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RP 10450

INTERNATIONAL VISIBILITY OF NORDIC SCIENTIFIC RESEARCH AND PATTERNS OF INTERNATIONAL COLLABORATION OF NORDIC SCIENTISTS

Terttu Luukkonen and Jean-François Miquel

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1. Introduction

Literature-based data provide quantitative indicators of outcomes of scientific research. For decades, publications have been regarded as a useful indicator for assessing the productivity of scientific research, to be complemented with other information and peer judgments. The development of bibliographic information data bases has permitted the generation of indicators to measure further aspects of scientific research such as the impact of a given piece of work on the international research front and scientists' cooperation patterns.

This paper presents some data which are obtainable for assessing productivity and international impact of Nordic scientific research and scientists' international collaboration; international collaboration has been measured by the volume of cross-country co-authorship. All data originate from the Science Citation Index (SCI)[1].

2. International publication productivity

The publication data are based on the 1973 composition of the Science Citation Index source journals, altogether 2300 publications. The majority of these are journals; monographs and report series have been excluded. The publications and citations have been fractionated among the countries of co-authors (on the basis of the addresses on articles). The data base searches relatively few national journals from the Nordic countries; this is especially true for Finland and Norway.

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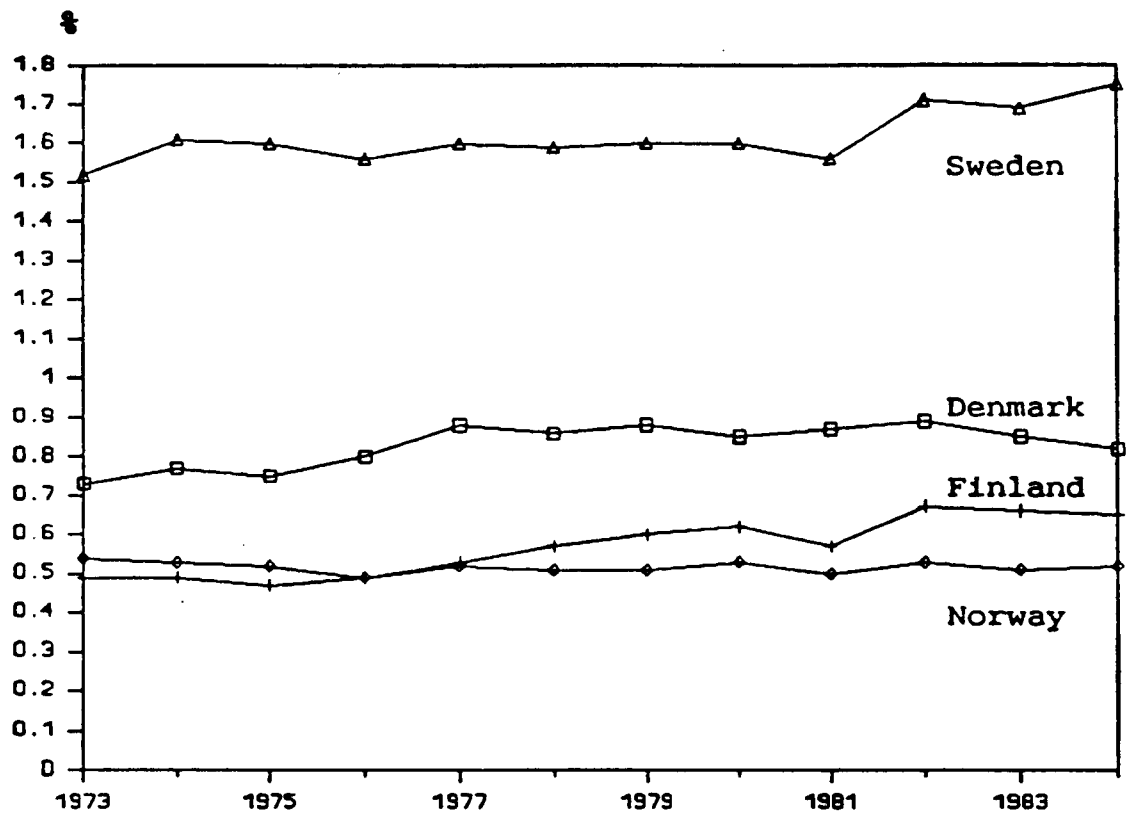
[1] The Science Citation Index is run by the Institute for Scientific Information (ISI), Philadelphia. This paper uses SCI data as compiled by Computer Horizons Inc. (CHI). The publication and citation data were obtained by courtesy of John Irvine and Ben Martin, SPRU, the University of Sussex; the co-authorship data have been further processed by the Laboratoire d'Evaluation et de Prospective Internationales at the Centre National de la Recherche Scientific (CNRS/LEPI MEV-MAC data base).

Therefore, the number of papers in the SCI and CHI data bases by the Nordic countries reflects their international publication activity. Figure 1 gives the development of the volume of papers by Nordic[2] authors in the CHI data base as a percentage of world publications in fields of natural, medical and technological sciences (absolute figures are given in Appendix 1).

Figure 1. Share of Nordic papers of world publications, 1793-84 (Source: CHI data base)



The share of papers by Nordic authors increased slightly during the period studied, with the exception of Norwegian papers which had a level growth. Sweden was the largest producer of papers among the Nordic countries, which was expected considering the large research volume in Sweden. Danish scientific research produced relatively more international

[2] Iceland was excluded from the analysis due to a small number of papers in the data base. Country affiliation was determined by the address of the authors.

papers than Finnish or Norwegian research; international publications by Danish scientists were more numerous than those by Finnish or Norwegian scientists whereas the total number of research scientists and engineers (in full-time equivalents) and their number in the higher education sector was smaller in Denmark than in Finland or Norway in 1983, as seen in Table 1. In the 70s the volume of Danish research personnel was close to that of Finland and Norway.

Table 1. Research scientists and engineers (full-time equivalents) in 1983.

	Total research scientists and engineers	Research scientists and engineers in the higher education sector
Denmark	7676	2810
Finland	9421	3773
Norway	8283	2985
Sweden	17 044*	5800*

Source: OECD Science and Technology Indicators Report No. 3: R & D, production and Diffusion of Technology. Paris: OECD, 1989, p. 17 and 27.

*Excluding social sciences and humanities.

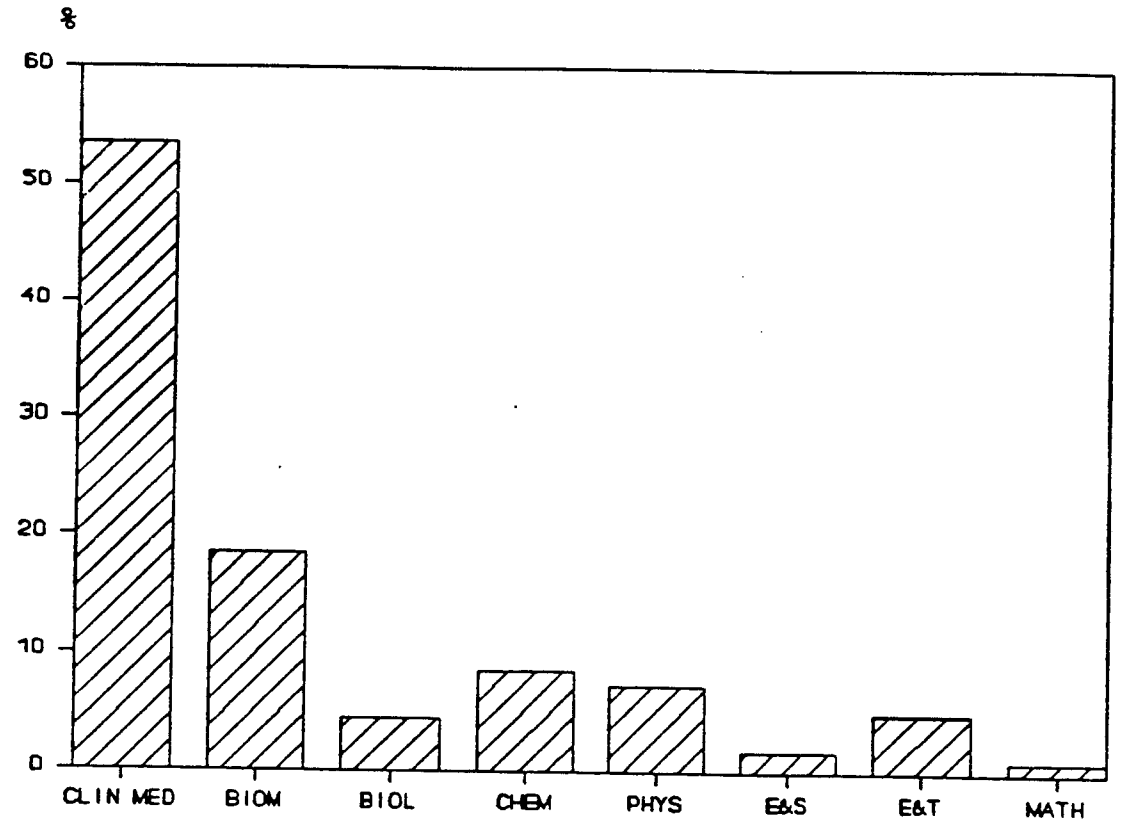
Figures 2 a-d give the distribution of Nordic papers by field of science. Papers are attributed to fields using a journal classification scheme developed by CHI. General scientific journals, e.g. Science and Nature, have been fractionated into several fields by approximate proportion of the field distribution of their articles.

The explanation of the abbreviations:

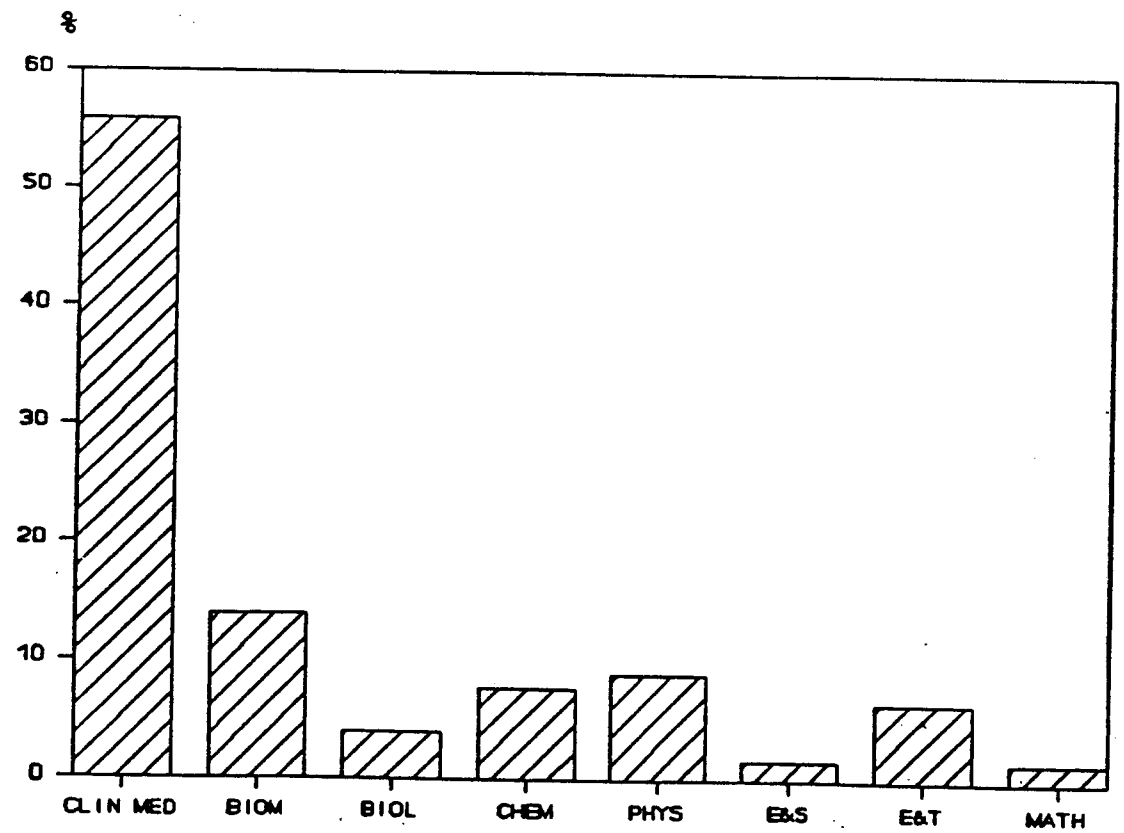
CLIN MED = clinical medicine
BIOM = biomedicine
BIOL = biology
CHEM = chemistry
PHYS = physics
E&S = earth and space
E&T = engineering and technology
MATH = mathematics

Figure 2. Nordic papers by field of science in the CHI data base

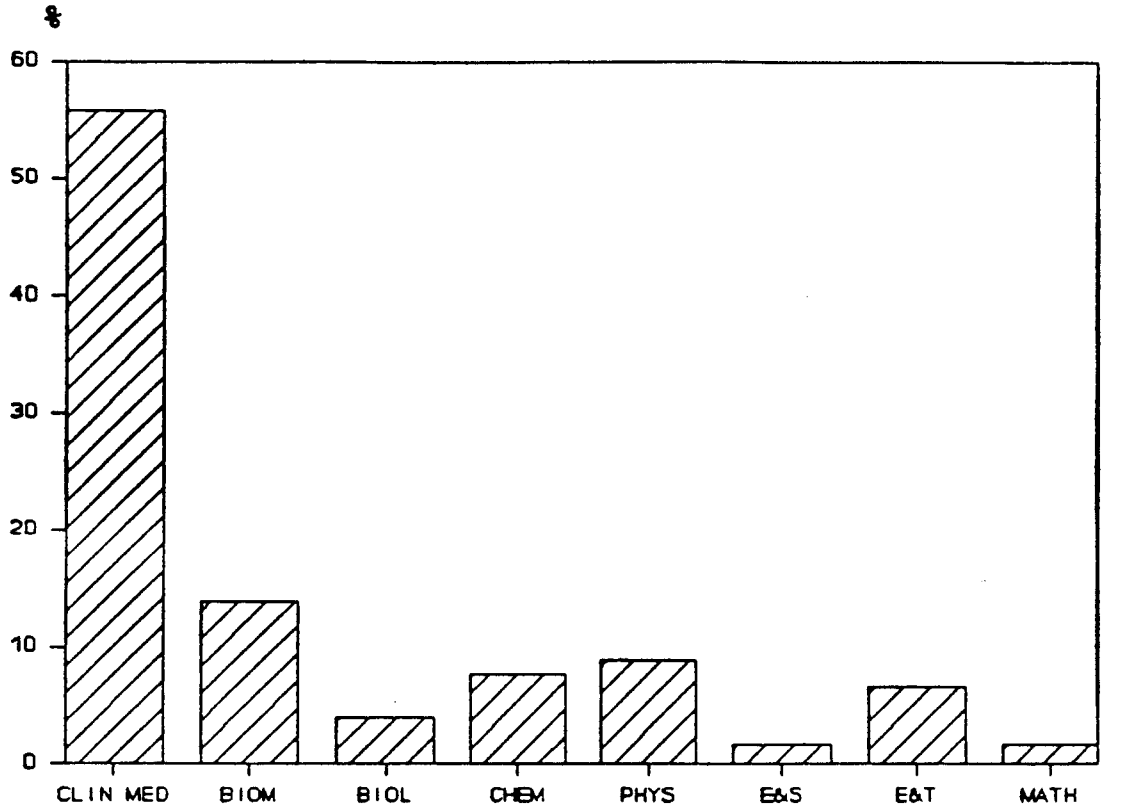
(a) Denmark



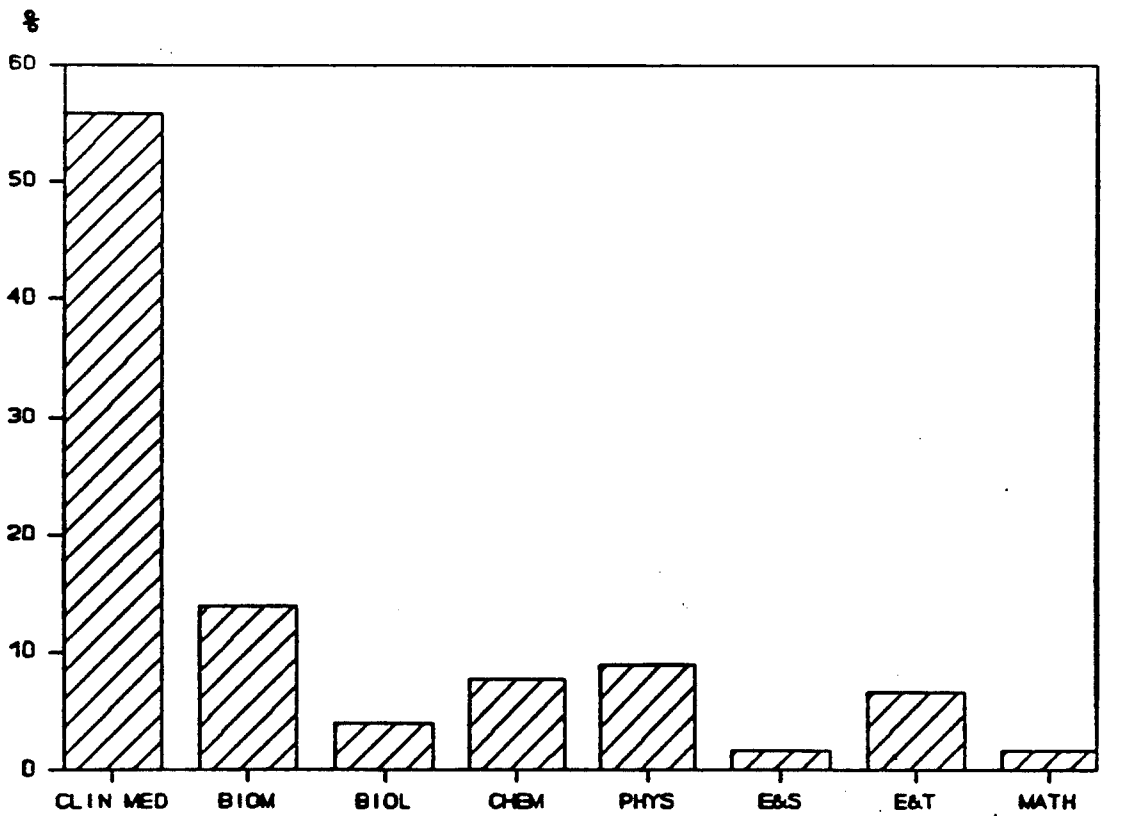
(b) Finland



(c) Norway



(d) Sweden



In all four countries medical papers, especially clinical papers comprised a major part of their total international publication activity. This reflects the fact that Nordic medical research is internationally oriented and produces a lot of articles. In medicine the data base covers a reasonably large proportion of the total publication activity of the field due to the publication habits of medical scientists. In other fields, the coverage varies a great deal. Without further information of the total publication output we are not entitled to draw any conclusions about the relative productivity of the fields. Such conclusions would also require information of the resources invested.

3. International impact

Citation counts are often used as indicators of qualitative aspects of research performance. Citation analysts use the word impact to describe what citations measure: the actual attention a given piece of work attracts. The motivations and reasons for citing and the information contents of citations are not uniform; in addition communication and publication factors affect the accumulation of citations and do not justify their interpretation as a perfect measure of quality. Citations reflect many factors besides quality: citation conventions of research fields, types of papers (theoretical vs. empirical or methodological), the size of the specialty, the size of the journal audience, previous reputation of authors and their institutions etc.

Since the citation indexing by the Institute for Scientific Information uses source journals which include few national publications from small and non-English speaking countries, citation counts measure international impact, and benefit Anglo-American publications.

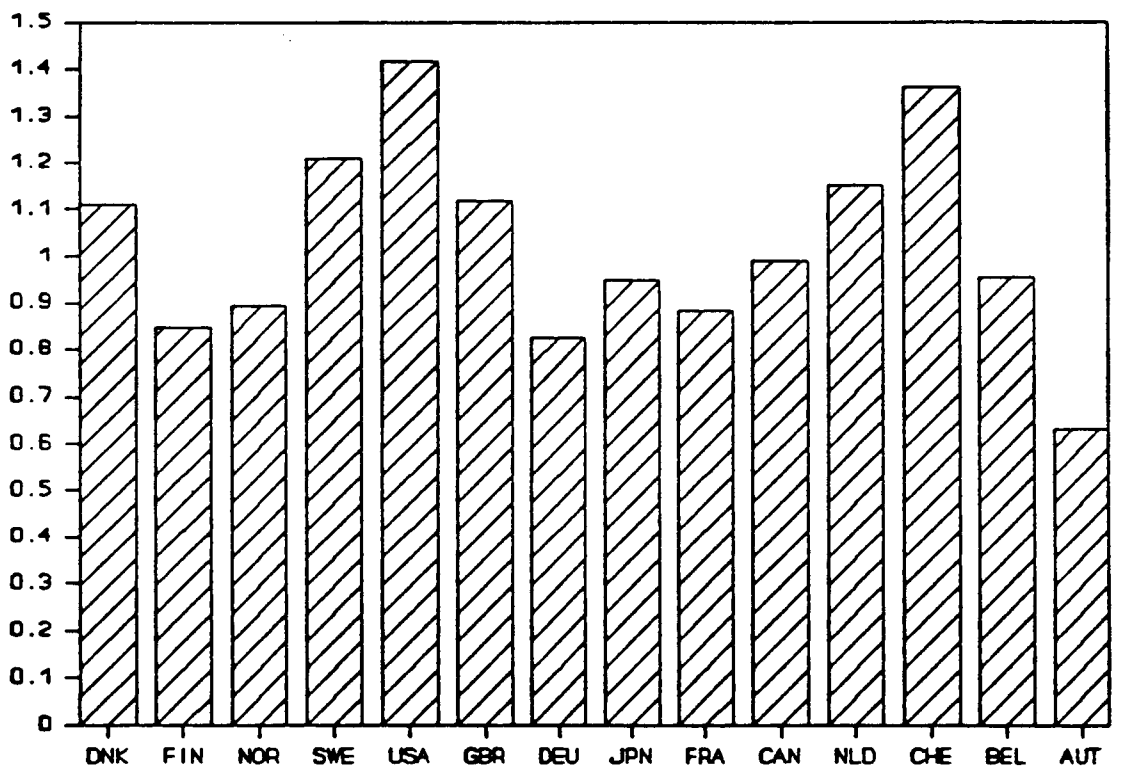
Figure 3 gives the relative citation rate of Nordic research in all fields of science in 1981-84 compared with the world mean and corresponding figures for select other countries. The Swedish papers had the highest relative citation rate among the

Nordic countries. All the Nordic countries fared relatively well in international comparison.

The country codes used in Figure 3 are as follows:

AUT = Austria
BEL = Belgium
CAN = Canada
CHE = Switzerland
DEU = West Germany
DNK = Denmark
FIN = Finland
FRA = France
GBR = Great Britain
JPN = Japan
NLD = The Netherlands
NOR = Norway
SWE = Sweden
USA = USA

Figure 3. Relative citation rates of Nordic papers and of those of select other countries, 1981-84 (Source: CHI data base)[3]



National averages are the combined result of the merits of individual work and the communication and publication patterns of scientists. Publication in less visible and little esteemed journals as well as in journals with limited audiences is apt to accumulate few citations. Therefore, we cannot draw any clear-cut conclusions about the reasons for the citation records observed.

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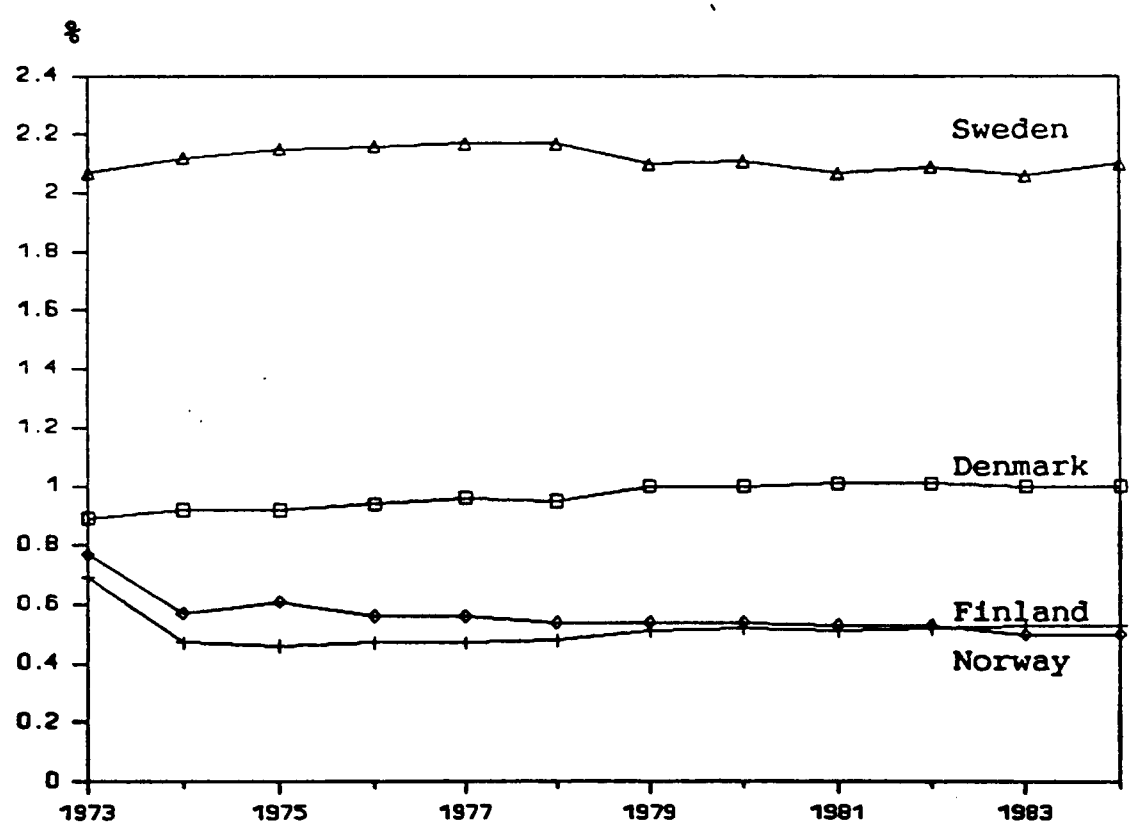
[3] These data are based on the 1981 composition of the SCI. They were obtained by courtesy of Gunnar Sivertsen, NAVF's utredningsinstitutt.

The share of citations by Nordic papers in the CHI data base has been relatively stable in 1973-84; Denmark increased its share somewhat (Figure 4). The decrease in the share of citations by Finnish and Norwegian authors at the beginning of the period observed is difficult to explain and may be due to technical matters (their small number and subsequent fluctuations in the time series).

Figure 4. Share of Nordic citations of world citations. Citations by year of citing (Source: CHI data base)



Figures 5 a-d consider citation rates by field. As in Figure 2, fields have been classified by journal. Citation counts have been related to the world mean in the respective fields. The figures give an index number, with number one representing the

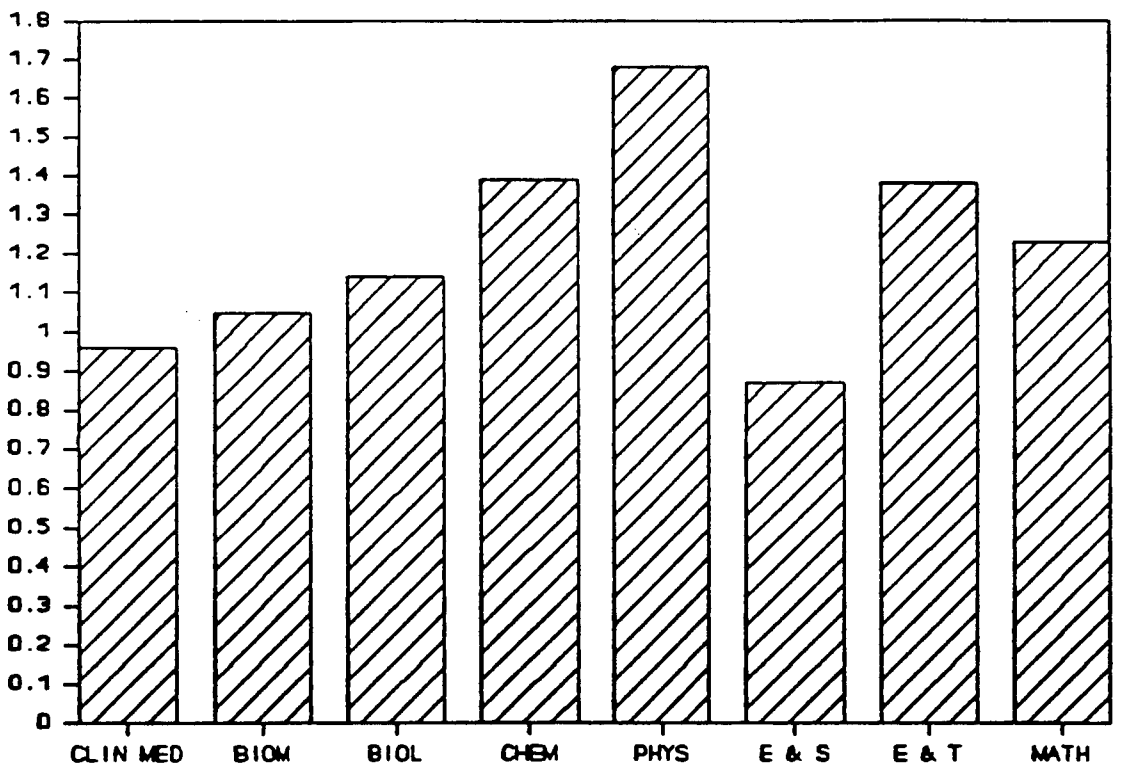
world mean.

The abbreviations used are as follows:

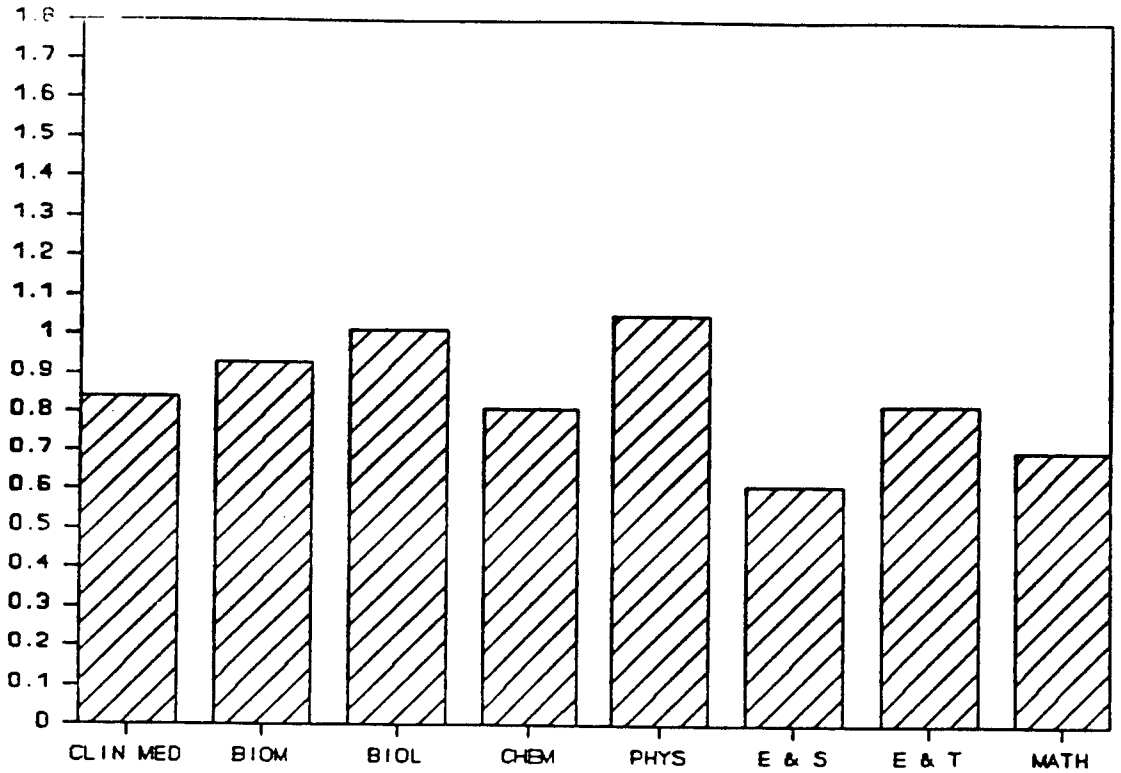
CLIN MED = clinical medicine
BIOM = biomedicine
BIOL = biology
CHEM = chemistry
PHYS = physics
E&S = earth and space
E&T = engineering and technology
MATH = mathematics

Figure 5. Relative citation rates of Nordic papers by field of science. Averages of 1973-84.

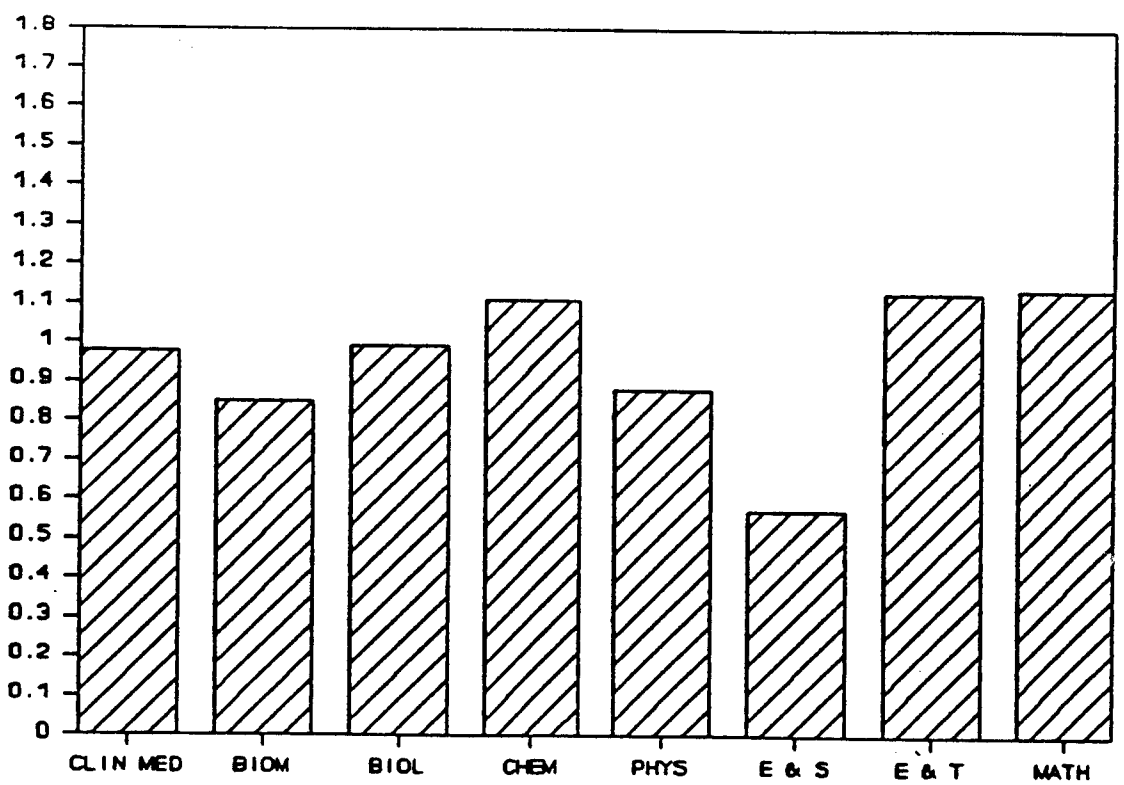
(a) Denmark



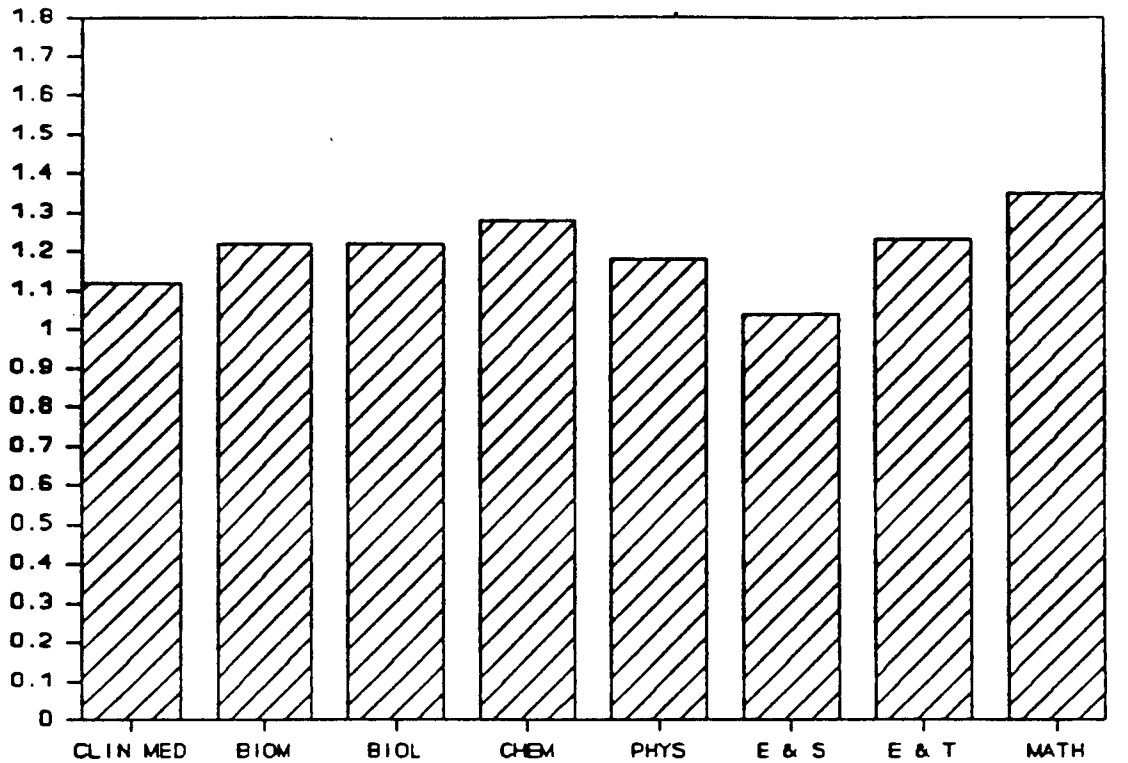
(b) Finland



(c) Norway



(d) Sweden

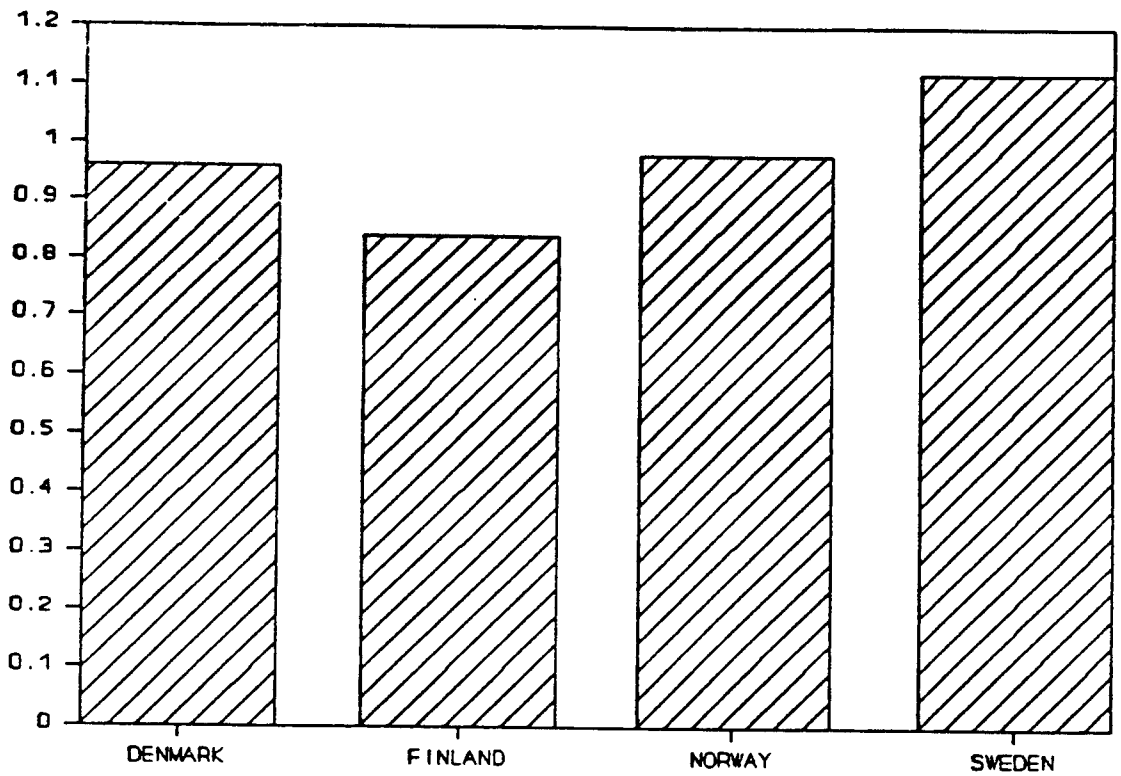


Swedish authors had a citation rate which was above the world mean in all fields of science, and the relative differences in the citation rates across fields were fairly small. The other Nordic countries had more variation in their citation rates across fields. Danish physics, chemistry, and engineering and technology had higher relative citation rates than the corresponding fields in the other Nordic countries, with Danish physics having the Nordic citation "peak". In Finland physics and in Norway and Sweden mathematics had the highest relative citation rates; in Norway also earth and space science and chemistry were among the most highly cited fields.

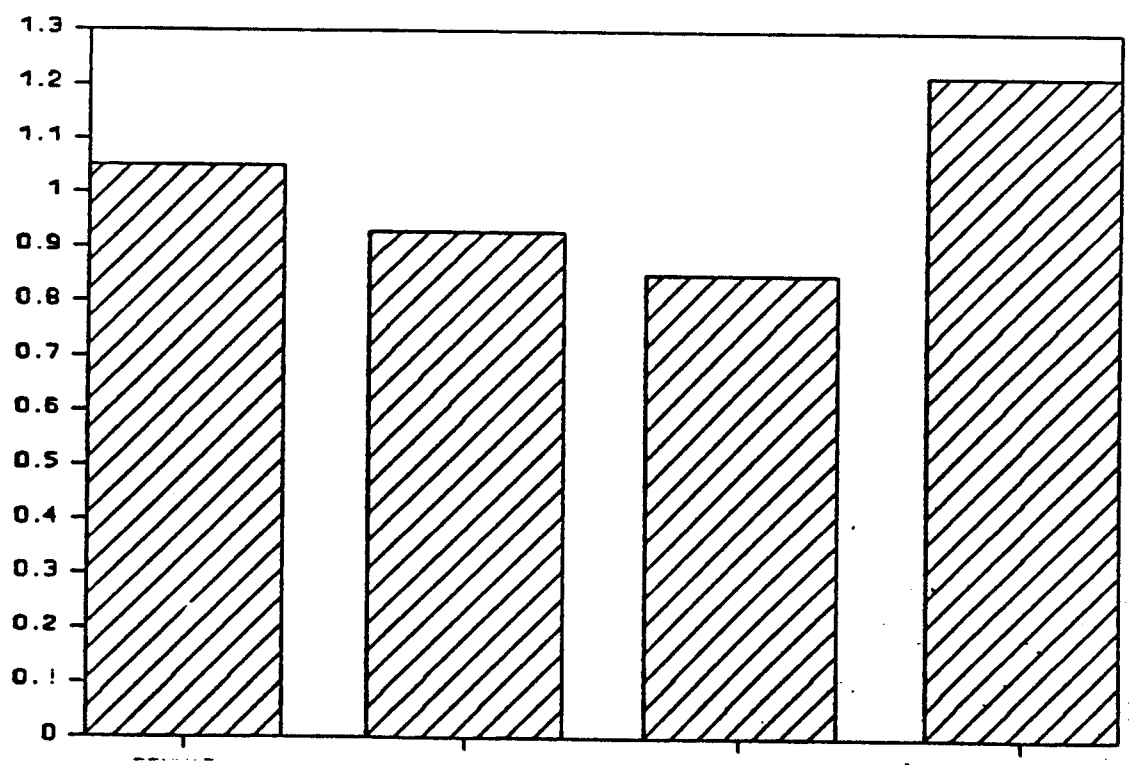
Figures 6 a-f compare the relative citation rates of Nordic papers across countries in select fields. Even though Swedish clinical medicine, biomedicine, and biology were not the most highly cited fields in the national context, they were more highly cited than the respective fields in the other Nordic countries.

Figure 6. Relative citation rates of Nordic papers in select fields by country. Averages of 1973-84.

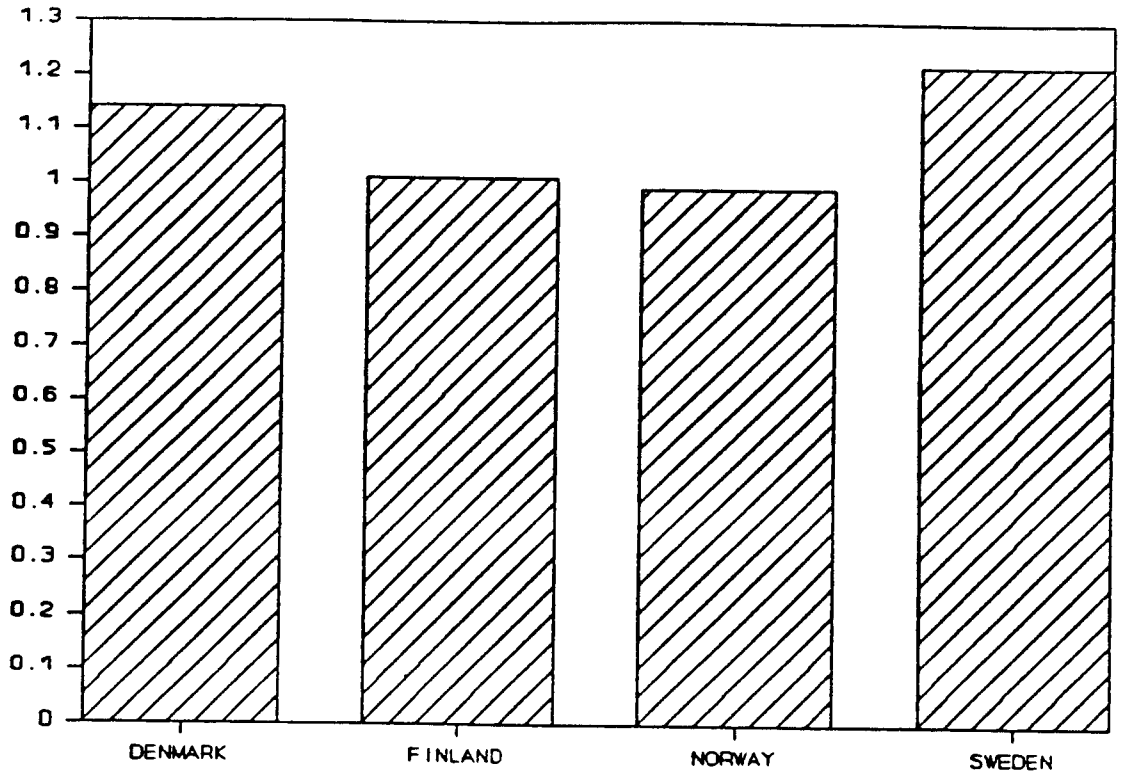
(a) Clinical medicine



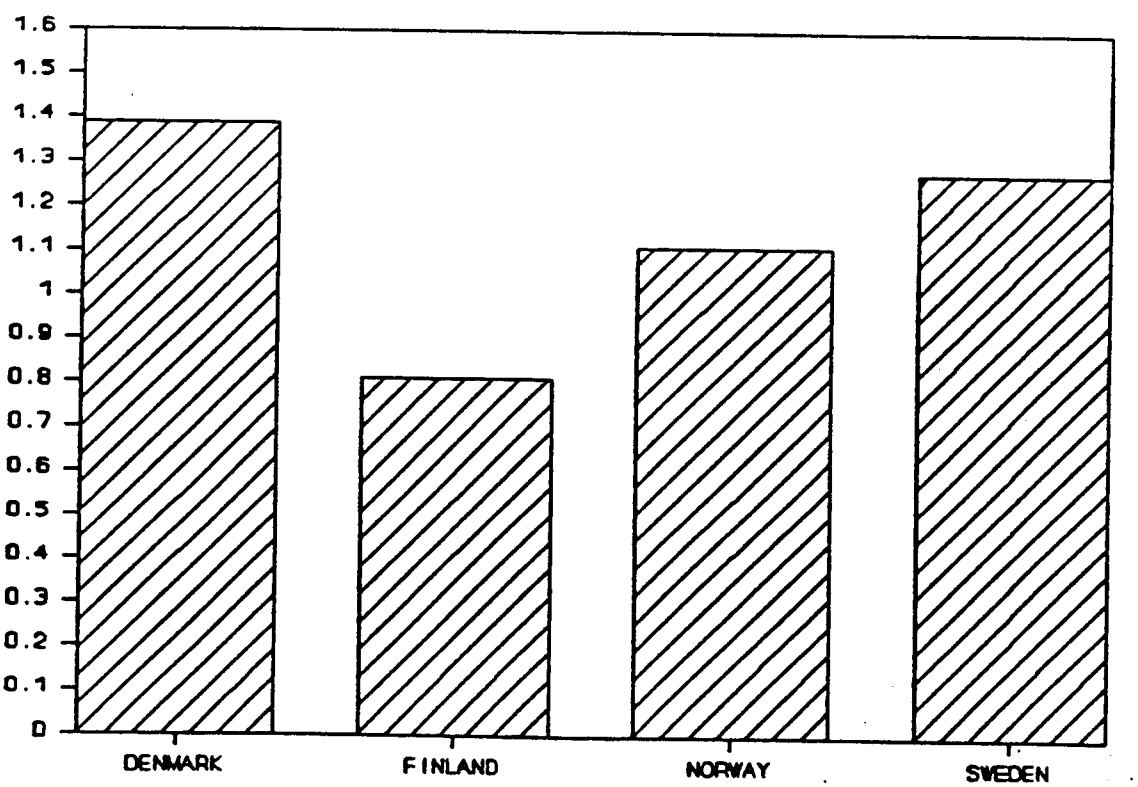
(b) Biomedicine



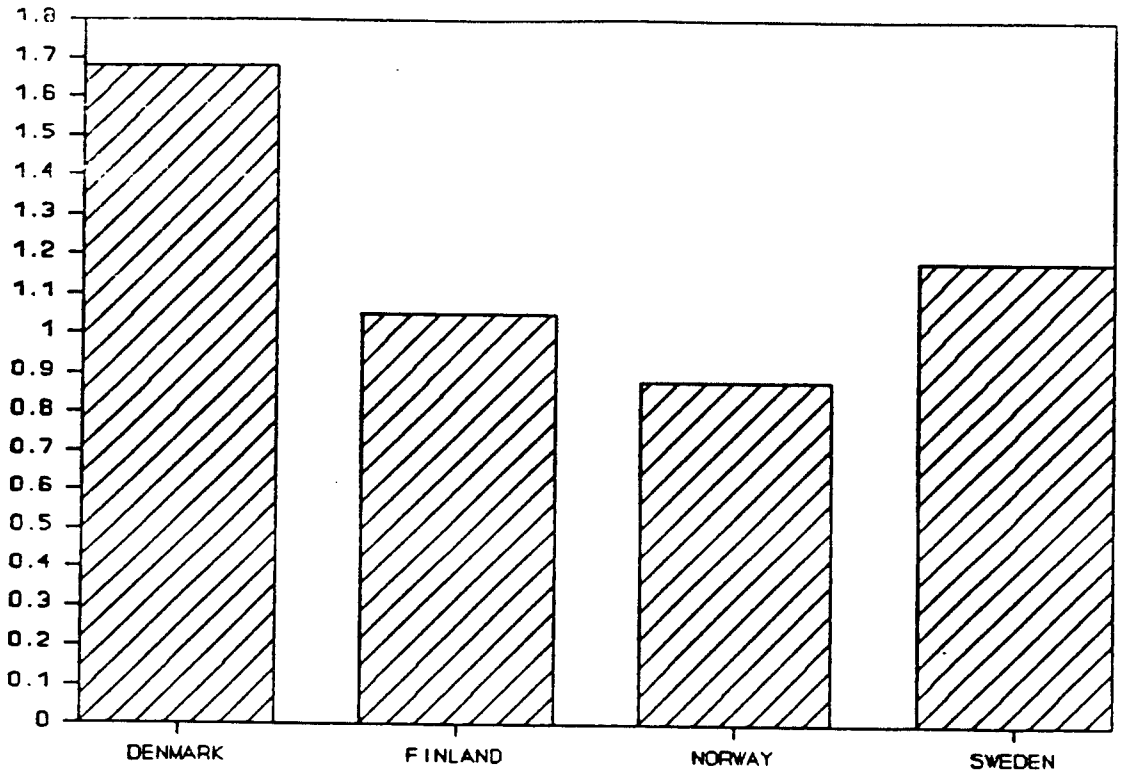
(c) Biology



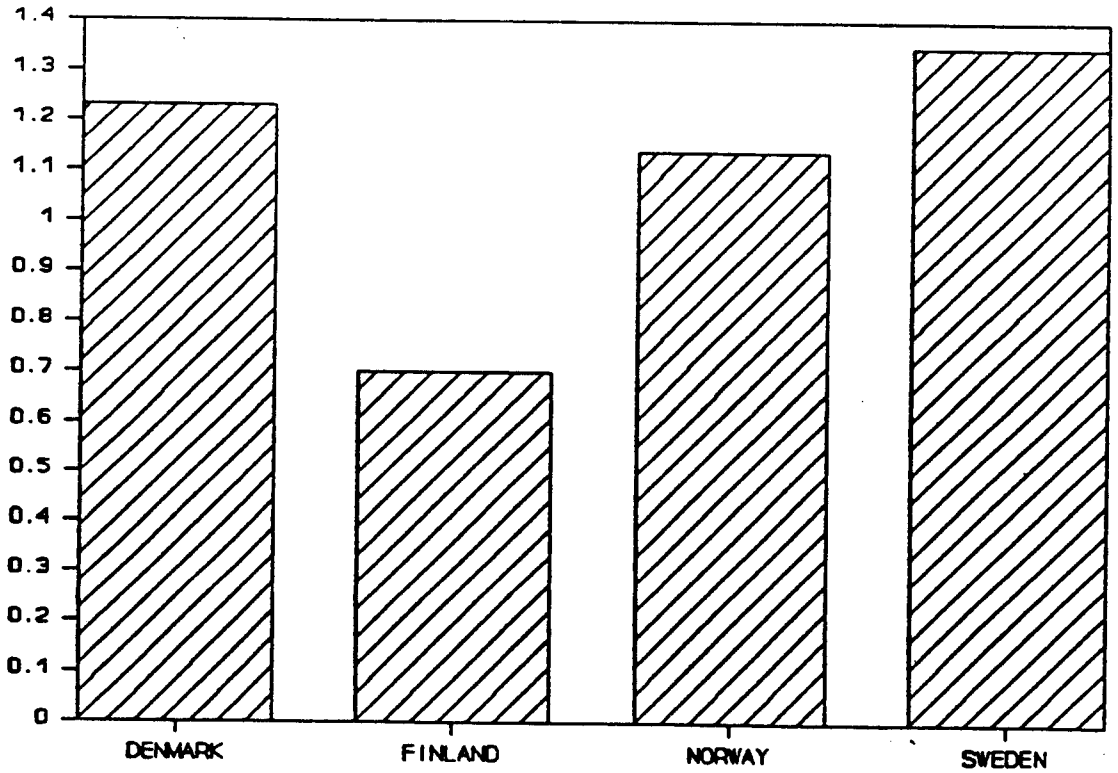
(d) Chemistry



(e) Physics



(f) Mathematics



We have to remember that the average citation rates of fields cover large variation across subfields, and low field averages do not preclude high citation rates by subfields. For example, Finnish clinical medicine had a relatively low average citation rate, whereas Finnish cancer research (which is included in clinical medicine in the CHI classification) had a very high relative citation rate, though not quite as high as that of Swedish cancer research (Table 2).

Table 2. Relative citation rate of cancer research in 1973-84. (Source: CHI data base)

	Relative citation rate in 1973-84 by year of citing
Denmark	0.76
Finland	1.35
Norway	0.92
Sweden	1.62
France	0.80
FRG	0.72
Great Britain	1.11
Italy	0.49
Netherlands	0.87
USA	1.16
World	1.00

Source: Terttu Luukkonen-Gronow & Pirjo Suutarinen: Bibliometric Analysis of Nordic Cancer Research: A report of Study Data. FPR-publication no. 8. Nordic Council of Ministers, Copenhagen 1988.

4. International cooperation

Scientists' international cooperation has been measured by the volume of their cross-country co-authorship. Co-authorship implies active cooperation and exchange of information which makes it an advanced form of collaboration.

The data on co-authored papers are drawn from the CNRS/LEPI MEV-MAC data base. It is based on the Computer Horizons Inc. data which comprise the SCI source journals for 1981 (approximately 3000 journals) and cover the years 1981-86. When counting the volume of cross-country co-authorship the addresses of all authors have been taken into account. The

address that the author has given has been decisive for determining the country affiliation. The "MEV-MAC" data base includes codes for 72 countries.

The proportion of internationally co-authored papers in relation to all papers produced by a given country does not indicate a clear linear variation with other factors such as the size of the country. Table 3 presents the percentage of internationally co-authored papers for select countries in 1981-86. Different patterns may be discerned. The USA had a relatively small percentage of co-authored papers, presumably due to the large size of its national scientific community. The Soviet Union had a very small percentage, which might be the result of both a large size and a closure of its national scientific community. The other East-European countries in Table 3 had percentages comparable or nearly comparable to those of West-European countries. Also Japan had a small percentage, presumably due to the same factors as the Soviet Union.

West-European countries had a range of 17.9 % (for Great Britain) to 40.2 % for Switzerland, the percentage typically being between 20-30 %. The high percentage for Switzerland most probably was the product of CERN and the international scientific community conducting research at CERN. The Nordic countries, with the exception of Iceland, had a percentage of co-authored papers corresponding to that of the other West-European countries.

Less developed countries had small absolute numbers of papers in the data base. The high average percentage of co-authored papers by these countries, though with a wide scatter, apparently was due to less developed scientific traditions and little international scientific production. Internationally co-authored papers might have been the product of visits to scientific institutions in other countries. Nevertheless, we have to remember that papers co-authored by scientists during their (longer) visits to other countries might bear the address of the institute to which the visit was paid, and be attributed to that country. For this reason, the US percentage apparently

underestimates the extent of international collaboration by US scientists.

Table 3. Share of internationally co-authored papers in select countries in 1981-86 (Source: CNRS/LEPI MEV-MAC data base).

Country	co-authored papers %	all papers N	Country	co-authored papers %	all papers N
USA	9.9	844 472	Denmark	31.0	21 951
			Finland	22.4	16 190
USSR	3.6	182 722	Norway	28.0	13 466
Poland	23.1	24 824	Sweden	26.4	43 048
GDR	17.2	22 817	Iceland	53.8	366
Hungary	26.0	13 462			
Czechosl	18.0	19 374			
Japan	7.3	169 404			
UK	17.9	203 588	Turkey	33.9	2 019
FRG	21.2	151 374	Thailand	51.7	1 464
France	22.2	121 693	Iraq	24.3	1 134
Italy	25.0	58 294	Philippines	54.9	841
The Nether-			Tunisia	70.7	580
lands	24.9	43 421	Morocco	61.9	551
Belgium	32.4	23 034	Tanzania	37.8	484
Switzer-			Cuba	60.0	472
land	40.2	35 116			
Austria	28.7	14 207			

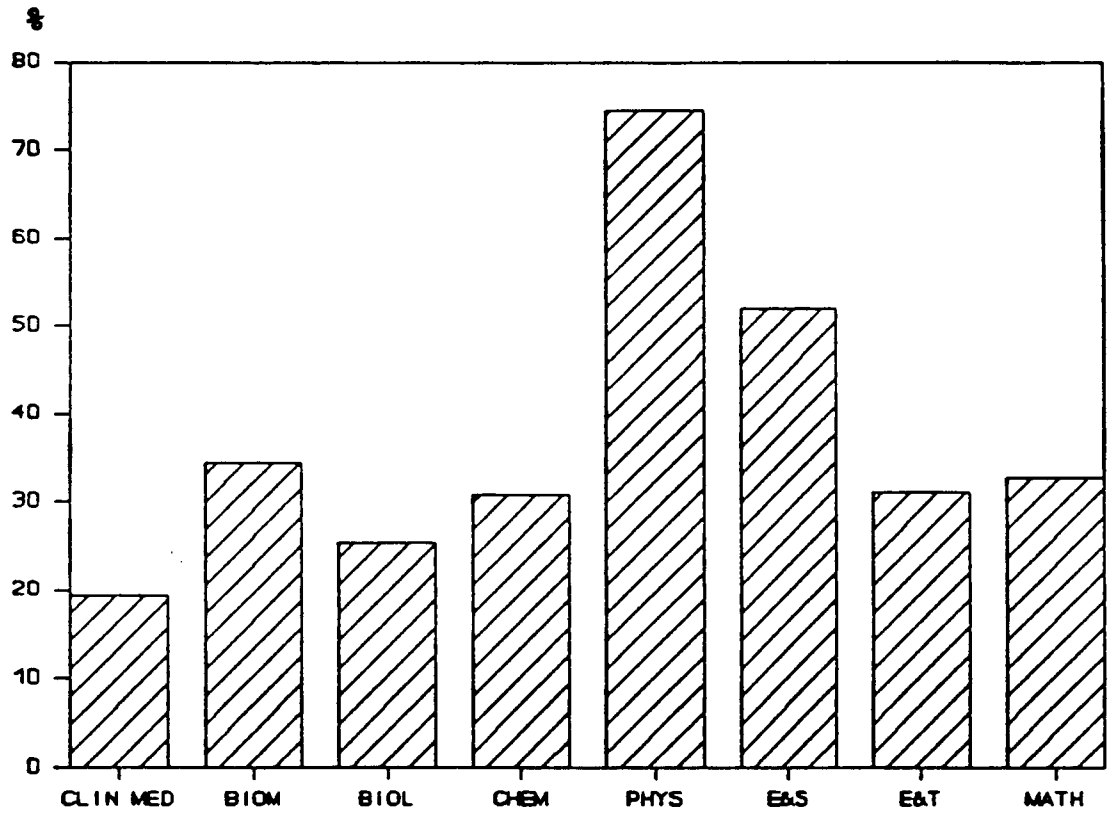
4.1. Nordic co-authorship patterns by field

Figures 7 a-d give the proportion of co-authored papers of all papers in scientific fields in 1981-86. All four Nordic countries had similar patterns: the proportion of internationally co-authored papers was largest in physics, then in earth and space science, followed by biomedical research or mathematics. In Norway mathematics had a slightly larger proportion of internationally co-authored papers than earth and space science. In both physics and earth and space science, international accelerators or observatories presumably answer for a large proportion of the collaborative efforts, a factor to be determined by more in-depth studies. There is some variation across Nordic countries as to the proportion of internationally co-authored papers by field (Figures 8 a-e).

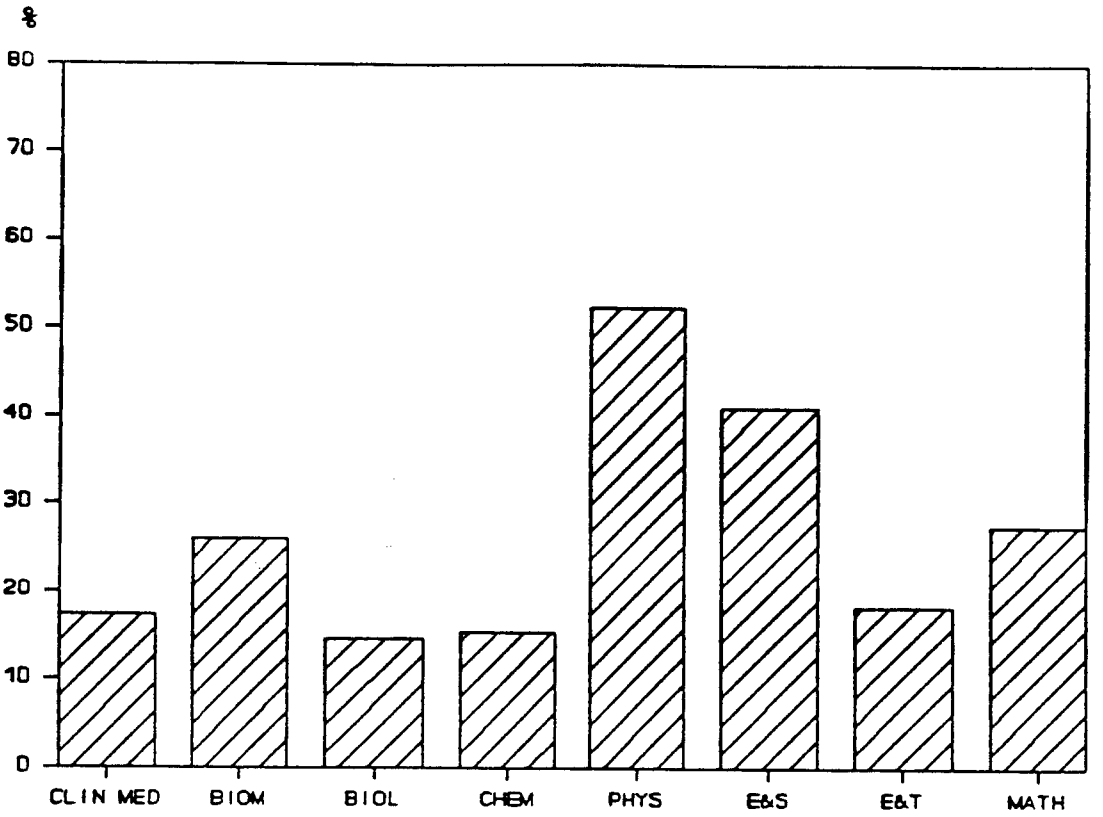
For example, mathematics in Norway had a larger proportion of internationally co-authored papers than mathematics in the other Nordic countries; physics in Norway and Denmark had a higher percentage of co-authored papers than physics in Finland or Sweden; the percentage was lowest in Finland.

Figure 7. Share of internationally co-authored papers in scientific fields, 1981-86 (Source: CNRS/LEPI MEV-MAC data base).

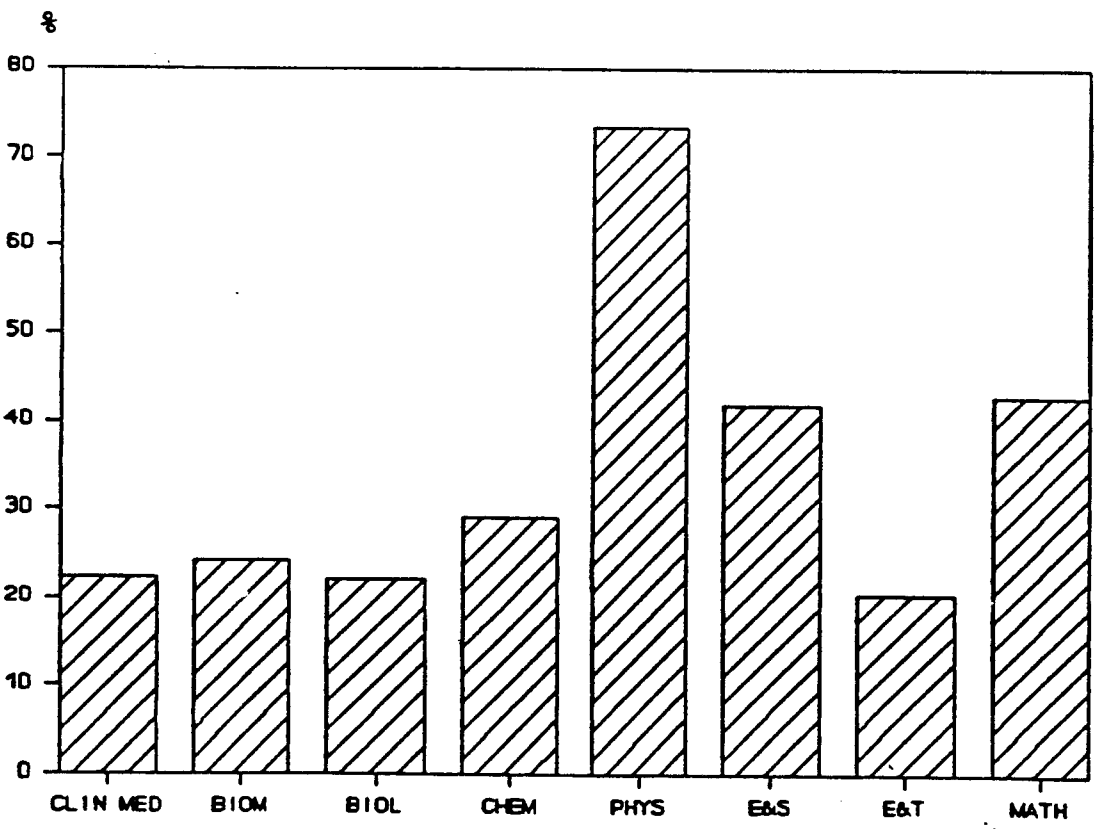
(a) Denmark



(b) Finland



(c) Norway



(d) Sweden

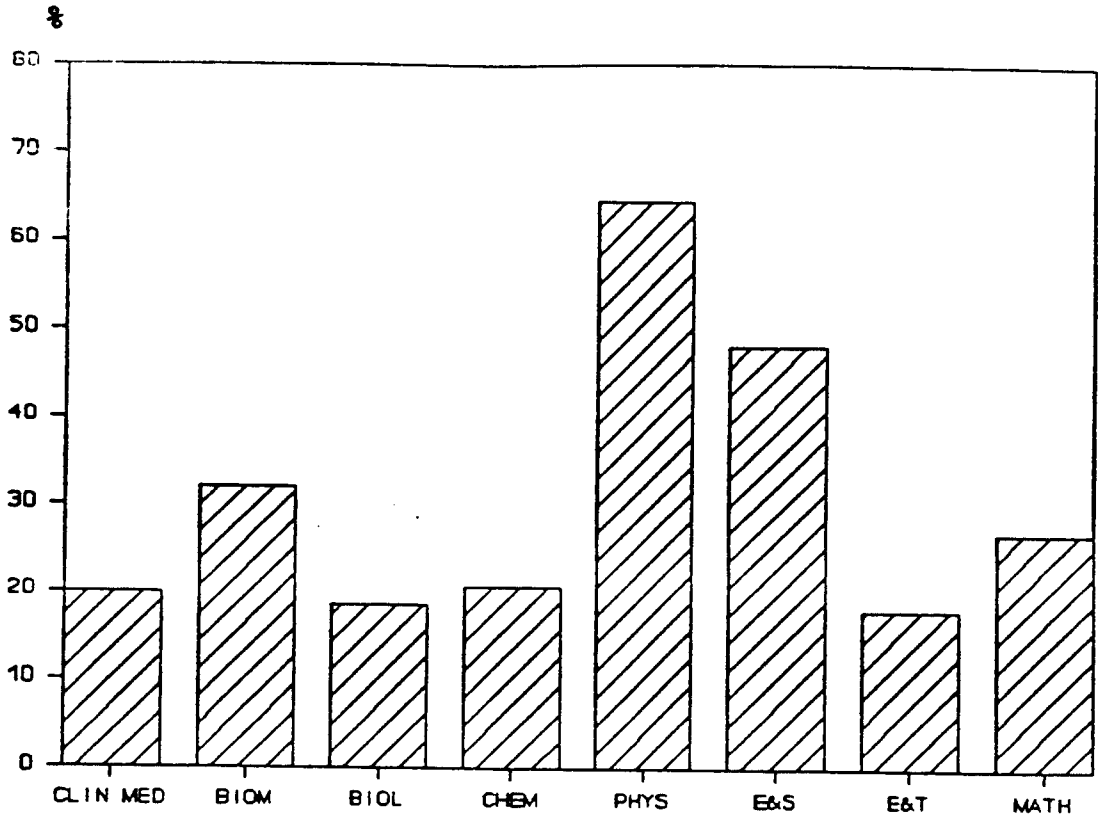
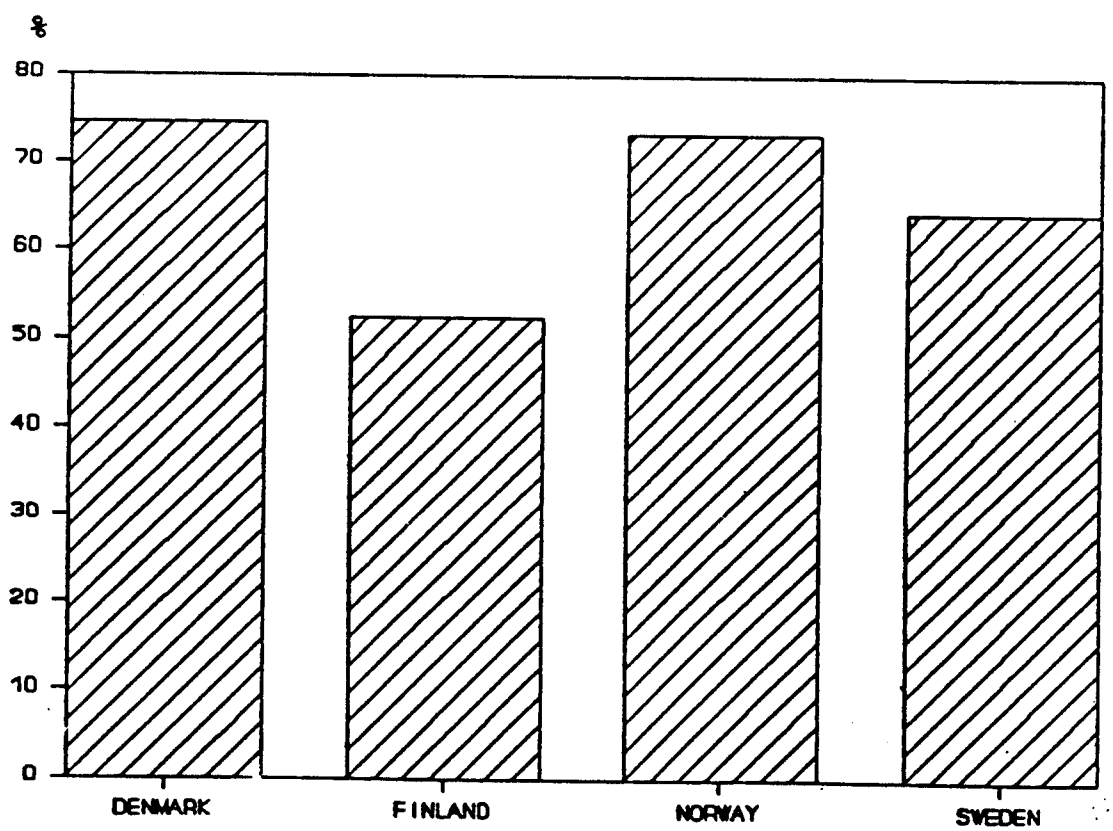
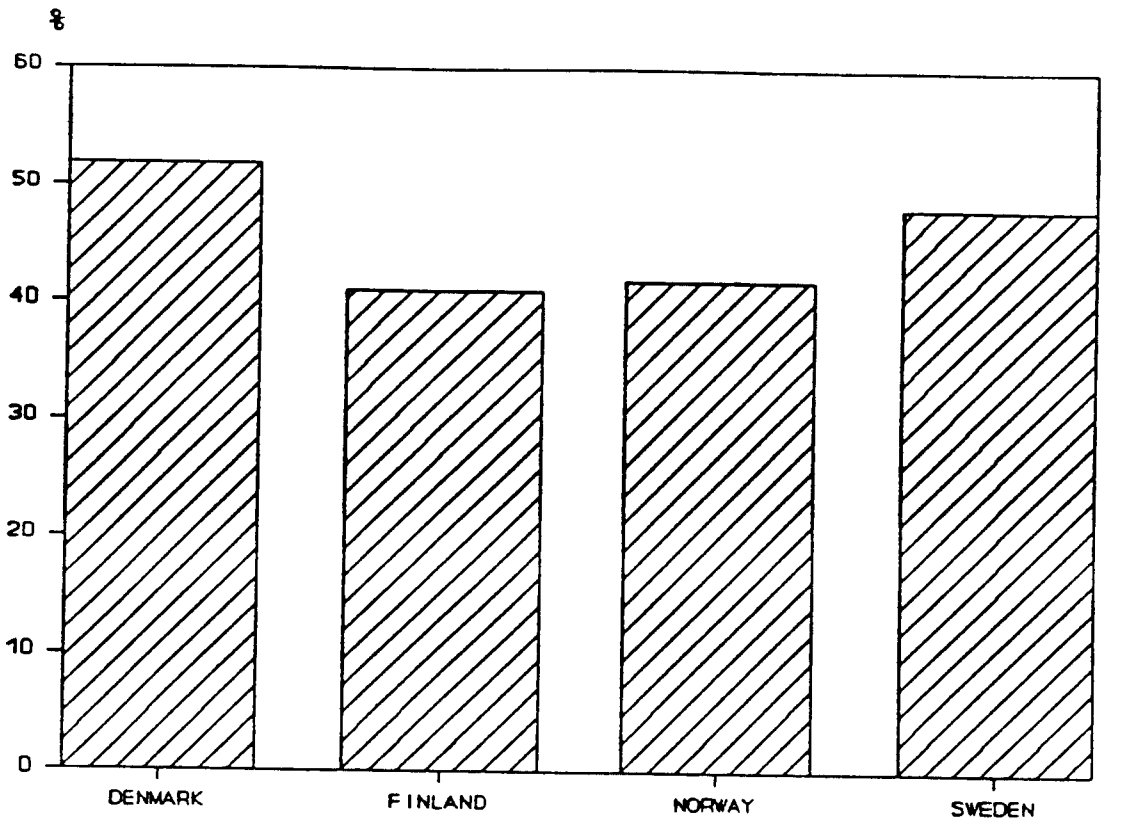


Figure 8. Share of internationally co-authored papers in select fields by country (Source: CNRS/LEPI MEV-MAC data base)

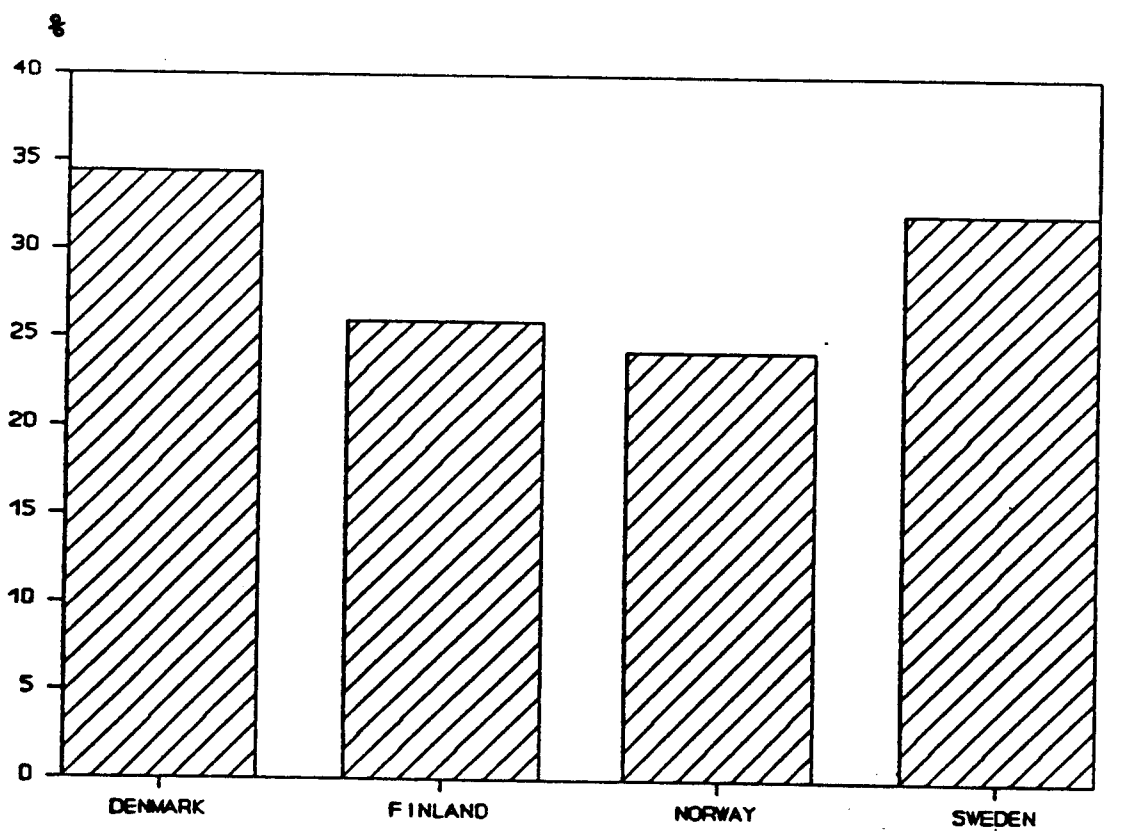
(a) Physics



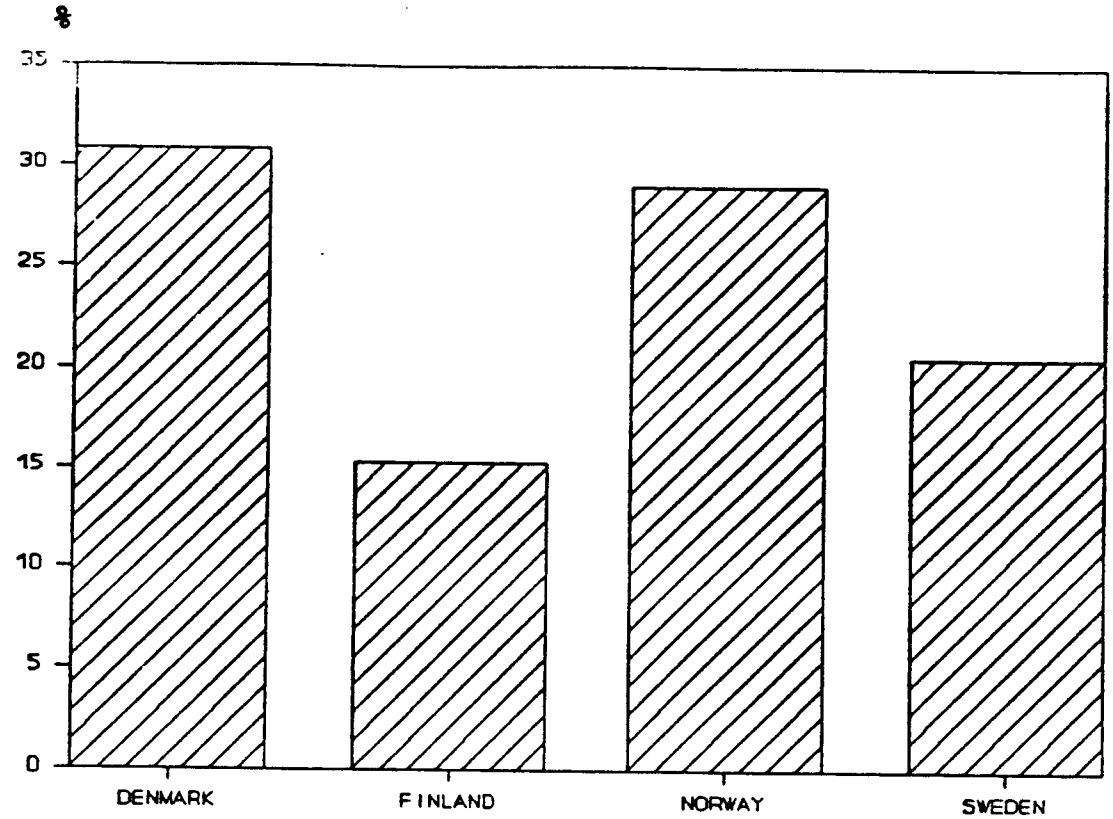
(b) Earth and space science



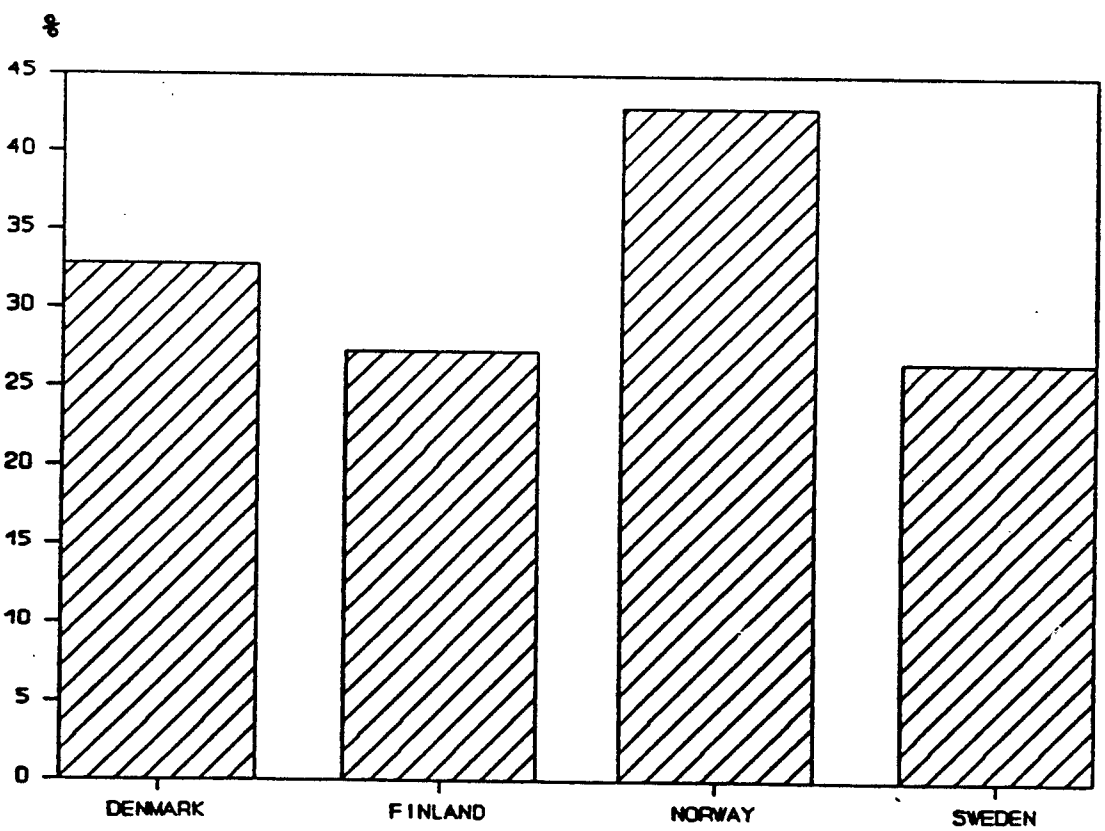
(c) Biomedicine



(d) Chemistry



(e) Mathematics



When we compare the relative citation rates of scientific fields (Figures 5 a-d) and the proportion of internationally co-authored papers in these fields (Figures 7 a-d), we may conclude that these indicators measure different aspects of international orientation; with the exception of physics in Denmark and Finland, and perhaps, mathematics in Norway, they do not converge. A field that has a high relative citation rate does not necessarily have a large volume of international co-authorship.

4.2. Nordic co-authorship patterns by country

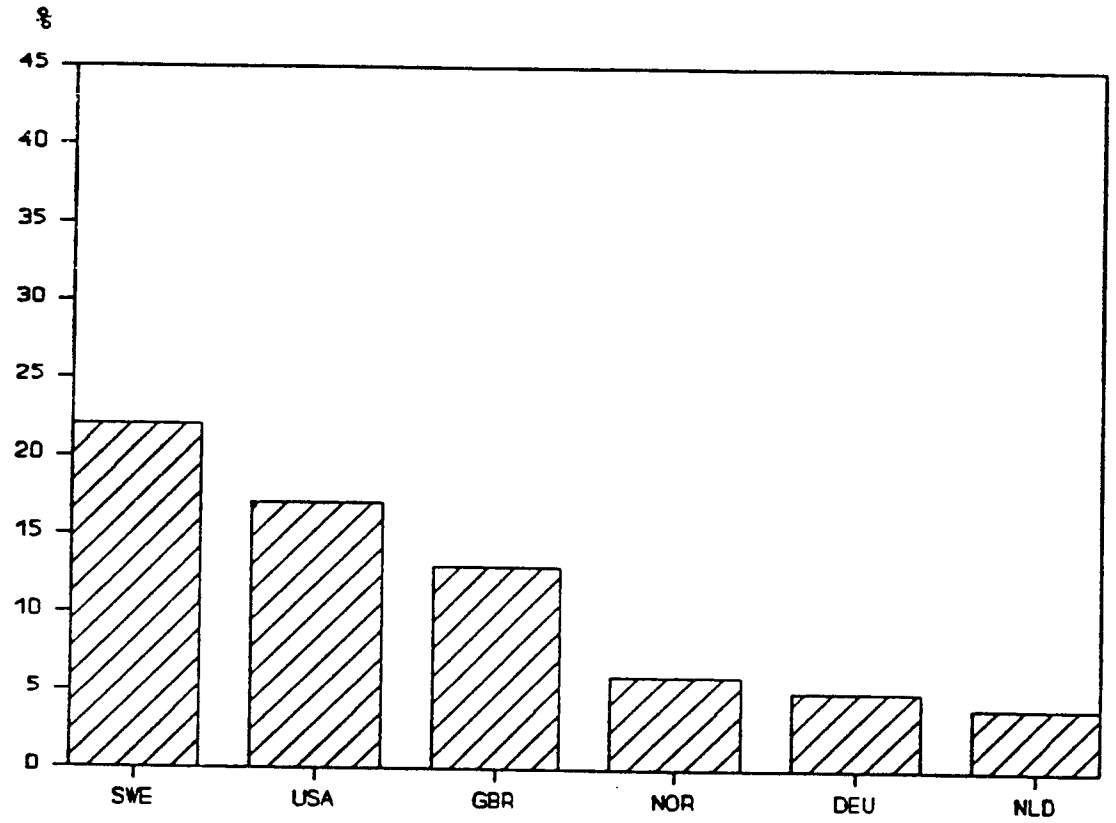
For all the four Nordic countries, scientists from the USA were the most important collaborative partners when all fields were grouped together (Appendix 2). As Figures 9-12 indicate, there is some variation when fields are considered separately, with scientists from Sweden being leading collaborative partners for clinical medicine in Denmark and Norway. Also scientists from Great Britain, Federal Republic of Germany, France, and the other Nordic countries played an important role in collaborative efforts.

The country codes used:

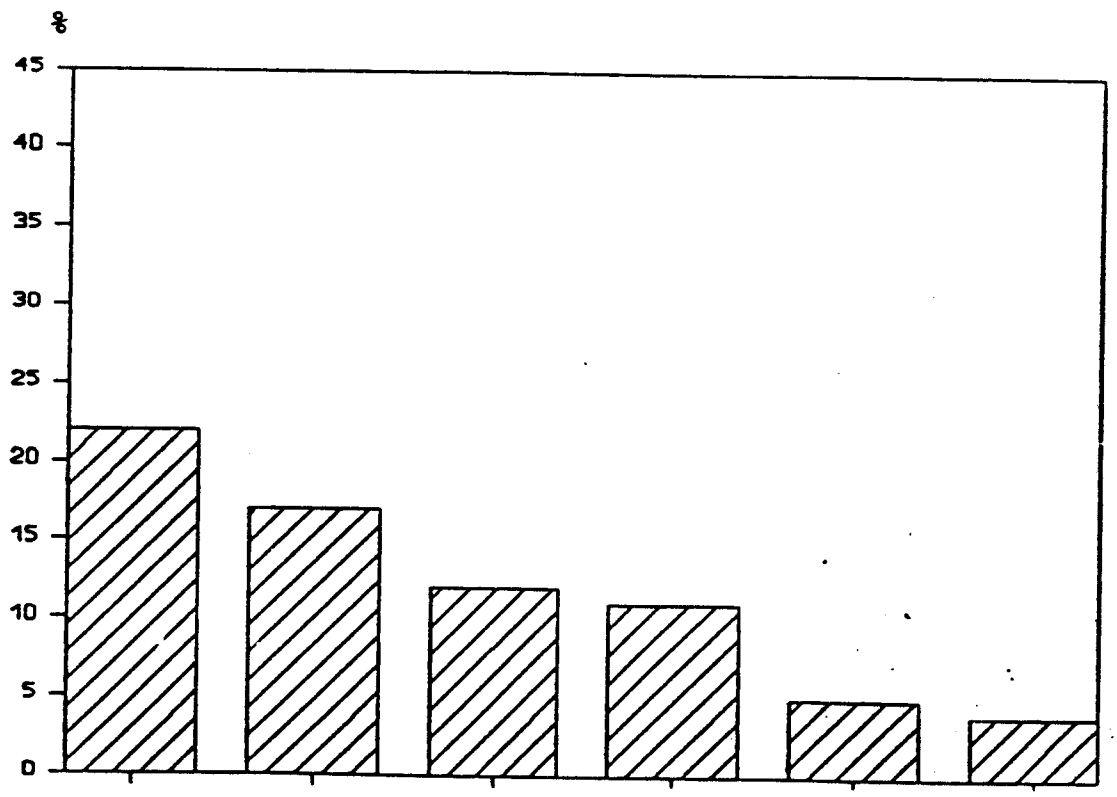
AUS = Australia
CHE = Switzerland
DEU = Federal Republic of Germany
DNK = Denmark
FIN = Finland
FRA = France
GBR = Great Britain
ITA = Italy
NLD = The Netherlands
NOR = Norway
SUN = USSR
SWE = Sweden
USA = USA

Figure 9. Denmark. Internationally co-authored papers by country of the collaborative partner. Six most important collaborative countries in select fields, 1981-86 (Source: CNRS/OST MEV-MAC data base)

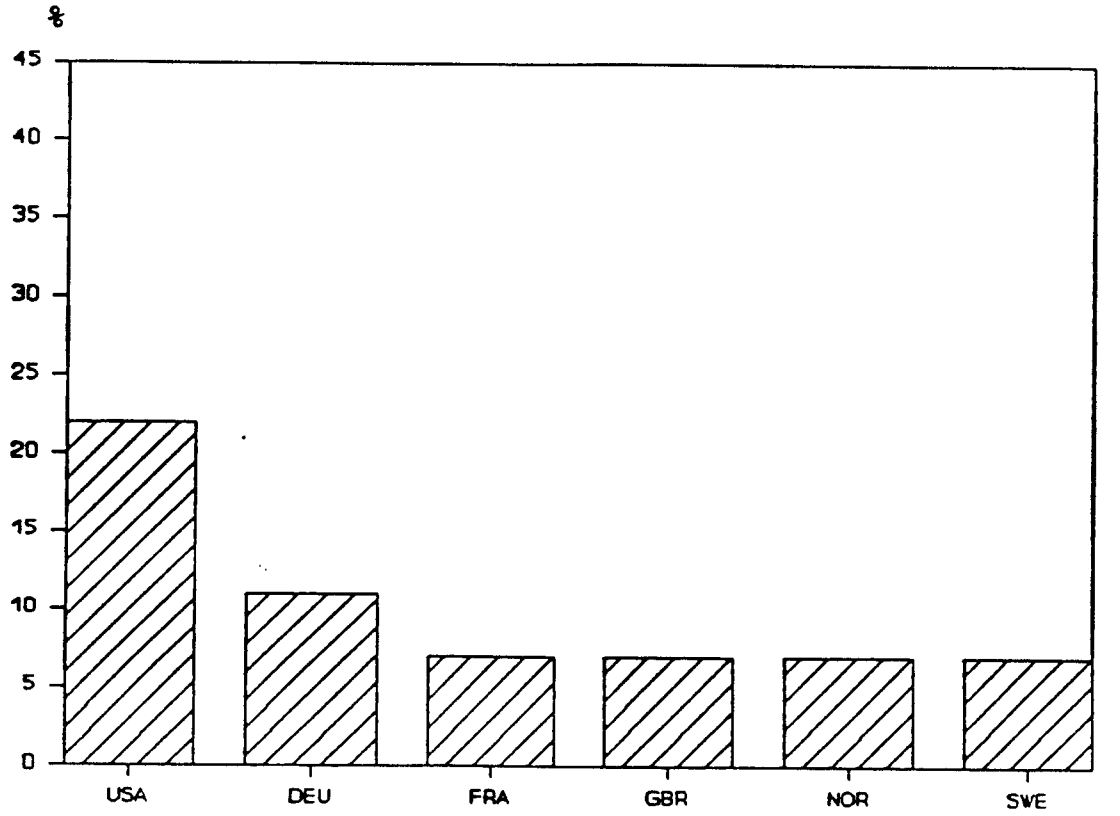
(a) Clinical medicine



(b) Biomedicine



(c) Chemistry



(d) Physics

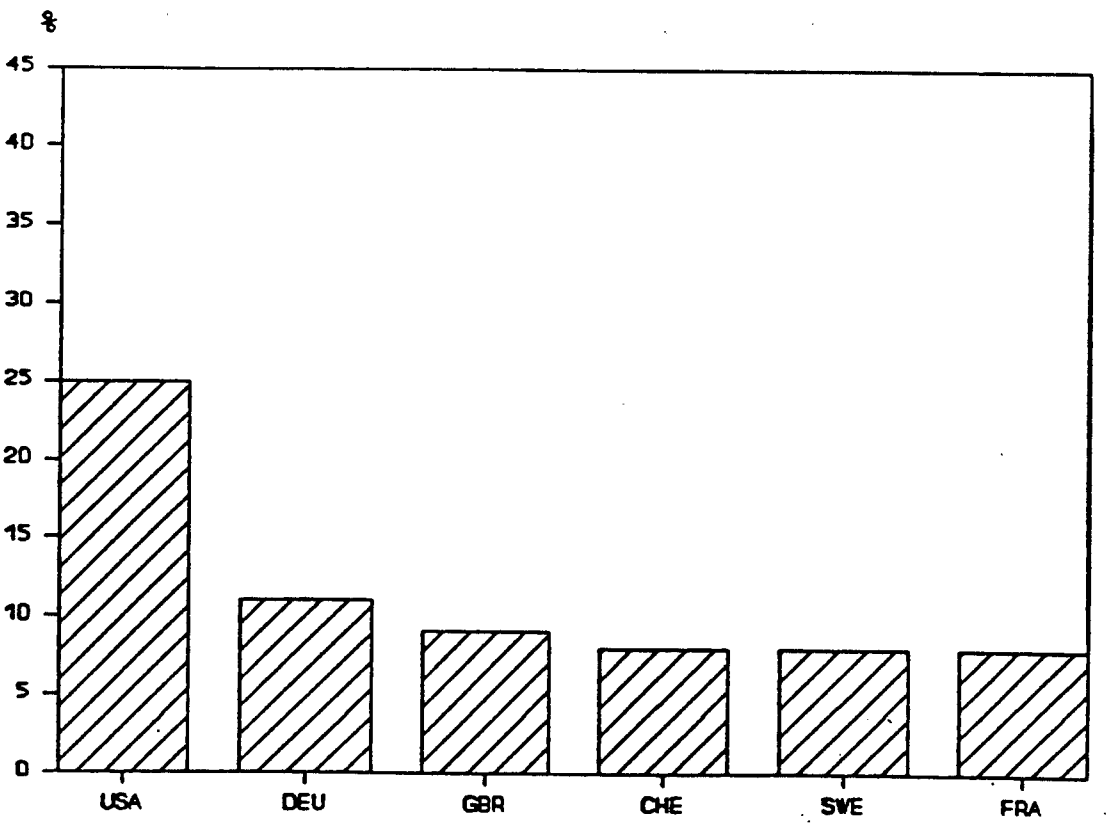
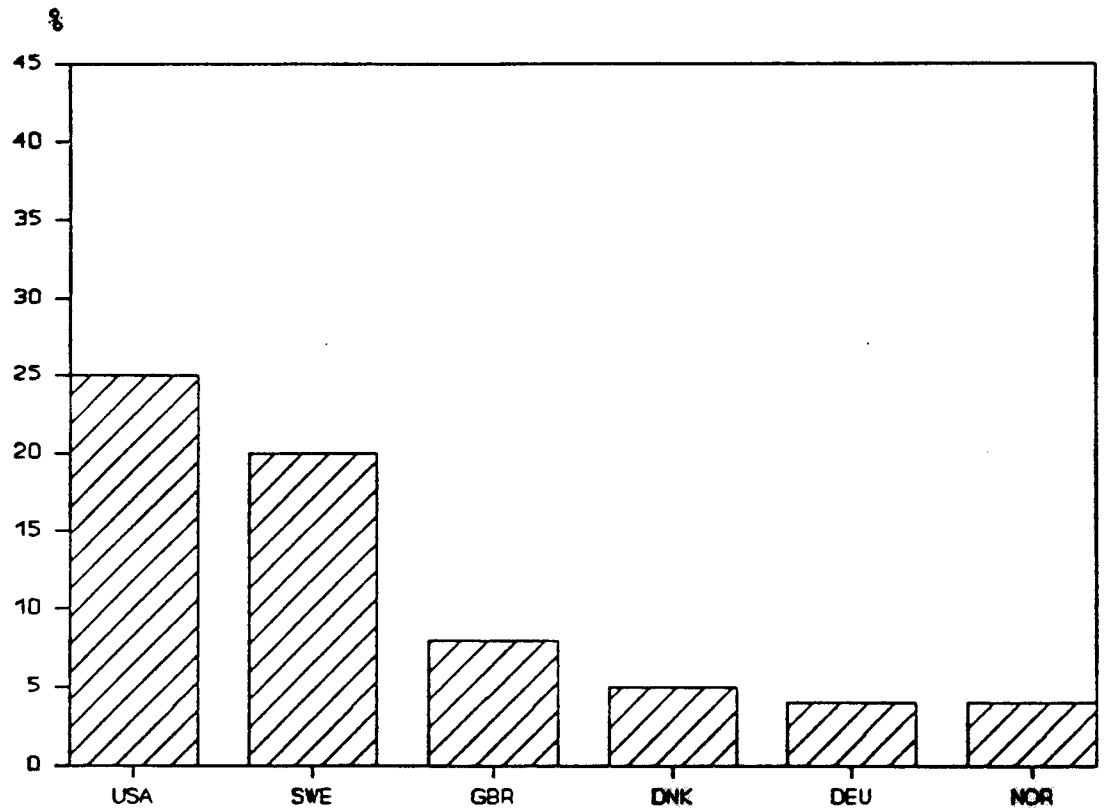
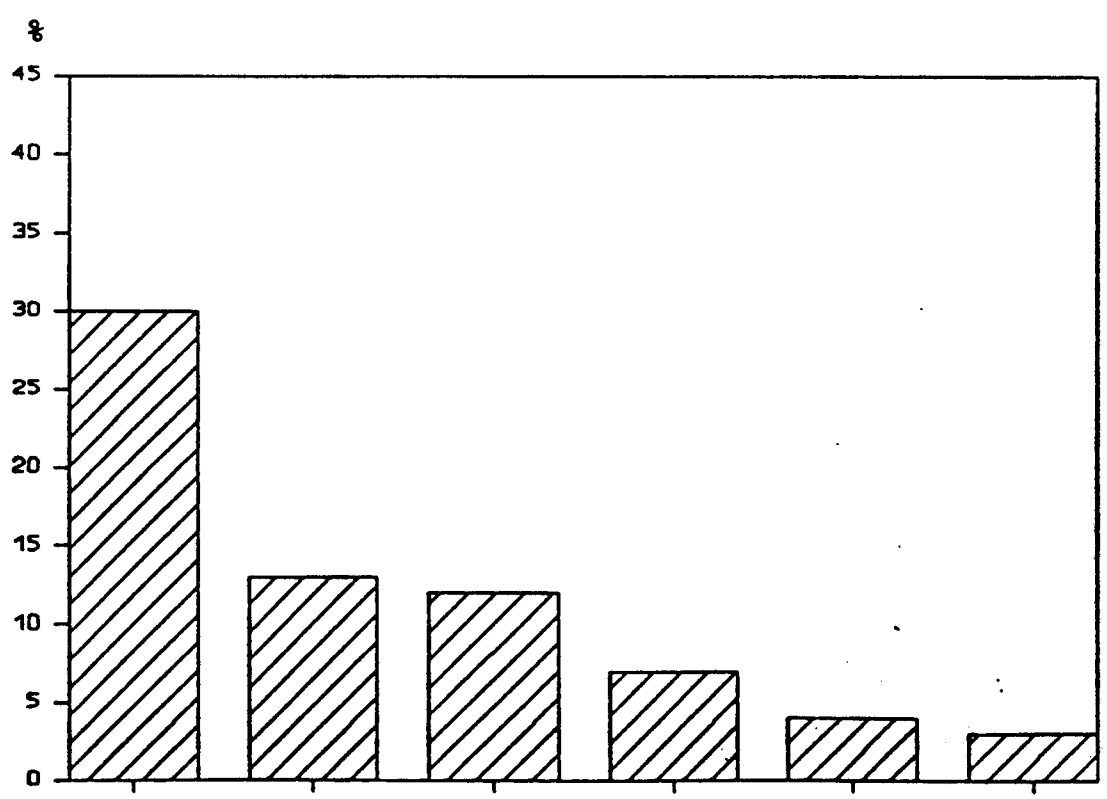


Figure 10. Finland. Internationally co-authored papers by country of the collaborative partner. Six most important collaborative countries in select fields, 1981-86 (Source: CNRS/LEPI MEV-MAC data base)

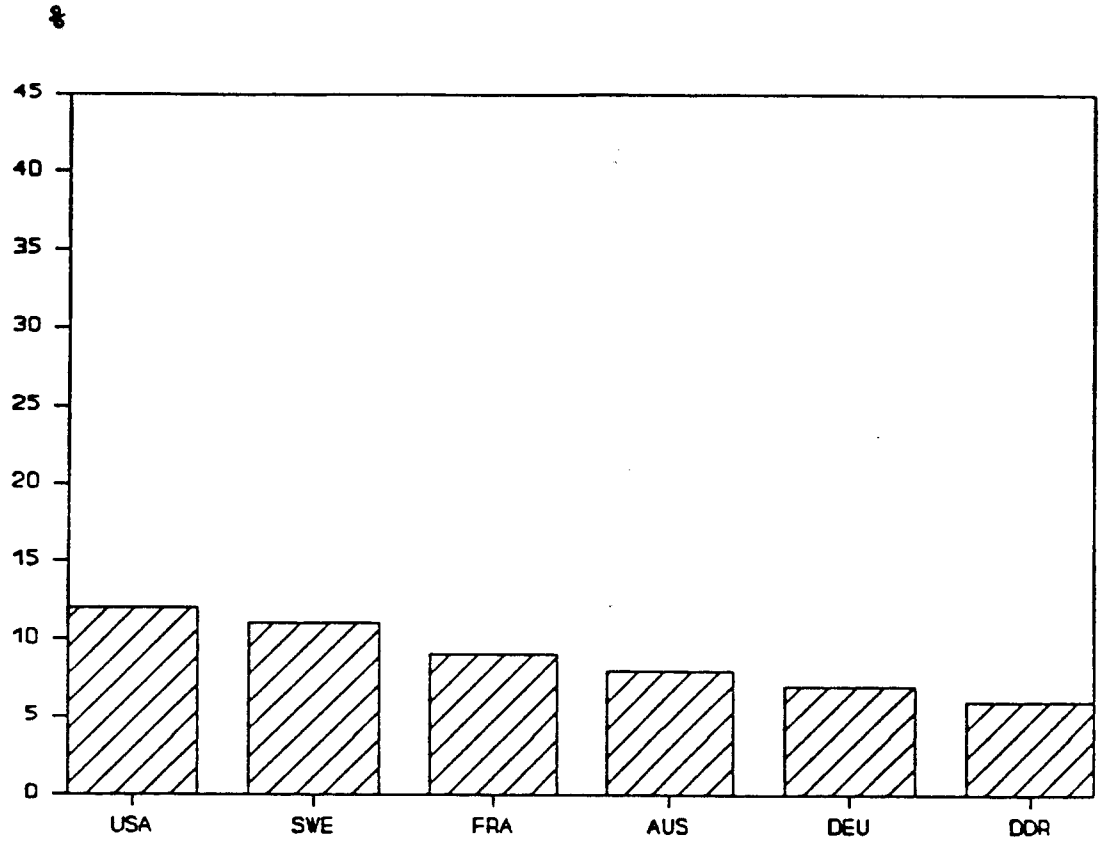
(a) Clinical medicine



(b) Biomedicine



(c) Chemistry



(d) Physics

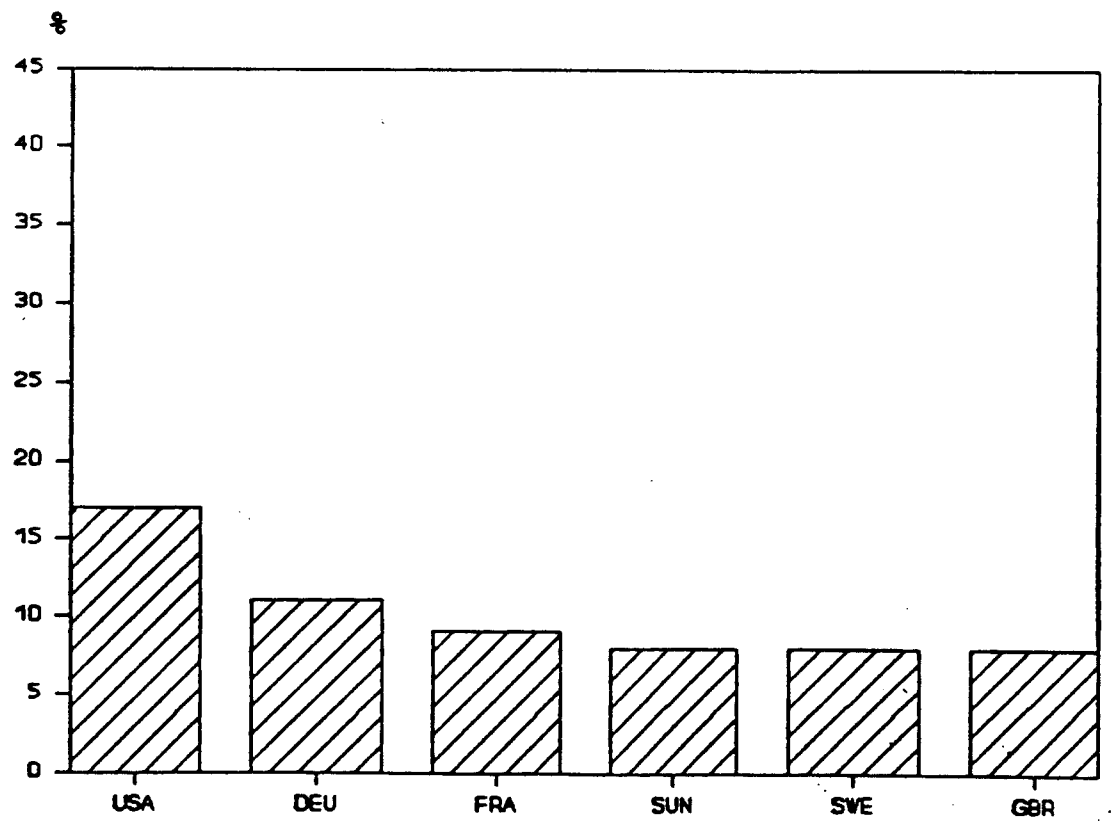
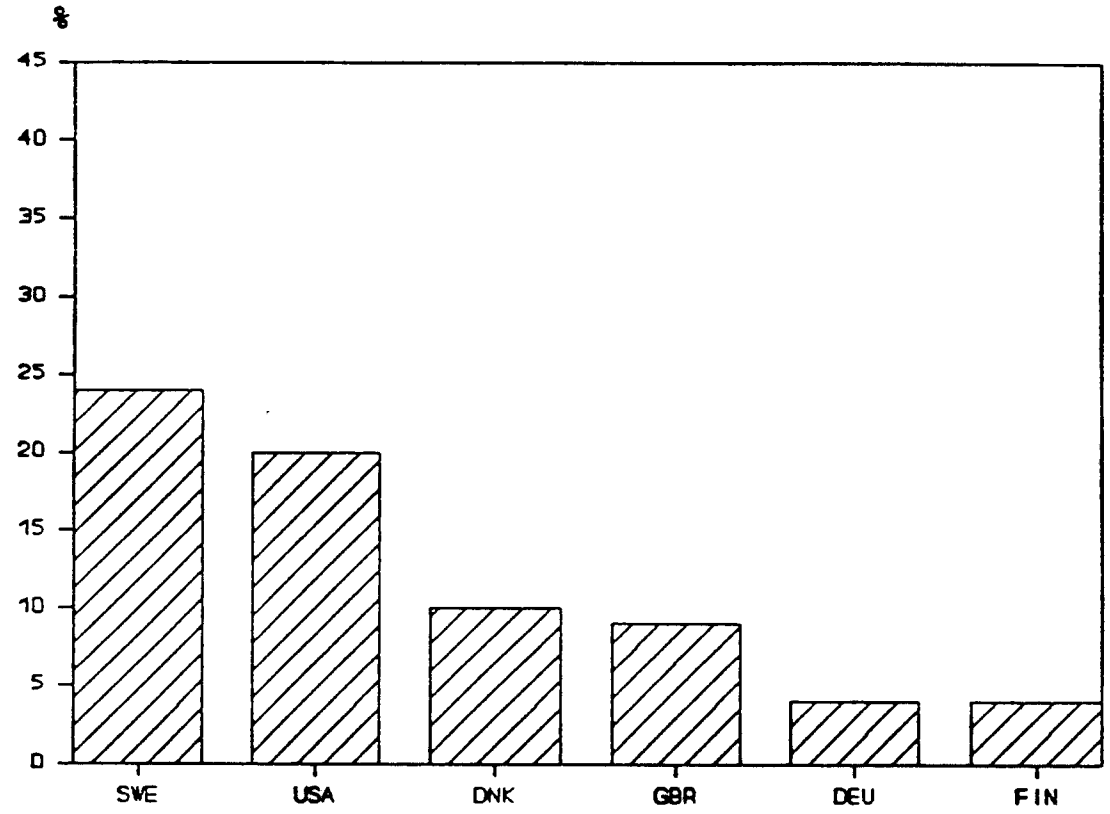
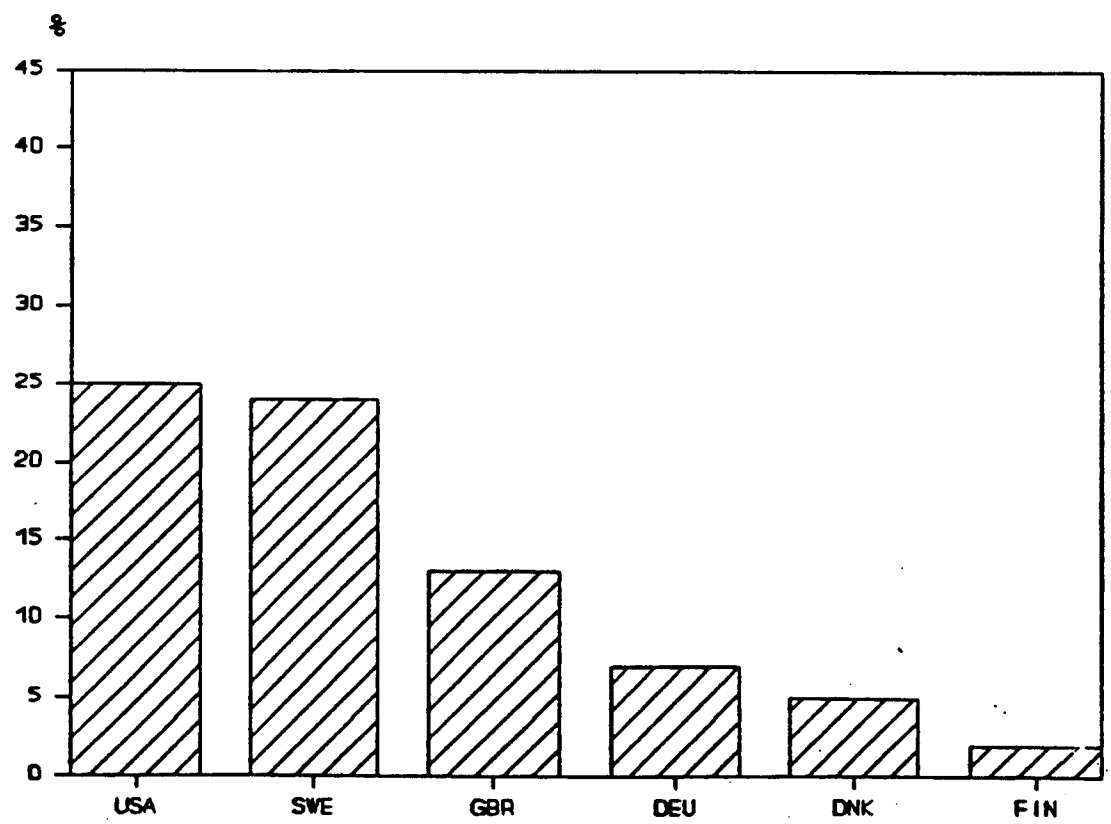


Figure 11. Norway. Internationally co-authored papers by country of the collaborative partner. Six most important collaborative countries in select fields, 1981-86 (Source: CNRS/LEPI MEV-MAC data base)

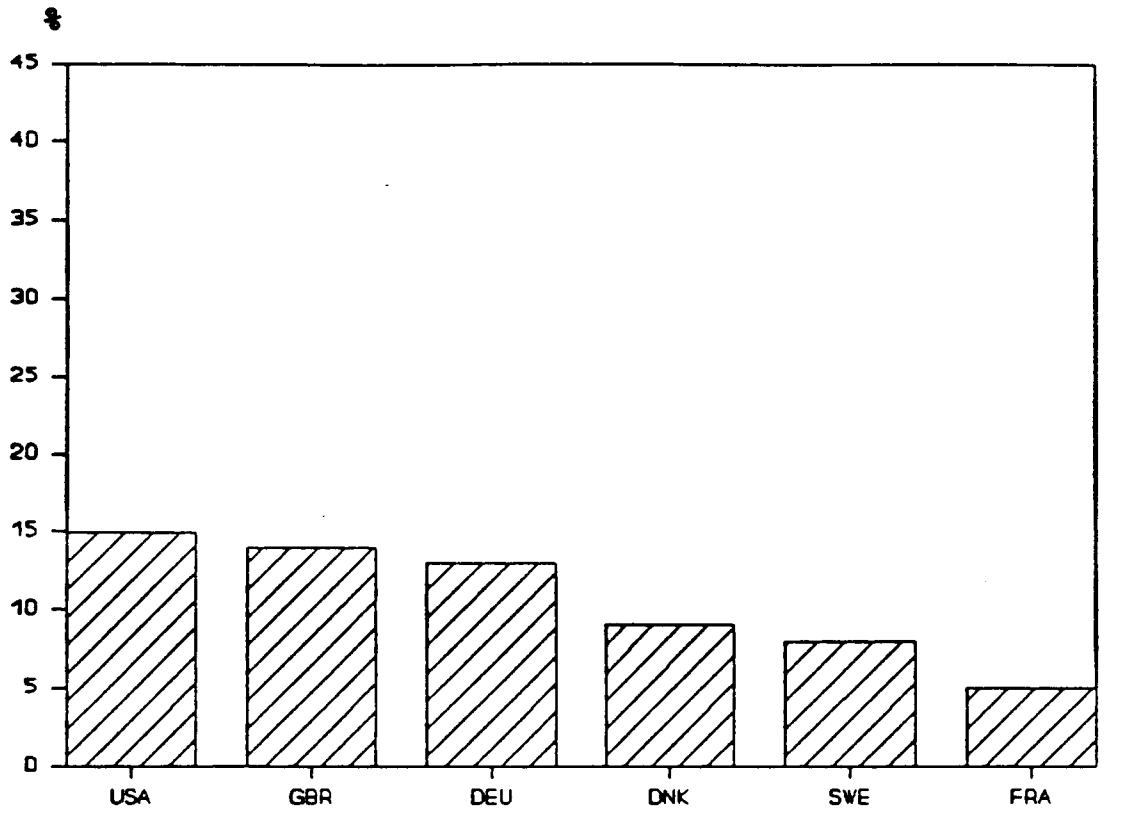
(a) Clinical medicine



(b) Biomedicine



(c) Chemistry



(d) Physics

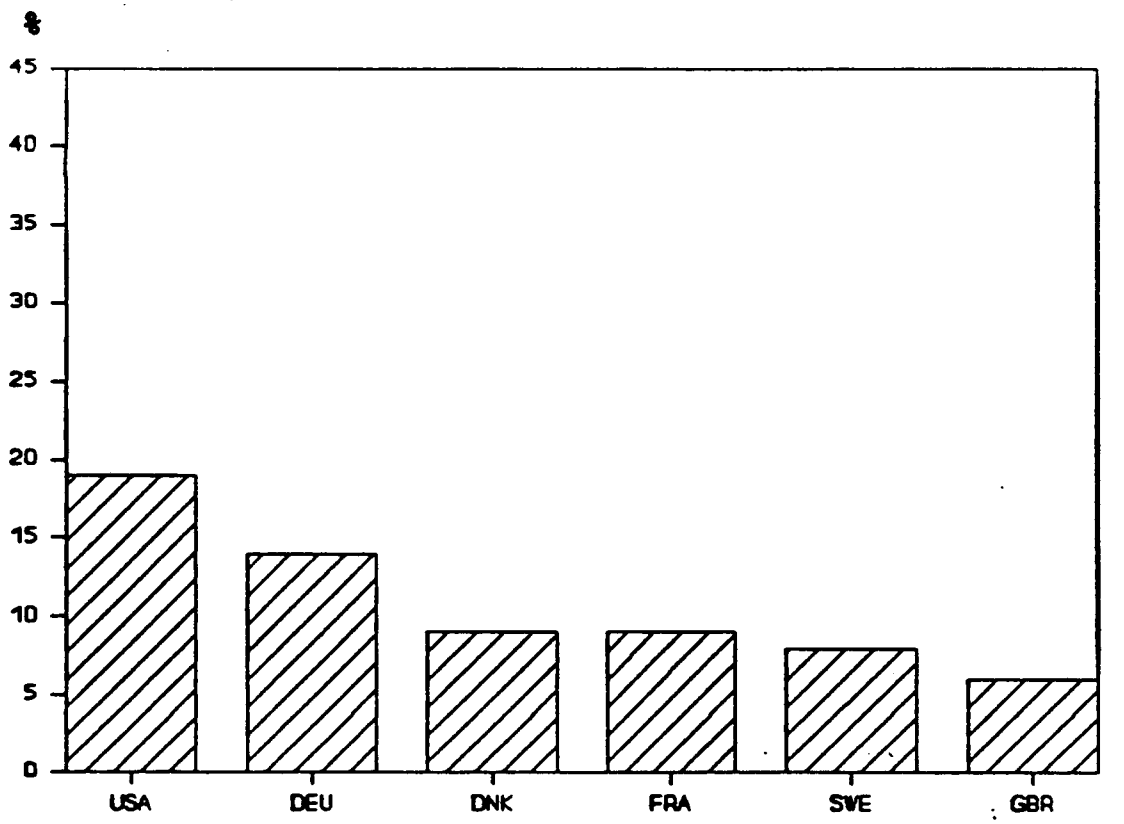
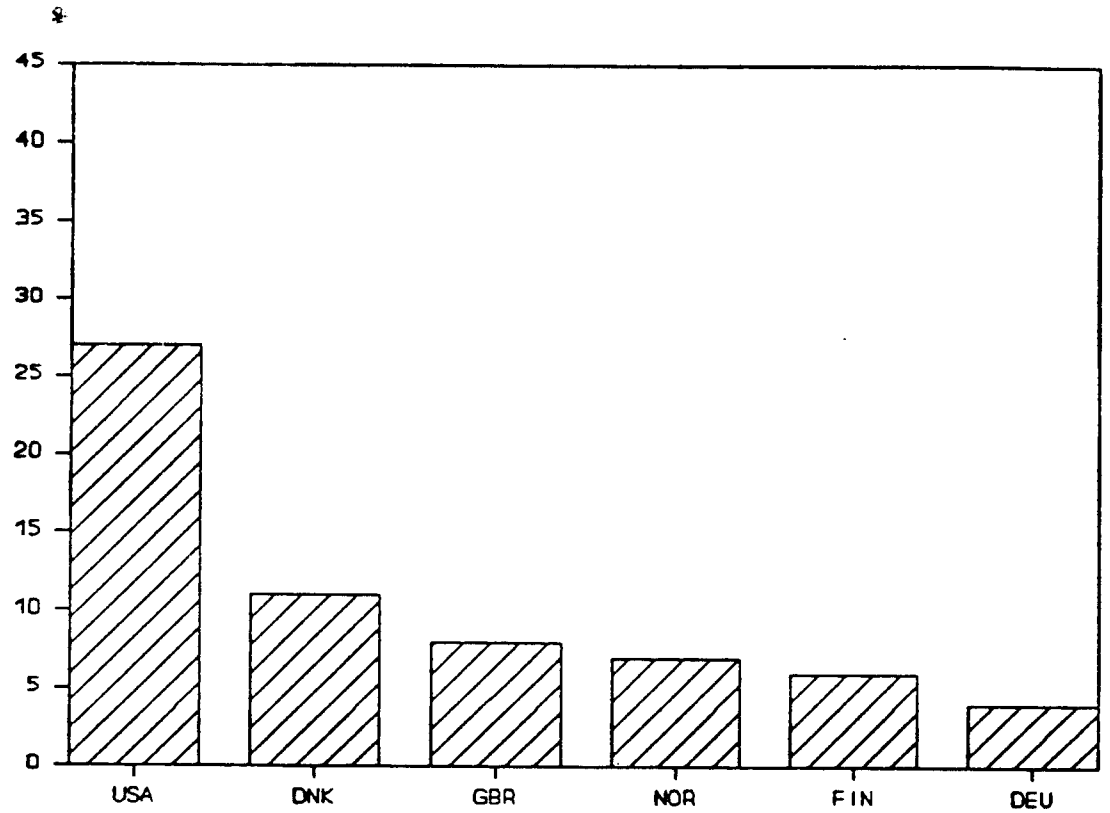
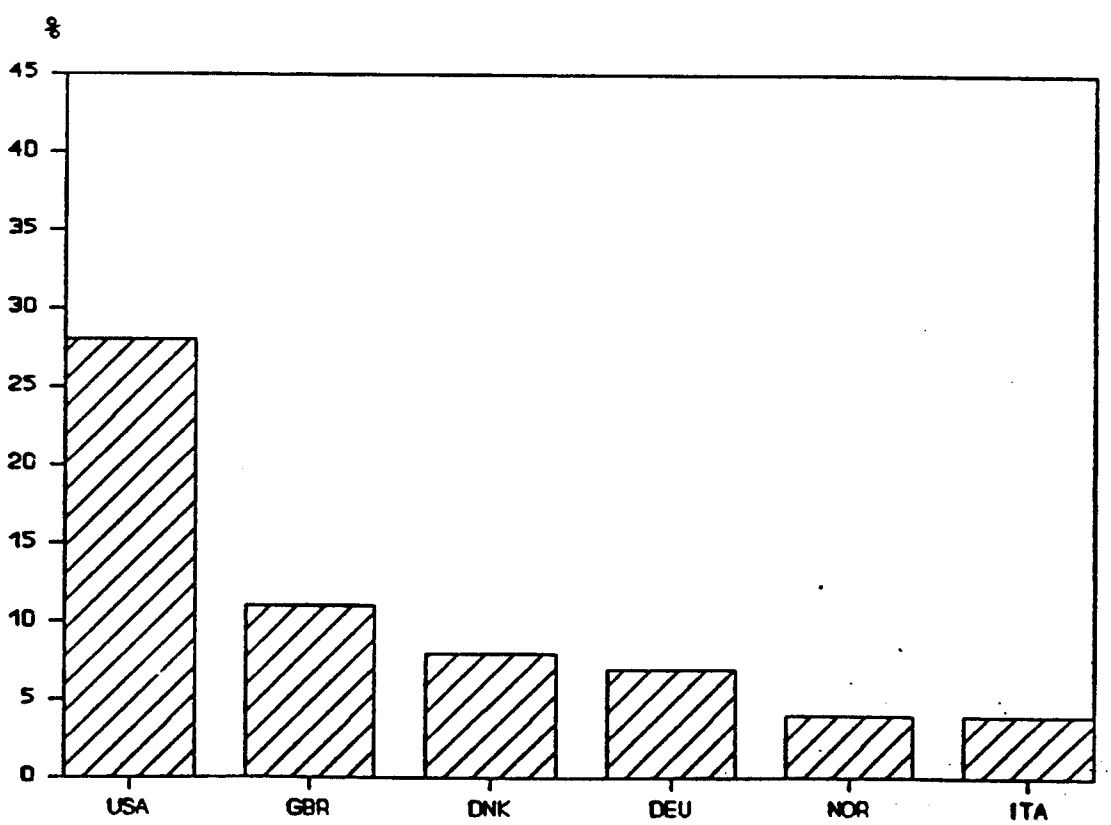


Figure 12. Sweden. Internationally co-authored papers by country of the collaborative partner. Six most important collaborative countries in select fields, 1981-86 (Source: CNRS, LEPI MEV-NAC data base)

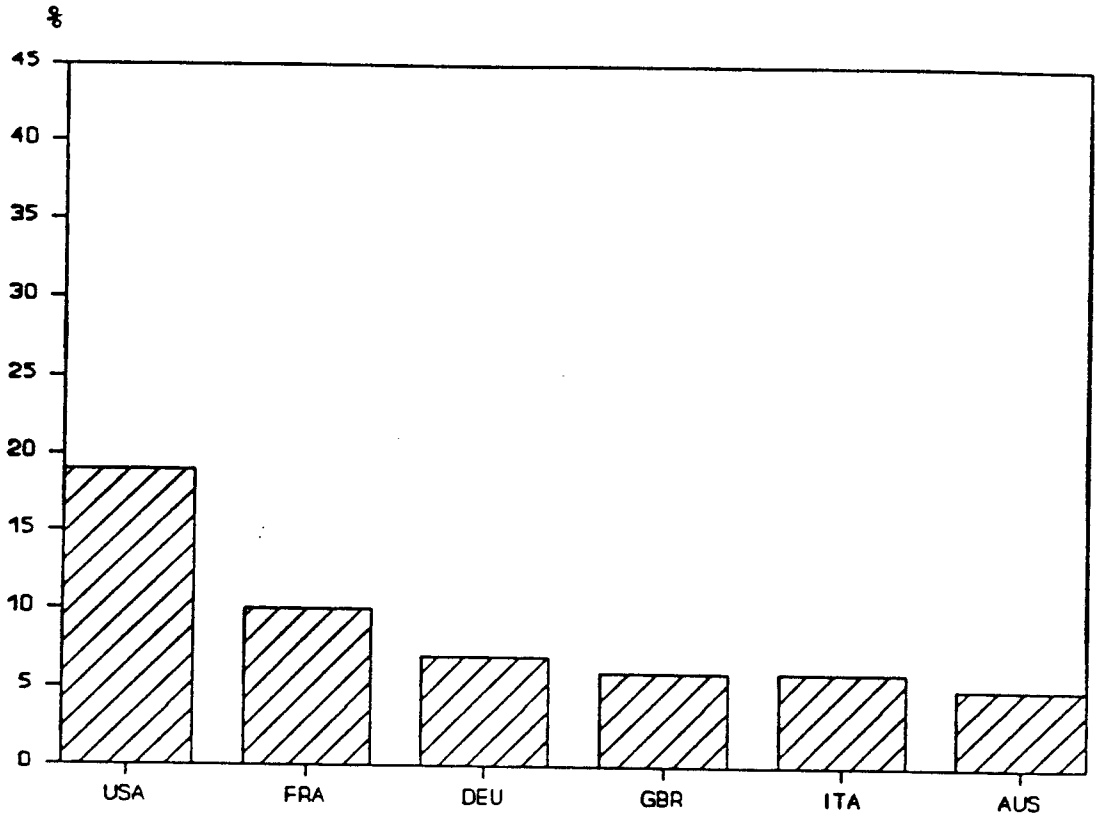
(a) Clinical medicine



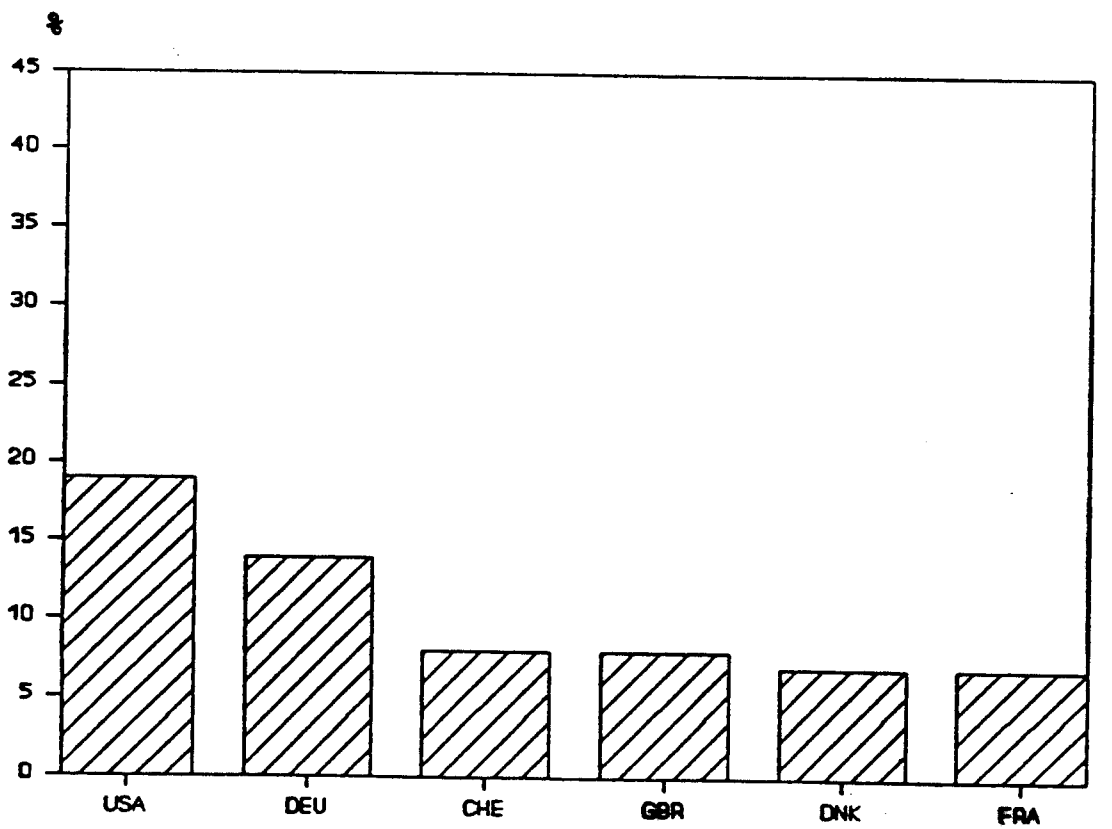
(b) Biomedicine



(c) Chemistry



(d) Physics



The relative importance of the Nordic countries vis-a-vis each other in co-authorship collaboration is manifested by Table 4.

Table 4. Share of Nordic co-authorship of all co-authored papers, 1981-86 (Source: CNRS/LEPI MEV-MAC data base).

DENMARK	%	FINLAND	%
Sweden	14	Sweden	15
Norway	4	Denmark	4
Finland	2	Norway	2
NORWAY	**%**	**SWEDEN**	**%**
Sweden	16	Denmark	8
Denmark	8	Norway	5
Finland	2	Finland	4

Swedish scientists were the most important Nordic partners for scientists from all the other Nordic countries; for Swedish scientists, Denmark provided the most important Nordic partner.

5. Concluding remarks

The three types of literature-based indicators revealed different aspects of international visibility and impact of Nordic scientific research. Sweden and Denmark produced most papers quantitatively; Swedish and Danish papers were also more highly-cited than the papers by the Finnish and Norwegian scientists. However, Denmark and Norway had the highest proportion of internationally co-authored papers. When considered by field, the indicators produced discrepant findings, which is a further indication of their multi-dimensionality.

The indicators of the volume of international co-authorship are highly influenced by the size of the national scientific production in the collaborating countries. The relative importance of various countries in international collaboration will change when the size factor is taken into account. This could not be done in this study, but will be a topic for further analyses.

Appendix 1. Nordic publications in the CHI data base. Absolute numbers.

	1973	1974	1975	1976
DENMARK	1989,1	2046,7	2010,0	2149,2
FINLAND	1322,5	1298,5	1267,3	1319,3
NORWAY	1482,5	1414,4	1388,1	1308,8
SWEDEN	4138,2	4268,3	4274,0	4196,6
WORLD	272347,9	265361,3	267712,8	269635,9

	1977	1978	1979	1980
DENMARK	2435,7	2349,2	2409,8	2359,2
FINLAND	1455,4	1558,8	1659,5	1719,4
NORWAY	1445,5	1388,8	1407,7	1482,3
SWEDEN	4418,0	4359,6	4398,2	4441,7
WORLD	275685,4	273738,0	274677,8	277767,1

YEAR	1981	1982	1983	1984
DENMARK	2478,1	2533,0	2464,6	2141,3
FINLAND	1634,6	1906,4	1918,4	1685,6
NORWAY	1420,1	1499,6	1483,3	1349,5
SWEDEN	4443,5	4894,2	4884,9	4573,1
WORLD	285300,8	285619,8	288936,2	261068,4

The reasons for fractional articles are two-fold:
1) articles are apportioned among the countries of co-authors;
2) some journals which include articles from several subfields are apportioned among those subfields approximately according to the share of the journal devoted to each subfield.

Appendix 2. Nordic co-authorship patterns by country and field (Source: CNRS/LEPI MEV-MAC data base).

The country codes used:

AUS = Australia
AUT = Austria
BEL = Belgium
CAN = Canada
CHE = Switzerland
CHL = Chile
CHN = People's Republic of China
CSK = Czechoslovakia
DDR = German Democratic Republic
DEU = Federal Republic of Germany
DNK = Denmark
FIN = Finland
FRA = France
GBR = Great Britain
HUN = Hungary
IND = India
ISL = Iceland
ISR = Israel
ITA = Italy
JPN = Japan
NLD = The Netherlands
NOR = Norway
NZL = New Zealand
POL = Poland
PRT = Portugal
ROM = Romania
SUN = USSR
SWE = Sweden
USA = USA

DENMARK

ALL FIELDS	%	MATH	%	PHYS	%
USA	21	USA	30	USA	25
SWE	14	GBR	13	DEU	11
GBR	12	NOR	10	GBR	9
DEU	8	DEU	8	CHE	8
FRA	5	CAN	6	SWE	8
NOR	4	AUS	5	FRA	8
CHE	4	JPN	4	ITA	4
CAN	3	BEL	2	SUN	3
NLD	3	SWE	2	NOR	2
FIN	2	FRA	2	ISR	2
ITA	2	NLD	1	FIN	1

CHEM	%	E&T	%	E&S	%
USA	22	USA	25	USA	28
DEU	11	GBR	17	GBR	10
FRA	7	DEU	12	DEU	8
GBR	7	CAN	7	SWE	7
NOR	7	NOR	4	CAN	7
SWE	7	CHE	4	FRA	6
CHE	4	SWE	4	NOR	5
CAN	3	NLD	2	ISL	2
AUS	3	AUS	2	NLD	2
NLD	2	SUN	2	CHL	2
SUN	2	POL	1	FIN	2

BIOL	%	BIOM	%	CLIN MED	%
				SWE	22
GBR	15	USA	22	USA	17
USA	14	SWE	17	GBR	13
SWE	11	GBR	12	NOR	6
NOR	8	DEU	11	DEU	5
DEU	8	FRA	5	NLD	4
CAN	7	CAN	4	FIN	3
NLD	3	NLD	3	FRA	3
IND	3	CHE	2	CAN	2
FRA	2	NOR	2	AUS	2
FIN	2	AUS	2	CHE	2
AUS	2	JPN	1	BEL	2

FINLAND

ALL	%	MATH	%	PHYS	%
USA	23	USA	41	USA	17
SWE	15	DEU	11	DEU	11
GBR	8	SWE	9	FRA	9
DEU	7	CAN	8	SUN	8
FRA	4	GBR	8	SWE	8
DNK	4	NLD	4	GBR	8
SUN	3	CSK	3	CHE	5
CAN	3	HUN	2	DNK	5
CHE	3	AUT	2	ITA	4
NOR	2	FRA	2	NLD	2
NLD	2	NZL	1	AUT	2

CHEM	%	E&T	%	E&S	%
USA	12	USA	26	USA	15
SWE	11	CAN	20	DEU	14
FRA	9	SWE	10	SUN	12
AUS	8	DEU	10	SWE	12
DEU	7	AUT	7	GBR	6
DDR	6	CSK	4	ISR	5
CSK	6	FRA	3	NOR	4
NOR	4	NOR	2	CAN	4
CAN	4	SUN	2	DNK	3
GBR	4	NLD	2	AUT	3
SUN	3	DDR	1	NLD	2

BIOL	%	BIOM	%	CLIN MED	%
SWE	16	USA	30	USA	25
USA	15	SWE	13	SWE	20
GBR	9	GBR	12	GBR	8
CAN	7	DEU	7	DNK	5
FRA	7	FRA	4	DEU	4
DNK	5	NLD	3	NOR	4
CHN	5	DDR	3	NLD	3
AUS	4	CAN	3	CHE	2
DEU	3	CHE	2	CAN	2
POL	2	ITA	2	FRA	2
NLD	2	DNK	2	ITA	2

NORWAY

ALL	%	MATH	%	PHYS	%
USA	22	USA	39	USA	19
SWE	16	DEU	13	DEU	14
GBR	11	DNK	12	DNK	9
DNK	8	GBR	6	FRA	9
DEU	8	FRA	5	SWE	8
FRA	4	CAN	3	GBR	6
CAN	3	AUS	3	CHE	5
FIN	2	CHE	2	ITA	3
NLD	2	SWE	2	NLD	3
CHE	2	IND	2	POL	3
ITA	1	ITA	1	ISR	3

CHEM	%	E&T	%	E&S	%
USA	15	USA	30	USA	32
GBR	14	DNK	8	GBR	16
DEU	13	GBR	8	DEU	10
DNK	9	CAN	7	SWE	7
SWE	8	SWE	5	DNK	6
FRA	5	FRA	5	CAN	4
SUN	4	FIN	4	FIN	2
CAN	3	DEU	4	NLD	2
HUN	2	NZL	3	SUN	2
FIN	2	POL	3	ITA	1
ITA	2	AUS	3	AUT	1

BIOL	%	BIOM	%	CLIN MED	%
GBR	22	USA	25	SWE	24
SWE	16	SWE	24	USA	20
USA	15	GBR	13	DNK	10
DNK	8	DEU	7	GBR	9
CAN	7	DNK	5	DEU	4
DEU	7	FIN	2	FIN	4
NLD	3	CAN	2	FRA	3
AUT	2	FRA	2	NLD	2
FRA	1	NLD	2	PRT	2
NZL	1	CSK	1	POL	2
CHE	1	BEL	1	CHE	2

SWEDEN

ALL	%	MATH	%	PHYS	%
USA	25	USA	41	USA	19
GBR	9	GBR	6	DEU	14
DNK	8	FIN	5	CHE	8
DEU	7	FRA	5	GBR	8
NOR	5	CAN	4	DNK	7
FRA	5	ISR	2	FRA	7
FIN	4	DDR	2	SUN	3
CHE	4	NOR	2	POL	3
ITA	3	CHE	2	FIN	2
NLD	2	NLD	2	ITA	2
CAN	2	DNK	2	BEL	2

CHEM	%	E&T	%	E&S	%
USA	19	USA	31	USA	26
FRA	10	DEU	9	DEU	13
DEU	7	GBR	9	GBR	10
GBR	6	ROM	8	FRA	8
ITA	6	FRA	5	NLD	5
AUS	5	FIN	4	DNK	5
DNK	4	CAN	4	NOR	4
NOR	4	ITA	2	FIN	4
POL	3	DNK	2	CAN	4
DDR	3	JPN	2	ITA	3
FIN	3	CHE	1	SUN	3

BIOL	%	BIOM	%	CLIN MED	%
USA	19	USA	28	USA	27
NOR	12	GBR	11	DNK	11
GBR	9	DNK	8	GBR	8
DNK	8	DEU	7	NOR	7
NLD	6	NOR	4	FIN	6
CAN	6	ITA	4	DEU	4
FIN	5	FRA	4	FRA	4
DEU	4	FIN	3	ITA	4
CHN	2	CHE	3	CHE	3
FRA	2	NLD	3	NLD	2
CHE	2	CAN	2	CAN	2