A Review of Canadian Publications and Impact in the Natural Sciences and Engineering, 1996 to 2005

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Report Highlights

This report provides an overview of Canadian publication trends in scientific and engineering journals in the natural sciences and engineering. Canada's performance over the past decade has improved and is reflected in several positive trends in the areas of production, productivity and quality as shown in Table 42 on page 57 – Canada's NSE Publication Scorecard. Other highlights from the report are described below.

- Canada's ranking in world production of natural sciences and engineering (NSE) publications stayed the same over the past decade of 7th position in 1996 and 2005.

- Canada produced 4.5% of the world's NSE publications in 2005. Discipline output ranged from a high of 6.9% in earth and space science to a low of 3.0% in chemistry.

- The United States produces, by far, the largest number of NSE publications, with nearly one-third of the world's output.

- China, South Korea, Spain, and Brazil have seen the largest increase in NSE article output over the past ten years.

- The Canadian university sector accounts for more than 85% of Canadian NSE article output.

- Canada's level of international collaboration has grown from 32.9% of Canadian NSE articles in 1996 to 43.1% in 2005.

- Not surprisingly, the United States is Canada's major collaborator with more than one-fifth of Canadian publications in the NSE having an American co-author.

- Canada's level of international co-authorship is middle-of-the-road compared to many European countries, but much higher than that of the United States or Japan.

1. Introduction

One of the first tangible outcomes of an investment in R&D is a publication in a scientific or engineering journal, especially in the university sector. The worldwide culture of university research places a great deal of importance on publishing new discoveries and advances in widely-circulated journals. Investment in this very public forum gives the country's researchers access to the latest international research and the ability to build on this research.

This report presents a summary of Canadian publication output, international comparisons and rankings, and Canadian international collaborations occurring through joint publications with foreign authors. The data presented in this report has been generated by the Observatoire des sciences et des technologies (OST) of Montreal, Quebec. The OST specializes in producing a clean database of Canadian publications from the Science Citation Index (SCI) produced by the Institute for Scientific Information (Thomson ISI).

NSERC (Natural Sciences and Engineering Research Council of Canada)

Canada's prosperity depends upon people, knowledge and innovation, especially in science and technology, as we transform our economy from one based on commodities to one based on value-added products in all sectors. Science and technology will also continue to enhance our quality of life by helping us improve the management of our resources, environment, public education and health system.

NSERC is the primary federal agency investing in research and research training in the natural sciences and engineering disciplines. It is funded directly by Parliament and reports to it through the Minister of Industry.

Our mission is to invest in people, discovery and innovation to build a strong Canadian economy and to improve the quality of life for all Canadians. NSERC advances government-wide priorities of building a stronger Canada, creating opportunities for young Canadians and investing in knowledge and creativity.

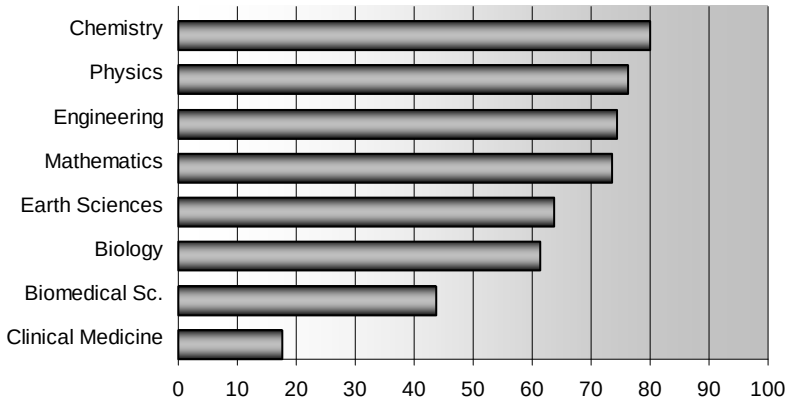
The agency's ultimate objective is to advance Canada's prosperity and high quality of life by supporting the creation and transfer of knowledge in the natural sciences and engineering (NSE) in Canada, and by ensuring people are trained to use and create that knowledge. To achieve this, NSERC supports research in Canadian universities and colleges that meets the highest international standards of excellence and supports the education of young people in that research.

As a result, Canada has access to leading-edge science and technology from around the world and highly-qualified experts. Partnerships with industry connect researchers with those who can use the new knowledge productively and enhance Canada's capacity for innovation. Innovation

contributes to wealth creation in the economy, which produces prosperity. New knowledge in NSE also enhances our quality of life through its impact on many policies, regulations, practices and institutions.

In a previous comprehensive study of publications and their relationship to NSERC-funded professors (see http://www.nserc.gc.ca/about/bibliometric_e.htm) it was determined that NSERC-funded professors are by far, the major contributors to Canada's science and engineering publication output. NSERC accomplishes this by funding a critical mass of professors and students in all disciplines of the natural sciences and engineering. This ensures that Canada has access to world knowledge produced in all fields and that the country's researchers can quickly participate in new emerging areas. When publications were examined by discipline (see Figure 1) it was shown that for nearly every major field NSERC-funded professors were responsible for a majority of publications. For this reason, the review of national output as contained in this report can be correlated to NSERC-funding.

Figure 1
NSERC-Funded Share of Canadian Publications by Field
1996-99 (%)



Source: Observatoire des Sciences et des Technologies

Methodology

The Science Citation Index comprises eight major discipline groupings: biology, biomedical research, clinical medicine, chemistry, earth and space science, engineering, mathematics, and physics. For the purposes of this study, the analysis will focus on the natural sciences and engineering (NSE) and therefore exclude the clinical medicine discipline category. (Note: for the biomedical sciences and clinical medicine disciplines the Canadian Institutes of Health Research are major supporters.)

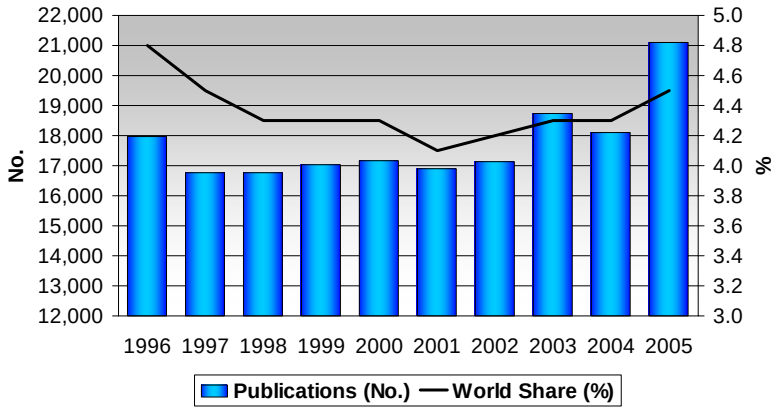
Unless otherwise mentioned, the numbers presented in this report are based on the whole count method, whereby a single article can be counted more than once. For example, an article with an author from Canada and the U.S. would be counted as one article for Canada and one article for the U.S. A similar counting method is used when assigning articles to sectors (e.g. university, industry, government, etc.).

2. Canadian Publications

2.1 Output and International Ranking by Field

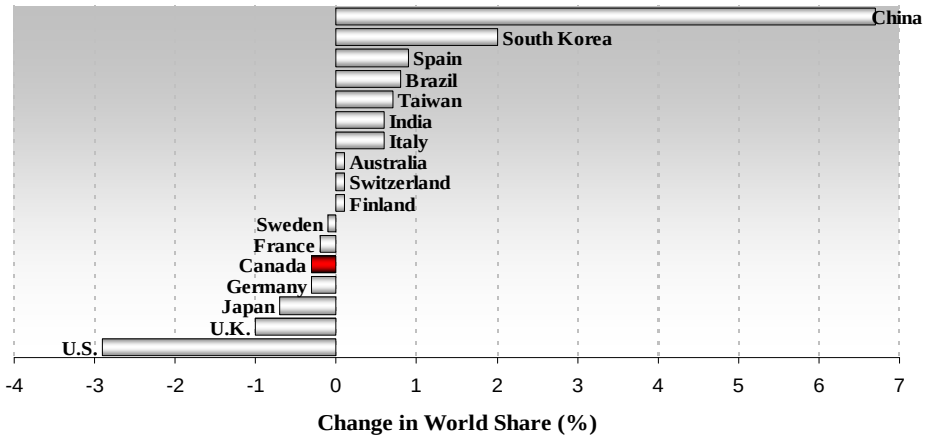
Canada is among an elite group of countries publishing a significant number of articles in science and engineering journals. Canadian researchers (all sectors) in the natural sciences and engineering (NSE) have been publishing roughly 17,000 to 18,000 journal articles per year over the past decade, but this number has jumped to 21,000 papers in 2005 as shown in Figure 2. Overall, Canada's world share of NSE papers has been climbing back since the low of 4.1% in 2001 and now stands at 4.5% in 2005. However, the 2005 figure is still below the 4.8% world share in 1996. As shown in Figure 3, Canada's performance in NSE article production versus many of our major competitors has been similar, as most industrialized countries lose publication share to developing countries such as China, India and Brazil. Since there could be a significant time delay (up to 6 six years) to publishing after an increase in research funding, the upswing of Canada's publications and world share of publications seen in 2005 may be the first signs of the impact of the additional investments in university research over the past several years.

Figure 2
Number of Canadian Publications in the NSE and World Share



Source: Observatoire des sciences et des technologies

Figure 3
Change in World Share of NSE Publications
2005 vs. 1996



Source: Observatoire des sciences et des technologies

Table 1 presents Canadian article production by field while Table 2 presents the world numbers. Although biomedical research is the largest contributor to Canadian NSE paper production, this is due mainly to the publishing traditions of that discipline. Readers must evaluate each discipline separately and try not to partake in cross-disciplinary comparisons when not warranted. Table 3 and Figure 4 provide a better picture of Canadian disciplinary output when comparisons to world production are presented. Canadian shares of world production are highest in earth and space science and biology, and at much lower levels in physics and chemistry. The Canadian share of world papers for physics and mathematics has inched up slightly, remained stable for biomedical research and has fallen for all other fields over the past decade.

Table 1

Canadian Papers by Field in the NSE, 1996-2005

Discipline	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Biology	3,261	2,994	2,868	2,848	3,088	2,814	2,949	3,040	3,112	3,532
Biomedical Research	4,488	4,242	4,452	4,572	4,315	4,459	4,331	4,713	4,435	4,946
Chemistry	2,491	2,263	2,254	2,275	2,277	2,169	2,102	2,436	2,322	2,811
Earth and Space Science	2,376	2,133	2,165	2,283	2,288	2,315	2,361	2,492	2,472	2,755
Engineering and Technology	2,161	2,113	2,136	2,277	2,277	2,274	2,349	2,712	2,581	3,114
Mathematics	604	528	570	602	622	602	620	738	682	805
Physics	2,588	2,482	2,322	2,193	2,285	2,259	2,418	2,605	2,482	3,123
NSE Total	**17,969**	**16,755**	**16,767**	**17,050**	**17,152**	**16,892**	**17,130**	**18,736**	**18,086**	**21,086**

Source : Observatoire des sciences et des technologies, SCI database.

Table 2

World Papers by Field in the NSE, 1996-2005

Discipline	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Biology	41,386	41,709	43,288	42,899	46,030	45,369	47,497	50,142	47,320	53,457
Biomedical Research	89,309	89,459	93,274	92,157	92,717	92,368	89,129	95,412	91,453	97,995
Chemistry	72,491	71,327	75,371	76,860	77,015	77,853	76,742	83,697	82,960	93,298
Earth and Space Science	30,824	29,694	30,499	32,688	33,044	35,436	34,572	38,720	36,695	39,807
Engineering and Technology	43,834	46,285	49,569	52,471	55,429	60,401	58,550	64,321	61,382	71,240
Mathematics	9,998	9,815	11,602	12,403	14,002	14,331	13,653	15,299	13,687	15,073
Physics	84,826	83,349	85,438	87,230	85,182	87,278	84,804	92,698	86,769	97,093
NSE Total	**372,668**	**371,638**	**389,041**	**396,708**	**403,419**	**413,036**	**404,947**	**440,289**	**420,266**	**467,963**

Source : Observatoire des sciences et des technologies, SCI database.

Table 3

Canadian Share of World Papers by Field in the NSE, 1996-2005 (%)

Discipline	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Biology	7.9	7.2	6.6	6.6	6.7	6.2	6.2	6.1	6.6	6.6
Biomedical Research	5.0	4.7	4.8	5.0	4.7	4.8	4.9	4.9	4.8	5.0
Chemistry	3.4	3.2	3.0	3.0	3.0	2.8	2.7	2.9	2.8	3.0
Earth and Space Science	7.7	7.2	7.1	7.0	6.9	6.5	6.8	6.4	6.7	6.9
Engineering and Technology	4.9	4.6	4.3	4.3	4.1	3.8	4.0	4.2	4.2	4.4
Mathematics	6.0	5.4	4.9	4.9	4.4	4.2	4.5	4.8	5.0	5.3
Physics	3.1	3.0	2.7	2.5	2.7	2.6	2.9	2.8	2.9	3.2
NSE Total	**4.8**	**4.5**	**4.3**	**4.3**	**4.3**	**4.1**	**4.2**	**4.3**	**4.3**	**4.5**

Source : Observatoire des sciences et des technologies, SCI database.

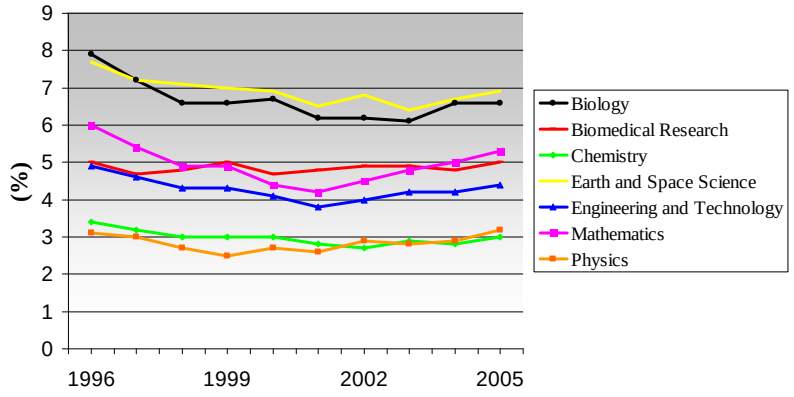
Table 4

Canada's Ranking in Share of World Papers by Field in the NSE, 1996-2005 (Rank)

Discipline	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Biology	4	4	4	4	4	5	5	5	4	5
Biomedical Research	6	6	6	6	6	6	6	6	6	6
Chemistry	11	11	11	11	11	11	12	12	12	12
Earth and Space Science	5	5	5	5	5	5	5	5	5	5
Engineering and Technology	6	7	7	7	7	9	8	8	8	8
Mathematics	5	5	6	7	9	10	9	9	8	7
Physics	9	9	11	13	12	13	12	13	12	11
NSE Total	**7**	**7**	**7**	**7**	**8**	**9**	**9**	**9**	**8**	**7**

Source : Observatoire des sciences et des technologies, SCI database.

Figure 4
World Share of Canadian Publications in the NSE by Field



Source: Observatoire des sciences et des technologies

World article production in the NSE has averaged roughly 400,000 articles per year, with a significant increase in 2005 as more journals were included in the dataset (see Table 2). Table 5 presents the number of publications by country for those countries producing more than 3,000 papers in 2005. The share of world NSE article production for the same set of countries is presented in Table 6 (as ranked by 2005 output). U.S. dominance is clearly evident as that country produces nearly one-third of NSE articles in any given year. The next closest output is from Japan at only one-third the size of the U.S. output (see Figure 5 for world share of NSE publications for the top 10 countries after the U.S.). Canada ranked in 7th position in 2005, improving from its 9th place showing in 2001 to 2003 and remaining in the same spot as in 1996. Over this ten-year period, Canada was overtaken by China in the rankings, while Canada surpassed Russia. Spain, India and South Korea are closing in on Canada and it wouldn't be surprising to see these countries pass Canada in the next ten years. Canada's rankings by discipline are presented in Table 4. In 2005, Canada's disciplinary rankings ranged from a high of 5th spot for biology and earth and space sciences to a low of 12th position in chemistry.

The top ten countries for NSE article production in 2005 by region and economic status are shown in Tables 7 and 8, respectively. Western Europe has the largest number of strong (>1.0% share) performers while African output ranks poorly. The lower-middle and low income groups include some major contributors such as China, India and Brazil.

Table 5
Number of World Papers in the NSE by Country, 1996-2005

Rank	Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	United States	121,218	118,841	120,650	121,206	122,923	125,766	122,901	133,479	126,930	138,503
2	Japan	37,786	37,851	41,550	42,843	42,991	45,093	42,516	47,181	42,353	44,110
3	China	8,563	10,891	12,122	14,425	18,296	20,980	23,591	28,837	32,180	42,117
4	Germany	33,497	34,990	37,634	37,935	37,860	38,349	36,409	39,021	36,108	40,803
5	United Kingdom	31,744	30,847	32,943	33,721	34,437	33,680	32,423	34,527	32,504	34,974
6	France	25,949	26,570	28,447	28,987	28,883	29,722	28,564	30,668	28,081	31,758
7	**Canada**	**17,969**	**16,755**	**16,767**	**17,050**	**17,152**	**16,892**	**17,130**	**18,736**	**18,086**	**21,086**
8	Italy	14,511	14,754	15,873	16,699	16,970	18,201	17,885	19,948	18,994	20,854
9	Russia	20,398	20,821	20,536	19,900	21,297	19,271	18,948	19,110	17,541	18,252
10	Spain	10,668	11,360	12,239	13,299	13,509	14,460	14,600	15,605	15,447	17,682
11	South Korea	4,715	5,644	6,923	7,940	8,899	10,251	11,079	12,847	13,277	15,381
12	India	9,137	8,663	9,434	9,791	9,506	10,520	10,918	11,919	12,118	14,081
13	Australia	9,682	9,896	10,584	10,801	10,714	11,077	10,801	11,853	11,266	12,796
14	Netherlands	8,722	8,835	9,016	9,043	9,191	9,326	9,149	9,701	9,269	10,316
15	Switzerland	6,749	7,256	7,432	7,813	7,840	7,694	7,524	8,365	8,089	8,976
16	Taiwan	4,561	4,731	5,232	5,521	5,865	6,685	6,490	7,323	7,543	8,836
17	Brazil	3,714	4,207	4,993	5,587	5,945	6,844	6,944	7,660	7,778	8,499
18	Sweden	6,800	6,684	7,172	7,383	7,439	8,138	7,797	8,056	7,643	8,290
19	Poland	5,321	5,292	5,810	6,146	6,356	6,799	6,957	7,640	7,317	8,100
20	Belgium	4,717	4,681	4,977	5,262	5,112	5,430	5,535	6,106	5,808	6,750
21	Israel	4,453	4,675	4,912	4,776	5,126	5,120	5,055	5,368	4,884	5,266
22	Turkey	1,419	1,546	1,713	1,995	2,158	2,554	3,031	3,725	4,396	4,610
23	Denmark	3,528	3,829	4,104	4,189	4,305	4,409	4,182	4,484	4,168	4,441
24	Mexico	2,039	2,247	2,686	2,925	3,066	3,403	3,448	3,840	3,862	4,219
25	Austria	2,764	3,006	3,121	3,299	3,394	3,720	3,611	3,972	3,791	4,193
26	Finland	2,887	2,946	3,228	3,469	3,687	3,836	3,768	4,010	3,741	4,053
27	Czech Republic	2,578	2,520	2,734	2,739	2,820	3,039	3,104	3,346	3,324	3,862
28	Singapore	1,052	1,203	1,480	1,871	2,205	2,481	2,614	2,947	3,131	3,639
29	Portugal	1,222	1,381	1,620	1,996	2,179	2,510	2,532	3,089	3,210	3,538
30	Greece	2,008	2,074	2,345	2,431	2,534	2,933	2,921	3,114	3,082	3,478
31	Argentina	2,063	2,208	2,365	2,518	2,658	2,854	2,978	3,001	2,798	3,238
32	Norway	2,138	2,210	2,412	2,386	2,497	2,604	2,526	2,625	2,750	3,047
	World	372,668	371,638	389,041	396,708	403,419	413,036	404,947	440,289	420,266	467,963

Rank is based on the number of papers in 2005. Only countries with more than 3,000 papers in 2005 are shown.
Source : Observatoire des sciences et des technologies, SCI database.

Table 6

Share of World Papers in the NSE by Country, 1996-2005 (%)

Rank	Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	United States	32.5	32.0	31.0	30.6	30.5	30.4	30.3	30.3	30.2	29.6
2	Japan	10.1	10.2	10.7	10.8	10.7	10.9	10.5	10.7	10.1	9.4
3	China	2.3	2.9	3.1	3.6	4.5	5.1	5.8	6.5	7.7	9.0
4	Germany	9.0	9.4	9.7	9.6	9.4	9.3	9.0	8.9	8.6	8.7
5	United Kingdom	8.5	8.3	8.5	8.5	8.5	8.2	8.0	7.8	7.7	7.5
6	France	7.0	7.1	7.3	7.3	7.2	7.2	7.1	7.0	6.7	6.8
7	**Canada**	**4.8**	**4.5**	**4.3**	**4.3**	**4.3**	**4.1**	**4.2**	**4.3**	**4.3**	**4.5**
8	Italy	3.9	4.0	4.1	4.2	4.2	4.4	4.4	4.5	4.5	4.5
9	Russia	5.5	5.6	5.3	5.0	5.3	4.7	4.7	4.3	4.2	3.9
10	Spain	2.9	3.1	3.1	3.4	3.3	3.5	3.6	3.5	3.7	3.8
11	South Korea	1.3	1.5	1.8	2.0	2.2	2.5	2.7	2.9	3.2	3.3
12	India	2.5	2.3	2.4	2.5	2.4	2.5	2.7	2.7	2.9	3.0
13	Australia	2.6	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
14	Netherlands	2.3	2.4	2.3	2.3	2.3	2.3	2.3	2.2	2.2	2.2
15	Switzerland	1.8	2.0	1.9	2.0	1.9	1.9	1.9	1.9	1.9	1.9
16	Taiwan	1.2	1.3	1.3	1.4	1.5	1.6	1.6	1.7	1.8	1.9
17	Brazil	1.0	1.1	1.3	1.4	1.5	1.7	1.7	1.7	1.9	1.8
18	Sweden	1.8	1.8	1.8	1.9	1.8	2.0	1.9	1.8	1.8	1.8
19	Poland	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.7	1.7
20	Belgium	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4
21	Israel	1.2	1.3	1.3	1.2	1.3	1.2	1.2	1.2	1.2	1.1
22	Turkey	0.4	0.4	0.4	0.5	0.5	0.6	0.7	0.8	1.0	1.0
23	Denmark	0.9	1.0	1.1	1.1	1.1	1.1	1.0	1.0	1.0	0.9
24	Mexico	0.5	0.6	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9
25	Austria	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9
26	Finland	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9
27	Czech Republic	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8
28	Singapore	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8
29	Portugal	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.8	0.8
30	Greece	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7
31	Argentina	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7
32	Norway	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7

Source : Observatoire des sciences et des technologies, SCI database.

Table 7

Top 10 Countries by Region, World Share of NSE Papers, 2005 (%)

Rank	Americas	(%)	Western Europe	(%)	Eastern Europe	(%)	Oceania/ Asia	(%)	Africa	(%)	Middle East	(%)
1	United States	29.60	Germany	8.72	Russia	3.90	Japan	9.43	South Africa	0.49	Israel	1.13
2	**Canada**	**4.51**	United Kingdom	7.47	Poland	1.73	China	9.00	Egypt	0.35	Turkey	0.99
3	Brazil	1.82	France	6.79	Czech Republic	0.83	South Korea	3.29	Tunisia	0.13	Iran	0.54
4	Mexico	0.90	Italy	4.46	Ukraine	0.63	India	3.01	Morocco	0.13	Saudi Arabia	0.10
5	Argentina	0.69	Spain	3.78	Hungary	0.62	Australia	2.73	Algeria	0.11	Jordan	0.06
6	Chile	0.39	Netherlands	2.20	Romania	0.30	Taiwan	1.89	Nigeria	0.06	United Arab Emir	0.05
7	Venezuela	0.13	Switzerland	1.92	Slovakia	0.27	Singapore	0.78	Kenya	0.06	Lebanon	0.04
8	Colombia	0.10	Sweden	1.77	Slovenia	0.25	New-Zealand	0.56	Cameroon	0.04	Kuwait	0.03
9	Cuba	0.07	Belgium	1.44	Bulgaria	0.24	Thailand	0.28	Senegal	0.02	Cyprus	0.03
10	Uruguay	0.05	Denmark	0.95	Croatia	0.17	Malaysia	0.15	Ethiopia	0.02	Oman	0.03

Source : Observatoire des sciences et des technologies, SCI database.

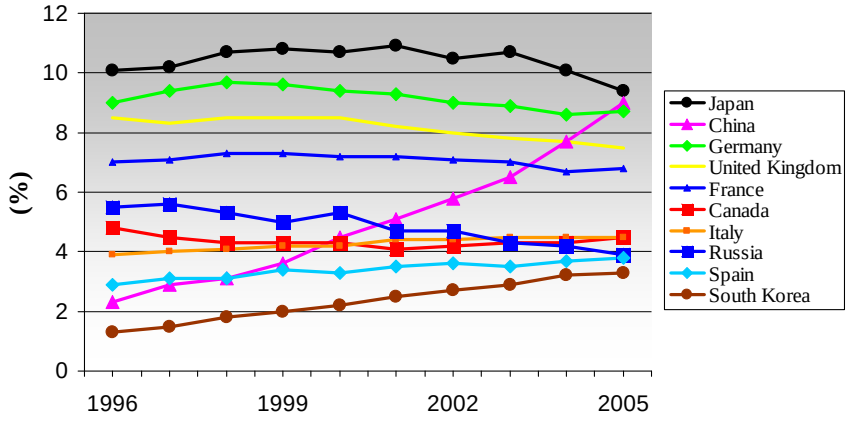
Table 8

Top 10 Countries by Economic Classification, World Share of NSE Papers, 2005 (%)

Rank	High Income	(%)	Upper-Middle Income	(%)	Lower-Middle Income	(%)	Low Income	(%)
1	United States	29.60	Russia	3.90	China	9.00	India	3.01
2	Japan	9.43	Poland	1.73	Brazil	1.82	Pakistan	0.11
3	Germany	8.72	Turkey	0.99	Ukraine	0.63	Vietnam	0.07
4	United Kingdom	7.47	Mexico	0.90	Iran	0.54	Nigeria	0.06
5	France	6.79	Czech Republic	0.83	Egypt	0.35	Kenya	0.06
6	**Canada**	**4.51**	Argentina	0.69	Romania	0.30	Bangledesh	0.05
7	Italy	4.46	Hungary	0.62	Thailand	0.28	Uzbekistan	0.05
8	Spain	3.78	South Africa	0.49	Bulgaria	0.24	Cameroon	0.04
9	Australia	2.73	Chile	0.39	Tunisia	0.13	Moldova	0.03
10	Netherlands	2.20	Slovakia	0.27	Morocco	0.13	Senegal	0.02

Source : Observatoire des sciences et des technologies, SCI database.

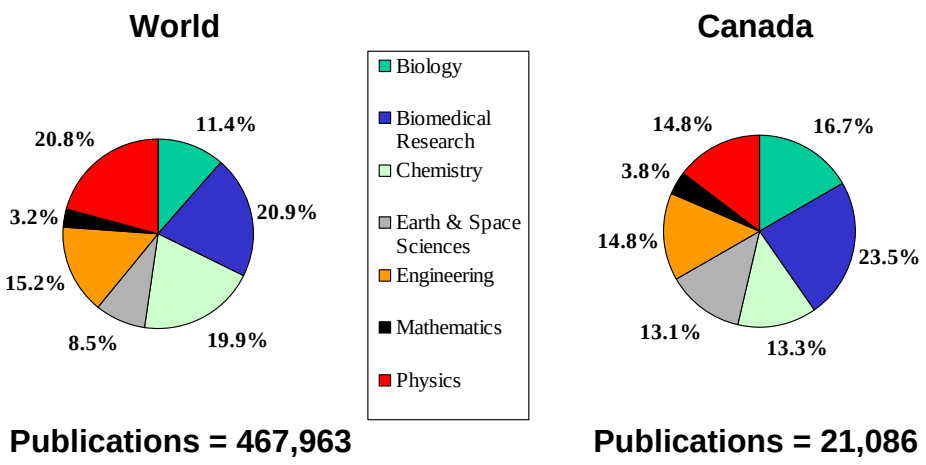
Figure 5
World Share of Publications in the NSE for Select Countries



Source: Observatoire des sciences et des technologies

Countries do not tend to publish equally in all fields and their output can vary widely. Figure 6 compares world publications by field against Canada's distribution for 2005. As shown in the figure, Canadian publications appear in higher proportions for the fields of biology, biomedical research, mathematics and earth and space sciences as compared to the world distribution. Table 9 presents the number of publications by field for the group of countries producing more than 3,000 papers in the NSE in 2005. To measure the country differences in field publications an index referred to as the "specialization index" is often used. The index is a ratio of papers in a given country and field divided by the same ratio for the world total. For example, from Table 9 it shows that in 2005 Canada produced 3,532 papers in biology or 16.8% of the Canadian NSE total versus a world share in biology of 11.4%. The specialization index for Canada in biology would therefore be 0.168/0.114 = 1.47. An index value of greater than 1.0 indicates that a country is more specialized in a given field than the world average. For Canada in 2005, the fields of specialization included biology, biomedical research, earth and space science, and mathematics. The specialization index values by field for G7 countries is presented in Figure 7. The U.S. was "specialized" in the same fields as Canada in 2005, but to different degrees.

Figure 6
Distribution of Publications by Field, Canada and the World, 2005



Source: Observatoire des sciences et des technologies

Table 9
Number of World Papers in the NSE by Country and Field, 2005

Rank	Country	Biology	Biomedical Research	Chemistry	Earth & Space Space Sci.	Engineering	Mathematics	Physics	NSE
1	United States	16,451	39,854	19,118	15,475	17,947	4,675	24,983	138,503
2	Japan	4,081	8,845	9,680	2,602	7,637	726	10,539	44,110
3	China	2,547	4,372	11,529	2,244	8,750	1,441	11,234	42,117
4	Germany	3,575	8,437	7,847	4,072	4,271	1,324	11,277	40,803
5	United Kingdom	3,966	9,005	5,085	4,610	4,521	1,005	6,782	34,974
6	France	2,681	6,219	5,536	3,718	3,773	1,805	8,026	31,758
7	**Canada**	**3,532**	**4,946**	**2,811**	**2,755**	**3,114**	**805**	**3,123**	**21,086**
8	Italy	1,786	3,991	3,627	2,354	2,562	878	5,656	20,854
9	Russia	634	1,546	4,835	1,718	1,505	684	7,330	18,252
10	Spain	2,861	2,913	4,199	1,645	1,932	704	3,428	17,682
11	South Korea	795	2,483	2,854	683	4,499	312	3,755	15,381
12	India	1,067	2,213	4,426	980	2,135	197	3,063	14,081
13	Australia	3,066	2,719	1,498	1,970	1,518	358	1,667	12,796
14	Netherlands	1,363	2,673	1,580	1,347	1,198	223	1,932	10,316
15	Switzerland	764	2,088	1,574	1,124	892	227	2,307	8,976
16	Taiwan	625	1,163	1,648	625	2,475	198	2,102	8,836
17	Brazil	1,268	1,689	1,606	633	922	278	2,103	8,499
18	Sweden	1,084	2,206	1,194	815	1,051	218	1,722	8,290
19	Poland	612	850	2,282	477	830	287	2,762	8,100
20	Belgium	972	1,508	1,184	615	790	201	1,480	6,750
21	Israel	572	1,202	709	356	692	340	1,395	5,266
22	Turkey	749	661	992	438	931	111	728	4,610
23	Denmark	845	1,261	574	506	390	102	763	4,441
24	Mexico	806	674	675	480	392	134	1,058	4,219
25	Austria	431	1,002	669	392	437	182	1,080	4,193
26	Finland	689	942	543	468	537	91	783	4,053
27	Czech Republic	414	673	916	298	449	127	985	3,862
28	Singapore	161	534	585	104	1,224	113	918	3,639
29	Portugal	482	568	780	301	572	138	697	3,538
30	Greece	518	490	614	378	591	129	758	3,478
31	Argentina	741	637	563	322	273	78	624	3,238
32	Norway	696	629	335	585	319	78	405	3,047
	World	53,457	97,995	93,298	39,807	71,240	15,073	97,093	467,963

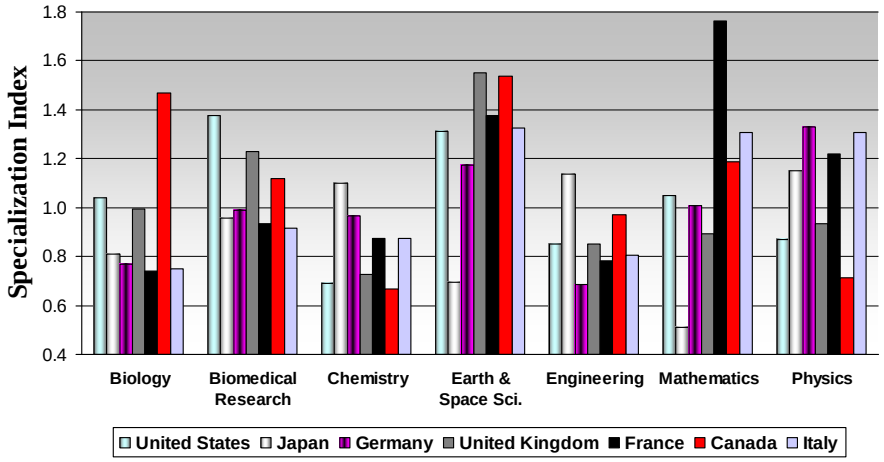
Rank is based on the number of papers in 2005. Only countries with more than 3,000 papers in 2005 are shown.
Source : Observatoire des sciences et des technologies, SCI database.

Table 10
Specialization Index for Select Countries, 2005

Rank	Country	Biology	Biomedical Research	Chemistry	Earth & Space Space Sci.	Engineering	Mathematics	Physics
1	United States	1.04	1.37	0.69	1.31	0.85	1.05	0.87
2	Japan	0.81	0.96	1.10	0.69	1.14	0.51	1.15
3	China	0.53	0.50	1.37	0.63	1.36	1.06	1.29
4	Germany	0.77	0.99	0.96	1.17	0.69	1.01	1.33
5	United Kingdom	0.99	1.23	0.73	1.55	0.85	0.89	0.93
6	France	0.74	0.94	0.87	1.38	0.78	1.76	1.22
7	**Canada**	**1.47**	**1.12**	**0.67**	**1.54**	**0.97**	**1.19**	**0.71**
8	Italy	0.75	0.91	0.87	1.33	0.81	1.31	1.31
9	Russia	0.30	0.40	1.33	1.11	0.54	1.16	1.94
10	Spain	1.42	0.79	1.19	1.09	0.72	1.24	0.93
11	South Korea	0.45	0.77	0.93	0.52	1.92	0.63	1.18
12	India	0.66	0.75	1.58	0.82	1.00	0.43	1.05
13	Australia	2.10	1.01	0.59	1.81	0.78	0.87	0.63
14	Netherlands	1.16	1.24	0.77	1.53	0.76	0.67	0.90
15	Switzerland	0.75	1.11	0.88	1.47	0.65	0.79	1.24
16	Taiwan	0.62	0.63	0.94	0.83	1.84	0.70	1.15
17	Brazil	1.31	0.95	0.95	0.88	0.71	1.02	1.19
18	Sweden	1.14	1.27	0.72	1.16	0.83	0.82	1.00
19	Poland	0.66	0.50	1.41	0.69	0.67	1.10	1.64
20	Belgium	1.26	1.07	0.88	1.07	0.77	0.92	1.06
21	Israel	0.95	1.09	0.68	0.79	0.86	2.00	1.28
22	Turkey	1.42	0.68	1.08	1.12	1.33	0.75	0.76
23	Denmark	1.67	1.36	0.65	1.34	0.58	0.71	0.83
24	Mexico	1.67	0.76	0.80	1.34	0.61	0.99	1.21
25	Austria	0.90	1.14	0.80	1.10	0.68	1.35	1.24
26	Finland	1.49	1.11	0.67	1.36	0.87	0.70	0.93
27	Czech Republic	0.94	0.83	1.19	0.91	0.76	1.02	1.23
28	Singapore	0.39	0.70	0.81	0.34	2.21	0.96	1.22
29	Portugal	1.19	0.77	1.11	1.00	1.06	1.21	0.95
30	Greece	1.30	0.67	0.89	1.28	1.12	1.15	1.05
31	Argentina	2.00	0.94	0.87	1.17	0.55	0.75	0.93
32	Norway	2.00	0.99	0.55	2.26	0.69	0.79	0.64

Rank is based on the number of papers in 2005. Only countries with more than 3,000 papers in 2005 are shown.
Source : Observatoire des sciences et des technologies, SCI database.

Figure 7
Specialization Index in the NSE for G7 Countries



Source: Observatoire des sciences et des technologies

Thompson ISI produces a slightly different version of publication output by field as compared to the OST. Table 11 highlights the world share of publications for 14 fields in the NSE for the 2001 to 2005 period for a select group of countries. Using the Thompson ISI field classification, Canadian publication production in the fields of biology and biochemistry, computer science, ecology/environment, geosciences, molecular biology/genetics, and plant and animal sciences outperform the other 8 fields.

Table 11
Share of World Publications by Field, 2001-05 - Thompson ISI Classification

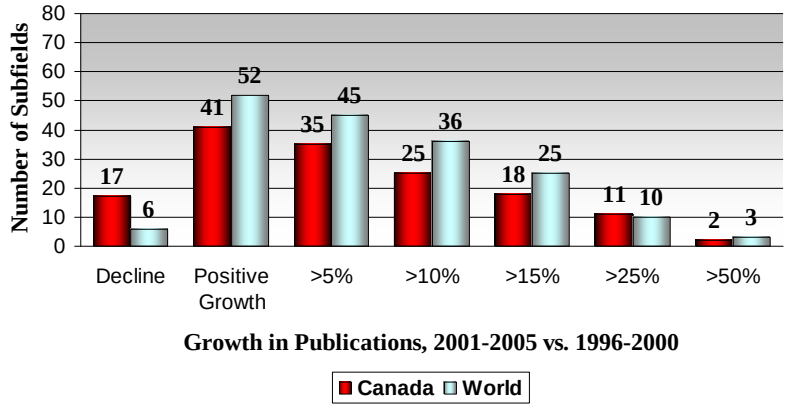
Country	Agricultural Sciences	Biology & Biochemistry	Chemistry	Computer Science	Ecology/ Environmental	Engineering	Geosciences	Materials Science	Mathematics	Microbiology	Molec. Bio./ Genetics	Physics	Plant & Animal Sciences	Space Science
Australia	4.01	2.91	1.69	2.41	4.67	2.27	5.02	1.80	2.19	2.94	2.79	1.60	5.30	4.42
Austria	0.64	0.93	0.83	1.00	0.88	0.71	1.11	0.80	1.09	1.04	0.99	1.00	1.00	1.09
Belgium	1.45	1.46	1.27	1.24	1.68	1.32	1.07	1.04	1.41	2.15	1.47	1.36	1.75	1.66
Brazil	3.51	1.82	1.63	0.92	1.79	1.23	1.40	1.48	1.77	2.31	1.45	2.24	2.42	1.90
Canada	**4.23**	**5.08**	**3.01**	**5.53**	**7.20**	**4.65**	**7.36**	**2.95**	**4.86**	**4.19**	**5.41**	**2.68**	**6.37**	**4.58**
China	2.71	2.86	9.64	6.25	4.45	7.62	6.52	12.72	9.58	2.74	2.26	10.26	3.00	4.23
Denmark	1.58	1.74	0.71	0.69	1.68	0.68	1.33	0.37	0.67	1.71	1.09	0.79	1.57	1.33
England	4.47	7.78	5.42	5.74	7.14	6.66	9.60	5.38	5.50	8.31	9.42	5.79	6.25	14.28
Finland	1.05	1.12	0.69	1.06	1.93	0.79	0.94	0.73	0.68	1.09	1.07	0.74	1.17	1.36
France	4.97	6.60	6.14	5.27	4.59	5.46	9.08	5.71	11.82	7.52	7.64	8.24	4.96	10.83
Germany	6.24	7.75	8.99	6.67	6.09	6.25	9.73	8.56	8.90	9.22	10.09	11.26	7.15	14.95
Ireland	1.06	0.38	0.29	0.40	0.31	0.37	0.36	0.35	0.44	0.67	0.30	0.35	0.48	0.50
Israel	0.58	1.27	0.83	2.06	0.91	1.13	0.73	0.61	2.54	1.03	1.46	1.43	1.09	1.39
Italy	3.61	4.27	4.28	5.13	3.07	4.81	4.82	2.63	5.84	3.48	4.63	5.31	3.08	10.70
Japan	9.80	10.71	11.31	8.14	3.99	9.45	6.59	14.28	5.60	9.70	9.98	13.99	7.56	6.69
Mexico	1.41	0.69	0.64	n/a	1.27	0.60	0.94	0.83	0.77	1.08	0.42	1.09	1.48	2.11
Netherlands	2.38	2.58	1.86	2.14	2.97	1.95	2.60	1.14	1.64	2.46	2.82	1.86	2.55	5.20
Norway	0.87	0.66	0.37	0.47	1.35	0.45	1.87	0.27	0.58	0.62	0.58	0.35	1.34	0.52
Russia	1.17	2.17	5.75	0.66	1.09	2.89	7.61	3.14	4.80	1.49	2.32	8.01	1.48	7.33
South Korea	2.02	2.00	2.84	5.25	1.61	4.43	1.06	5.81	1.87	2.43	1.20	4.37	1.27	1.04
Spain	5.73	3.03	4.26	2.72	3.65	2.65	2.66	2.89	4.86	4.58	2.76	3.18	4.04	6.10
Sweden	1.35	2.70	1.49	1.27	3.07	1.63	1.95	1.62	1.33	2.21	2.22	1.68	2.03	1.87
Switzerland	1.18	1.91	1.84	1.36	2.06	1.65	2.51	1.13	1.37	2.14	2.56	2.23	1.65	2.46
Taiwan	1.23	0.98	1.72	4.22	1.56	3.81	1.05	3.14	1.30	1.22	0.71	2.22	0.84	0.62
UK	5.84	9.32	6.24	6.67	8.66	7.77	11.12	6.03	6.53	10.31	11.19	6.56	8.26	16.28

Source: Thompson ISI Sci-Bytes

2.2 Output by Subfield

The 7 fields of NSE presented in the previous section are broken down further into 65 subfields by the OST. Table 12 presents the number of publications for the 65 subfields for Canada and the world for two 5-year time periods, 1996-2000 and 2001-2005. In addition, Table 12 highlights the Canadian share of world publications by subfield and the resulting specialization indices. Figure 8 presents the number of subfields and the growth rates in publications for the two time periods in question. The analysis is limited to the 58 subfields in which Canada produced a minimum of 250 publications over the 5-year period. As the figure indicates, Canadian production in 17 subfields actually declined from 2001-2005 to 1996-2000 versus only 6 subfields for the world. The eleven subfields in which Canadian production declined but world production increased include: agriculture & food science, dairy & animal science, entomology, general zoology, marine biology & hydrobiology, genetics & heredity, general chemistry, metals & metallurgy, nuclear technology, applied physics and chemical physics. At the opposite end of the scale, the eleven subfields where Canadian growth in publications exceeded 25% include: ecology, mechanical engineering, general biology, computers, chemical engineering, astronomy & astrophysics, fluids & plasmas, optics, miscellaneous biology, miscellaneous mathematics, miscellaneous engineering & technology.

Figure 8
Publication Growth in Subfields of the NSE, Canada and the World, 2001-2005 vs. 1996-2000



Source: Observatoire des Sciences et des Technologies. Only includes subfields in which Canada produces 250 publications in the 5-year period.

Table 12
Canadian Publications by Subfield for Years 1996-2000 and 2001-2005

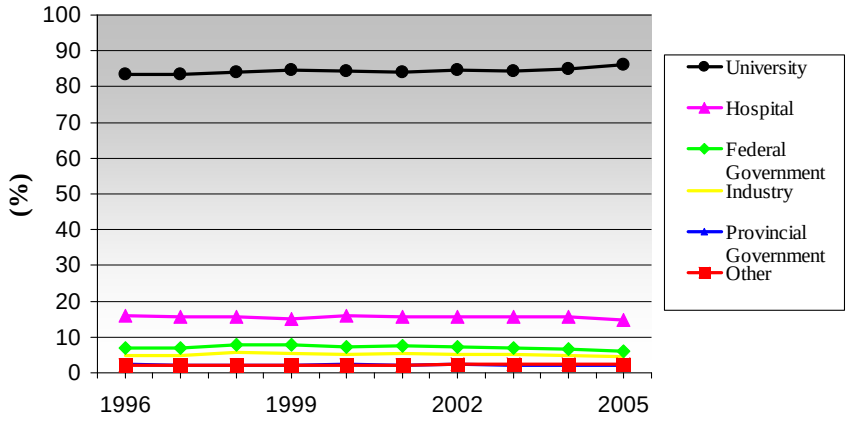
Field/Subfield	Canada			World			Canada's World Share (%)		Canada Specialization Index	
	1996-2000	2001-2005	% Growth	1996-2000	2001-2005	% Growth	1996-2000	2001-2005	1996-2000	2001-2005
Biology	**15,059**	**15,447**	**2.6**	**215,312**	**243,785**	**13.2**	**7.0**	**6.3**	**1.58**	**1.48**
Agricult & Food Science	3,615	3,457	-4.4	50,206	57,466	14.5	7.2	6.0	1.62	1.40
Botany	3,257	3,261	0.1	59,128	61,516	4.0	5.5	5.3	1.24	1.24
Dairy & Animal Science	1,175	1,151	-2.0	13,584	13,986	3.0	8.6	8.2	1.95	1.92
Ecology	1,306	1,886	44.4	20,519	26,000	26.7	6.4	7.3	1.44	1.69
Entomology	1,001	911	-9.0	14,181	15,705	10.7	7.1	5.8	1.59	1.35
General Biology	413	570	38.0	5,700	7,298	28.0	7.2	7.8	1.63	1.82
General Zoology	905	780	-13.8	10,498	12,133	15.6	8.6	6.4	1.95	1.50
Marine Biology & Hydrobiology	2,541	2,322	-8.6	29,053	31,753	9.3	8.7	7.3	1.97	1.71
Miscellaneous Biology	208	479	130.3	3,966	9,991	151.9	5.2	4.8	1.18	1.12
Miscellaneous Zoology	638	630	-1.3	8,477	7,937	-6.4	7.5	7.9	1.70	1.85
Biomedical Research	**22,069**	**22,884**	**3.7**	**456,916**	**466,357**	**2.1**	**4.8**	**4.9**	**1.09**	**1.15**
Anatomy & Morphology	124	84	-32.3	3,570	3,159	-11.5	3.5	2.7	0.78	0.62
Biochemistry & Molecular Biology	8,141	8,498	4.4	167,884	170,146	1.3	4.8	5.0	1.09	1.17
Biomedical Engineering	792	872	10.1	18,297	21,532	17.7	4.3	4.0	0.98	0.95
Biophysics	348	403	15.8	6,460	7,327	13.4	5.4	5.5	1.22	1.28
Cellular Biology Cytology & Histology	1,216	1,272	4.6	27,389	28,931	5.6	4.4	4.4	1.00	1.03
Embryology	262	300	14.5	6,258	6,637	6.1	4.2	4.5	0.94	1.06
General Biomedical Research	2,043	2,032	-0.5	60,423	55,505	-8.1	3.4	3.7	0.76	0.85
Genetics & Heredity	2,931	2,906	-0.9	48,074	48,092	0.0	6.1	6.0	1.38	1.41
Microbiology	1,776	1,942	9.3	37,515	42,226	12.6	4.7	4.6	1.07	1.07
Microscopy	104	84	-19.2	2,726	2,457	-9.9	3.8	3.4	0.86	0.80
Miscellaneous Biomedical Research	421	495	17.6	10,448	12,070	15.5	4.0	4.1	0.91	0.96
Nutrition & Dietetic	628	715	13.9	13,059	14,967	14.6	4.8	4.8	1.09	1.12
Parasitology	325	278	-14.5	8,825	8,440	-4.4	3.7	3.3	0.83	0.77
Physiology	2,303	2,259	-1.9	29,398	26,780	-8.9	7.8	8.4	1.77	1.97
Virology	655	744	13.6	16,590	18,088	9.0	3.9	4.1	0.89	0.96
Chemistry	**11,560**	**11,840**	**2.4**	**373,064**	**414,550**	**11.1**	**3.1**	**2.9**	**0.70**	**0.67**
Analytical Chemistry	1,419	1,349	-4.9	45,747	44,667	-2.4	3.1	3.0	0.70	0.71
Applied Chemistry	190	194	2.1	5,528	6,183	11.8	3.4	3.1	0.78	0.73
General Chemistry	2,537	2,442	-3.7	77,571	85,952	10.8	3.3	2.8	0.74	0.66
Inorganic & Nuclear Chemistry	757	827	9.2	29,103	32,975	13.3	2.6	2.5	0.59	0.59
Organic Chemistry	2,018	2,024	0.3	66,390	73,946	11.4	3.0	2.7	0.69	0.64
Physical Chemistry	3,463	3,643	5.2	112,038	129,522	15.6	3.1	2.8	0.70	0.66
Polymers	1,176	1,361	15.7	36,687	41,305	12.6	3.2	3.3	0.72	0.77
Earth and Space	**11,245**	**12,395**	**10.2**	**156,749**	**185,230**	**18.2**	**7.2**	**6.7**	**1.62**	**1.56**
Astronomy & Astrophysics	1,619	2,083	28.7	36,459	43,126	18.3	4.4	4.8	1.00	1.13
Earth & Planetary Science	2,879	3,030	5.2	35,377	41,275	16.7	8.1	7.3	1.84	1.71
Environmental Science	2,646	3,082	16.5	36,098	44,113	22.2	7.3	7.0	1.65	1.63
Geology	2,390	2,426	1.5	24,126	28,025	16.2	9.9	8.7	2.24	2.02
Meteorology & Atmospheric Science	1,013	1,018	0.5	14,256	16,292	14.3	7.1	6.2	1.60	1.46
Oceanography & Limnology	698	756	8.3	10,433	12,399	18.8	6.7	6.1	1.51	1.42
Engineering and Technology	**10,964**	**13,030**	**18.8**	**247,588**	**315,894**	**27.6**	**4.4**	**4.1**	**1.00**	**0.96**
Aerospace Technology	252	272	7.9	8,545	8,663	1.4	2.9	3.1	0.67	0.73
Chemical Engineering	1,360	1,760	29.4	23,865	31,049	30.1	5.7	5.7	1.29	1.32
Civil Engineering	821	881	7.3	7,451	10,611	42.4	11.0	8.3	2.49	1.94
Computers	1,340	1,783	33.1	24,975	30,441	21.9	5.4	5.9	1.21	1.37
Electrical Engineering & Electronics	2,555	3,028	18.5	56,635	66,993	18.3	4.5	4.5	1.02	1.06
General Engineering	47	55	17.0	1,718	1,696	-1.3	2.7	3.2	0.62	0.76
Industrial Engineering	86	134	55.8	1,189	2,066	73.8	7.2	6.5	1.63	1.51
Library & Information Science	15	41	173.3	354	1,040	193.8	4.2	3.9	0.96	0.92
Materials Science	1,603	1,963	22.5	49,329	76,490	55.1	3.2	2.6	0.73	0.60
Mechanical Engineering	770	1,079	40.1	24,229	30,189	24.6	3.2	3.6	0.72	0.83
Metals & Metallurgy	1,212	1,039	-14.3	28,199	30,668	8.8	4.3	3.4	0.97	0.79
Miscellaneous Engineering & Technology	286	385	34.6	6,259	8,117	29.7	4.6	4.7	1.03	1.11
Nuclear Technology	357	313	-12.3	11,922	14,043	17.8	3.0	2.2	0.68	0.52
Operations Research	260	297	14.2	2,918	3,828	31.2	8.9	7.8	2.01	1.81
Mathematics	**2,926**	**3,447**	**17.8**	**57,820**	**72,043**	**24.6**	**5.1**	**4.8**	**1.14**	**1.12**
Applied Mathematics	757	940	24.2	15,384	20,559	33.6	4.9	4.6	1.11	1.07
General Mathematics	1,541	1,630	5.8	32,558	38,195	17.3	4.7	4.3	1.07	1.00
Miscellaneous Mathematics	200	415	107.5	2,799	5,428	93.9	7.1	7.6	1.61	1.79
Probability & Statistics	428	462	7.9	7,079	7,861	11.0	6.0	5.9	1.36	1.37
Physics	**11,870**	**12,887**	**8.6**	**426,025**	**448,642**	**5.3**	**2.8**	**2.9**	**0.63**	**0.67**
Acoustics	467	450	-3.6	10,581	10,535	-0.4	4.4	4.3	1.00	1.00
Applied Physics	1,907	1,895	-0.6	101,737	103,619	1.8	1.9	1.8	0.42	0.43
Chemical Physics	1,784	1,653	-7.3	43,412	45,132	4.0	4.1	3.7	0.93	0.86
Fluids & Plasmas	291	369	26.8	11,056	12,957	17.2	2.6	2.8	0.59	0.66
General Physics	3,318	3,786	14.1	128,023	135,073	5.5	2.6	2.8	0.58	0.65
Miscellaneous Physics	91	122	34.1	2,405	3,262	35.6	3.8	3.7	0.85	0.87
Nuclear & Particle Physics	1,937	2,189	13.0	48,106	51,974	8.0	4.0	4.2	0.91	0.98
Optics	961	1,203	25.2	33,360	36,344	8.9	2.9	3.3	0.65	0.77
Solid State Physics	1,114	1,220	9.5	47,345	49,746	5.1	2.4	2.5	0.53	0.57
NSE Total	**85,693**	**91,930**	**7.3**	**1,933,474**	**2,146,501**	**11.0**	**4.4**	**4.3**	**--**	**--**

Source : Observatoire des sciences et des technologies, SCI database.

2.3 Sector Output

The university sector is by far the largest contributor to NSE article production in Canada, with university authors represented on over 80% of Canadian articles (see Figure 9). Federal government scientists are typically represented on 6-7% of articles while industrial and provincial scientists are on less than 5% of Canadian publications. Table 13 presents the number of articles by sector in the NSE, while Table 14 presents the corresponding percentages.

Figure 9
Share of Canadian Publications in the NSE by Sector



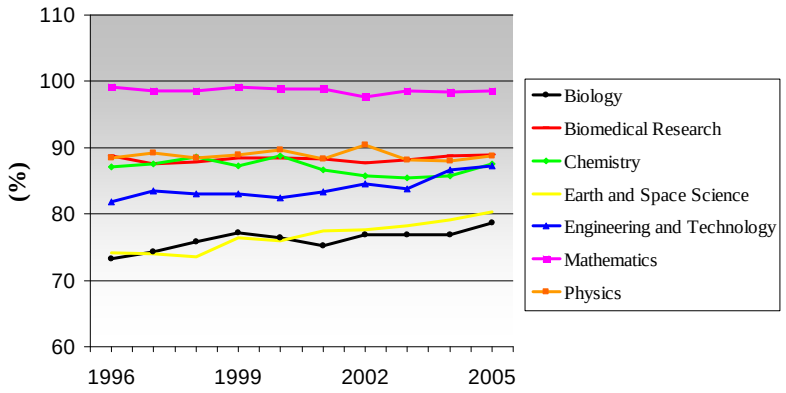
Source: Observatoire des sciences et des technologies

Figure 10 and Tables 15 and 16 present the number and percentage of Canadian articles with at least one university author on the paper by field. The university presence on papers ranges from over 75% in biology to nearly 100% in mathematics. For the vast majority of countries in the world, NSE articles tend to originate from the university sector.

Table 17 presents Canadian university publications by subfield. As in the case by field, the Canadian university sector also dominates publication production in all subfields in the country. When compared to world growth in publications (Table 12), the following subfields of Canadian university production grew at a much faster pace than world production: fluids & plasmas, ecology, optics, miscellaneous biomedical research, mechanical engineering, astronomy & astrophysics, general biology, miscellaneous mathematics, computers, general biomedical

research, environmental science, general physics, physiology, electrical engineering & electronics, and embryology.

Figure 10
The University Sector Share of Canadian Publications in the NSE by Field



Source: Observatoire des sciences et des technologies

Table 13

Number of Canadian Papers by Sector in the NSE, 1996-2005

Sector	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
University	14,960	13,994	14,063	14,408	14,473	14,208	14,478	15,817	15,363	18,140
Hospital	2,853	2,642	2,640	2,578	2,732	2,633	2,671	2,937	2,828	3,094
Federal Government	1,237	1,168	1,291	1,331	1,244	1,254	1,222	1,306	1,215	1,273
Industry	868	829	939	907	880	906	882	939	856	946
Provincial Government	407	367	341	376	422	354	408	378	383	423
Other	388	346	333	352	376	350	392	462	456	489
NSE Total*	**17,969**	**16,755**	**16,767**	**17,050**	**17,152**	**16,892**	**17,130**	**18,736**	**18,086**	**21,086**

Source : Observatoire des sciences et des technologies, SCI database.
* Sector totals do not add up due to multi-sectorial papers.

Table 14

Percentage of Canadian Papers by Sector in the NSE, 1996-2005

Discipline	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
University	83.3	83.5	83.9	84.5	84.4	84.1	84.5	84.4	84.9	86.0
Hospital	15.9	15.8	15.7	15.1	15.9	15.6	15.6	15.7	15.6	14.7
Federal Government	6.9	7.0	7.7	7.8	7.3	7.4	7.1	7.0	6.7	6.0
Industry	4.8	4.9	5.6	5.3	5.1	5.4	5.1	5.0	4.7	4.5
Provincial Government	2.3	2.2	2.0	2.2	2.5	2.1	2.4	2.0	2.1	2.0
Other	2.2	2.1	2.0	2.1	2.2	2.1	2.3	2.5	2.5	2.3
NSE Total*	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source : Observatoire des sciences et des technologies, SCI database.
* Sector percentages do not add up due to multi-sectorial papers.

Table 15

Number of Canadian Papers with University Authors by Field in the NSE, 1996-2005

Discipline	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Biology	2,390	2,226	2,174	2,200	2,359	2,117	2,268	2,335	2,390	2,781
Biomedical Research	3,980	3,711	3,913	4,041	3,818	3,936	3,798	4,156	3,940	4,398
Chemistry	2,170	1,981	1,997	1,984	2,022	1,879	1,804	2,083	1,990	2,459
Earth and Space Science	1,764	1,578	1,592	1,745	1,736	1,791	1,831	1,948	1,955	2,216
Engineering and Technology	1,768	1,764	1,772	1,891	1,876	1,896	1,986	2,274	2,234	2,719
Mathematics	599	520	562	597	615	595	606	727	671	794
Physics	2,289	2,214	2,053	1,950	2,047	1,994	2,185	2,294	2,183	2,773
NSE Total	**14,960**	**13,994**	**14,063**	**14,408**	**14,473**	**14,208**	**14,478**	**15,817**	**15,363**	**18,140**

Source : Observatoire des sciences et des technologies, SCI database.

Table 16

Percentage of Canadian Papers with University Authors by Field in the NSE, 1996-2005

Discipline	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Biology	73.3	74.3	75.8	77.2	76.4	75.2	76.9	76.8	76.8	78.7
Biomedical Research	88.7	87.5	87.9	88.4	88.5	88.3	87.7	88.2	88.8	88.9
Chemistry	87.1	87.5	88.6	87.2	88.8	86.6	85.8	85.5	85.7	87.5
Earth and Space Science	74.2	74.0	73.5	76.4	75.9	77.4	77.6	78.2	79.1	80.4
Engineering and Technology	81.8	83.5	83.0	83.0	82.4	83.4	84.5	83.8	86.6	87.3
Mathematics	99.2	98.5	98.6	99.2	98.9	98.8	97.7	98.5	98.4	98.6
Physics	88.4	89.2	88.4	88.9	89.6	88.3	90.4	88.1	88.0	88.8
NSE Total	83.3	83.5	83.9	84.5	84.4	84.1	84.5	84.4	84.9	86.0

Source : Observatoire des sciences et des technologies, SCI database.

Table 17
Canadian University Publications by Subfield for Years 1996-2000 and 2001-2005 and Share of Canadian Total

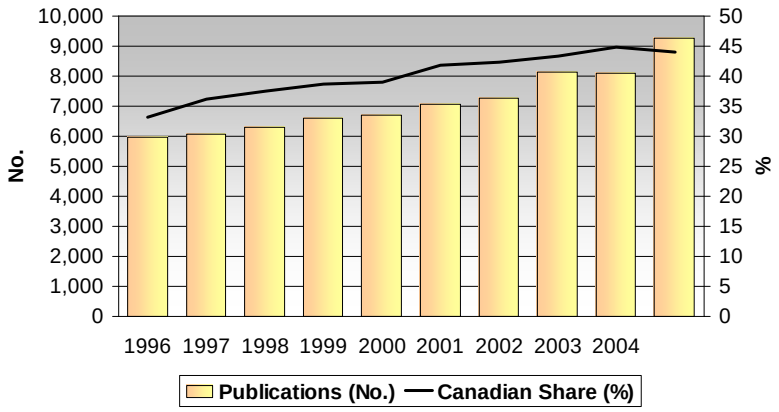
Field/Subfield	Canada			University Sector			University Share (%)	
	1996-2000	2001-2005	% Growth	1996-2000	2001-2005	% Growth	1996-2000	2001-2005
Biology	**15,059**	**15,447**	**2.6**	**11,349**	**11,891**	**4.8**	**75.4**	**77.0**
Agricult & Food Science	3,615	3,457	-4.4	2,366	2,237	-5.5	65.4	64.7
Botany	3,257	3,261	0.1	2,477	2,599	4.9	76.1	79.7
Dairy & Animal Science	1,175	1,151	-2.0	902	909	0.8	76.8	79.0
Ecology	1,306	1,886	44.4	1,096	1,644	50.0	83.9	87.2
Entomology	1,001	911	-9.0	683	601	-12.0	68.2	66.0
General Biology	413	570	38.0	357	501	40.3	86.4	87.9
General Zoology	905	780	-13.8	805	696	-13.5	89.0	89.2
Marine Biology & Hydrobiology	2,541	2,322	-8.6	1,931	1,758	-9.0	76.0	75.7
Miscellaneous Biology	208	479	130.3	183	420	129.5	88.0	87.7
Miscellaneous Zoology	638	630	-1.3	549	526	-4.2	86.1	83.5
Biomedical Research	**22,069**	**22,884**	**3.7**	**19,463**	**20,228**	**3.9**	**88.2**	**88.4**
Anatomy & Morphology	124	84	-32.3	122	80	-34.4	98.4	95.2
Biochemistry & Molecular Biology	8,141	8,498	4.4	7,290	7,644	4.9	89.5	90.0
Biomedical Engineering	792	872	10.1	716	791	10.5	90.4	90.7
Biophysics	348	403	15.8	332	382	15.1	95.4	94.8
Cellular Biology Cytology & Histology	1,216	1,272	4.6	1,082	1,125	4.0	89.0	88.4
Embryology	262	300	14.5	238	264	10.9	90.8	88.0
General Biomedical Research	2,043	2,032	-0.5	1,775	1,790	0.8	86.9	88.1
Genetics & Heredity	2,931	2,906	-0.9	2,489	2,481	-0.3	84.9	85.4
Microbiology	1,776	1,942	9.3	1,437	1,598	11.2	80.9	82.3
Microscopy	104	84	-19.2	94	70	-25.5	90.4	83.3
Miscellaneous Biomedical Research	421	495	17.6	290	396	36.6	68.9	80.0
Nutrition & Dietetic	628	715	13.9	538	613	13.9	85.7	85.7
Parasitology	325	278	-14.5	280	235	-16.1	86.2	84.5
Physiology	2,303	2,259	-1.9	2,210	2,155	-2.5	96.0	95.4
Virology	655	744	13.6	570	604	6.0	87.0	81.2
Chemistry	**11,560**	**11,840**	**2.4**	**10,154**	**10,215**	**0.6**	**87.8**	**86.3**
Analytical Chemistry	1,419	1,349	-4.9	990	887	-10.4	69.8	65.8
Applied Chemistry	190	194	2.1	163	149	-8.6	85.8	76.8
General Chemistry	2,537	2,442	-3.7	2,340	2,246	-4.0	92.2	92.0
Inorganic & Nuclear Chemistry	757	827	9.2	715	799	11.7	94.5	96.6
Organic Chemistry	2,018	2,024	0.3	1,763	1,749	-0.8	87.4	86.4
Physical Chemistry	3,463	3,643	5.2	3,112	3,179	2.2	89.9	87.3
Polymers	1,176	1,361	15.7	1,071	1,206	12.6	91.1	88.6
Earth and Space	**11,245**	**12,395**	**10.2**	**8,415**	**9,741**	**15.8**	**74.8**	**78.6**
Astronomy & Astrophysics	1,619	2,083	28.7	1,334	1,784	33.7	82.4	85.6
Earth & Planetary Science	2,879	3,030	5.2	2,316	2,519	8.8	80.4	83.1
Environmental Science	2,646	3,082	16.5	1,771	2,308	30.3	66.9	74.9
Geology	2,390	2,426	1.5	1,881	1,926	2.4	78.7	79.4
Meteorology & Atmospheric Science	1,013	1,018	0.5	639	676	5.8	63.1	66.4
Oceanography & Limnology	698	756	8.3	474	528	11.4	67.9	69.8
Engineering and Technology	**10,964**	**13,030**	**18.8**	**9,071**	**11,109**	**22.5**	**82.7**	**85.3**
Aerospace Technology	252	272	7.9	194	227	17.0	77.0	83.5
Chemical Engineering	1,360	1,760	29.4	1,160	1,472	26.9	85.3	83.6
Civil Engineering	821	881	7.3	722	774	7.2	87.9	87.9
Computers	1,340	1,783	33.1	1,278	1,677	31.2	95.4	94.1
Electrical Engineering & Electronics	2,555	3,028	18.5	2,081	2,595	24.7	81.4	85.7
General Engineering	47	55	17.0	39	47	20.5	83.0	85.5
Industrial Engineering	86	134	55.8	79	128	62.0	91.9	95.5
Library & Information Science	15	41	173.3	15	41	173.3	100.0	100.0
Materials Science	1,603	1,963	22.5	1,288	1,597	24.0	80.3	81.4
Mechanical Engineering	770	1,079	40.1	672	959	42.7	87.3	88.9
Metals & Metallurgy	1,212	1,039	-14.3	846	769	-9.1	69.8	74.0
Miscellaneous Engineering & Technology	286	385	34.6	235	312	32.8	82.2	81.0
Nuclear Technology	357	313	-12.3	209	219	4.8	58.5	70.0
Operations Research	260	297	14.2	253	292	15.4	97.3	98.3
Mathematics	**2,926**	**3,447**	**17.8**	**2,893**	**3,393**	**17.3**	**98.9**	**98.4**
Applied Mathematics	757	940	24.2	750	918	22.4	99.1	97.7
General Mathematics	1,541	1,630	5.8	1,535	1,622	5.7	99.6	99.5
Miscellaneous Mathematics	200	415	107.5	198	407	105.6	99.0	98.1
Probability & Statistics	428	462	7.9	410	446	8.8	95.8	96.5
Physics	**11,870**	**12,887**	**8.6**	**10,553**	**11,429**	**8.3**	**88.9**	**88.7**
Acoustics	467	450	-3.6	383	369	-3.7	82.0	82.0
Applied Physics	1,907	1,895	-0.6	1,565	1,552	-0.8	82.1	81.9
Chemical Physics	1,784	1,653	-7.3	1,577	1,467	-7.0	88.4	88.7
Fluids & Plasmas	291	369	26.8	248	358	44.4	85.2	97.0
General Physics	3,318	3,786	14.1	3,113	3,485	11.9	93.8	92.0
Miscellaneous Physics	91	122	34.1	89	116	30.3	97.8	95.1
Nuclear & Particle Physics	1,937	2,189	13.0	1,878	2,109	12.3	97.0	96.3
Optics	961	1,203	25.2	693	911	31.5	72.1	75.7
Solid State Physics	1,114	1,220	9.5	1,007	1,062	5.5	90.4	87.0
NSE Total	**85,693**	**91,930**	**7.3**	**71,898**	**78,006**	**8.5**	**83.9**	**84.9**

Source : Observatoire des sciences et des technologies, SCI database.

2.4 International Collaboration

Canadians collaborate with foreign authors to a large and growing degree as shown in Figure 11. In 2005, 44.0% of Canadian NSE papers had an international co-author, growing from 33.1% in 1996. The field breakdown of Canadian international co-authorship is presented in Tables 18 and 19 and summarized in Figure 12. More than one-half of mathematics, physics, and earth and space science articles are co-authored with international partners. All the fields presented have a significant international co-authorship component to them. Similar international collaborative figures for the university sector are presented in Tables 20 and 21.

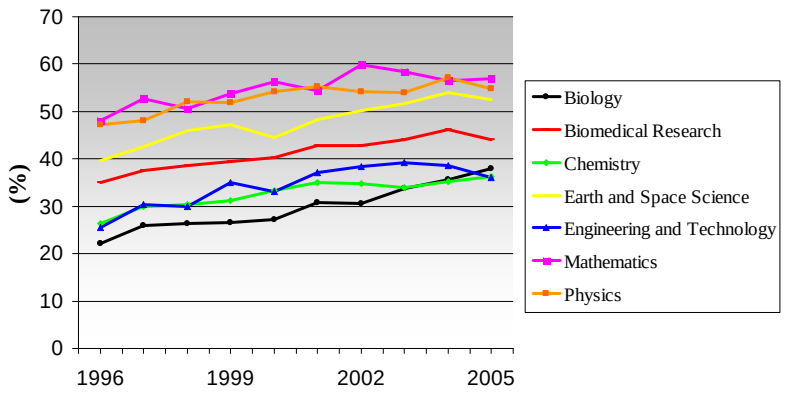
Figure 11
Number of Internationally Co-authored Canadian Publications in the NSE and Share of Canadian Total



Source: Observatoire des sciences et des technologies

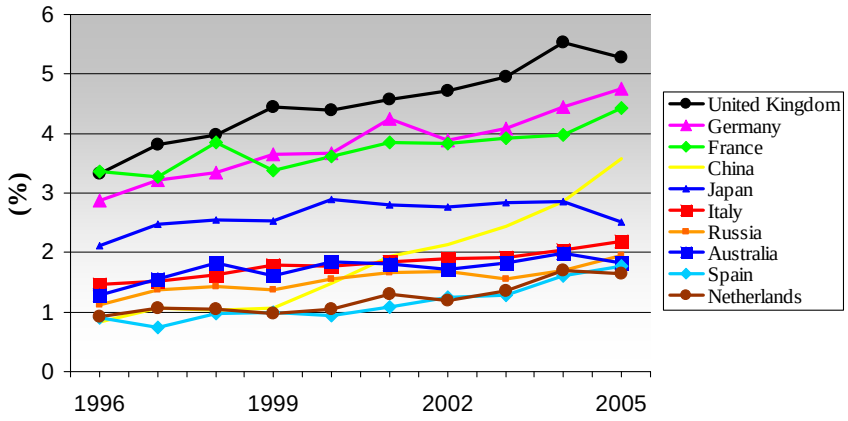
Table 22 presents the number of Canadian international collaborative papers for the top twenty-five partner countries and Table 23 presents the same data as a percentage of Canadian papers. At the top of the list of countries collaborating with Canadians on NSE papers is the United States, with one-fifth of Canadian papers also having an American author. Five of the other G7 countries make the top 7 list, with China ranking in 5th position. By the 15th position (Brazil), the level of international collaboration falls to less than 1%. However, the level of collaboration with Canada for almost all of the top twenty-five countries has been increasing over the past decade. Figure 13 presents the level of international collaboration for the top 10 countries after the U.S.

Figure 12
Percentage of Canadian Publications Internationally Co-authored in the NSE by Field



Source: Observatoire des sciences et des technologies

Figure 13
Percentage of Canadian Publications Internationally Co-authored for Top 10 Collaborative Countries after the U.S.



Source: Observatoire des sciences et des technologies

The top 10 countries collaborating with Canada on NSE articles in 2005 by field is presented in Table 24. The United States is by far the largest collaborator for each of the seven major disciplines. The U.K., France, Germany, and China are other important collaborators in most disciplines.

Using a different data set to explore the levels of international collaboration in other countries, Table 25 presents National Science Foundation data on the numbers and percentages of international collaboration in 1994, 2001, and 2003. In 2003, Canada ranked in the middle of the pack of the countries presented as a percentage of articles with international collaborators. Many European countries ranked ahead of Canada, while the U.S. and Japan were significantly below Canada's mark.

Table 18

Number of Canadian Papers with International Collaborators by Field in the NSE, 1996-2005

Discipline	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Biology	723	777	756	755	840	865	902	1,023	1,111	1,342
Biomedical Research	1,566	1,592	1,719	1,805	1,738	1,903	1,860	2,078	2,049	2,178
Chemistry	654	678	682	707	760	761	730	829	820	1,021
Earth and Space Science	943	907	993	1,080	1,016	1,119	1,186	1,285	1,335	1,444
Engineering and Technology	552	642	639	798	754	847	899	1,065	995	1,123
Mathematics	290	279	289	324	350	328	371	432	385	459
Physics	1,223	1,195	1,209	1,137	1,238	1,250	1,310	1,405	1,420	1,713
NSE Total	**5,951**	**6,070**	**6,287**	**6,606**	**6,696**	**7,073**	**7,258**	**8,117**	**8,115**	**9,280**

Source : Observatoire des sciences et des technologies, SCI database.

Table 19

Percentage of Canadian Papers with International Collaborators by Field in the NSE, 1996-2005

Discipline	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Biology	22.2	26.0	26.4	26.5	27.2	30.7	30.6	33.7	35.7	38.0
Biomedical Research	34.9	37.5	38.6	39.5	40.3	42.7	42.9	44.1	46.2	44.0
Chemistry	26.3	30.0	30.3	31.1	33.4	35.1	34.7	34.0	35.3	36.3
Earth and Space Science	39.7	42.5	45.9	47.3	44.4	48.3	50.2	51.6	54.0	52.4
Engineering and Technology	25.5	30.4	29.9	35.0	33.1	37.2	38.3	39.3	38.6	36.1
Mathematics	48.0	52.8	50.7	53.8	56.3	54.5	59.8	58.5	56.5	57.0
Physics	47.3	48.1	52.1	51.8	54.2	55.3	54.2	53.9	57.2	54.9
NSE Total	**33.1**	**36.2**	**37.5**	**38.7**	**39.0**	**41.9**	**42.4**	**43.3**	**44.9**	**44.0**

Source : Observatoire des sciences et des technologies, SCI database.

Table 20

Number of Canadian University Papers with International Collaborators by Field in the NSE, 1996-2005

Discipline	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Biology	530	577	572	593	638	662	683	785	832	1,044
Biomedical Research	1,296	1,318	1,409	1,525	1,473	1,583	1,545	1,747	1,758	1,871
Chemistry	568	571	605	588	657	633	607	664	666	832
Earth and Space Science	694	663	694	794	751	859	910	975	1,033	1,121
Engineering and Technology	459	536	521	659	609	691	750	887	868	973
Mathematics	288	275	285	322	347	322	364	423	380	453
Physics	1,086	1,055	1,064	1,004	1,114	1,101	1,181	1,236	1,250	1,516
NSE Total	**4,921**	**4,995**	**5,150**	**5,485**	**5,589**	**5,851**	**6,040**	**6,717**	**6,787**	**7,810**

Source : Observatoire des sciences et des technologies, SCI database.

Table 21

Percentage of Canadian University Papers with International Collaborators by Field in the NSE, 1996-2005

Discipline	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Biology	22.2	25.9	26.3	27.0	27.0	31.3	30.1	33.6	34.8	37.5
Biomedical Research	32.6	35.5	36.0	37.7	38.6	40.2	40.7	42.0	44.6	42.5
Chemistry	26.2	28.8	30.3	29.6	32.5	33.7	33.6	31.9	33.5	33.8
Earth and Space Science	39.3	42.0	43.6	45.5	43.3	48.0	49.7	50.1	52.8	50.6
Engineering and Technology	26.0	30.4	29.4	34.8	32.5	36.4	37.8	39.0	38.9	35.8
Mathematics	48.1	52.9	50.7	53.9	56.4	54.1	60.1	58.2	56.6	57.1
Physics	47.4	47.7	51.8	51.5	54.4	55.2	54.1	53.9	57.3	54.7
NSE Total	**32.9**	**35.7**	**36.6**	**38.1**	**38.6**	**41.2**	**41.7**	**42.5**	**44.2**	**43.1**

Source : Observatoire des sciences et des technologies, SCI database.

Table 22

Number of Canadian Papers in the NSE with International Collaborators by Country, 1996-2005

Rank	Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	United States	2,858	2,969	3,085	3,122	3,191	3,463	3,590	3,863	3,867	4,460
2	United Kingdom	598	639	667	758	754	772	807	927	1,001	1,112
3	Germany	518	538	562	623	629	718	666	766	805	1,001
4	France	603	548	646	577	619	650	657	737	719	933
5	China	150	177	173	180	255	327	367	458	517	755
6	Japan	380	415	427	432	496	475	473	530	517	531
7	Italy	265	254	273	306	306	312	325	357	370	459
8	Russia	201	230	239	234	267	281	287	291	307	411
9	Australia	232	260	305	272	318	306	293	342	360	384
10	Spain	163	126	162	170	161	183	214	240	289	374
11	Netherlands	165	178	174	167	178	222	204	252	308	348
12	Switzerland	180	222	200	207	218	180	195	229	257	283
13	South Korea	54	58	86	115	151	145	165	159	171	269
14	Sweden	123	121	161	132	153	171	188	198	188	230
15	Brazil	81	119	108	108	154	114	143	141	146	203
16	Belgium	84	67	89	103	118	112	134	139	138	191
17	Norway	41	45	49	73	61	94	94	114	132	191
18	Poland	110	111	119	108	136	126	142	164	147	160
19	India	89	91	77	85	98	123	112	139	110	158
20	Israel	125	131	136	130	140	125	114	137	153	148
21	Mexico	54	57	61	52	77	106	83	90	99	148
22	Denmark	90	101	106	112	105	115	121	138	116	144
23	Taiwan	39	59	53	58	58	75	108	95	80	144
24	Finland	52	54	79	73	78	104	98	120	108	143
25	Iran	13	15	21	34	40	46	53	76	89	107

Rank based on number of collaborative papers in 2005.

Source : Observatoire des sciences et des technologies, SCI database.

Table 23

Percentage of Canadian Papers in the NSE with International Collaborators by Country, 1996-2005 (%)

Rank	Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	United States	15.91	17.72	18.40	18.31	18.60	20.50	20.96	20.62	21.38	21.15
2	United Kingdom	3.33	3.81	3.98	4.45	4.40	4.57	4.71	4.95	5.53	5.27
3	Germany	2.88	3.21	3.35	3.65	3.67	4.25	3.89	4.09	4.45	4.75
4	France	3.36	3.27	3.85	3.38	3.61	3.85	3.84	3.93	3.98	4.42
5	China	0.83	1.06	1.03	1.06	1.49	1.94	2.14	2.44	2.86	3.58
6	Japan	2.11	2.48	2.55	2.53	2.89	2.81	2.76	2.83	2.86	2.52
7	Italy	1.47	1.52	1.63	1.79	1.78	1.85	1.90	1.91	2.05	2.18
8	Russia	1.12	1.37	1.43	1.37	1.56	1.66	1.68	1.55	1.70	1.95
9	Australia	1.29	1.55	1.82	1.60	1.85	1.81	1.71	1.83	1.99	1.82
10	Spain	0.91	0.75	0.97	1.00	0.94	1.08	1.25	1.28	1.60	1.77
11	Netherlands	0.92	1.06	1.04	0.98	1.04	1.31	1.19	1.35	1.70	1.65
12	Switzerland	1.00	1.32	1.19	1.21	1.27	1.07	1.14	1.22	1.42	1.34
13	South Korea	0.30	0.35	0.51	0.67	0.88	0.86	0.96	0.85	0.95	1.28
14	Sweden	0.68	0.72	0.96	0.77	0.89	1.01	1.10	1.06	1.04	1.09
15	Brazil	0.45	0.71	0.64	0.63	0.90	0.67	0.83	0.75	0.81	0.96
16	Belgium	0.47	0.40	0.53	0.60	0.69	0.66	0.78	0.74	0.76	0.91
17	Norway	0.23	0.27	0.29	0.43	0.36	0.56	0.55	0.61	0.73	0.91
18	Poland	0.61	0.66	0.71	0.63	0.79	0.75	0.83	0.88	0.81	0.76
19	India	0.50	0.54	0.46	0.50	0.57	0.73	0.65	0.74	0.61	0.75
20	Israel	0.70	0.78	0.81	0.76	0.82	0.74	0.67	0.73	0.85	0.70
21	Mexico	0.30	0.34	0.36	0.30	0.45	0.63	0.48	0.48	0.55	0.70
22	Denmark	0.50	0.60	0.63	0.66	0.61	0.68	0.71	0.74	0.64	0.68
23	Taiwan	0.22	0.35	0.32	0.34	0.34	0.44	0.63	0.51	0.44	0.68
24	Finland	0.29	0.32	0.47	0.43	0.45	0.62	0.57	0.64	0.60	0.68
25	Iran	0.07	0.09	0.13	0.20	0.23	0.27	0.31	0.41	0.49	0.51

Rank based on number of collaborative papers in 2005.

Source : Observatoire des sciences et des technologies, SCI database.

Table 24

Top 10 International Collaborators by Discipline, Share of Canadian NSE Papers by Field, 2005 (%)

Rank	Biology	(%)	Biomedical Research	(%)	Chemistry	(%)	Earth and Space Sci.	(%)	Engineering	(%)	Mathematics	(%)	Physics	(%)
1	United States	18.71	United States	24.87	United States	12.13	United States	28.53	United States	14.35	United States	21.86	United States	26.22
2	United Kingdom	3.71	United Kingdom	5.05	Germany	3.17	United Kingdom	8.49	China	4.08	China	6.96	Germany	12.42
3	France	2.75	France	4.41	China	3.09	Germany	6.90	France	2.18	France	6.71	United Kingdom	10.63
4	China	2.15	Germany	3.58	United Kingdom	2.92	France	5.99	Germany	2.15	Germany	2.98	Russia	8.13
5	Australia	1.93	Japan	2.67	France	2.85	Australia	3.48	United Kingdom	1.96	United Kingdom	2.73	France	8.04
6	Germany	1.87	Australia	1.80	Japan	1.92	China	3.38	Japan	1.80	Russia	2.61	China	7.40
7	Netherlands	1.27	China	1.72	Italy	1.46	Japan	2.54	South Korea	1.32	Australia	1.86	Italy	6.76
8	Japan	1.13	Italy	1.56	Russia	1.14	Italy	2.29	Australia	1.25	Israel	1.74	Spain	5.44
9	Norway	0.91	Netherlands	1.56	Poland	1.10	Russia	2.03	Iran	1.25	Italy	1.74	Japan	5.41
10	Brazil	0.88	Switzerland	1.50	Spain	1.10	Spain	1.92	Italy	0.96	Brazil	1.49	Netherlands	4.29

Source : Observatoire des sciences et des technologies, SCI database.

Table 25
Levels of International Collaboration by Country, 1994, 2001, and 2003

	1994			2001			2003		
Country	S&E articles	Internationally coauthored articles	Share of internationally coauthored articles	S&E articles	Internationally coauthored articles	Share of internationally coauthored articles	S&E articles	Internationally coauthored articles	Share of internationally coauthored articles
	Number		Percent	Number		Percent	Number		Percent
Switzerland	10,056	4,474	44.5	12,067	6,455	53.5	13,343	7,711	57.8
Hungary	2,460	1,198	48.7	3,624	1,987	54.8	3,769	2,140	56.8
Belgium	6,620	2,889	43.6	8,818	4,724	53.6	9,941	5,547	55.8
Ukraine	3,396	859	25.3	3,187	1,603	50.3	3,064	1,672	54.6
Portugal	1,236	570	46.1	3,056	1,619	53.0	3,758	2,010	53.5
Austria	4,112	1,640	39.9	6,476	3,291	50.8	7,066	3,622	51.3
Czech Republic	2,746	1,179	42.9	3,753	1,936	51.6	4,204	2,144	51.0
Denmark	5,800	2,310	39.8	7,136	3,609	50.6	7,624	3,873	50.8
Norway	3,558	1,313	36.9	4,503	2,112	46.9	4,780	2,403	50.3
Sweden	11,239	4,073	36.2	14,096	6,524	46.3	14,374	7,086	49.3
Netherlands	14,579	4,659	32.0	17,134	7,692	44.9	18,746	8,905	47.5
South Africa	2,830	667	23.6	3,050	1,266	41.5	3,218	1,504	46.7
Poland	5,384	2,346	43.6	7,901	3,798	48.1	9,328	4,318	46.3
Finland	4,851	1,571	32.4	6,747	2,892	42.9	7,062	3,256	46.1
France	34,284	11,135	32.5	41,397	17,918	43.3	43,242	19,900	46.0
Germany	44,434	13,591	30.6	57,231	23,887	41.7	59,597	26,689	44.8
Mexico	2,138	836	39.1	4,393	2,066	47.0	5,002	2,215	44.3
Argentina	2,118	676	31.9	3,812	1,587	41.6	4,031	1,716	42.6
New Zealand	2,941	873	29.7	3,716	1,435	38.6	4,034	1,717	42.6
Israel	7,045	2,669	37.9	8,502	3,561	41.9	9,122	3,809	41.8
Greece	2,505	938	37.4	4,371	1,812	41.5	4,946	2,019	40.8
Russia	24,463	5,080	20.8	20,356	7,774	38.2	20,630	8,363	40.5
Canada	**28,983**	**8,189**	**28.3**	**28,846**	**11,070**	**38.4**	**32,145**	**12,978**	**40.4**
Italy	20,574	6,734	32.7	28,384	11,269	39.7	31,567	12,669	40.1
United Kingdom	52,714	13,253	25.1	60,438	22,328	36.9	62,729	24,999	39.9
Spain	12,536	3,651	29.1	19,809	7,508	37.9	21,756	8,624	39.6
Australia	14,663	3,606	24.6	18,589	6,751	36.3	20,259	7,879	38.9
Singapore	1,208	337	27.9	3,212	1,107	34.5	3,934	1,499	38.1
Brazil	3,989	1,624	40.7	9,078	3,369	37.1	10,779	3,794	35.2
South Korea	3,496	1,005	28.7	12,801	3,296	25.7	16,114	4,507	28.0
China	7,846	2,181	27.8	24,638	6,703	27.2	34,110	9,132	26.8
United States	216,862	34,226	15.8	228,015	52,862	23.2	242,397	60,180	24.8
India	10,757	1,516	14.1	12,561	2,685	21.4	14,529	3,187	21.9
Turkey	1,613	398	24.7	4,704	1,078	22.9	7,062	1,517	21.5
Japan	50,309	6,898	13.7	64,073	12,622	19.7	67,728	14,534	21.5
Taiwan	4,916	862	17.5	9,115	1,897	20.8	10,448	2,178	20.8

Source: National Science Foundation, Science & Engineering Indicators – 2004 and 2006
S&E includes clinical medicine and social science articles. Only includes countries with more than 3,000 articles in 2003.

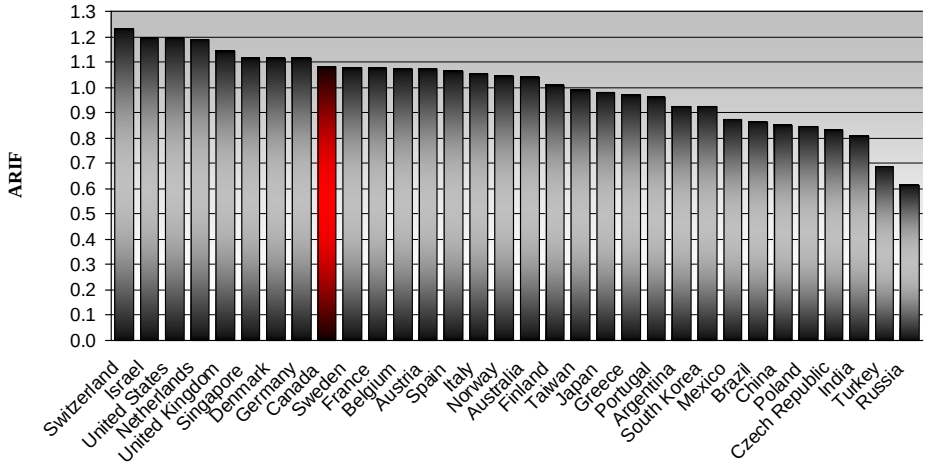
3. Performance Indicators

3.1 Average Relative Impact Factor (ARIF)

Similar to common rating systems, in which a higher score indicates more viewers, listeners or readers, the impact factor is a measure of the potential use of a researcher's work by fellow researchers. If a researcher's work is being referenced or cited more often by his/her peers, then there may be more intrinsic value to the work. Each scientific journal is rated and assigned an impact factor based on the number of citations the articles appearing in the journal receive. A standardized measure called the Average Relative Impact Factor (ARIF) is then calculated for each country and field and normalized to 1.0. An ARIF value above 1.0 for a country and field means that, on average, the country's publications in that field are cited more often than the world average. An ARIF value below 1.0 would mean that a country is publishing in journals in that field that are not cited as often as the world average.

Figure 14 presents the ARIF values for the top 32 countries (those publishing more than 3,000 articles in the NSE in 2005) in the NSE for 2005. Canada's ARIF in the NSE ranks 9th and is in a tight grouping with the G7, and only significantly behind the top 4 countries (Switzerland, Israel, U.S. and the Netherlands). The ARIF value falls below 1.0 or the world average, beginning at Taiwan.

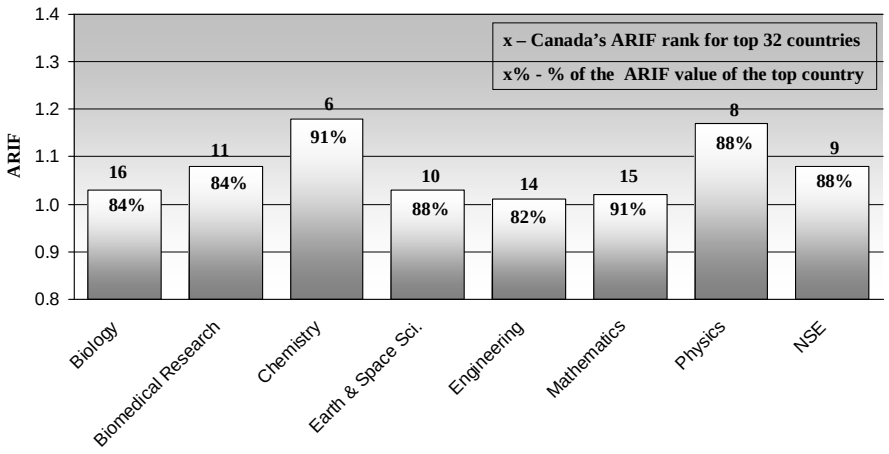
Figure 14
Average Relative Impact Factor (ARIF) in the NSE, 2005



Sources: Observatoire des sciences et des technologies. Only includes countries with at least 3,000 publications in the NSE in 2005.

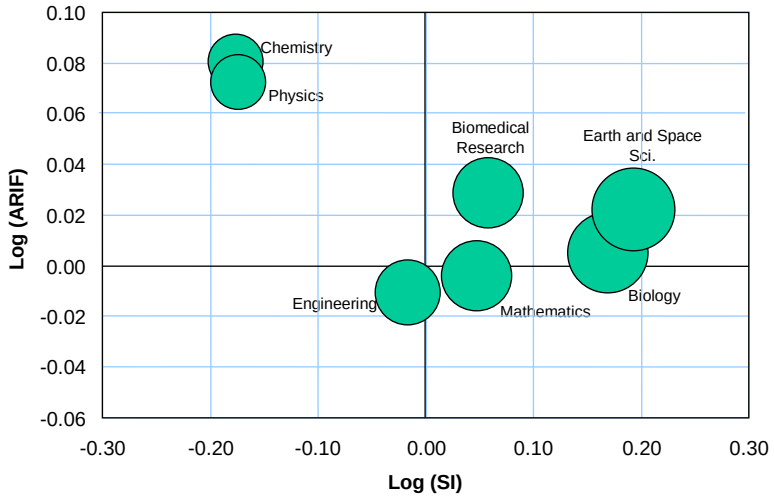
Canada's average relative impact factor (ARIF) by field and rank is presented in Figure 15 and Table 26. Canada achieves a top 10 ARIF ranking in three of the seven fields presented. Canada is behind the lead country in ARIF in each field by a similar margin. Canada's ARIF by field is 82% to 91% of the lead country's value (Switzerland is in the lead 4 times, the U.S. twice and once each for the Netherlands and Israel). Figure 16 presents a combination of the ARIF value and the specialization index (SI) by field for Canada for 2001 to 2005. The top right quadrant in the figure highlights areas of Canadian strength and specialization, such as biomedical research and earth and space science. The upper left quadrant is also an area of Canadian strength but with publication counts less than the world average, for such fields as chemistry and physics. The fields of mathematics and engineering are in quadrants below the world average quality line.

Figure 15
Average Relative Impact Factor (ARIF) in the NSE by Field for Canada, 2005



Source: Observatoire des sciences et des technologies

Figure 16
Canadian Specialization (SI) and Impact (ARIF) by Field, 2001-2005



SI = Specialization Index, ARIF = Average Relative Impact Factor.
Source: Observatoire des sciences et des technologies

Figures 17 to 23 present similar data to Figure 16, but by subfield. Positive results are when the subfields appear above the X-axis, and especially in the right quadrant where Canada would be publishing in more highly cited journals and be more specialized than the world average. Of the 65 subfields presented in Figures 17 to 23, 18 subfields are positioned in the top right quadrant, 26 in the top left quadrant, 5 in the bottom left quadrant and 16 in the bottom right quadrant. Table 27 presents the details of publications, world share, ARIF and the specialization index by subfield for Canada.

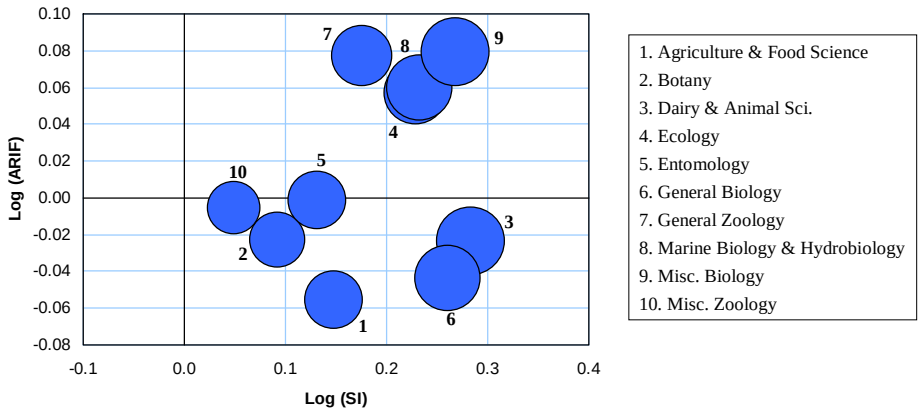
Table 26
Average Relative Impact Factor (ARIF) by Field and Country, 2005

Rank	Biology		Biomedical Research		Chemistry		Earth and Space Science	
1	Switzerland	1.22	Switzerland	1.28	United States	1.29	Israel	1.17
2	United Kingdom	1.21	United States	1.20	Netherlands	1.29	United States	1.15
3	Singapore	1.16	United Kingdom	1.18	Israel	1.27	Switzerland	1.10
4	Netherlands	1.16	Netherlands	1.15	Singapore	1.20	United Kingdom	1.08
5	Israel	1.15	Israel	1.15	Switzerland	1.19	Germany	1.06
6	Belgium	1.14	Germany	1.11	**Canada**	**1.18**	Netherlands	1.06
7	Denmark	1.14	France	1.10	Sweden	1.18	Denmark	1.04
8	Sweden	1.14	Singapore	1.10	United Kingdom	1.18	Australia	1.04
9	France	1.13	Denmark	1.09	Denmark	1.18	Italy	1.03
10	Germany	1.13	Austria	1.08	Spain	1.13	**Canada**	**1.03**
11	United States	1.09	**Canada**	**1.08**	Germany	1.12	Belgium	1.02
12	Italy	1.04	Belgium	1.06	Belgium	1.11	Norway	1.02
13	Norway	1.04	Australia	1.02	France	1.11	Sweden	1.02
14	Spain	1.04	Sweden	1.01	Italy	1.11	Finland	1.01
15	Austria	1.03	Finland	0.99	Greece	1.11	Spain	1.00
16	**Canada**	**1.03**	Italy	0.95	Australia	1.08	Japan	1.00
17	South Korea	1.01	Norway	0.93	Austria	1.06	France	1.00
18	Taiwan	1.01	Spain	0.93	Japan	1.05	Brazil	0.98
19	Australia	0.99	Japan	0.93	Finland	1.02	Austria	0.97
20	Finland	0.99	Portugal	0.89	Norway	1.02	Mexico	0.96
21	Greece	0.94	Taiwan	0.86	Portugal	1.00	South Korea	0.95
22	Portugal	0.93	South Korea	0.83	Taiwan	1.00	Poland	0.94
23	Japan	0.91	Greece	0.82	Argentina	0.94	Portugal	0.93
24	Czech Republic	0.91	Mexico	0.79	Mexico	0.93	China	0.93
25	Argentina	0.89	Argentina	0.78	South Korea	0.93	Argentina	0.92
26	Brazil	0.88	Poland	0.72	China	0.84	Taiwan	0.88
27	China	0.87	China	0.72	Poland	0.83	Greece	0.87
28	Poland	0.83	Czech Republic	0.72	Czech Republic	0.81	Czech Republic	0.87
29	Mexico	0.81	Brazil	0.67	Brazil	0.80	India	0.86
30	India	0.75	India	0.57	India	0.78	Singapore	0.79
31	Turkey	0.67	Turkey	0.56	Turkey	0.64	Turkey	0.67
32	Russia	0.53	Russia	0.54	Russia	0.41	Russia	0.59

Rank	Engineering		Mathematics		Physics		NSE	
1	Netherlands	1.23	Switzerland	1.12	United States	1.33	Switzerland	1.23
2	Switzerland	1.22	Czech Republic	1.12	France	1.30	Israel	1.19
3	Israel	1.20	France	1.09	Israel	1.27	United States	1.19
4	United States	1.18	Germany	1.07	Switzerland	1.25	Netherlands	1.19
5	Singapore	1.14	Spain	1.06	Czech Republic	1.23	United Kingdom	1.14
6	Denmark	1.09	Israel	1.06	United Kingdom	1.20	Singapore	1.12
7	Germany	1.08	Denmark	1.06	Italy	1.17	Denmark	1.11
8	Australia	1.06	Norway	1.06	**Canada**	**1.17**	Germany	1.11
9	Spain	1.06	Netherlands	1.05	Denmark	1.15	**Canada**	**1.08**
10	Italy	1.05	United Kingdom	1.05	Singapore	1.15	Sweden	1.08
11	Belgium	1.05	Belgium	1.04	Germany	1.15	France	1.08
12	France	1.05	United States	1.04	Spain	1.14	Belgium	1.07
13	United Kingdom	1.04	Singapore	1.04	Norway	1.12	Austria	1.07
14	**Canada**	**1.01**	India	1.02	Netherlands	1.10	Spain	1.06
15	Taiwan	1.00	**Canada**	**1.02**	India	1.09	Italy	1.05
16	Portugal	1.00	Australia	1.02	Argentina	1.08	Norway	1.05
17	Norway	0.99	Argentina	1.01	Mexico	1.07	Australia	1.04
18	Argentina	0.99	Sweden	1.01	Portugal	1.07	Finland	1.01
19	Sweden	0.98	Italy	1.00	Poland	1.07	Taiwan	0.99
20	Austria	0.97	Taiwan	0.99	Belgium	1.06	Japan	0.98
21	Greece	0.95	Finland	0.99	Japan	1.03	Greece	0.97
22	Poland	0.93	South Korea	0.98	Australia	1.02	Portugal	0.96
23	South Korea	0.93	Brazil	0.95	Sweden	0.98	Argentina	0.93
24	Japan	0.93	Greece	0.95	Brazil	0.98	South Korea	0.92
25	India	0.92	Portugal	0.94	Austria	0.95	Mexico	0.88
26	China	0.91	Poland	0.94	Finland	0.94	Brazil	0.86
27	Finland	0.90	Japan	0.91	Taiwan	0.89	China	0.85
28	Brazil	0.90	China	0.91	China	0.85	Poland	0.84
29	Mexico	0.89	Austria	0.89	Greece	0.84	Czech Republic	0.83
30	Czech Republic	0.85	Mexico	0.87	South Korea	0.84	India	0.81
31	Turkey	0.80	Turkey	0.77	Russia	0.76	Turkey	0.69
32	Russia	0.70	Russia	0.65	Turkey	0.73	Russia	0.62

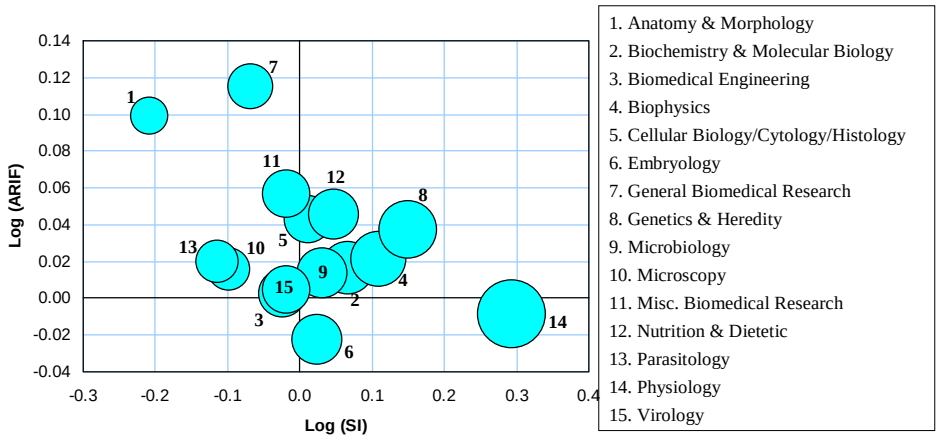
Source : Observatoire des sciences et des technologies, SCI database. Only includes countries with more than 3,000 publications in the NSE in 2005.

Figure 17
Canadian Specialization (SI) and Impact (ARIF) by Subfield, Biology 2001-2005



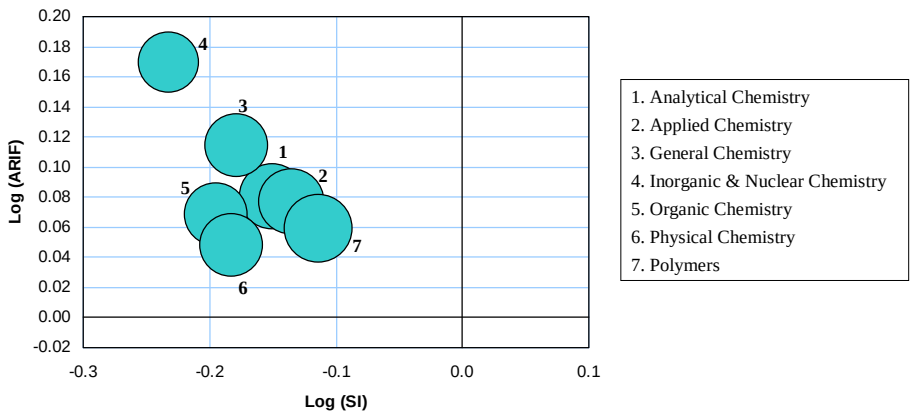
SI = Specialization Index, ARIF = Average Relative Impact Factor. Bubble size proportional to world share of publications in the subfield. Source: Observatoire des sciences et des technologies

Figure 18
Canadian Specialization (SI) and Impact (ARIF) by Subfield, Biomedical Research, 2001-2005



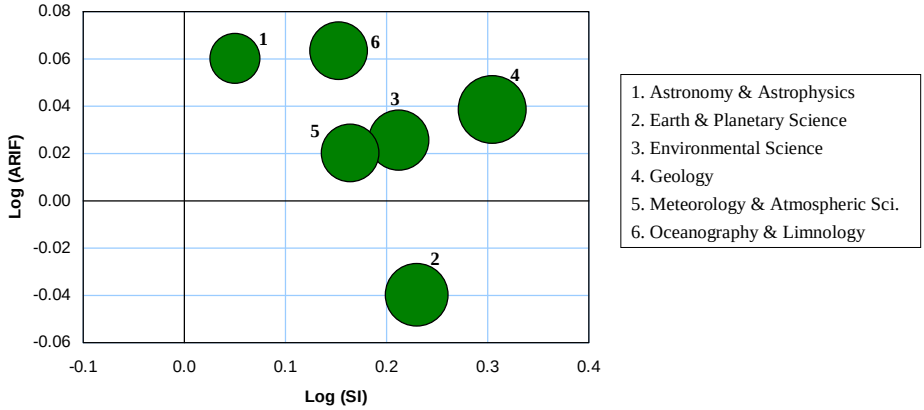
SI = Specialization Index, ARIF = Average Relative Impact Factor. Bubble size proportional to world share of publications in the subfield. Source: Observatoire des sciences et des technologies

Figure 19
Canadian Specialization (SI) and Impact (ARIF) by Subfield, Chemistry, 2001-2005



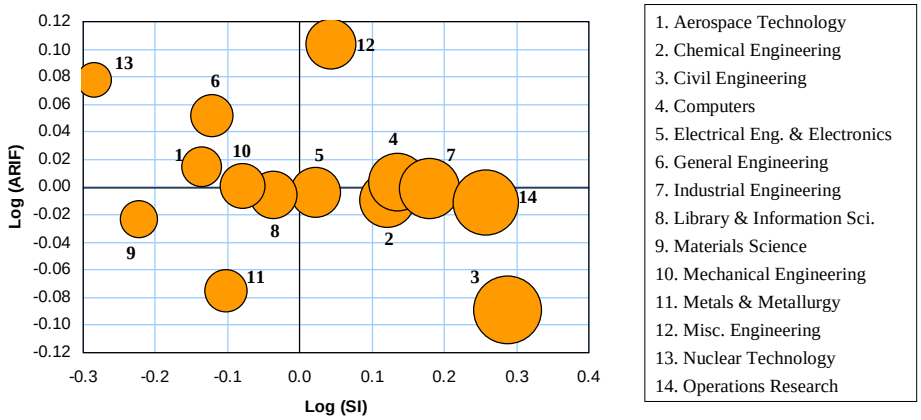
SI = Specialization Index, ARIF = Average Relative Impact Factor. Bubble size proportional to world share of publications in the subfield. Source: Observatoire des sciences et des technologies

Figure 20
Canadian Specialization (SI) and Impact (ARIF) by Subfield, Earth and Space Sciences, 2001-2005



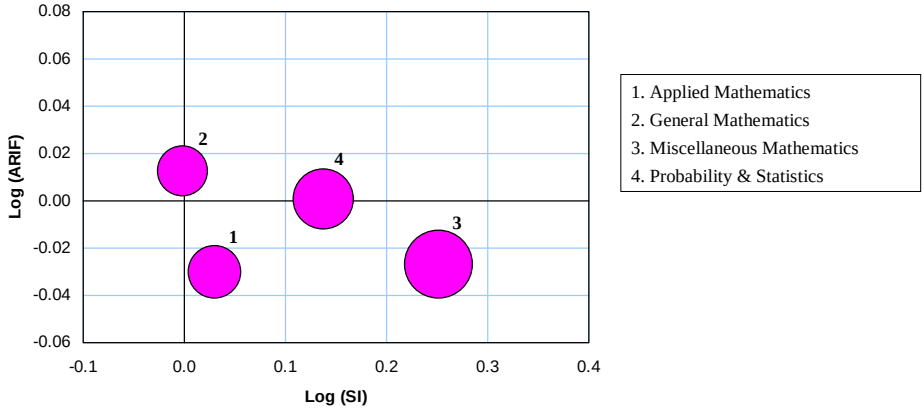
SI = Specialization Index, ARIF = Average Relative Impact Factor. Bubble size proportional to world share of publications in the subfield. Source: Observatoire des sciences et des technologies

Figure 21
Canadian Specialization (SI) and Impact (ARIF) by Subfield, Engineering, 2001-2005



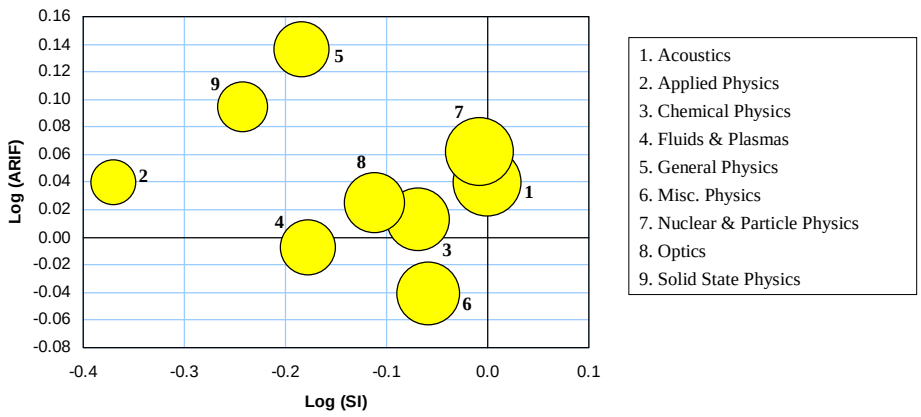
SI = Specialization Index, ARIF = Average Relative Impact Factor. Bubble size proportional to world share of publications in the subfield. Source: Observatoire des sciences et des technologies

Figure 22
Canadian Specialization (SI) and Impact (ARIF) by Subfield, Mathematics, 2001-2005



SI = Specialization Index, ARIF = Average Relative Impact Factor. Bubble size proportional to world share of publications in the subfield. Source: Observatoire des sciences et des technologies

Figure 23
Canadian Specialization (SI) and Impact (ARIF) by Subfield, Physics 2001-2005



SI = Specialization Index, ARIF = Average Relative Impact Factor. Bubble size proportional to world share of publications in the subfield. Source: Observatoire des sciences et des technologies

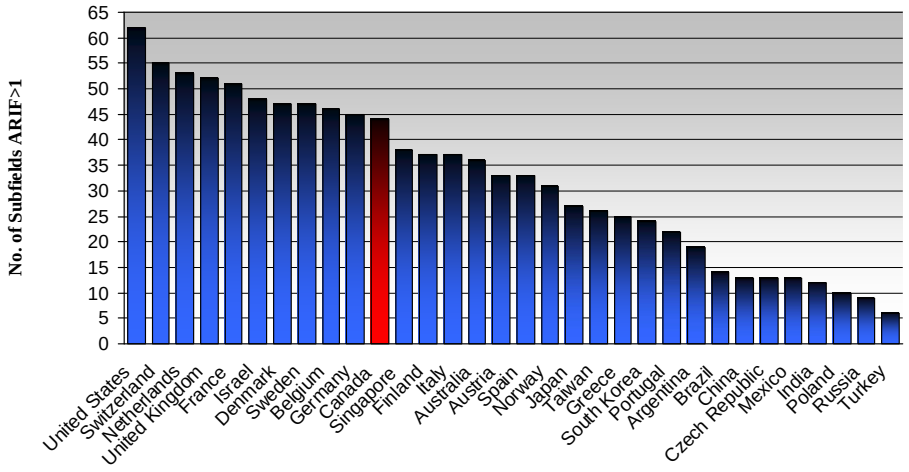
Table 27
Canada's Average Relative Impact Factor by Subfield

Field/Subfield	Publications		World Share (%)		ARIF		Specialization Index	
	1996-2000	2001-2005	1996-2000	2001-2005	1996-2000	2001-2005	1996-2000	2001-2005
Biology	**15,059**	**15,447**	**7.0**	**6.3**	**1.05**	**1.01**	**1.58**	**1.48**
Agricult & Food Science	3,615	3,457	7.2	6.0	0.94	0.88	1.62	1.40
Botany	3,257	3,261	5.5	5.3	0.98	0.95	1.24	1.24
Dairy & Animal Science	1,175	1,151	8.6	8.2	0.94	0.95	1.95	1.92
Ecology	1,306	1,886	6.4	7.3	1.17	1.14	1.44	1.69
Entomology	1,001	911	7.1	5.8	1.00	1.00	1.59	1.35
General Biology	413	570	7.2	7.8	0.92	0.90	1.63	1.82
General Zoology	905	780	8.6	6.4	1.17	1.19	1.95	1.50
Marine Biology & Hydrobiology	2,541	2,322	8.7	7.3	1.23	1.15	1.97	1.71
Miscellaneous Biology	208	479	5.2	4.8	1.04	0.99	1.18	1.12
Miscellaneous Zoology	638	630	7.5	7.9	1.19	1.20	1.70	1.85
Biomedical Research	**22,069**	**22,884**	**4.8**	**4.9**	**1.05**	**1.07**	**1.09**	**1.15**
Anatomy & Morphology	124	84	3.5	2.7	1.18	1.26	0.78	0.62
Biochemistry & Molecular Biology	8,141	8,498	4.8	5.0	1.01	1.04	1.09	1.17
Biomedical Engineering	792	872	4.3	4.0	1.00	1.01	0.98	0.95
Biophysics	348	403	5.4	5.5	0.99	1.05	1.22	1.28
Cellular Biology Cytology & Histology	1,216	1,272	4.4	4.4	1.04	1.10	1.00	1.03
Embryology	262	300	4.2	4.5	0.93	0.95	0.94	1.06
General Biomedical Research	2,043	2,032	3.4	3.7	1.29	1.30	0.76	0.85
Genetics & Heredity	2,931	2,906	6.1	6.0	1.09	1.09	1.38	1.41
Microbiology	1,776	1,942	4.7	4.6	1.02	1.03	1.07	1.07
Microscopy	104	84	3.8	3.4	1.00	1.04	0.86	0.80
Miscellaneous Biomedical Research	421	495	4.0	4.1	1.18	1.14	0.91	0.96
Nutrition & Dietetic	628	715	4.8	4.8	1.08	1.11	1.09	1.12
Parasitology	325	278	3.7	3.3	0.93	1.05	0.83	0.77
Physiology	2,303	2,259	7.8	8.4	0.94	0.98	1.77	1.97
Virology	655	744	3.9	4.1	1.01	1.01	0.89	0.96
Chemistry	**11,560**	**11,840**	**3.1**	**2.9**	**1.21**	**1.20**	**0.70**	**0.67**
Analytical Chemistry	1,419	1,349	3.1	3.0	1.23	1.21	0.70	0.71
Applied Chemistry	190	194	3.4	3.1	1.25	1.19	0.78	0.73
General Chemistry	2,537	2,442	3.3	2.8	1.26	1.30	0.74	0.66
Inorganic & Nuclear Chemistry	757	827	2.6	2.5	1.43	1.48	0.59	0.59
Organic Chemistry	2,018	2,024	3.0	2.7	1.21	1.17	0.69	0.64
Physical Chemistry	3,463	3,643	3.1	2.8	1.11	1.12	0.70	0.66
Polymers	1,176	1,361	3.2	3.3	1.22	1.15	0.72	0.77
Earth and Space	**11,245**	**12,395**	**7.2**	**6.7**	**1.03**	**1.05**	**1.62**	**1.56**
Astronomy & Astrophysics	1,619	2,083	4.4	4.8	1.12	1.16	1.00	1.13
Earth & planetary Science	2,879	3,030	8.1	7.3	0.86	0.90	1.84	1.71
Environmental Science	2,646	3,082	7.3	7.0	1.11	1.06	1.65	1.63
Geology	2,390	2,426	9.9	8.7	1.00	1.09	2.24	2.02
Meteorology & Atmospheric Science	1,013	1,018	7.1	6.2	1.02	1.05	1.60	1.46
Oceanography & Limnology	698	756	6.7	6.1	1.26	1.16	1.51	1.42
Engineering and Technology	**10,964**	**13,030**	**4.4**	**4.1**	**0.97**	**0.98**	**1.00**	**0.96**
Aerospace Technology	252	272	2.9	3.1	0.94	1.03	0.67	0.73
Chemical Engineering	1,360	1,760	5.7	5.7	1.08	0.98	1.29	1.32
Civil Engineering	821	881	11.0	8.3	0.92	0.81	2.49	1.94
Computers	1,340	1,783	5.4	5.9	1.03	1.01	1.21	1.37
Electrical Engineering & Electronics	2,555	3,028	4.5	4.5	0.90	0.99	1.02	1.06
General Engineering	47	55	2.7	3.2	1.45	1.13	0.62	0.76
Industrial Engineering	86	134	7.2	6.5	0.99	1.00	1.63	1.51
Library & Information Science	15	41	4.2	3.9	0.88	0.99	0.96	0.92
Materials Science	1,603	1,963	3.2	2.6	0.90	0.95	0.73	0.60
Mechanical Engineering	770	1,079	3.2	3.6	1.04	1.00	0.72	0.83
Metals & Metallurgy	1,212	1,039	4.3	3.4	0.83	0.84	0.97	0.79
Miscellaneous Engineering & Technology	286	385	4.6	4.7	1.19	1.27	1.03	1.11
Nuclear Technology	357	313	3.0	2.2	1.37	1.19	0.68	0.52
Operations Research	260	297	8.9	7.8	1.03	0.97	2.01	1.81
Mathematics	**2,926**	**3,447**	**5.1**	**4.8**	**0.99**	**0.99**	**1.14**	**1.12**
Applied Mathematics	757	940	4.9	4.6	0.98	0.94	1.11	1.07
General Mathematics	1,541	1,630	4.7	4.3	1.00	1.03	1.07	1.00
Miscellaneous Mathematics	200	415	7.1	7.6	0.96	0.94	1.61	1.79
Probability & Statistics	428	462	6.0	5.9	1.01	1.00	1.36	1.37
Physics	**11,870**	**12,887**	**2.8**	**2.9**	**1.14**	**1.18**	**0.63**	**0.67**
Acoustics	467	450	4.4	4.3	1.15	1.10	1.00	1.00
Applied Physics	1,907	1,895	1.9	1.8	1.08	1.09	0.42	0.43
Chemical Physics	1,784	1,653	4.1	3.7	1.04	1.03	0.93	0.86
Fluids & Plasmas	291	369	2.6	2.8	1.01	0.98	0.59	0.66
General Physics	3,318	3,786	2.6	2.8	1.28	1.37	0.58	0.65
Miscellaneous Physics	91	122	3.8	3.7	0.98	0.91	0.85	0.87
Nuclear & Particle Physics	1,937	2,189	4.0	4.2	1.13	1.15	0.91	0.98
Optics	961	1,203	2.9	3.3	1.01	1.06	0.65	0.77
Solid State Physics	1,114	1,220	2.4	2.5	1.18	1.24	0.53	0.57
NSE	**85,693**	**91,930**	**4.4**	**4.3**	**1.07**	**1.07**	**--**	**--**

Source : Observatoire des sciences et des technologies, SCI database.

Another measure of the quality of publications by country is the number of subfields within the NSE for which the ARIF value is greater than 1.0. This indicator can be thought of as an indicator of the "breadth of excellence." Ideally, a country would like to have all publications in every subfield attain an ARIF value of greater than 1.0. Figure 24 presents the number of subfields of the NSE by country for which the ARIF value is greater than 1.0. Canada had 44 subfields with an ARIF greater than 1.0 in the 2001-2005 time period, two more than in 1996 to 2001. Not surprisingly the leader is the U.S., with almost a perfect score, of 62 out of 65 subfields in which the ARIF was greater than one. Table 28 presents the detailed count for the 32 countries presented.

Figure 24
Number of Subfields in the NSE with ARIF>1 by Country, 2001-2005



Source: Observatoire des sciences et des technologies.

Table 28
Number of Subfields with ARIF>1 by Country in the NSE

Rank	Country	No. of subfields ARIF >1.0	
		1996-2000	2001-2005
1	United States	62	62
2	Switzerland	54	55
3	Netherlands	45	53
4	United Kingdom	47	52
5	France	39	51
6	Israel	45	48
7	Denmark	43	47
8	Sweden	43	47
9	Belgium	40	46
10	Germany	34	45
11	**Canada**	**42**	**44**
12	Singapore	23	38
13	Finland	29	37
14	Italy	34	37
15	Australia	36	36
16	Austria	22	33
17	Spain	32	33
18	Norway	28	31
19	Japan	28	27
20	Taiwan	29	26
21	Greece	17	25
22	South Korea	24	24
23	Portugal	21	22
24	Argentina	18	19
25	Brazil	21	14
26	China	13	13
27	Czech Republic	10	13
28	Mexico	16	13
29	India	12	12
30	Poland	9	10
31	Russia	8	9
32	Turkey	7	6

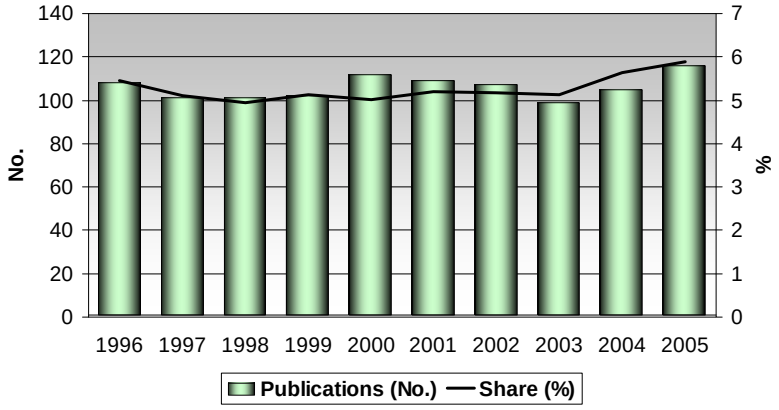
Source: Observatoire des sciences et des technologies, SCI database.

3.2 Top Journal Indices

Publishing in the top journals in a scientific field is a potential indicator of excellence and a complementary indicator to the average relative impact factor. In this section, two indices will be developed based on top journals. One will measure Canada's and the world's publications in the world's two most respected multi-disciplinary journals, Science and Nature, and the other will examine the publishing trends in the top 10% ranked journals.

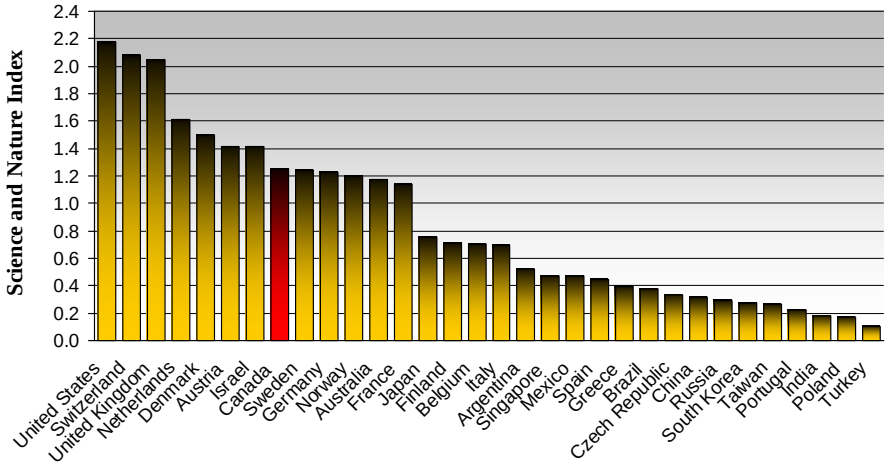
Science and Nature are two journals that are highly influential and widely read. Figure 25 presents the number of Canadian articles and Canada's share of the world total in these journals from 1996 to 2005. Canadian researchers were authors on nearly 6% of articles appearing in Science and Nature in 2005. Figure 26 and Table 29 present details of a "Science and Nature Index" in which a country's share of Science and Nature articles is compared to a country's share of publications in the natural sciences (engineering is excluded since it is not a prominent component of Science or Nature). For example, from 2001 to 2005, the U.S. share of Science and Nature articles was 2.2 times their share of natural science publications. The corresponding figure for Canada was 1.2. Using this index measure, Canada ranks 8th for the time period in question (the analysis was once again limited to those countries producing more than 3,000 articles in the NSE).

Figure 25
Number of Canadian Publications in the World's Two Most Prestigious Science Journals, Nature and Science



Source: Science Citation Index.

Figure 26
Science and Nature Index[1], 2001-2005



1. World share of Science and Nature publications divided by world share of natural science publications.
Source: Observatoire des sciences et des technologies, Science Citation Index.

Another means of examining a country's publications in top journals is to select the top 10% of journals in each subfield as ranked by the journal's impact factor. Figure 27 presents a "top 10 index" which equals a country's share of publications in journals that are in the top 10% ranking divided by the country's share of all publications in the field. A value above 1 indicates that a country's share of top journal publications is greater than the country's share of world publications in the field. The "top 10 index" is especially strong in Canada for chemistry and physics, but considerably weaker in biology and mathematics. Tables 30 to 32 provide the details for Canada and several country groupings in the compilation of the "top 10 index."

Table 33 highlights the "top 10 index" data and calculations by subfield for Canada. The subfields of particular strength in Canada include: marine biology & hydrobiology, general biomedical research, genetics & heredity, analytical chemistry, general chemistry, polymers, astronomy & astrophysics, geology, oceanography & limnology, general physics, and solid state physics.

Table 29
Publications in Science and Nature, 2001-2005

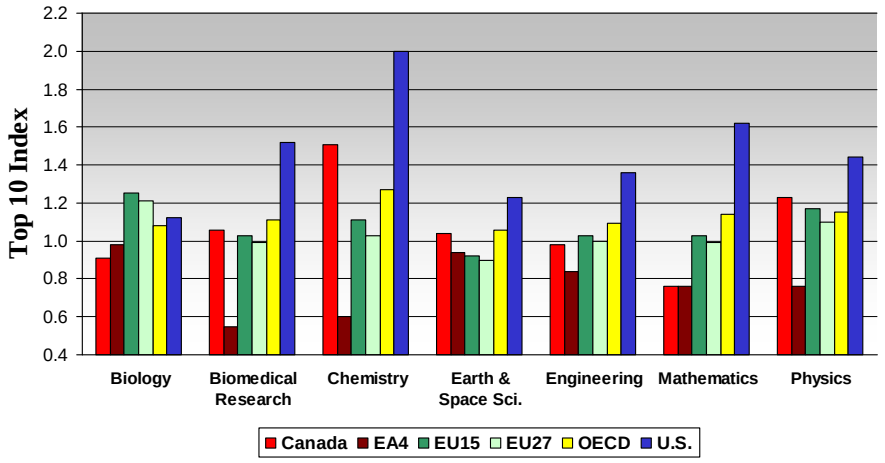
Rank	Country	Science/Nature		World (Natural Sciences)[1]		SN Index[2]
		2001-2005	% Share	2001-2005	% Share	2001-2005
1	United States	6,647	67.0	564,297	30.8	2.17
2	Switzerland	414	4.2	36,708	2.0	2.08
3	United Kingdom	1,633	16.5	147,087	8.0	2.05
4	Netherlands	370	3.7	42,430	2.3	1.61
5	Denmark	162	1.6	19,928	1.1	1.50
6	Austria	131	1.3	17,089	0.9	1.41
7	Israel	171	1.7	22,362	1.2	1.41
8	**Canada**	**536**	**5.4**	**78,900**	**4.3**	**1.25**
9	Sweden	236	2.4	35,010	1.9	1.24
10	Germany	1,125	11.3	169,211	9.2	1.23
11	Norway	79	0.8	12,131	0.7	1.20
12	Australia	326	3.3	51,202	2.8	1.17
13	France	811	8.2	131,035	7.2	1.14
14	Japan	753	7.6	184,266	10.1	0.75
15	Finland	65	0.7	16,922	0.9	0.71
16	Belgium	100	1.0	26,272	1.4	0.70
17	Italy	316	3.2	83,843	4.6	0.70
18	Argentina	39	0.4	13,689	0.7	0.53
19	Singapore	25	0.3	9,745	0.5	0.47
20	Mexico	43	0.4	16,801	0.9	0.47
21	Spain	167	1.7	69,631	3.8	0.44
22	Greece	27	0.3	12,771	0.7	0.39
23	Brazil	68	0.7	33,464	1.8	0.37
24	Czech Republic	27	0.3	14,881	0.8	0.33
25	China	205	2.1	118,826	6.5	0.32
26	Russia	135	1.4	84,694	4.6	0.29
27	South Korea	69	0.7	46,367	2.5	0.27
28	Taiwan	38	0.4	26,528	1.4	0.26
29	Portugal	15	0.2	12,392	0.7	0.22
30	India	49	0.5	50,514	2.8	0.18
31	Poland	31	0.3	32,655	1.8	0.18
32	Turkey	8	0.1	14,324	0.8	0.10

1. World publications in natural sciences, excluding engineering.

2. SN Index is the Science and Nature Index, dividing the world share of Science and Nature publications by the world share of natural science publications.

Source : Observatoire des sciences et des technologies, SCI database and ISI Web of Science.

Figure 27
Top 10 Index[1] in the NSE by Field, 2005



1. Percentage of publications in the top 10% of journals divided by percentage of world publications for the country in the field.

Source: Observatoire des sciences et des technologies

Table 30
Number of Publications in the Top 10% High Impact Journals for Canada, USA and Specific Groups of Countries by Field, 1996, 2001 and 2005

Field	Canada			EA4			EU15			EU27			G8*			OECD*			United States			World		
	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005
Biology	453	423	561	89	240	696	1,833	2,725	4,105	1,883	2,799	4,225	3,739	4,546	6,195	4,693	5,829	8,218	2,431	2,612	3,209	5,333	6,526	9,324
Biomedical Research	699	690	762	145	388	670	4,523	5,092	5,244	4,579	5,183	5,310	12,350	12,504	12,339	13,509	13,782	13,449	9,128	8,881	8,828	14,119	14,483	14,284
Chemistry	520	378	502	246	616	1,173	2,894	2,951	3,933	3,012	3,127	4,093	7,065	6,282	8,198	8,095	7,500	9,734	4,384	3,572	4,524	8,962	8,358	11,050
Earth and Space	327	475	429	52	329	502	1,317	2,474	2,259	1,342	2,517	2,302	3,007	5,324	4,450	3,357	6,055	5,307	2,077	3,856	2,861	3,676	6,588	5,963
Engineering and Technology	284	245	361	414	804	1,649	1,546	2,263	2,515	1,612	2,355	2,634	4,475	5,066	5,307	5,131	5,992	6,632	3,025	2,820	2,899	5,892	7,075	8,465
Mathematics	27	26	49	16	51	121	243	309	519	251	326	544	489	547	923	533	607	1,076	299	332	604	597	691	1,202
Physics	444	404	758	769	1,562	2,611	5,174	6,092	8,212	5,389	6,353	8,515	9,762	11,149	14,326	11,146	12,741	16,482	5,197	5,512	7,073	12,514	14,402	19,090
NSE Total	**2,754**	**2,641**	**3,422**	**1,731**	**3,990**	**7,422**	**17,530**	**21,906**	**26,787**	**18,068**	**22,660**	**27,623**	**40,887**	**45,418**	**51,738**	**46,464**	**52,506**	**60,898**	**26,541**	**27,585**	**29,998**	**51,093**	**58,123**	**69,378**

Source : Observatoire des sciences et des technologies, SCI database
* Excluding Canada.

Table 31
Publications by Field, 1996, 2001 and 2005

Field	Canada			EA4			EU15			EU27			G8*			OECD*			United States			World		
	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005
Biology	3,261	2,814	3,532	890	2,046	4,052	13,537	15,894	18,783	14,141	16,652	20,018	26,040	27,527	30,943	33,629	37,404	43,607	13,645	14,260	16,451	41,386	45,369	53,457
Biomedical Research	4,488	4,459	4,946	1,812	4,540	8,413	32,944	34,513	35,029	34,290	36,139	36,849	68,301	68,599	69,089	77,953	81,290	83,341	37,741	38,824	39,854	89,309	92,368	97,995
Chemistry	2,491	2,169	2,811	4,376	9,576	16,395	26,108	27,127	29,828	29,738	30,636	33,607	47,435	47,207	51,747	55,587	57,543	64,886	16,654	16,141	19,118	72,491	77,853	93,298
Earth and Space	2,376	2,315	2,755	945	2,187	3,574	12,186	14,793	16,466	12,747	15,336	17,139	22,451	25,598	28,060	26,232	30,089	33,443	12,903	13,905	15,475	30,824	35,436	39,807
Engineering and Technology	2,161	2,274	3,114	4,019	9,177	16,616	12,327	19,596	20,461	13,160	21,105	22,111	28,705	37,632	39,158	33,128	46,274	51,341	14,078	16,376	17,947	43,834	60,401	71,240
Mathematics	604	602	805	633	1,530	2,001	3,894	6,068	6,318	4,228	6,683	6,912	7,080	9,715	9,901	8,193	11,554	11,882	3,808	4,459	4,675	9,998	14,331	15,073
Physics	2,588	2,259	3,123	6,007	10,607	17,450	32,340	33,607	35,811	34,978	36,580	39,202	61,459	60,577	61,972	66,712	68,568	72,580	22,389	21,801	24,983	84,826	87,278	97,093
NSE Total	**17,969**	**16,892**	**21,086**	**18,682**	**39,663**	**68,501**	**133,336**	**151,598**	**162,696**	**143,282**	**163,131**	**175,838**	**261,471**	**276,855**	**290,870**	**301,434**	**332,722**	**361,080**	**121,218**	**125,766**	**138,503**	**372,668**	**413,036**	**467,963**

Source : Observatoire des sciences et des technologies, SCI database
* Excluding Canada

Table 32
Top 10 Index (Share of Publications by Field in the 10% High Impact Journals Divided by Share All Publications by Field), 1996, 2001 and 2005

Field	Canada			EA4			EU15			EU27			G8*			OECD*			United States			World		
	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005	1996	2001	2005
Biology	1.08	1.05	0.91	0.78	0.82	0.98	1.05	1.19	1.25	1.03	1.17	1.21	1.11	1.15	1.15	1.08	1.08	1.08	1.38	1.27	1.12	1.00	1.00	1.00
Biomedical Research	0.99	0.99	1.06	0.51	0.55	0.55	0.87	0.94	1.03	0.84	0.91	0.99	1.14	1.16	1.23	1.10	1.08	1.11	1.53	1.46	1.52	1.00	1.00	1.00
Chemistry	1.69	1.62	1.51	0.45	0.60	0.60	0.90	1.01	1.11	0.82	0.95	1.03	1.20	1.24	1.34	1.18	1.21	1.27	2.13	2.06	2.00	1.00	1.00	1.00
Earth and Space	1.15	1.10	1.04	0.46	0.81	0.94	0.91	0.90	0.92	0.88	0.88	0.90	1.12	1.12	1.06	1.07	1.08	1.06	1.35	1.49	1.23	1.00	1.00	1.00
Engineering and Technology	0.98	0.92	0.98	0.77	0.75	0.84	0.93	0.99	1.03	0.91	0.95	1.00	1.16	1.15	1.14	1.15	1.11	1.09	1.60	1.47	1.36	1.00	1.00	1.00
Mathematics	0.75	0.90	0.76	0.42	0.69	0.76	1.05	1.06	1.03	0.99	1.01	0.99	1.16	1.17	1.17	1.09	1.09	1.14	1.31	1.54	1.62	1.00	1.00	1.00
Physics	1.16	1.08	1.23	0.87	0.89	0.76	1.08	1.10	1.17	1.04	1.05	1.10	1.08	1.12	1.18	1.13	1.13	1.15	1.57	1.53	1.44	1.00	1.00	1.00
NSE Total	**1.12**	**1.11**	**1.09**	**0.68**	**0.71**	**0.73**	**0.96**	**1.03**	**1.11**	**0.92**	**0.99**	**1.06**	**1.14**	**1.17**	**1.20**	**1.12**	**1.12**	**1.14**	**1.60**	**1.56**	**1.46**	**1.00**	**1.00**	**1.00**

Source : Observatoire des sciences et des technologies, SCI database
* Excluding Canada

EU15 = Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom
EU27 = Austria , Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden, Spain, Unitedustria ,

OECD = Australia, Austria, Belgium,Czech Republic, Denmark, Finland, France, Germany,, Greece, Hungary, Iceland, Ireland, Italy, Japan, South Korea, Luxembourgh Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Swielgium,Czech Republic, Den
EA4 = East Asia 4 = Japan, China, South Korea and Taiwan.

Table 33
Canadian Publications in the Top 10% Journals by Subfield for Years 1996-2000 and 2001-2005

Field/Subfield	Canada			World			Canada's World Share (%)		Top 10 Index[1]	
	1996-2000	2001-2005	% Growth	1996-2000	2001-2005	% Growth	1996-2000	2001-2005	1996-2000	2001-2005
Biology	**2,058**	**2,496**	**21.3**	**29,437**	**40,302**	**36.9**	**7.0**	**6.2**	**1.00**	**0.98**
Agricult & Food Science	668	575	-13.9	9,268	11,681	26.0	7.2	4.9	1.00	0.82
Botany	335	427	27.5	7,248	10,238	41.3	4.6	4.2	0.84	0.79
Dairy & Animal Science	278	326	17.3	3,656	3,531	-3.4	7.6	9.2	0.88	1.12
Ecology	150	217	44.7	1,593	2,303	44.6	9.4	9.4	1.48	1.30
Entomology	83	68	-18.1	1,115	1,508	35.2	7.4	4.5	1.05	0.78
General Biology	56	54	-3.6	1,074	955	-11.1	5.2	5.7	0.72	0.72
General Zoology	74	66	-10.8	967	1,401	44.9	7.7	4.7	0.89	0.73
Marine Biology & Hydrobiology	299	466	55.9	3,322	4,521	36.1	9.0	10.3	1.03	1.41
Miscellaneous Biology	18	121	572.2	376	3,031	706.1	4.8	4.0	0.91	0.83
Miscellaneous Zoology	97	176	81.4	818	1,133	38.5	11.9	15.5	1.58	1.96
Biomedical Research	**3,920**	**3,295**	**-15.9**	**82,256**	**68,649**	**-16.5**	**4.8**	**4.8**	**0.99**	**0.98**
Anatomy & Morphology	19	20	5.3	553	421	-23.9	3.4	4.8	0.99	1.79
Biochemistry & Molecular Biology	1,268	599	-52.8	24,770	12,678	-48.8	5.1	4.7	1.06	0.95
Biomedical Engineering	135	48	-64.4	3,004	1,270	-57.7	4.5	3.8	1.04	0.93
Biophysics	1	4	300.0	79	95	20.3	1.3	4.2	0.23	0.77
Cellular Biology Cytology & Histology	213	255	19.7	4,784	5,095	6.5	4.5	5.0	1.00	1.14
Embryology	92	95	3.3	2,392	2,530	5.8	3.8	3.8	0.92	0.83
General Biomedical Research	1,065	1,138	6.9	24,466	25,118	2.7	4.4	4.5	1.29	1.24
Genetics & Heredity	362	344	-5.0	4,909	4,645	-5.4	7.4	7.4	1.21	1.23
Microbiology	229	39	-83.0	4,694	940	-80.0	4.9	4.1	1.03	0.90
Microscopy	30	42	40.0	718	813	13.2	4.2	5.2	1.10	1.51
Miscellaneous Biomedical Research	98	221	125.5	2,021	4,214	108.5	4.8	5.2	1.20	1.28
Nutrition & Dietetic	104	151	45.2	1,921	2,337	21.7	5.4	6.5	1.13	1.35
Parasitology	18	24	33.3	680	770	13.2	2.6	3.1	0.72	0.95
Physiology	17	14	-17.6	438	333	-24.0	3.9	4.2	0.50	0.50
Virology	269	301	11.9	6,827	7,390	8.2	3.9	4.1	1.00	0.99
Chemistry	**2,045**	**2,212**	**8.2**	**40,504**	**50,788**	**25.4**	**5.0**	**4.4**	**1.63**	**1.52**
Analytical Chemistry	325	450	38.5	5,232	9,797	87.3	6.2	4.6	2.00	1.52
Applied Chemistry	58	27	-53.4	961	816	-15.1	6.0	3.3	1.76	1.05
General Chemistry	695	944	35.8	14,468	21,908	51.4	4.8	4.3	1.47	1.52
Inorganic & Nuclear Chemistry	113	44	-61.1	1,680	607	-63.9	6.7	7.2	2.59	2.89
Organic Chemistry	169	63	-62.7	3,255	1,570	-51.8	5.2	4.0	1.71	1.47
Physical Chemistry	354	303	-14.4	8,668	8,490	-2.1	4.1	3.6	1.32	1.27
Polymers	331	381	15.1	6,240	7,600	21.8	5.3	5.0	1.65	1.52
Earth and Space	**1,783**	**2,691**	**50.9**	**21,115**	**34,738**	**64.5**	**8.4**	**7.7**	**1.18**	**1.16**
Astronomy & Astrophysics	243	745	206.6	4,613	11,013	138.7	5.3	6.8	1.19	1.40
Earth & Planetary Science	239	287	20.1	3,608	4,248	17.7	6.6	6.8	0.81	0.92
Environmental Science	682	867	27.1	6,884	11,136	61.8	9.9	7.8	1.35	1.11
Geology	377	516	36.9	3,742	4,781	27.8	10.1	10.8	1.02	1.25
Meteorology & Atmospheric Science	80	129	61.3	997	1,938	94.4	8.0	6.7	1.13	1.07
Oceanography & Limnology	162	147	-9.3	1,271	1,622	27.6	12.7	9.1	1.91	1.49
Engineering and Technology	**1,339**	**1,322**	**-1.3**	**33,043**	**35,401**	**7.1**	**4.1**	**3.7**	**0.92**	**0.91**
Aerospace Technology	20	3	-85.0	1,028	85	-91.7	1.9	3.5	0.66	1.12
Chemical Engineering	365	220	-39.7	5,534	5,109	-7.7	6.6	4.3	1.16	0.76
Civil Engineering	40	24	-40.0	697	603	-13.5	5.7	4.0	0.52	0.48
Computers	158	125	-20.9	2,777	2,467	-11.2	5.7	5.1	1.06	0.87
Electrical Engineering & Electronics	213	302	41.8	7,218	7,958	10.3	3.0	3.8	0.65	0.84
General Engineering	19	22	15.8	347	517	49.0	5.5	4.3	2.00	1.31
Industrial Engineering	26	12	-53.8	336	195	-42.0	7.7	6.2	1.07	0.95
Library & Information Science	7	12	71.4	215	257	19.5	3.3	4.7	0.77	1.18
Materials Science	106	133	25.5	5,892	5,023	-14.7	1.8	2.6	0.55	1.03
Mechanical Engineering	88	99	12.5	2,544	3,498	37.5	3.5	2.8	1.09	0.79
Metals & Metallurgy	88	152	72.7	2,912	5,248	80.2	3.0	2.9	0.70	0.85
Miscellaneous Engineering & Technology	47	108	129.8	745	1,262	69.4	6.3	8.6	1.38	1.80
Nuclear Technology	121	97	-19.8	2,434	2,951	21.2	5.0	3.3	1.66	1.47
Operations Research	41	13	-68.3	364	228	-37.4	11.3	5.7	1.26	0.73
Mathematics	**191**	**181**	**-5.2**	**3,838**	**4,803**	**25.1**	**5.0**	**3.8**	**0.98**	**0.79**
Applied Mathematics	83	71	-14.5	1,628	2,367	45.4	5.1	3.0	1.04	0.66
General Mathematics	52	55	5.8	1,231	1,337	8.6	4.2	4.1	0.89	0.96
Miscellaneous Mathematics	13	2	-84.6	310	261	-15.8	4.2	0.8	0.59	0.10
Probability & Statistics	43	53	23.3	669	838	25.3	6.4	6.3	1.06	1.08
Physics	**2,234**	**2,583**	**15.6**	**70,046**	**73,169**	**4.5**	**3.2**	**3.5**	**1.14**	**1.23**
Acoustics	64	5	-92.2	1,193	171	-85.7	5.4	2.9	1.22	0.68
Applied Physics	328	440	34.1	17,822	20,612	15.7	1.8	2.1	0.98	1.17
Chemical Physics	8	11	37.5	211	145	-31.3	3.8	7.6	0.92	2.07
Fluids & Plasmas	11	34	209.1	604	967	60.1	1.8	3.5	0.69	1.23
General Physics	759	895	17.9	19,119	17,210	-10.0	4.0	5.2	1.53	1.86
Miscellaneous Physics	40	41	2.5	1,137	1,450	27.5	3.5	2.8	0.93	0.76
Nuclear & Particle Physics	233	85	-63.5	5,532	2,106	-61.9	4.2	4.0	1.05	0.96
Optics	158	140	-11.4	5,611	4,356	-22.4	2.8	3.2	0.98	0.97
Solid State Physics	633	932	47.2	18,817	26,152	39.0	3.4	3.6	1.43	1.45
NSE Total	**13,570**	**14,780**	**8.9**	**280,239**	**307,850**	**9.9**	**4.8**	**4.8**	**1.09**	**1.12**

1. Canada's world share of top 10% journal publications divided by Canada's world share of all publications (see Table 12) by field/subfied.
Source : Observatoire des sciences et des technologies, SCI database.

3.3 Citations

Counting citations or how often a publication is cited in other publications is another popular means of assessing the quality of a nation's scientific output. The Observatoire des Sciences et des Technologies does not yet produce a clean citation database for Canada, and therefore, other public sources will have to be used for this indicator.

Table 34 presents the relative citation impact (as constructed by the U.S. National Science Foundation), a measure of citations to a country's articles relative to the country's output for the top twenty-five nations who are also large producers (i.e. greater than 3,000 NSE papers). Using this measure, Canada ranks in the top ten for 3 of the 8 fields presented, namely psychology, chemistry and biomedical research.

Table 35 and Figure 28 present similar data to Table 34 but from a different source (Thompson ISI Sci Bytes) and for the most recent time period, 2001-2005. The data in Table 35 presents the ratio of a country's world's share of citations in a particular subfield to the country's world share of publications in that subfield. For example, the percentage of citations to Canadian space science publications exceeded Canada's world production of space science papers by 57% in 2001-2005. Canada is only one of two countries, of the 25 countries in Table 35, to have a positive relative citation impact for all 17 subfields presented.

Table 36 highlights the relative share of citations compared to share of publications for select countries and fields. Canada's performance using this source of data (PSA target metrics for the UK research base, Department of Trade and Industry, UK) is relatively good in the environmental and physical sciences, but weaker in the biological sciences, mathematics and engineering.

Not all publications are cited in a given period. Table 37 presents a comparison of two five-year periods and the percentage of publications that remain uncited in the period by field. Canada's performance on this indicator is relatively similar to most of the G8 countries highlighted in the table. However, the reduction of uncited papers when comparing the two time periods has been better for all of the other G8 countries when compared to Canada.

Table 34
Relative Prominence of Scientific Literature, by Selected Field and Country: 1995 and 2003
(Relative citation index)

Field, Rank, and Country		1995	2003
Biomedical research			
1	Switzerland	1.165	1.154
2	United States	1.140	1.122
3	United Kingdom	0.857	0.927
4	Israel	0.824	0.859
5	Austria	0.848	0.858
6	Germany	0.784	0.849
7	Netherlands	0.721	0.832
8	**Canada**	**0.712**	**0.789**
9	Denmark	0.620	0.770
10	Belgium	0.669	0.732
11	France	0.692	0.731
12	Sweden	0.702	0.727
13	Finland	0.652	0.723
14	Singapore	0.576	0.716
15	Australia	0.583	0.713
16	Japan	0.564	0.609
17	Italy	0.470	0.557
18	Spain	0.336	0.485
19	Portugal	0.344	0.461
20	South Korea	0.299	0.396
21	Taiwan	0.329	0.370
22	Greece	0.277	0.365
23	Mexico	0.253	0.359
24	Poland	0.219	0.327
25	Czech Republic	na	0.304
Chemistry			
1	Netherlands	1.017	1.193
2	Switzerland	1.104	1.128
3	Denmark	1.050	1.127
4	United States	1.121	1.114
5	Israel	0.950	1.045
6	Sweden	1.222	1.011
7	**Canada**	**0.991**	**1.004**
8	United Kingdom	0.843	0.943
9	Belgium	0.744	0.870
10	Germany	0.723	0.846
11	Austria	0.685	0.811
12	France	0.678	0.791
13	Australia	0.803	0.785
14	Singapore	0.608	0.759
15	Italy	0.710	0.742
16	Spain	0.522	0.679
17	Finland	0.661	0.671
18	Japan	0.596	0.627
19	Greece	0.459	0.600
20	Portugal	0.572	0.570
21	South Korea	0.382	0.547
22	Taiwan	0.472	0.537
23	Czech Republic	na	0.479
24	Brazil	0.449	0.442
25	Mexico	0.464	0.422

Field, Rank, and Country		1995	2003
Biology			
1	Switzerland	1.025	1.264
2	Netherlands	0.942	1.077
3	Sweden	0.942	1.032
4	United Kingdom	0.833	1.024
5	Denmark	0.871	0.859
6	Israel	0.713	0.837
7	France	0.672	0.836
8	United States	0.807	0.821
9	Belgium	0.788	0.815
10	Austria	0.654	0.814
11	Germany	0.714	0.810
12	Finland	0.681	0.810
13	**Canada**	**0.676**	**0.707**
14	Italy	0.584	0.678
15	Australia	0.645	0.675
16	Portugal	0.649	0.620
17	Spain	0.445	0.594
18	South Korea	0.640	0.570
19	Czech Republic	na	0.533
20	Singapore	0.557	0.518
21	Greece	0.411	0.465
22	Japan	0.442	0.456
23	Poland	0.372	0.454
24	Taiwan	0.287	0.423
25	Brazil	0.348	0.421
Physics			
1	Switzerland	1.338	1.304
2	Denmark	1.232	1.264
3	United States	1.138	1.097
4	Netherlands	1.060	1.055
5	Austria	0.852	1.037
6	Germany	0.950	0.950
7	Israel	0.884	0.877
8	United Kingdom	0.819	0.871
9	Sweden	0.834	0.870
10	Belgium	0.763	0.830
11	France	0.795	0.809
12	**Canada**	**0.788**	**0.783**
13	Finland	0.795	0.782
14	Spain	0.534	0.764
15	Australia	0.627	0.682
16	Italy	0.678	0.679
17	Portugal	0.594	0.649
18	Singapore	0.256	0.633
19	Greece	0.553	0.618
20	Japan	0.546	0.569
21	Czech Republic	na	0.567
22	South Korea	0.397	0.489
23	Poland	0.434	0.485
24	Taiwan	0.328	0.467
25	India	0.285	0.411

Table 34
Relative Prominence of Scientific Literature, by Selected Field and Country: 1995 and 2003 (cont'd)
(Relative citation index)

Field, Rank, and Country		1995	2003
Earth and space sciences			
1	Netherlands	0.803	1.000
2	United States	0.985	0.964
3	Switzerland	1.051	0.928
4	Germany	0.843	0.927
5	Denmark	0.712	0.857
6	United Kingdom	0.808	0.842
7	Israel	0.534	0.794
8	Sweden	0.693	0.765
9	France	0.728	0.746
10	Italy	0.638	0.735
11	Belgium	0.664	0.725
12	Austria	0.516	0.696
13	Australia	0.678	0.695
14	**Canada**	**0.683**	**0.659**
15	Finland	0.490	0.658
16	Japan	0.538	0.579
17	Spain	0.463	0.578
18	Mexico	0.460	0.574
19	Portugal	0.261	0.557
20	Poland	0.402	0.536
21	Brazil	0.343	0.515
22	Greece	0.250	0.495
23	South Korea	0.250	0.468
24	Czech Republic	na	0.454
25	China	0.278	0.365
Mathematics			
1	Switzerland	1.022	1.035
2	Singapore	0.451	0.948
3	Finland	0.802	0.931
4	Belgium	0.683	0.918
5	United States	0.874	0.907
6	United Kingdom	0.869	0.897
7	Denmark	1.759	0.881
8	Sweden	0.773	0.871
9	Netherlands	0.804	0.861
10	Germany	0.602	0.797
11	Israel	0.659	0.750
12	Portugal	0.310	0.747
13	Australia	0.626	0.728
14	Austria	0.499	0.706
15	France	0.610	0.659
16	**Canada**	**0.603**	**0.645**
17	Taiwan	0.596	0.603
18	Greece	0.337	0.592
19	Italy	0.530	0.586
20	Czech Republic	0.235	0.578
21	Brazil	0.777	0.475
22	Spain	0.457	0.465
23	Poland	0.339	0.439
24	India	0.334	0.401
25	Japan	0.584	0.393

Field, Rank, and Country		1995	2003
Engineering and technology			
1	Switzerland	1.013	1.196
2	Denmark	1.253	1.010
3	Netherlands	0.872	0.969
4	United States	0.854	0.898
5	Germany	0.587	0.885
6	Sweden	0.853	0.791
7	Austria	0.638	0.755
8	Belgium	0.711	0.745
9	Australia	0.712	0.738
10	Czech Republic	na	0.725
11	France	0.731	0.722
12	Israel	0.615	0.710
13	Spain	0.600	0.692
14	United Kingdom	0.676	0.684
15	Portugal	0.514	0.674
16	**Canada**	**0.646**	**0.672**
17	Singapore	0.319	0.626
18	Finland	0.547	0.604
19	Italy	0.639	0.599
20	South Korea	0.473	0.569
21	Japan	0.524	0.550
22	Brazil	0.427	0.521
23	Greece	0.370	0.518
24	Mexico	0.451	0.504
25	China	0.385	0.501
Psychology			
1	**Canada**	**0.830**	**0.847**
2	United Kingdom	0.728	0.819
3	United States	0.747	0.773
4	Netherlands	0.727	0.752
5	Belgium	0.520	0.732
6	Italy	0.591	0.694
7	Sweden	0.691	0.694
8	Israel	0.515	0.676
9	Finland	0.621	0.670
10	Australia	0.591	0.645
11	Switzerland	0.637	0.643
12	France	0.478	0.638
13	South Korea	na	0.634
14	Denmark	0.513	0.585
15	Austria	0.644	0.554
16	Germany	0.360	0.516
17	Spain	0.319	0.512
18	China	na	0.501
19	Brazil	0.679	0.433
20	Poland	0.312	0.401
21	Portugal	na	0.399
22	India	0.172	0.380
23	Japan	0.230	0.349
24	Turkey	na	0.332
25	Singapore	na	0.299

na = not applicable
EU = European Union

NOTES: Relative prominence of scientific literature measured on basis of relative citation index of country/economy, i.e., country/economy's share of cited literature adjusted for its share of published literature. Country/economy's citation of own literature excluded. Index of 1.00 indicates country/economy's share of cited literature equals its world share of scientific literature. Index >1.00 or <1.00 indicates country/economy cited relatively more/less than indicated by its share of scientific literature. Countries/economies with share of world publications in cited field <0.10% during period either excluded or na. Citations on fractional-count basis, i.e., for cited articles with collaborating institutions from multiple countries/economies, each country/economy receives fractional credit on basis of proportion of its participating institutions.

Source: National Science Foundation, Science and Engineering Indicators 2006

Table 35
Relative Citation Impact by Subfield, 2001-2005

Country	Agricultural Sciences	Biology & Biochemistry	Chemistry	Computer Science	Ecology/ Environmental	Engineering	Geosciences	Materials Science	Mathematics	Microbiology	Molec. Bio./ Genetics	Neurosciences & Behavior	Pharmacology	Physics	Plant & Animal Sciences	Psychology/ Psychiatry	Space Science
Australia	15	5	4	0	11	8	25	-12	23	9	-4	-11	4	14	15	-9	38
Austria	9	-3	12	3	13	14	23	40	39	9	46	7	5	59	4	-5	-39
Belgium	32	6	7	3	18	29	13	17	21	3	-6	2	16	14	18	-7	-9
Brazil	-49	-58	-29	-27	-21	-21	-23	-22	-13	-43	-69	-40	-44	-15	-41	-19	-31
Canada	**13**	**6**	**15**	**13**	**18**	**5**	**10**	**1**	**8**	**3**	**2**	**5**	**18**	**33**	**7**	**10**	**57**
China	-15	-52	-32	-23	-37	-17	-26	-19	-17	-39	-43	-45	-51	-32	-27	-35	-50
Denmark	58	13	50	41	29	49	45	30	39	22	17	-7	11	61	37	17	33
Finland	72	8	2	7	31	26	35	2	8	-8	5	-10	8	42	8	-2	-31
France	25	-5	8	-8	15	-18	21	16	17	13	2	-3	2	17	34	-7	10
Germany	9	17	19	5	19	26	34	17	17	18	14	3	11	36	31	-7	27
Israel	44	8	31	45	-16	15	30	57	9	4	59	1	28	32	29	-12	41
Italy	16	-14	1	17	-9	6	-5	-1	10	-21	-21	-9	2	23	-8	10	20
Japan	-13	-13	-1	-48	-19	-4	-5	3	-21	-28	-12	-25	-22	0	1	-38	11
Mexico	-44	-54	-38	n/a	-28	-24	-25	-27	-20	-39	-54	-44	-48	-33	-42	-59	-18
Netherlands	52	13	45	18	34	37	24	50	23	23	14	-6	13	51	35	11	43
Norway	59	-3	-3	40	27	38	22	-2	38	-4	-7	9	8	27	8	-8	-12
Poland	n/a	-48	-34	-7	-46	-3	-38	-44	-21	-51	-51	-46	n/a	-7	-56	-42	9
Russia	-59	-62	-65	-32	-40	-30	-58	-48	-39	-47	-73	-56	-32	-21	-58	-69	-52
Singapore	32	-18	-9	-26	-20	-2	-60	4	22	-11	-17	-34	5	-28	17	-50	n/a
South Korea	-16	-38	-14	-38	-28	-25	-19	0	-23	-48	-43	-43	-44	-13	-12	n/a	-33
Spain	6	-25	2	-19	-8	4	-12	3	-3	-19	-16	-16	-18	20	-4	-31	-1
Sweden	55	9	30	25	48	30	37	7	24	11	1	2	36	31	33	-6	7
Switzerland	48	38	44	56	53	60	59	41	15	31	26	18	60	83	52	-8	22
Taiwan	-8	-44	-23	-38	-33	-24	-12	-13	-11	-27	-46	-44	-28	-23	-25	-42	-37
U.K.	51	23	24	5	40	6	32	16	33	23	32	18	40	39	54	13	32

1. Relative Citation Impact compares citations per paper compared to world average for a given field/subfield. Values above 0 are a positive result.
Source: Thompson ISI Sci-Bytes. Relative Citation Impact compares citations per paper compared to world average for a given field/subfield.

Table 36
Share of Citations Relative to Share of Publications by Field, 2004

Country	Share of citations relative to share of publications				
	Biological Sciences	Environment	Mathematics	Physical Sciences	Engineering
Australia	-0.69	0.14	0.23	0.09	-0.15
Belgium	-0.15	-0.07	0.25	-0.1	0.17
Brazil	-1.15	-0.46	-0.29	-0.51	-0.34
Canada	**-0.62**	**0.27**	**-0.34**	**0.44**	**-0.32**
China	-1.22	-1.55	-2.05	-3.34	-2.16
Denmark	-0.06	0.26	0.14	0.26	0.26
Finalnd	-0.11	0.07	0.01	-0.02	0.01
France	0.13	0.37	0.45	-0.06	0.44
Germany	0.88	0.92	0.23	0.98	1.49
India	-1.93	-1.13	-0.83	-1.35	-0.97
Iran	-0.14	-0.1	-0.23	-0.17	-0.15
Israel	0.14	-0.13	0.06	0.18	0.09
Italy	-0.67	-0.56	-0.07	0.17	-0.35
Japan	-1.34	-1.28	-1.89	-1.79	-0.72
Netherlands	0.19	0.26	0.34	0.67	0.48
Poland	-0.79	-0.44	-0.48	-0.63	-0.46
Russia	-1.04	-1.99	-1.35	-2.98	-1.43
Singapore	-0.03	-0.08	0.19	-0.25	-0.37
South Africa	-0.47	-0.19	-0.07	-0.08	-0.12
South Korea	-0.63	-0.46	-0.94	-0.93	-1.01
Spain	-1.18	-0.62	-0.36	-0.1	0.09
Sweden	0.08	0.47	0.06	0.13	0.28
Switzerland	0.61	0.65	0.18	0.66	0.64
Taiwan	-0.45	-0.41	-0.49	-0.61	-1.05
U.K.	2.02	1.43	0.94	1.27	0.27
U.S.	8.59	4.63	6.34	8.09	5.36

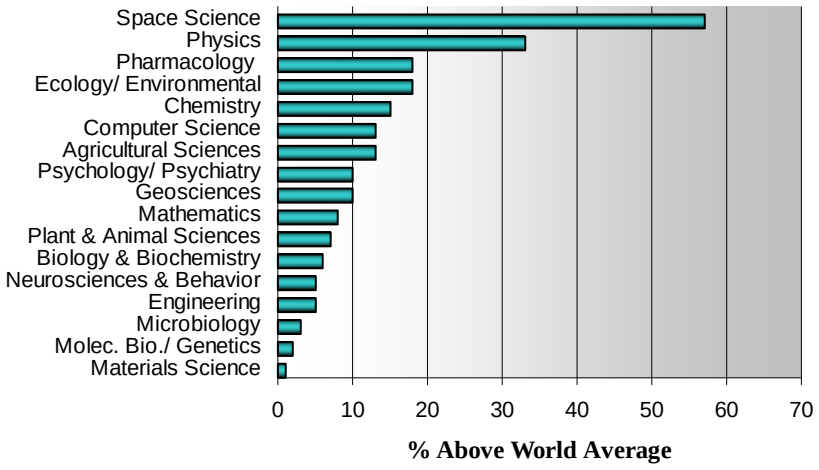
Source: PSA target metrics for the UK research base. Department of Trade and Industry, UK.

Table 37
Percentage of Publications That are Uncited by Field

Country	Biological Sciences	Environment	Mathematics	Physical Sciences	Engineering
5 yr period ending in 2000					
Canada	**42.3**	**40.9**	**58.5**	**45.6**	**58.5**
France	42.9	41.6	58.7	48.1	57.8
Germany	43.1	43.5	59.9	45.0	56.8
Italy	46.1	48.8	58.9	46.8	59.6
Japan	48.4	49.5	67.9	52.3	61.5
Russia	67.1	66.1	73.1	62.7	71.2
UK	40.3	41.3	56.6	46.1	58.3
USA	40.1	43.7	55.3	45.2	58.2
5 yr period ending in 2004					
Canada	**41.3**	**41.1**	**58.3**	**44.7**	**56.4**
France	40.7	38.3	54.7	44.5	53.6
Germany	40.8	38.9	54.9	41.6	52.8
Italy	44.3	44.9	56.7	43.8	56.4
Japan	46.5	46.7	64.0	48.6	57.9
Russia	63.8	66.0	68.9	59.1	65.2
UK	37.8	37.3	53.3	42.3	54.5
USA	39.1	42.0	53.2	42.3	55.4
Difference between earlier and later periods (2000 value - 2004 value, positive result = decrease in uncitedness)					
Canada	**1.0**	**-0.2**	**0.2**	**0.9**	**2.1**
France	2.2	3.2	4.0	3.6	4.3
Germany	2.3	4.6	5.0	3.3	4.0
Italy	1.8	3.8	2.2	3.0	3.2
Japan	1.9	2.8	3.9	3.7	3.6
Russia	3.2	0.1	4.2	3.6	6.0
UK	2.5	4.0	3.4	3.8	3.8
USA	1.0	1.7	2.1	2.9	2.9

Source: PSA target metrics for the UK research base. Department of Trade and Industry, UK.

Figure 28
Canada's Relative Citaion Impact for Select Subfields, 2001-2005



Source: Thompson ISI. Sci-Bytes.

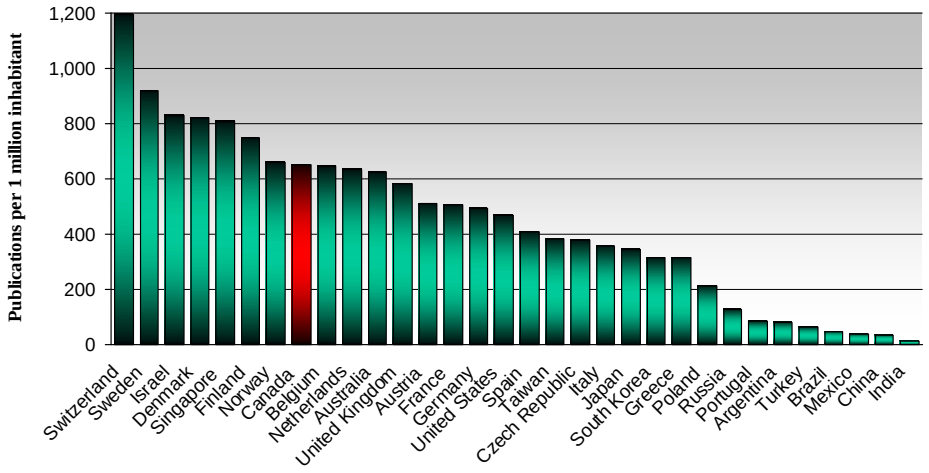
3.4 Productivity and Capacity

In this section, indicators of productivity and capacity as they relate to scientific publication production will be explored. The first indicator is simply a measure of a country's output of NSE publications per capita population. Figure 29 and Table 38 present the 2005 per capita output per one million inhabitants for those countries producing a significant number of articles (the cut-off chosen was at least 3,000 articles published in 2005). Using this criterion, Switzerland has the highest per capita output while Canada ranks in 8th position, but ahead of some significant players such as the U.K., France, Germany, United States, Japan, and Italy.

Another measure of productivity would be to compare publication output with expenditures on R&D and the number of researchers. Since most scientific publications are produced by the public sector (higher education and government), R&D expenditures and researchers are only counted for these two sectors. An additional complication is to isolate the NSE expenditures and researchers in each country. R&D expenditure and researcher data from the OECD (Main Science and Technology Indicators) is adjusted according to the percentage of a country's publications in the NSE. Figure 30 and Table 39 present the data for publications per billion dollars in R&D expenditures for 2005. On this indicator Canada ranks 19th, but above countries such as the U.S., Italy, Germany, France and Japan. Most western economies have a fairly similar publication output per R&D dollar. The indicator for the number of publications per researcher in the public sector is presented in Figure 31 and Table 40. For the countries presented, Canada ranks 5th on this indicator and only significantly behind the perennial frontrunner in Switzerland.

A country's ability to meaningfully engage in all aspects of science and engineering research is an important measure. A country with a breadth of capacity could minimize the risk of missing out on the development of important new areas of science or engineering (e.g. nanotechnology, biotechnology, fuel cells, quantum computing, etc.) Unfortunately an indicator does not exist to measure this situation. The U.S. stands apart in the world in being capable to easily engage in all aspects of science and engineering research. However, other countries probably do not have to match the U.S.'s production to also be a well diversified scientific nation. The capacity index developed to measure the breadth of a country's scientific R&D capabilities is based on the average publication production of the top 5 countries in each field after the U.S.. In other words, a country is most likely fairly capable in each field of science or engineering if it could match the average production of the top 5 countries. Using this measure, Figure 32 and Table 41 present the capacity index for the 32 countries included in the analysis. Canada ranks 7th using this measure and can be considered to have overall, 60% of the capacity of major performers in the NSE.

Figure 29
Per Capita Output of Publications in the NSE, 2005



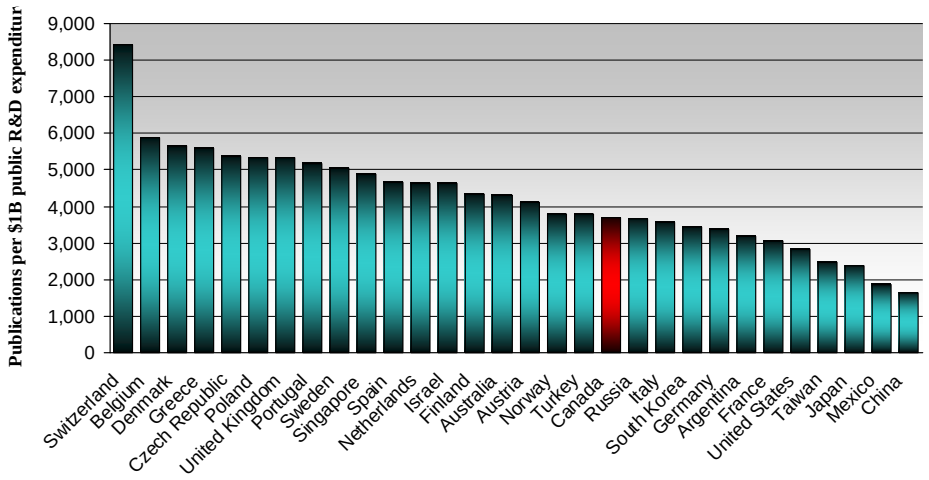
Sources: Observatoire des sciences et des technologies, OECD, 2005 CIA World Fact Book.
Only includes countries with at least 3,000 articles in the NSE in 2005.

Table 38
NSE Publications per Million Inhabitants, 2005

Rank	Country	NSE Publications	Population (000's)	Publications per Million Inhabitants
1	Switzerland	8,976	7,501	1,197
2	Sweden	8,290	9,030	918
3	Israel	5,266	6,352	829
4	Denmark	4,441	5,419	820
5	Singapore	3,639	4,492	810
6	Finland	4,053	5,419	748
7	Norway	3,047	4,622	659
8	**Canada**	**21,086**	**32,271**	**653**
9	Belgium	6,750	10,473	645
10	Netherlands	10,316	16,316	632
11	Australia	12,796	20,474	625
12	United Kingdom	34,974	60,218	581
13	Austria	4,193	8,233	509
14	France	31,758	62,702	506
15	Germany	40,803	82,464	495
16	United States	138,503	296,677	467
17	Spain	17,682	43,398	407
18	Taiwan	8,836	23,036	384
19	Czech Republic	3,862	10,234	377
20	Italy	20,854	58,530	356
21	Japan	44,110	127,761	345
22	South Korea	15,381	48,846	315
23	Greece	3,478	11,083	314
24	Poland	8,100	38,161	212
25	Russia	18,252	142,893	128
26	Portugal	3,538	41,549	85
27	Argentina	3,238	39,922	81
28	Turkey	4,610	72,065	64
29	Brazil	8,499	188,078	45
30	Mexico	4,219	105,300	40
31	China	42,117	1,313,973	32
32	India	14,081	1,095,351	13

Sources : Observatoire des sciences et des technologies, SCI database, OECD Main Science and Technology Indicators, CIA World Fact Book.

Figure 30
Number of Publications in the NSE Per $B (PPP) Public R&D, 2005



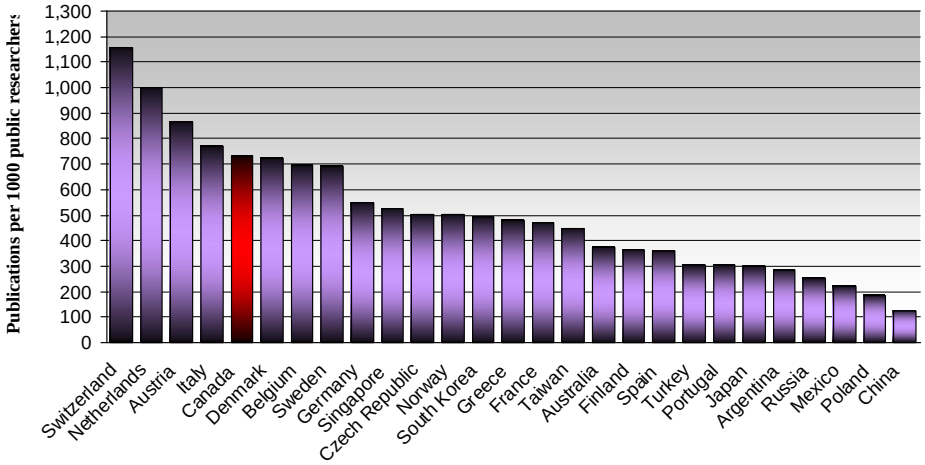
Sources: Observatoire des sciences et des technologies, OECD, Public R&D = HERD + GOVERD for 2003 or most recent year. Only includes countries with at least 3,000 articles in the NSE in 2005.

Table 39
NSE Publications per $Billion (PPP) Public R&D Expenditures (PUBERD)

Rank	Country	Publications 2005	R&D Expenditures ($M PPP) HERD	GOVERD	PUBERD	Adjusted PUBERD ($B PPP)	Publications per $B PUBERD
1	Switzerland	8,976	1,530	78	1,607	1.064	8,434
2	Belgium	6,750	1,307	403	1,710	1.147	5,884
3	Denmark	4,441	988	298	1,286	0.787	5,643
4	Greece	3,478	669	291	959	0.623	5,583
5	Czech Republic	3,862	340	519	859	0.720	5,366
6	Poland	8,100	785	1,006	1,791	1.519	5,334
7	United Kingdom	34,974	7,102	3,238	10,340	6.571	5,322
8	Portugal	3,538	552	243	795	0.684	5,173
9	Sweden	8,290	2,300	364	2,664	1.639	5,059
10	Singapore	3,639	609	292	901	0.742	4,902
11	Spain	17,682	3,327	1,685	5,012	3.805	4,647
12	Netherlands	10,316	2,551	1,313	3,865	2.223	4,640
13	Israel	5,266	1,294	424	1,718	1.142	4,613
14	Finland	4,053	988	498	1,486	0.933	4,343
15	Australia	12,796	2,566	1,857	4,423	2.969	4,311
16	Austria	4,193	1,389	292	1,681	1.017	4,121
17	Norway	3,047	808	444	1,252	0.800	3,808
18	Turkey	4,610	1,937	305	2,242	1.211	3,807
19	**Canada**	**21,086**	**6,546**	**1,928**	**8,473**	**5.719**	**3,687**
20	Russia	18,252	1,016	4,237	5,253	5.000	3,651
21	Italy	20,854	5,926	3,060	8,987	5.840	3,571
22	South Korea	15,381	2,465	3,062	5,527	4.477	3,435
23	Germany	40,803	9,694	7,698	17,393	12.093	3,374
24	Argentina	3,238	515	773	1,287	1.020	3,176
25	France	31,758	7,403	6,379	13,782	10.441	3,042
26	United States	138,503	40,173	36,230	76,403	48.853	2,835
27	Taiwan	8,836	1,557	3,230	4,786	3.577	2,470
28	Japan	44,110	15,427	10,514	25,941	18.642	2,366
29	Mexico	4,219	1,622	1,119	2,741	2.276	1,854
30	China	42,117	8,107	20,831	28,937	25.635	1,643

Sources : Observatoire des sciences et des technologies, SCI database, OECD Main Science and Technology Indicators. PUBERD adjusted for fraction of science and engineering publications in the NSE. PUBERD equals HERD (Higher Education R&D Expenditures) + GOVERD (Government R&D Expenditures for intramural R&D) for 2003 or most recent year available. PUBERD expressed in $ PPP = Purchasing Power Parity.

Figure 31
Number of Publications in the NSE Per 1000 Public Researchers, 2005



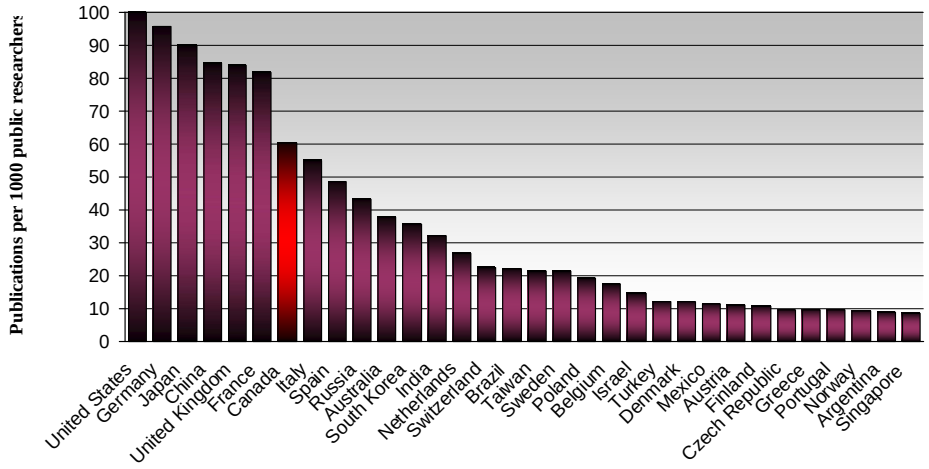
Sources: Observatoire des sciences et des technologies, OECD, Public Researchers = HE + GOV researchers for 2003 or most recent year. Only includes countries with at least 3,000 articles in the NSE in 2005.

Table 40
NSE Publications per 1000 Public Researchers (PUBR)

Rank	Country	Publications 2005	No. of Researchers HE	GOV	PUBR	Adjusted PUBR	Publications per 1000 PUBR
1	Switzerland	8,976	11,240	460	11,700	7,748	1,158
2	Netherlands	10,316	10,211	7,672	17,883	10,289	1,003
3	Austria	4,193	6,977	999	7,976	4,828	868
4	Italy	20,854	27,774	13,976	41,750	27,130	769
5	**Canada**	**21,086**	**34,910**	**7,820**	**42,730**	**28,840**	**731**
6	Denmark	4,441	7,669	2,337	10,006	6,124	725
7	Belgium	6,750	12,389	2,026	14,415	9,670	698
8	Sweden	8,290	17,146	2,287	19,433	11,955	693
9	Germany	40,803	68,243	38,719	106,962	74,369	549
10	Singapore	3,639	8,090	292	8,382	6,907	527
11	Czech Republic	3,862	4,318	4,833	9,151	7,671	503
12	Norway	3,047	6,251	3,258	9,509	6,075	502
13	South Korea	15,381	26,419	11,974	38,393	31,098	495
14	Greece	3,478	9,072	2,136	11,208	7,278	478
15	France	31,758	64,403	24,541	88,944	67,381	471
16	Taiwan	8,836	12,747	13,690	26,437	19,760	447
17	Australia	12,796	42,780	8,036	50,816	34,105	375
18	Finland	4,053	13,033	4,710	17,743	11,142	364
19	Spain	17,682	49,196	15,489	64,685	49,107	360
20	Turkey	4,610	24,226	3,646	27,872	15,056	306
21	Portugal	3,538	10,062	3,440	13,502	11,620	304
22	Japan	44,110	172,396	33,711	206,107	148,114	298
23	Argentina	3,238	13,485	773	14,258	11,293	287
24	Russia	18,252	71,174	4,237	75,411	71,773	254
25	Mexico	4,219	16,791	6,376	23,167	19,237	219
26	Poland	8,100	38,455	13,233	51,688	43,817	185
27	China	42,117	185,987	191,957	377,944	334,817	126

Sources : Observatoire des sciences et des technologies, SCI database, OECD Main Science and Technology Indicators. PUBR adjusted for fraction of science and engineering publications in the NSE. PUBR equals the number of researchers in the HIgher Education (HE) sector + the governmnet (GOV) sector for 2003 or most recent year available.

Figure 32
Capacity Index by Country, 2005



Sources: Observatoire des sciences et des technologies, NSERC estimates.

Table 41
Country Capacity Index, 2005

		Capacity by Field[1]								
Rank	Country	Biology	Biomedical Research	Chemistry	Earth and Space Sci.	Engineering	Mathematics	Physics	NSE	Capacity Index
1	United States	1.00	1.00	1.00	1.00	1.00	1.00	1.00	7.00	100.0
2	Germany	0.98	1.00	0.99	1.00	0.72	1.00	1.00	6.69	95.6
3	Japan	1.00	1.00	1.00	0.73	1.00	0.56	1.00	6.30	89.9
4	China	0.70	0.58	1.00	0.63	1.00	1.00	1.00	5.91	84.5
5	United Kingdom	1.00	1.00	0.64	1.00	0.76	0.78	0.70	5.88	84.0
6	France	0.74	0.83	0.70	1.00	0.64	1.00	0.83	5.73	81.8
7	**Canada**	**0.97**	**0.66**	**0.35**	**0.78**	**0.52**	**0.62**	**0.32**	**4.23**	**60.4**
8	Italy	0.49	0.53	0.46	0.66	0.43	0.68	0.58	3.84	54.8
9	Spain	0.79	0.39	0.53	0.46	0.33	0.55	0.35	3.39	48.4
10	Russia	0.17	0.21	0.61	0.48	0.25	0.53	0.76	3.01	43.1
11	Australia	0.84	0.36	0.19	0.55	0.26	0.28	0.17	2.65	37.9
12	South Korea	0.22	0.33	0.36	0.19	0.76	0.24	0.39	2.49	35.6
13	India	0.29	0.30	0.56	0.28	0.36	0.15	0.32	2.25	32.2
14	Netherlands	0.37	0.36	0.20	0.38	0.20	0.17	0.20	1.88	26.9
15	Switzerland	0.21	0.28	0.20	0.32	0.15	0.18	0.24	1.57	22.4
16	Brazil	0.35	0.23	0.20	0.18	0.16	0.22	0.22	1.54	22.0
17	Taiwan	0.17	0.16	0.21	0.18	0.42	0.15	0.22	1.50	21.4
18	Sweden	0.30	0.29	0.15	0.23	0.18	0.17	0.18	1.50	21.4
19	Poland	0.17	0.11	0.29	0.13	0.14	0.22	0.29	1.35	19.3
20	Belgium	0.27	0.20	0.15	0.17	0.13	0.16	0.15	1.23	17.6
21	Israel	0.16	0.16	0.09	0.10	0.12	0.26	0.14	1.03	14.7
22	Turkey	0.21	0.09	0.13	0.12	0.16	0.09	0.08	0.86	12.3
23	Denmark	0.23	0.17	0.07	0.14	0.07	0.08	0.08	0.84	12.0
24	Mexico	0.22	0.09	0.09	0.14	0.07	0.10	0.11	0.81	11.6
25	Austria	0.12	0.13	0.08	0.11	0.07	0.14	0.11	0.77	11.0
26	Finland	0.19	0.13	0.07	0.13	0.09	0.07	0.08	0.76	10.8
27	Czech Republic	0.11	0.09	0.12	0.08	0.08	0.10	0.10	0.68	9.7
28	Greece	0.14	0.07	0.08	0.11	0.10	0.10	0.08	0.67	9.6
29	Portugal	0.13	0.08	0.10	0.08	0.10	0.11	0.07	0.67	9.5
30	Norway	0.19	0.08	0.04	0.16	0.05	0.06	0.04	0.64	9.1
31	Argentina	0.20	0.09	0.07	0.09	0.05	0.06	0.06	0.62	8.9
32	Singapore	0.04	0.07	0.07	0.03	0.21	0.09	0.09	0.61	8.7

1. Based on publication in field as compared to publications in the field of top 5 countries after the U.S.. Maximum value per field is 1.
Source : Observatoire des sciences et des technologies, SCI database. NSERC estimates.

3.5 Canada's NSE Publication Scorecard

In Chapter 3, several indicators have been presented highlighting various quality and productivity indicators for Canada. Table 41 is a summary of some of the key indicators for Canada and the trend over the two five-year periods compared. Overall, Canada is doing well and is maintaining to slightly improving its international position in an increasingly competitive world.

Table 42
Canada's NSE Publication Scorecard

Indicator	1996-2000	2001-2005	Trend
Production:			
Number of publications – all sectors[1]	85,693	91,930	+
- University sector	71,898	78,006	+
- Federal Government	6,271	6,270	0
- Industry	4,423	4,529	+
World share of publications[2]	4.43%	4.28%	-
Capacity Index[3] (1996 and 2005)	68.7%	60.4%	-
Productivity:			
Publications per million inhabitants[4]	568	581	+
Publications per $M PUBERD expenditures	4.86	4.92	+
University sector $M HERD[5]	7.59	7.45	-
Federal Government $M Intramural R&D[6]	0.77	0.76	0
Quality:			
Average Relative Impact Factor (ARIF)[7]	1.07	1.07	0
Breadth of excellence, no. of subfields ARIF>1[8]	42	44	+
Science and Nature Index[9]	1.16	1.25	+
Top 10 Journal Publication Index[10]	1.09	1.12	+

1. See Tables 1 and 13. 2. See Table 3. 3. See Table 40. 4. See Table 37. 5. Based on 1996 constant dollar R&D expenditures in the higher education sector in the NSE of $9.469B from 1996-2000 and $10.469B from 2001-2005. 6. Based on 1996 constant dollar R&D intramural expenditures in the federal government sector in the NSE of $8.159B from 1996-2000 and $8.231B from 2001-2005. 7. See Table 26. 8. See Table 28. 9. See Table 29. 10. See Table 32.

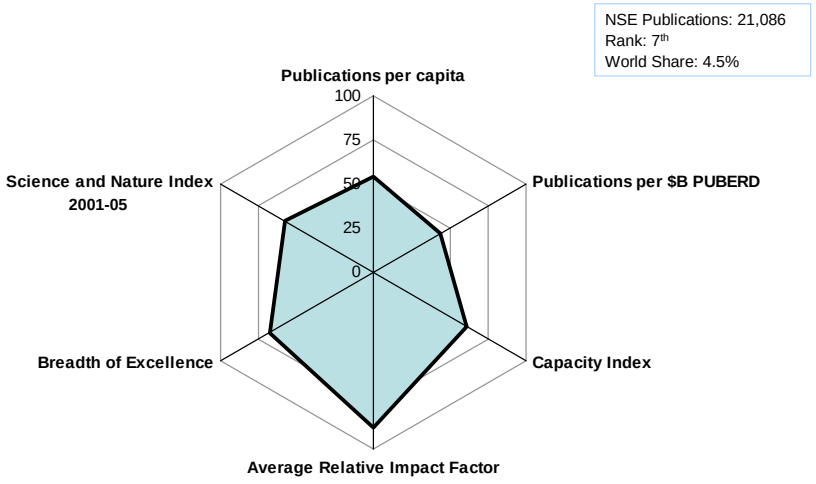
4. International NSE Footprints

In Chapter 3 several indicators were presented that highlighted publication performance indicators related to quality and productivity. In this chapter, a visual representation of several of these indicators together in one figure called a "footprint" will be presented. The indicators selected for the footprint are presented below, limited to some extent by the availability of data for some key countries (e.g. U.S., U.K.). For each of the indicators selected for the footprint, the data is presented as it relates to the lead country for the indicator in terms of a percentage value of the lead country.

Indicator		Lead Country	Source
Publication per capita	Number of publications per 1 million inhabitants	Switzerland, 1,197	See Table 38
Publications per $B PUBERD	Number of publications per 1billion dollar (PPP) expenditure on public R&D	Switzerland, 8,434	See Table 39
Capacity Index	Publications by field as related to production of top 5 countries after the U.S.	U.S., 100	See Table 41
Average Relative Impact Factor	A country's publications relative to the journals in which they are published. A score above 1 is better than the world average.	Switzerland, 1.23	See Table 26
Breadth of Excellence	The number of subfields for which the average relative impact factor is greater than 1.	65 subfields, U.S. 62	See Table 28
Science and Nature Index	A comparison of a country's percentage of articles in Science and Nature (2001-05) versus a country's share of natural science publications.	U.S., 2.17	See Table 29

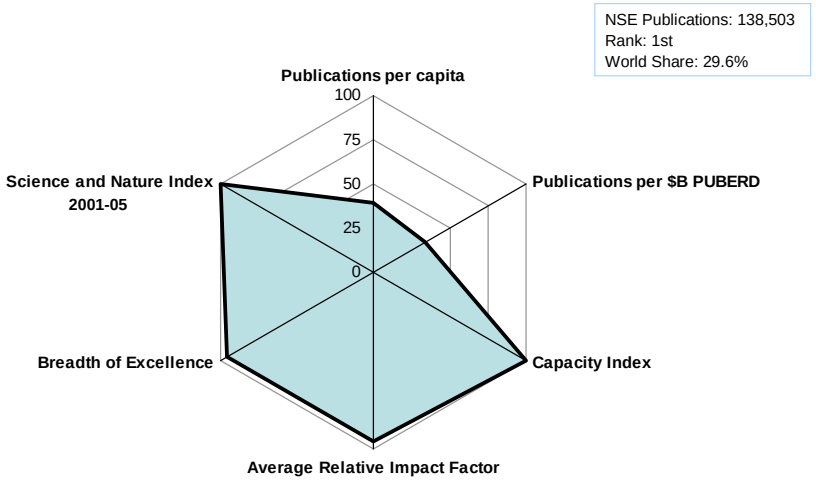
Canada's NSE footprint is presented in Figure 33. The remaining countries in order of NSE publication output for 2005 are presented in Figures 34 to 53. Canada's footprint is equivalent to countries such as Australia, Sweden, and France but behind countries such as the U.S., U.K. Switzerland, the Netherlands and Germany. Overall, Canada's performance is respectable but not in a top five position.

Figure 33
NSE Publication Footprint – Canada 2005



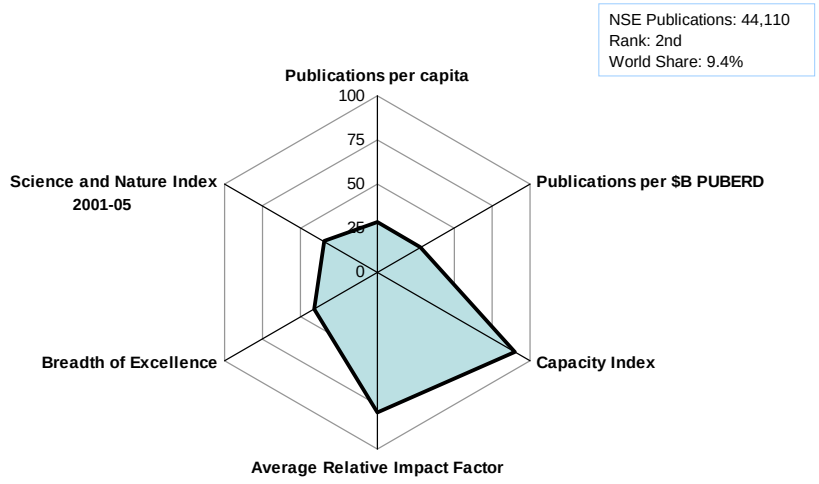
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 34
NSE Publication Footprint – United States 2005



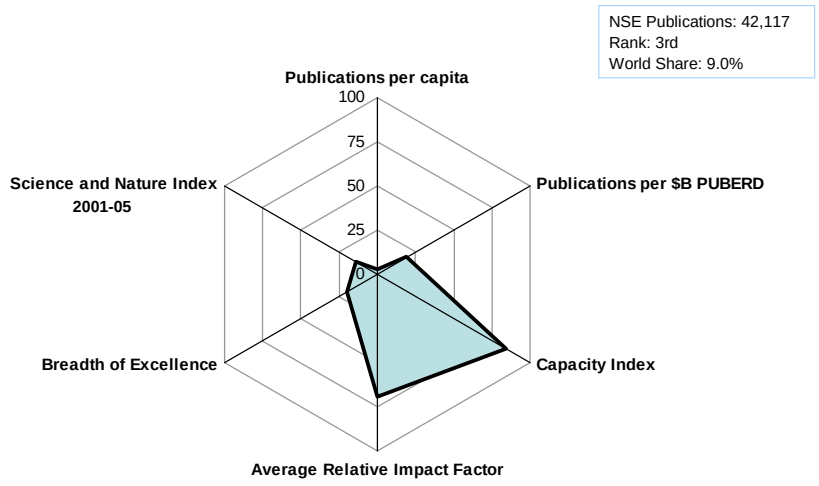
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 35
NSE Publication Footprint – Japan 2005



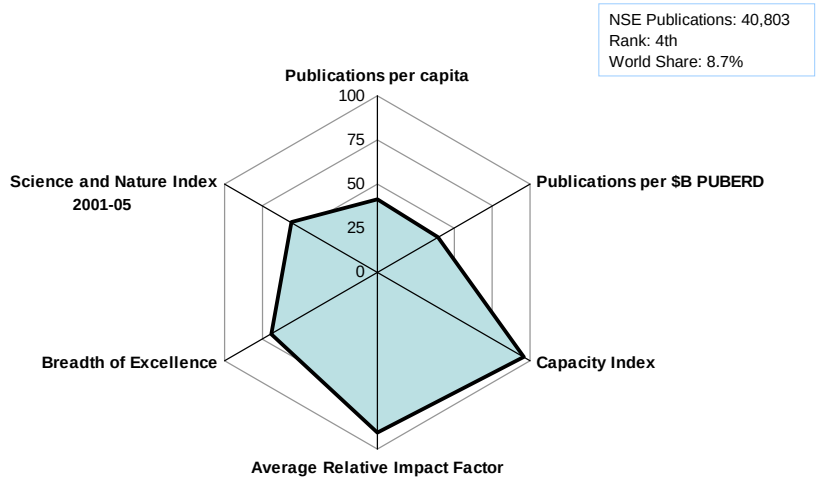
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 36
NSE Publication Footprint – China 2005



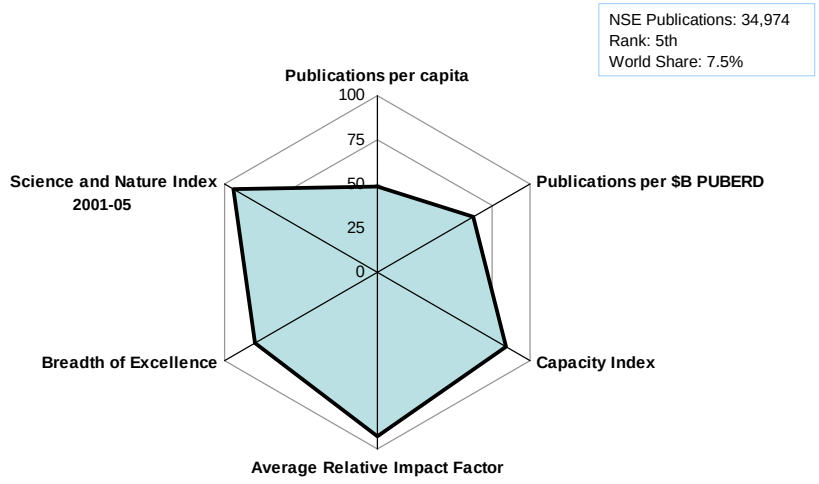
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 37
NSE Publication Footprint – Germany 2005



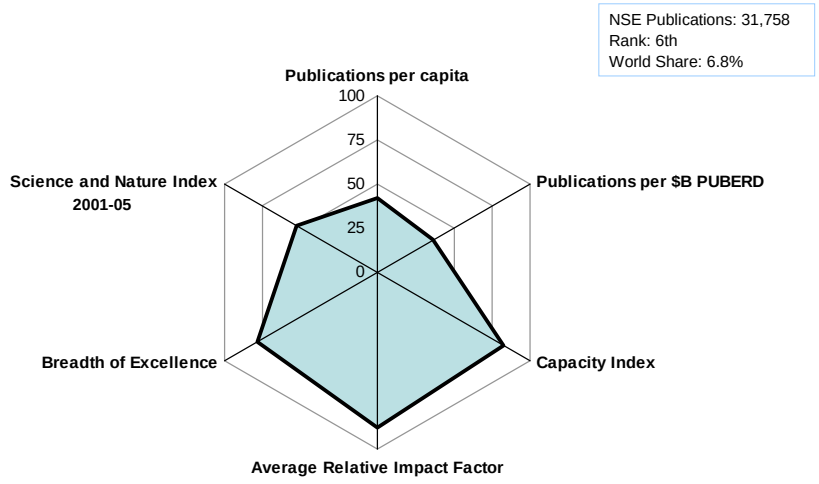
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 38
NSE Publication Footprint – U.K. 2005



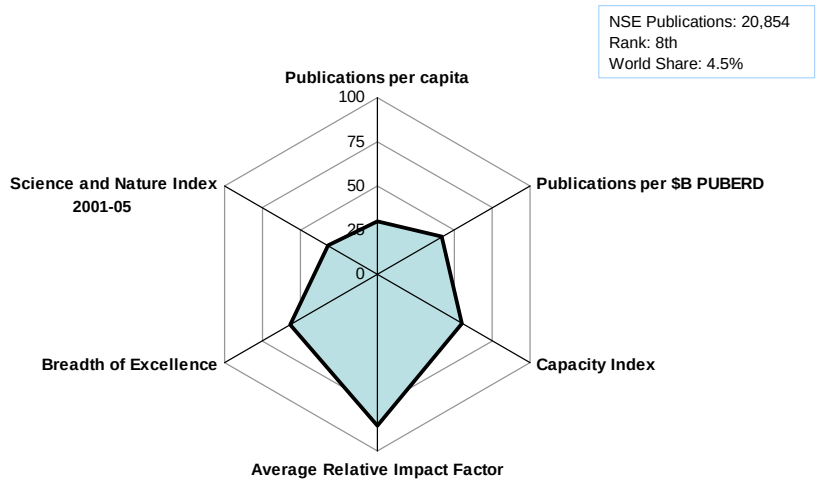
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 39
NSE Publication Footprint – France 2005



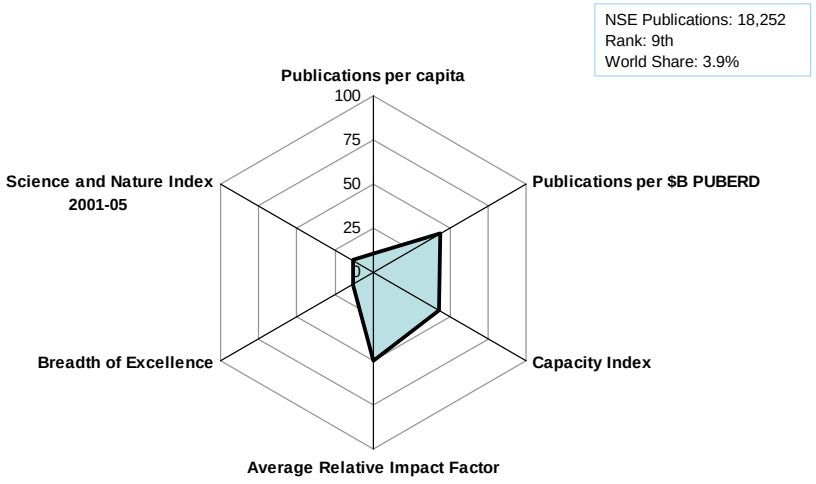
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 40
NSE Publication Footprint – Italy 2005



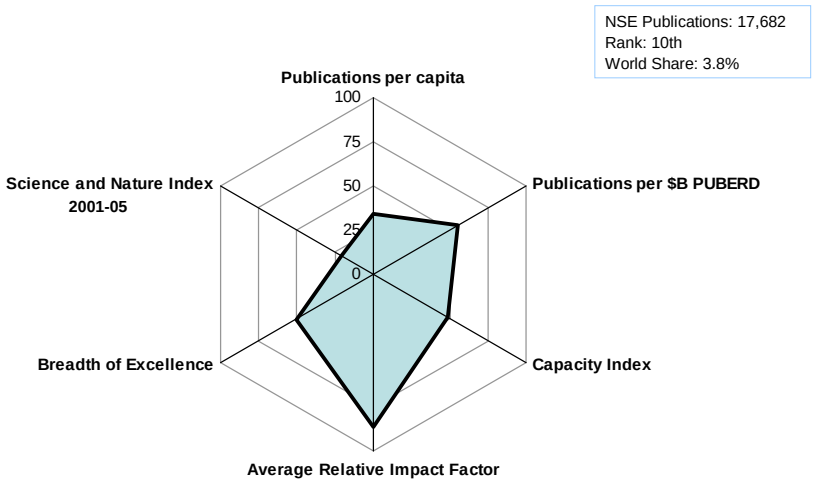
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 41
NSE Publication Footprint – Russia 2005



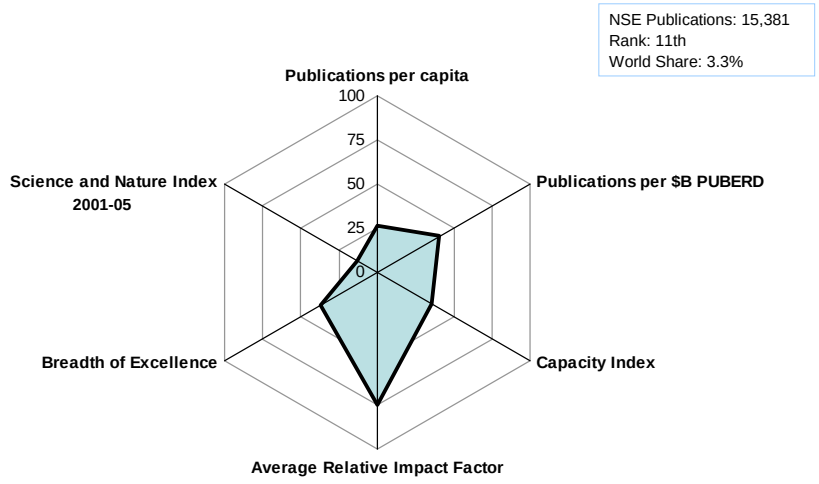
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 42
NSE Publication Footprint – Spain 2005



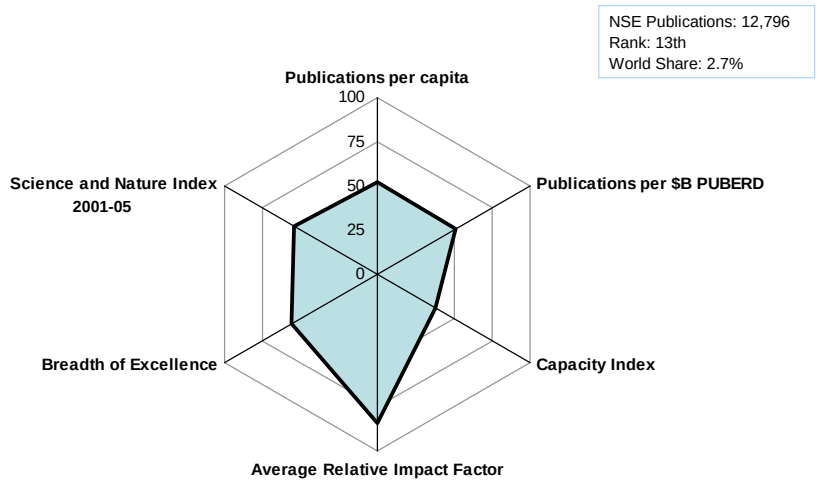
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 43
NSE Publication Footprint – South Korea 2005



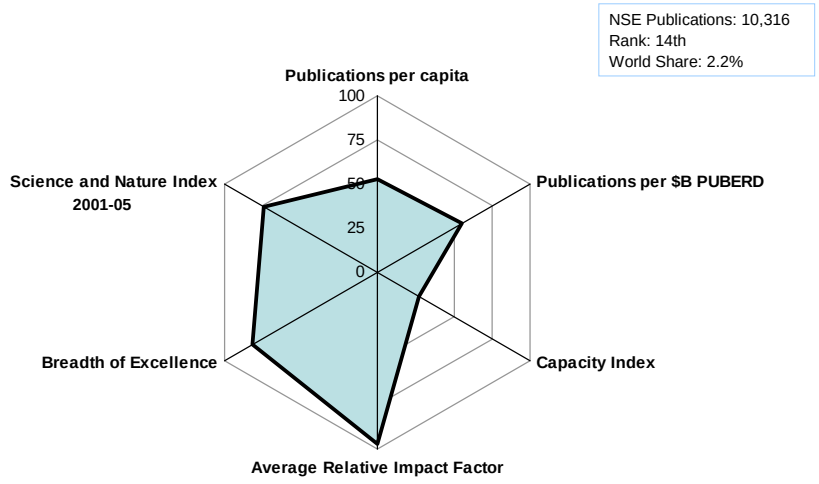
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 44
NSE Publication Footprint – Australia 2005



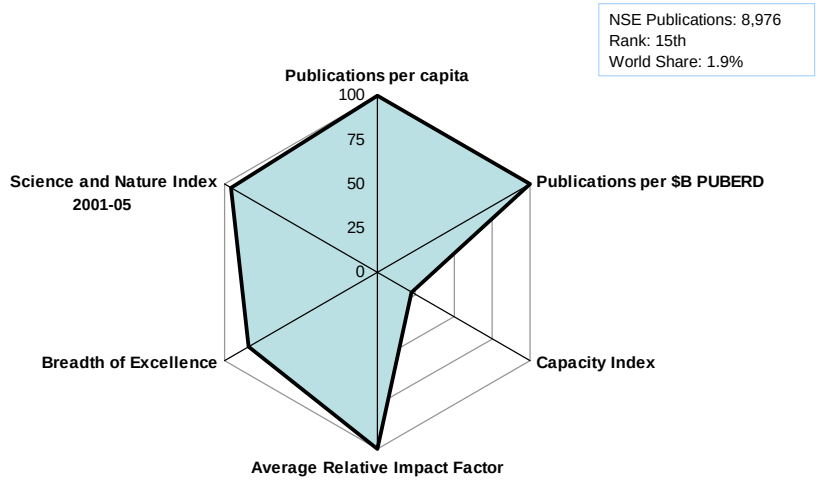
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 45
NSE Publication Footprint – Netherlands 2005



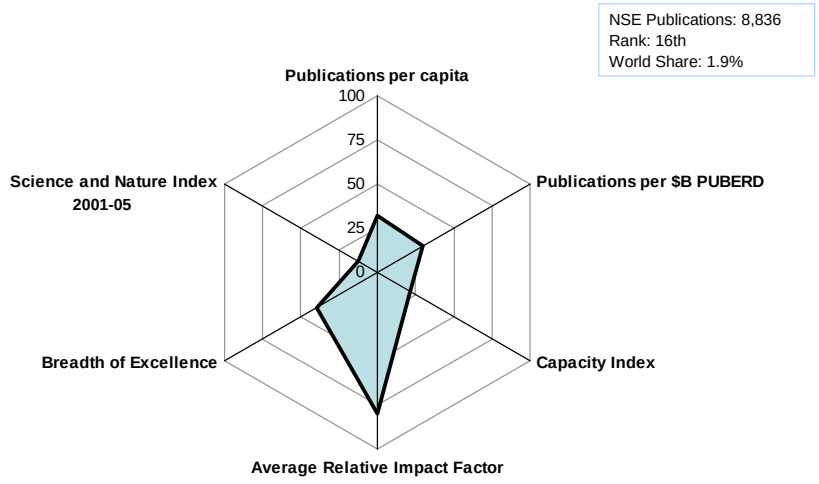
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 46
NSE Publication Footprint – Switzerland 2005



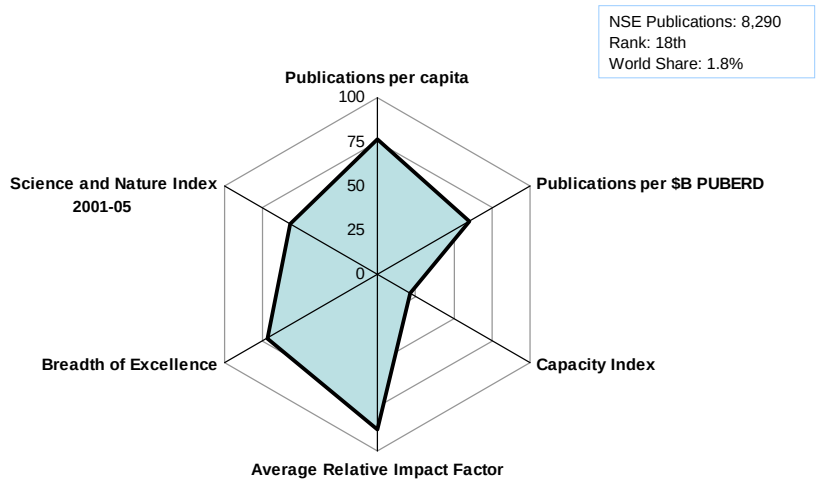
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 47
NSE Publication Footprint – Taiwan 2005



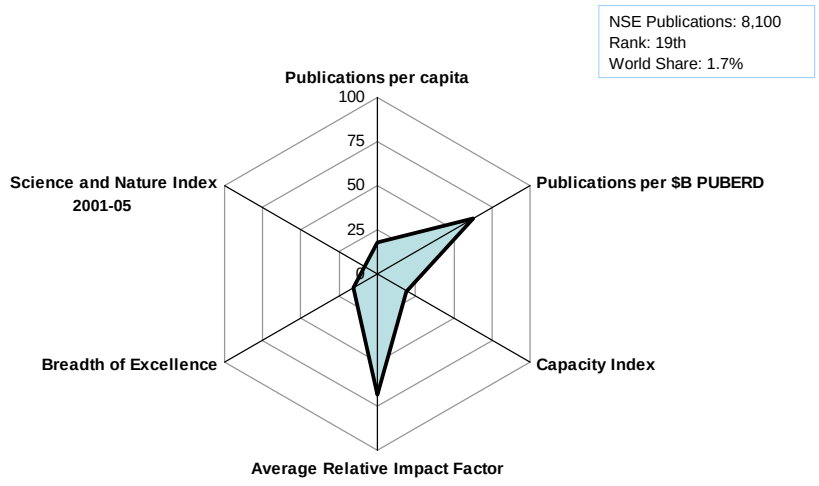
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 48
NSE Publication Footprint – Sweden 2005



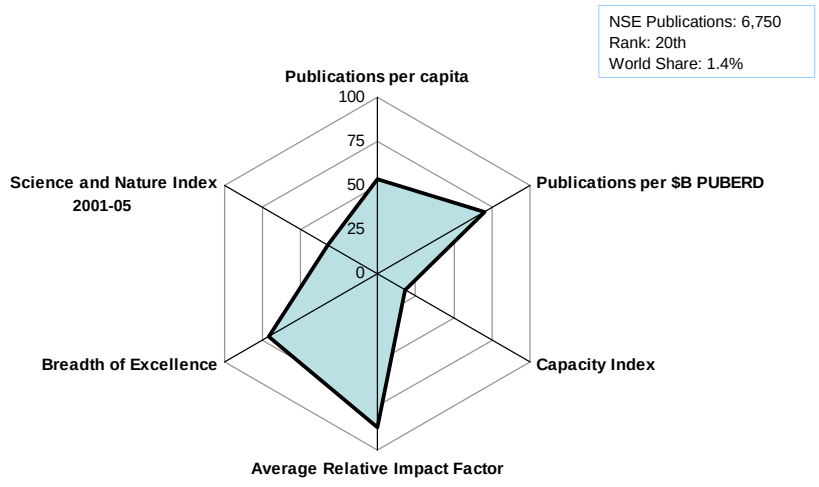
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 49
NSE Publication Footprint – Poland 2005



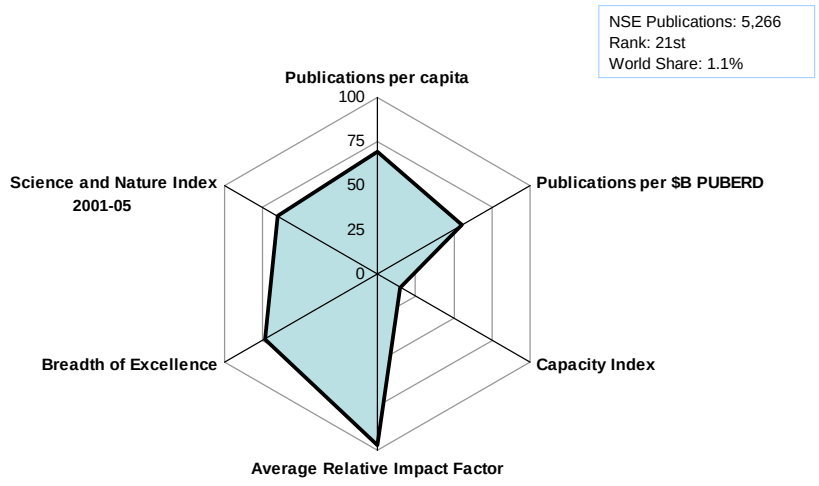
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 50
NSE Publication Footprint – Belgium 2005



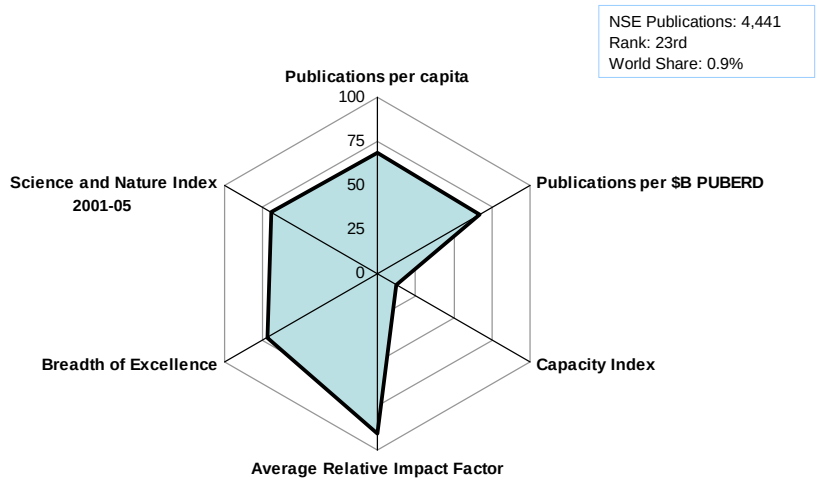
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 51
NSE Publication Footprint – Israel 2005



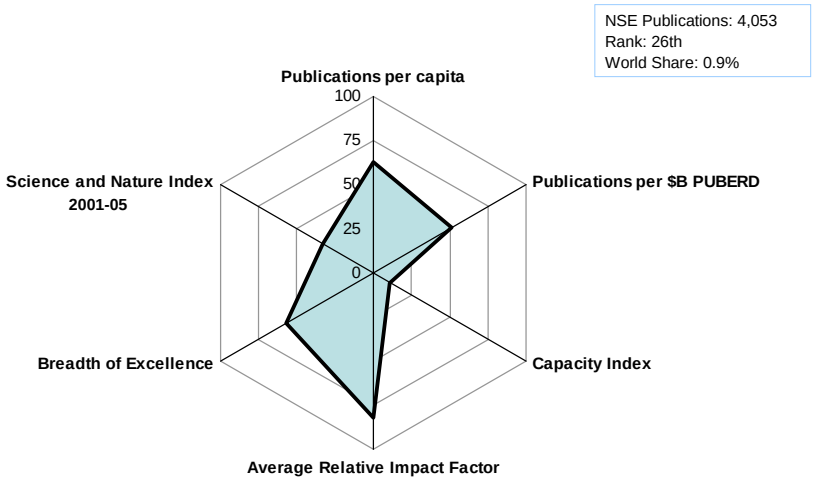
Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 52
NSE Publication Footprint – Denmark 2005



Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.

Figure 53
NSE Publication Footprint – Finland 2005



Source: Observatoire des Sciences et des Technologies and NSERC estimates. Scale is based on percentage of lead country value for each indicator except for breadth of excellence based on 65 subfields.