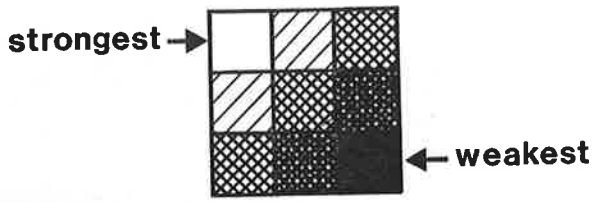
In the light of US patent statistics, the relative strength of the Finnish industry seems to be in the mechanical engineering area, whilst the electrical/electronics sectors are relatively weak and so are the 'high-tech' sectors. In chemicals, the picture is mixed: a good performance in chemical apparatus and inorganic chemicals, in contrast to weakness in organic chemicals and drugs. Also, investment goods and intermediates seem to have performed better than consumer goods.

Polarisation

Further graphically analysing the sectoral data in table 2, a certain polarisation becomes noticeable. This is shown in Figure 1, where the top small box illustrates the message of the classification of industrial sectors into the nine 'boxes' of table 2, from the strongest and lightest in the top left-hand corner, to the weakest and darkest in the bottom right-hand corner.

Following this 'guide' the Finnish data are shown first. A relatively large number of sectors - one third of the total of 23 - is in the 'strongest' position, and another relatively large number in the 'weakest' box, particularly if those sectors are also counted that have not been included in table 2 because of the very small number or total lack of patents. In the 'medium' boxes either horizontally or vertically (i.e. with average and stable RTA) the numbers are small. 'Polarisation' appears at the two extreme ends of the spectrum.

Figure 1. Relative technological advantage (RTA): comparison of Finnish and UK sectoral patterns



FINLAND

			Σ
1A 7	2A 1	3A 2	10
1B 2	2B 1	3B 3	6
1C 3	2C –	3C 4+	7(17)
Σ 12	2	9 (19)	23 (33)

U.K.

			Σ
1A 4	2A 1	3A 1	6
1B 4	2B 8	3B 5	17
1C 1	2C 2	3C 6	9
Σ 9	11	12	32*

Sources: for Finland, table 2; for UK, Patel-Pavitt (1987). For explanation, see text.

* Sector 33 ('Other' n.e.c.) not classified in the UK case.

Perhaps this form of polarisation is a characteristic of smaller countries and thus not unique to Finland. A comparison with the similar sectoral pattern of a large country, in this case the UK, indicates an almost opposite situation: relatively high figures in the 'medium' rows and less outstanding ones at the extremes. In a modest way it reflects the path Finnish industries have taken: specialising in selected areas, in 'niches' where the country's special advantages - natural endowments or particular specialist skills - justify it. However, whilst this may explain the fair number of sectors with a better than average 'revealed technological advantage' it does not provide an equally tentative but acceptable view to account for the high number of sectors in the 'weakest' position (or indeed for those in the middle position). Clearly, a small country cannot be outstanding - in terms of innovation, patenting and so forth - in every sector; its competitive strengths are likely to be limited. Nevertheless, there seems to be plenty of scope for further progress and improvement in the large number of relatively weak sectors.

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(1) The most notable are: F. Scherer, 'Firm size, market structure and the output of patented inventions, *American Economic Review*, vol. 55, 1965; J. Schmookler, *Invention and Economic Growth*, Harvard University Press, 1966; L. Soete and S. Wyatt, 'The use of foreign patenting as an internationally comparable science and technology output indicator, *Scientometrics*, vol. 5, 1983; P. Patel and K. Pavitt, 'The elements of British technological competitiveness, *National Institute Economic Review*, November 1987.

APPENDIX

Table A 1

Number of US patents granted to Finland

	Sector	63-68	69-74	75-80	81-86
01	Inorganic Chemicals	1	7	14	17
02	Organic Chemicals	3	8	25	28
03	Agricultural Chemicals	0	1	2	2
04	Chemical Processes	2	25	38	42
05	Hydrocarbons, mineral oils, fuels etc.	0	0	1	0
06	Bleaching Dyeing and Disinfecting	1	0	0	2
07	Drugs and Bio-affcting agents	0	1	6	25
08	Plastic and rubber products	6	2	9	12
09	Non-metallic minerals, glass & other materials	1	8	15	43
10	Food and Tobacco (processes and products)	0	4	5	5
11	Metallurgical and other mineral processes	4	19	35	36
12	Apparatus for chemicals, food, glass etc.	20	59	146	185
13	General Industrial Equipment (non-electrical)	10	15	36	63
14	General Industrial Apparatus (electrical)	8	9	18	30
15	Non-electrical specialized machinery	10	39	52	83
16	Metallurgical and metal working equipment	6	25	26	48
17	Assembling and material handling apparatus	21	33	44	47
18	Nuclear Reactors and systems	0	0	0	0
19	Power Plants	0	1	1	1
20	Road vehicles and engines	3	8	10	9
21	Other transport equipment (exc. aircraft)	5	9	15	27
22	Aircraft	1	2	0	3
23	Mining and wells machinery and processes	3	5	5	18
24	Telecommunications	0	6	5	11
25	Semiconductors	0	0	0	1
26	Electrical devices and systems	2	13	13	32
27	Calculators, computers, other office equipment	0	2	6	4
28	Image and sound equipment	1	1	1	3
29	Photography and photocopy	0	1	0	1
30	Instruments and controls	6	34	50	101
31	Miscellaneous metal products	19	39	32	48
32	Textile, clothing, leather, wood products	4	6	7	5
33	Other n.e.c.	4	31	18	23
	Total	141	413	635	955

Source: Science Policy Research Unit at the University of Sussex, Brighton - Database; data supplied by the US Department of Commerce, Patent and Trademark Office, Washington, US.

Table A 2.

Percentage share of foreign (i.e. non-US) patenting in the US for Finland

	Sector	63-68	69-74	75-80	81-86
01	Inorganic Chemicals	0.11	0.57	0.89	1.15
02	Organic Chemicals	0.03	0.05	0.15	0.21
03	Agricultural Chemicals	0.00	0.38	0.31	0.25
04	Chemical Processes	0.07	0.37	0.48	0.43
05	Hydrocarbons, mineral oils, fuels etc.	0.00	0.00	0.13	0.00
06	Bleaching Dyeing and Disinfecting	0.23	0.00	0.00	0.23
07	Drugs and Bio-affcting agents	0.00	0.04	0.10	0.33
08	Plastic and rubber products	0.65	0.13	0.48	0.58
09	Non-metallic minerals, glass etc.	0.06	0.23	0.34	0.72
10	Food and Tobacco (processes and products)	0.00	0.43	0.40	0.39
11	Metallurgical and other mineral processes	0.25	0.61	1.03	1.00
12	Apparatus for chemicals, food, glass etc.	0.45	0.76	1.68	2.10
13	General Industrial Equipment (non-electrical)	0.19	0.18	0.46	0.64
14	General Industrial Apparatus (electrical)	0.32	0.17	0.35	0.41
15	Non-electrical specialized machinery	0.16	0.41	0.55	0.83
16	Metallurgical and metal working equipment	0.20	0.46	0.51	0.90
17	Assembling and material handling apparatus	0.73	0.77	1.02	1.07
18	Nuclear Reactors and systems	0.00	0.00	0.00	0.00
19	Power Plants	0.00	0.09	0.07	0.08
20	Road vehicles and engines	0.27	0.42	0.28	0.16
21	Other transport equipment (exc. aircraft)	0.34	0.34	0.55	0.93
22	Aircraft	0.20	0.41	0.00	0.91
23	Mining and wells machinery and processes	0.49	0.45	0.34	1.23
24	Telecommunications	0.00	0.15	0.11	0.20
25	Semiconductors	0.00	0.00	0.00	0.04
26	Electrical devices and systems	0.04	0.16	0.18	0.36
27	Calculators, computers, other office equip.	0.00	0.07	0.16	0.06
28	Image and sound equipment	0.16	0.06	0.04	0.08
29	Photography and photocopy	0.00	0.03	0.00	0.02
30	Instruments and controls	0.12	0.31	0.40	0.59
31	Miscellaneous metal products	0.51	0.67	0.50	0.65
32	Textile, clothing, leather, wood product	0.70	0.65	0.72	0.42
33	Other n.e.c.	0.26	1.19	0.64	0.72
	Total	0.20	0.32	0.44	0.57

Source: Science Policy Research Unit at the University of Sussex, Brighton - Database; data supplied by the US Department of Commerce, Patent and Trademark Office, Washington, US.

Table A 3.

Revealed Technology Advantage Index for Finland

	Sector	63-68	69-74	75-80	81-86
01	Inorganic Chemicals	0.54	1.77	2.00	2.02
02	Organic Chemicals	0.17	0.16	0.33	0.36
03	Agricultural Chemicals	0.00	1.18	0.69	0.43
04	Chemical Processes	0.34	1.15	1.07	0.76
05	Hydrocarbons, mineral oils, fuels etc.	0.00	0.00	0.30	0.00
06	Bleaching Dyeing and Disinfecting	1.15	0.00	0.00	0.41
07	Drugs and Bio-affcting agents	0.00	0.13	0.23	0.59
08	Plastic and rubber products	3.29	0.41	1.09	1.03
09	Non-metallic minerals, glass etc.	0.29	0.71	0.77	1.26
10	Food and Tobacco (processes and products)	0.00	1.34	0.89	0.68
11	Metallurgical and other mineral processes	1.28	1.90	2.32	1.75
12	Apparatus for chemicals, food, glass etc.	2.27	2.35	3.78	3.69
13	General Industrial Equipment (non-electrical)	0.94	0.55	1.03	1.12
14	General Industrial Apparatus (electrical)	1.62	0.53	0.78	0.72
15	Non-electrical specialized machinery	0.82	1.26	1.24	1.46
16	Metallurgical and metal working equipment	1.01	1.43	1.16	1.58
17	Assembling and material handling apparatus	3.71	2.38	2.29	1.89
18	Nuclear Reactors and systems	0.00	0.00	0.00	0.00
19	Power Plants	0.00	0.28	0.17	0.14
20	Road vehicles and engines	1.39	1.31	0.63	0.28
21	Other transport equipment (exc. aircraft)	1.74	1.06	1.23	1.63
22	Aircraft	1.04	1.27	0.00	1.60
23	Mining and wells machinery and processes	2.46	1.39	0.76	2.15
24	Telecommunications	0.00	0.47	0.26	0.36
25	Semiconductors	0.00	0.00	0.00	0.08
26	Electrical devices and systems	0.23	0.51	0.41	0.63
27	Calculators, computers, other office equip.	0.00	0.21	0.36	0.10
28	Image and sound equipment	0.80	0.18	0.10	0.14
29	Photography and photocopy	0.00	0.08	0.00	0.03
30	Instruments and controls	0.60	0.96	0.90	1.03
31	Miscellaneous metal products	2.59	2.06	1.12	1.14
32	Textile, clothing, leather, wood products	3.54	2.00	1.63	0.74
33	Other n.e.c.	1.32	3.70	1.44	1.27

Source: Tables A1 and A2. For definition of Revealed Technological Advantage (RTA) - see text.

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