# Funding Research:

# A Bibliometric Evaluation of the NSERC Research Grants Program

Report Prepared for NSERC

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## 1. Introduction

For many years, the Natural Sciences and Engineering Research Council of Canada (NSERC) has been administering a program of grants that is virtually unique in the Western world. Instead of funding specific, individual research projects, NSERC's Research Grants Program (recently renamed the Discovery Grants Program) funds Canadian researchers and their general research activities. For this reason, the majority of Canadian researchers receive a research grant year in and year out. An annual budget of $240 million is allocated for this program.

In the firm belief that such investments should be made wisely, NSERC has retained the Observatoire des sciences and des technologies (OST) to carry out the present evaluation. NSERC has asked the OST to investigate four main questions:

1. What is the place of NSERC in Canadian scientific production?
2. What is the profile of the collaborative ties that NSERC establishes with other Canadian researchers and researchers elsewhere in the world?
3. What impact does NSERC have on researchers' productivity?
4. What impact does NSERC have on the quality of their research?

Questions 1 and 2 are addressed in section 3 of this report, while questions 3 and 4 are addressed in section 4. Our analysis is based on the OST's bibliometric database, which comprises papers by Canadian researchers that have appeared in over 4 000 scientific journals indexed by the Institute of Scientific Information (ISI).[1] The journals in which these papers appeared are regarded as representative of scientific production in the following sense. First, they collectively account for over 80% of all citations made in scientific journals worldwide, so that they constitute a representative sample of the knowledge produced. Second, since Canadian researchers are assumed to publish mostly in English, at least in the sciences covered by NSERC, this database constitutes a reliable source for the production of indicators designed to quantitatively evaluate the production and productivity of Canadian researchers.[2]

Every year, the OST does a great deal of work to standardize and code the information in its database on the "address" field for the authors credited in the papers, so that the scientific production of every Canadian institution can be correctly identified and attributed and reliable statistics can be derived from it. For the present study, however, an additional operation had to be carried out, the papers had to be assigned to each of the 14 837 researchers who were funded by NSERC from 1990 to 1999. Because the ISI data do not provide any link between the authors' names and the addresses in the address field, the OST's staff had to perform this additional operation manually. This was no small task; though invisible to the reader, it actually accounted for 90% of the effort involved in conducting the present study.

This report is intended for a broad audience. OST has already produced a large volume of statistics and delivered them to NSERC. In this report, we present the statistics that are most significant and that provide an overall picture of the research being funded. All of the methodological details appear in Appendixes 1 and 2, to which interested readers may

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[1] The disciplines covered are biology, clinical medicine, biomedical research, physics, chemistry, engineering, earth and space sciences, and mathematics.

[2] The types of papers included in the present study are those that convey new scientific knowledge: articles, research notes, and review papers, which account for over 90% of the papers indexed.

refer. Likewise, all statistical tables are presented in Appendix 3, while graphs are used to present most of the statistics in the body of this report.

This report is divided into three parts. The first part sketches a very brief portrait of Canadian scientific production, to provide a context for the production of the researchers who are funded by NSERC. The second part examines the contribution of NSERC-funded researchers to Canadian scientific production. It analyzes the proportion of all Canadian papers that are written by these researchers and how this proportion has changed over the past ten years. It also presents two indicators that are qualitative: the proportion of the funded researchers' papers written in collaboration with other authors and the quality of the journals in which the funded researchers' papers appear (the quality indicator is based on the number of citations). The third part of this report attempts to determine the impact of NSERC's Research Grants Program, in two ways. The first is by analyzing the volume and quality of funded researchers' papers as a function of the dollar amount of the grants they receive. The second way is by comparing established researchers (researchers who have received funding regularly for 10 years) with researchers who have just come into the system, as well as with researchers who have never received any grants.

The results of this study show that researchers funded by NSERC are responsible for the majority of Canadian papers in natural sciences and engineering, and that these papers appear in high-quality journals. Our main conclusion is that the NSERC grants program has a measurable effect on research in Canada: the volume of papers grows with the level of funding. However, the correlation discriminates only those researchers with what are classified as high levels of funding. Our second conclusion is that the level of funding has no impact on the quality of the journals in which the researchers publish. Regardless of the level of funding, the quality of the journals remains the same. Only the number of papers varies.

## 2. Canadian scientific production

With 24 989 papers in 1999, Canada was responsible for 4.3% of world scientific production, which ranks it in 6th place. This percentage was down slightly from 1990, when it stood at 4.8%. Since 1999, Canada has been slightly surpassed by Italy.

In 1999, the health sciences (biomedical research and clinical medicine) accounted for half of all Canadian scientific papers (49.5%). The other half was accounted for by the scientific disciplines in which NSERC is active: biology (11.6%), physics (9.3%), chemistry (9.1%), earth and space sciences (8.7%), engineering (8.2%), and mathematics (2.1%).

By far the greatest proportion of Canadian papers is produced by universities, which account for 84.0% of all Canadian scientific papers. This percentage has increased since 1990, when it stood at 75.5%. The universities are followed by the federal government, whose researchers are authors or coauthors of 14.4% of all Canadian papers, and then by hospitals (11.5%), industry (6.3%), and provincial governments (2.6%).

## 3. Place of NSERC in Canadian scientific production

Each year, an average of 7 000 researchers receive research grants from NSERC. In total, from 1990 through 1999, nearly 15 000 Canadian researchers have obtained NSERC funding (see Table 1 in Appendix 3). The average annual grant, which was $25 552 in 1990, rose to $31 239 by 1999 (see Table 2 in Appendix 3), an increase of 22.2%.

In 1999, NSERC-funded researchers were responsible for nearly 12 000 scientific papers, or 48% of all Canadian papers and 57% of all papers by Canadian universities (Figure 1 , and Table 3 in Appendix 3). These percentages have changed very little since 1990. From 1990 to 1999, papers by NSERC-funded researchers grew by 13.3%, slightly less than for the university sector as a whole (15.1%), but more than for Canadian researchers overall (10.1%).

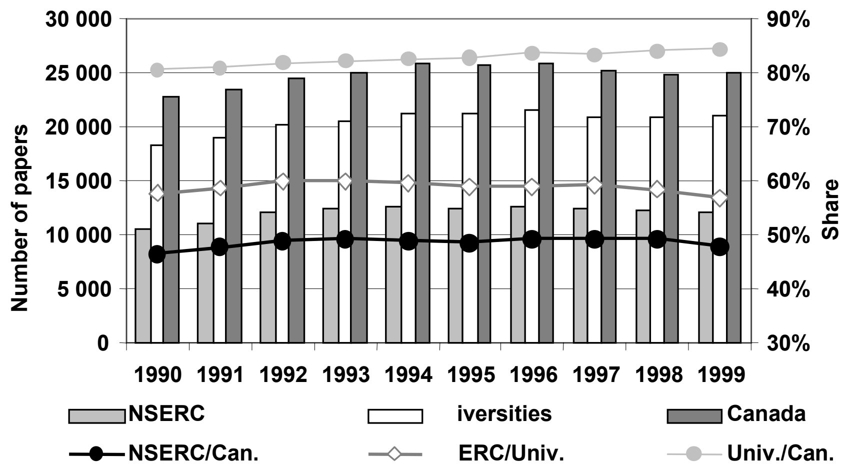



**Figure 1. Number of papers, NSERC and Canada, 1990-1999**

Because NSERC's funding specifically targets research in natural sciences and engineering, its contribution to Canadian papers is not equally distributed across the disciplines (Figure 2, and Table 4 in Appendix 3). In 1996-99, NSERC-funded researchers authored three-quarters or even more of all Canadian papers in chemistry (80.0%), physics (76.2%), engineering (74.4%), and mathematics (73.6%). Next came the earth and space sciences (63.7%) and biology (61.3%). More unexpectedly, the health science disciplines were also represented, and substantially so in the case of biomedical research, where 43% of all Canadian papers were signed by a researcher who was funded by NSERC.

In the disciplines that define NSERC's field of activity–natural sciences and engineering–NSERC-funded researchers accounted for 70% of all Canadian papers in 1999 (up from 65% in 1990), and 85% of all papers from Canadian universities (up from 83%) (Figure 3, and Table 5 in Appendix 3). In absolute numbers, however, the volume of papers has grown very little. It totalled nearly 8 000 in 1990, climbed to over 9 000 in the mid-

1990s, then fell back to slightly more than 8 300 in 1999. Overall, however, NSERC-funded researchers are responsible for a growing share of Canadian papers.

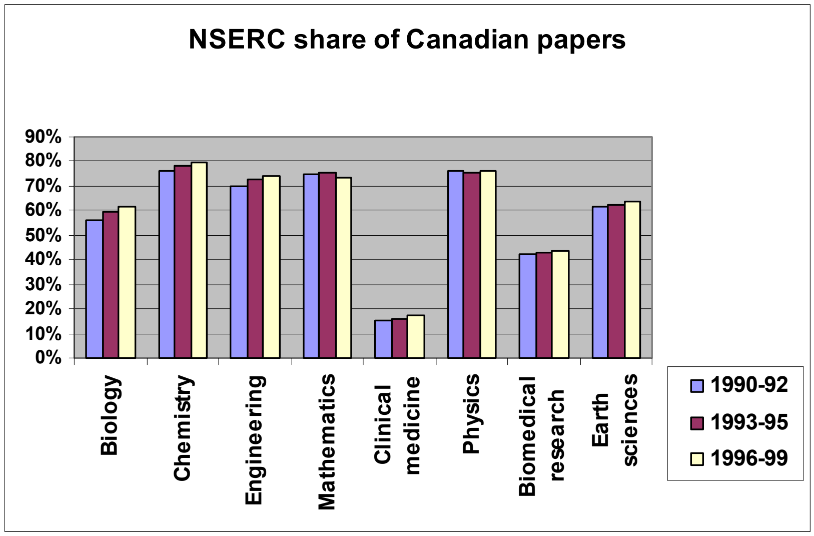



**Figure 2. NSERC share of Canadian papers, 1990-1999**

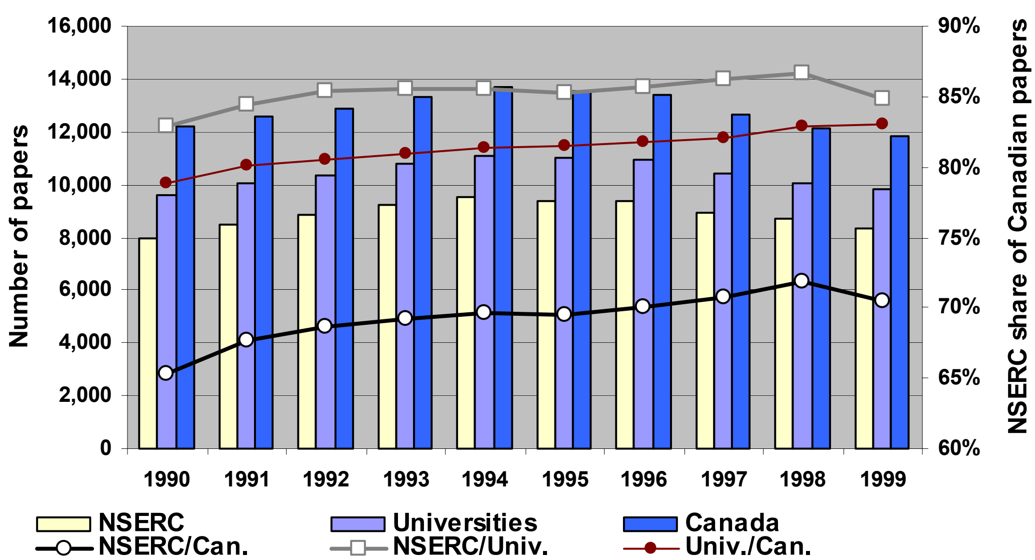



**Figure 3. Papers in natural sciences and engineering, NSERC and Canada, 1990-1999**

Researchers with NSERC grants made a substantial contribution to the scientific papers of the university sector as a whole. Their contribution covered all science and engineering disciplines, including sub-disciplines. This contribution did vary, however, from one discipline to another, with some areas of strength and others of weakness. In 1996-99, NSERC-funded researchers authored more than three-quarters of all Canadian university papers in chemistry (91.2%), physics (85.9%), engineering (90.0%) and earth and space sciences (85.2%). They also accounted for high percentages of all papers in biology (81.2%) and mathematics (74.5%). These results are not surprising, since the majority of researchers in natural sciences and engineering do receive NSERC grants. Lastly, NSERC-funded researchers also authored a respectable share of all university papers in the health sciences: 49.6% in biomedical research and 21% in clinical research. Figure 4 (and Table 6 in Appendix 3) shows the trends in the number of papers in the university sector that were attributable to NSERC researchers from 1990 to 1999.

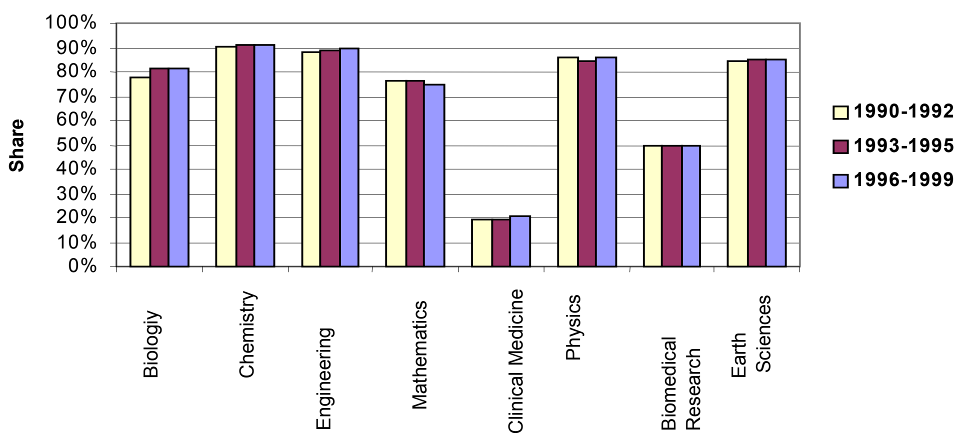



**Figure 4. NSERC share of Canadian university research papers, 1990-1999**

By virtue of its mission, NSERC specializes in certain disciplines, and the papers of the researchers whom its funds reflect this specialization (Figure 5, and Table 7 in Appendix 3). In comparison with world scientific production as a whole, the scientific production of NSERC-funded researchers is specialized (has a specialization index greater than 1) mainly in earth and space sciences (with an index of 2.2 in 1999), biology (1.9), mathematics (1.7), and engineering (1.6). It shows just about no specialization, however, in chemistry (1.1), biomedical research (1.0), or physics (0.9), and it is underspecialized in clinical medicine (0.4).

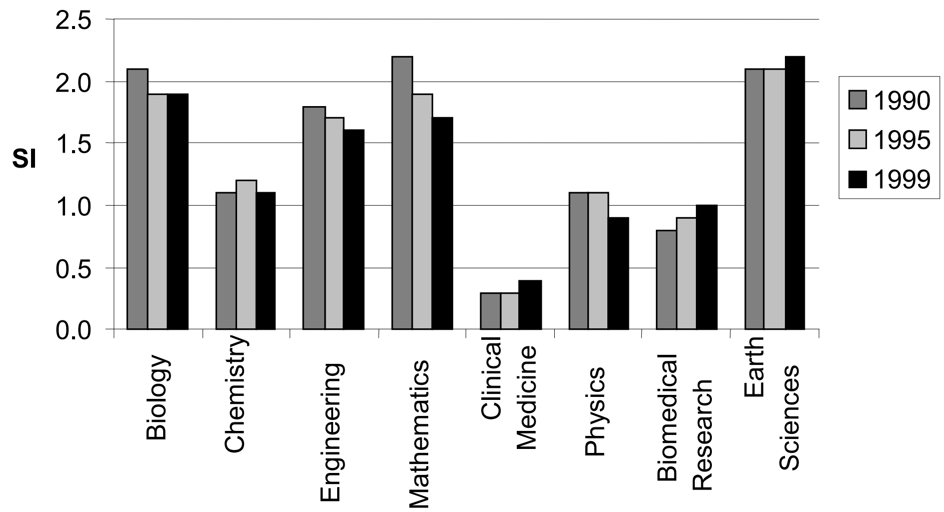
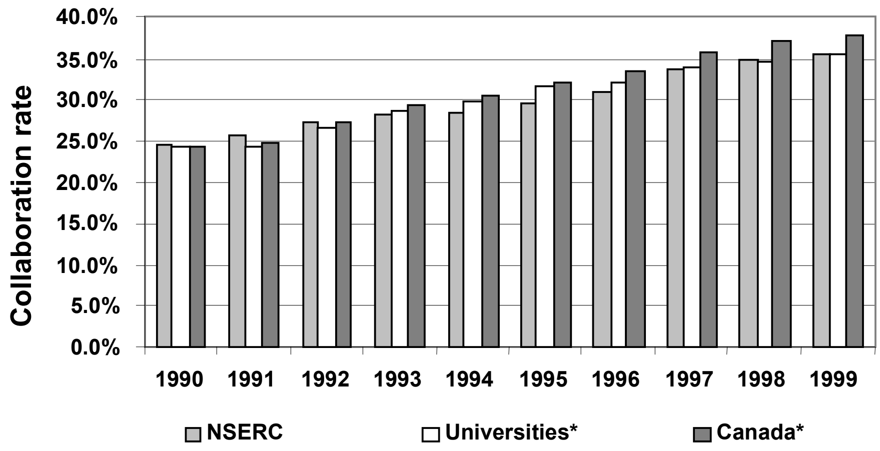


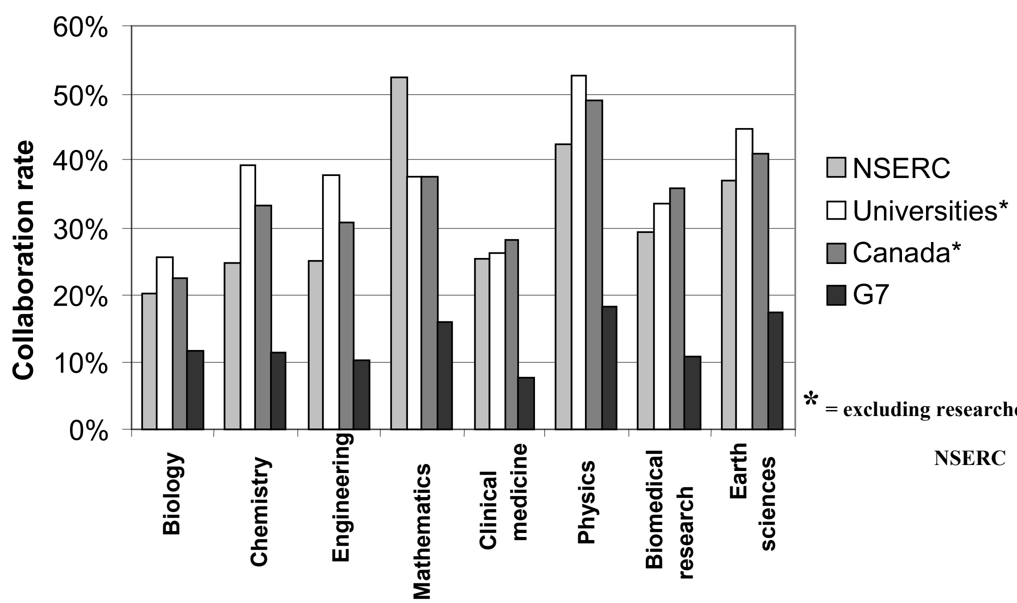

**Figure 5. Specialization index (SI) by field (1990, 1995, and 1999) (Base: Wo**

On a number of more qualitative dimensions, NSERC-funded researchers also contribute, to varying extents, to Canadian performance as a whole. First of all, the international collaboration rate for NSERC-funded researchers rose from 25% in 1990 to 35.6% in 1999; in other words, one-third of all papers by NSERC-funded researchers are now written in collaboration with foreign partners. This percentage is equal to that for the university sector (excluding NSERC-funded researchers), but slightly lower than that for Canada as a whole (excluding NSERC-funded researchers) (Figure 6, and Table 8 in Appendix 3). For the entire period considered in this study, the disciplines in which NSERC-funded researchers engaged in the most international collaboration were mathematics (52%)–the only discipline where NSERC-funded researchers surpass the university sector–followed by physics (42%) and earth sciences (37%) (Figure 7 and Table 9). As of 1999, the highest proportion of foreign co-authors (41.6%) still came from the United States, followed by the United Kingdom (10.9%), Germany (9.8%), Fran




* = excluding researchers funded by NSERC

**Figure 6. International collaboration rate for NSERC-funded researchers, other university researchers, and other Canadian researchers, all disciplines, 1990-1999.**




* = excluding researchers funded by NSERC

**Figure 7. International collaboration rate for NSERC-funded researchers, other university researchers, and other Canadian researchers, by discipline, 1990-1999**

In another form of collaboration, NSERC-funded researchers write slightly over 20% of their papers with researchers from other sectors (government and industry). This rate was 15.3% in 1990. Government researchers are the main co-authors (52.4%), while researchers in industry account for 16.0% of the collaborations. This form of collaboration is most common in biology (30.9% of papers) and the earth and space sciences (27.3%). These figures are comparable in all respects with those for the Canadian university sector as a whole and seem to indicate that NSERC funding has no effect on collaboration.

Lastly, the "quality" of the scientific papers published by NSERC-funded researchers, as measured by the relative weighted impact factor (RWIF) (see Appendix 2) of the journals in which these papers appear, is generally greater than or equal to that for the university sector and the rest of Canada (Figure 8, and Table 10 in Appendix 3). In comparison with the RWIF for university researchers, for example, the RWIF for NSERC-funded researchers is 31% higher in chemistry and 18% higher in biology. Next come physics, where the advantage is slighter (5%), engineering and mathematics (4% each), and earth sciences (2%).

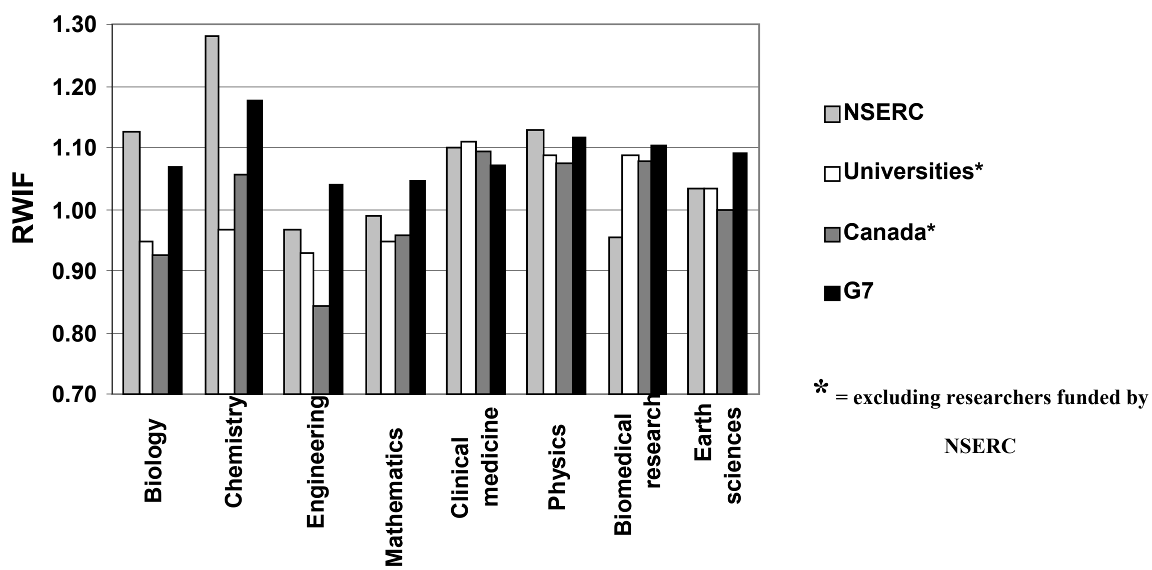
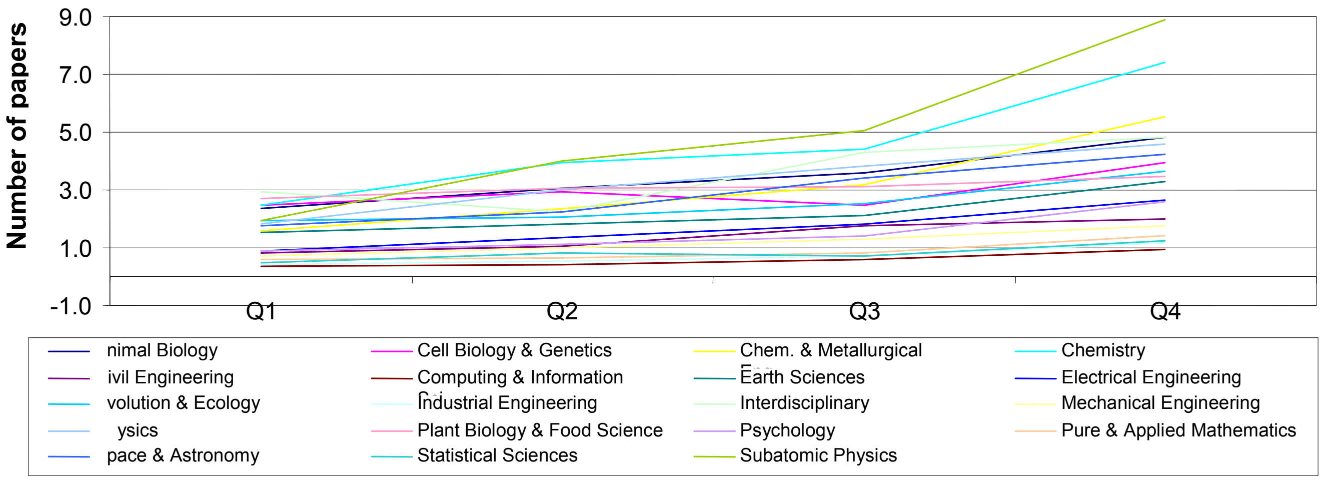



**Figure 8. Relative weighted impact factor (RWIF) for NSERC, universities, Canada, and G7 countries**

## 4. Impact of the NSERC Research Grants Program on scientific production

Researchers who are receiving grants specifically through the NSERC Research Grants Program produce an average of 6 000 papers annually, or about half of all papers by funded researchers for all grant programs combined. As can be seen from Figure 9 (and from Table 11 in Appendix 3), there is a positive correlation between funding level and number of papers.

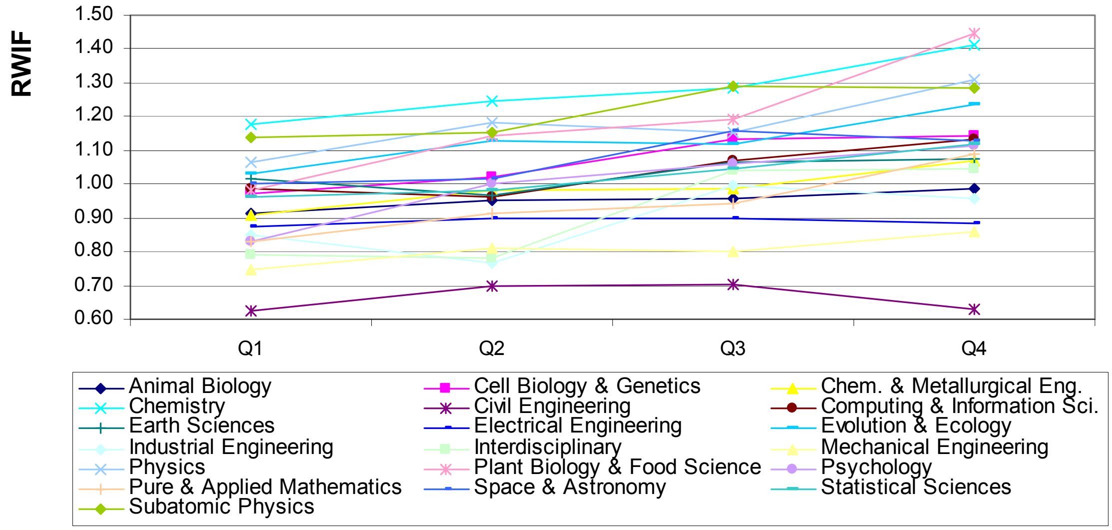



Q1 = $3 190 - 19 017     Q2 = $19 018 - 26 820     Q3 = $26 821 - 38 850     Q4 = $38 851 - 357 494

**Figure 9. Average annual number of papers by established researchers, by funding quartile and by committee**

The correlation does vary, however, from committee to committee. It is stronger in the case of chemical engineering and metallurgy, space and astronomy, physics, and electrical engineering, but far weaker (virtually non-existent) in biology and interdisciplinary research. It should be noted, however, that the differences in scientific production by funding level are not always significant. In general, it is only when funding is relatively high (quartiles 3 and 4: see Appendix 2), that the number of papers differentiates the researchers.

There is also a very weak statistical relationship between funding level and RWIF, a significant difference by funding level exists for a limited number of committees only, such as chemistry, plant biology, physics, and mathematics (Figure 10, and Table 12 in Appendix 3). From these results, we must conclude that regardless of the level of funding that researchers receive, they publish in journals of similar quality, and this quality is high.




Q1 = $3 190 - 19 017 Q2 = $19 018 - 26 820 Q3 = $26 821 - 38 850 Q4 = $38 851 - 357 494

**Figure 10. Relative weighted impact factor (RWIF) for established researchers, by funding quartile and by committee**

To analyze these results more closely and to measure the impact of funding from a different angle, we have constructed four groups of researchers, as follows:

*Group 1. Established researchers*

This group consists of researchers who received funding every year for the entire period from 1990 to 1999.

*Group 2. New researchers funded since 1993*

This group consists of researchers who made their first grant applications in 1993. This group, along with group 3, gives us a control group so that we can perform a quasi-experimental analysis in order to measure the effect of the program on new researchers.

*Group 3. New researchers not funded in 1993*

This group consist of researchers who made their first grant applications in 1993, but never received funding from the agency during the period covered by this study.

*Group 4. Researchers whose funding terminated in 1992*

This group consist of researchers who received annual funding between 1988 and 1992, but never received any more funding from 1993 to 1999.

Figure 11 (and Table 13 in Appendix 3) reveal three facts. First, the established researchers (Group 1) are the ones who produce the most papers: over two per year throughout the period. Their productivity has decreased slightly, however, since 1994. Perhaps some of them are slowly joining the ranks of researchers who are winding down their careers. Second, the productivity of newly funded researchers (Group 2) has increased steadily: they went from less than one paper per year in 1993 to 1.5 in 1999, which is almost double. It should be noted that their productivity had already begun to climb before 1993. At this rate, they should catch up with the established researchers within a few years. Lastly, the new researchers who did not receive funding (Group 3) have seen their productivity languish below one paper per year. In short, the data show that the funding has a definite impact on researchers' productivity, and on the productivity of new researchers in particular.

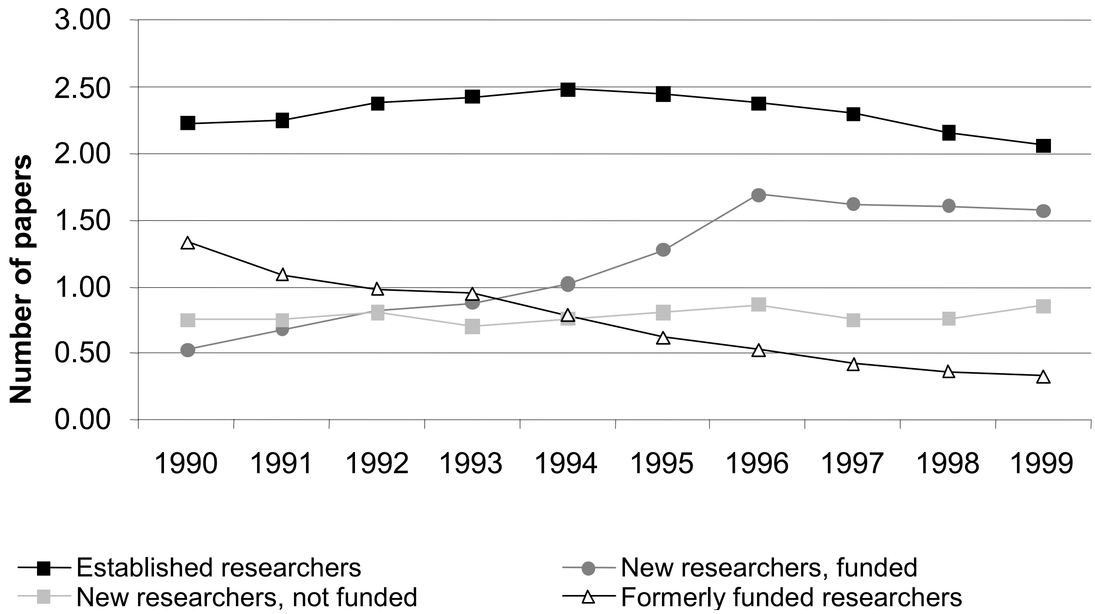



**Figure 11. Productivity (average number of papers per year) for researchers with different funding histories**

Regarding the RWIF for the researchers in the four groups, we see the same trends as before, funding has no impact on the quality of the journals in which authors publish (Figure 12, and Table 14 in Appendix 3). Apart from those researchers who have not received any funding since 1992 (Group 4), all the researchers, including those who were unsuccessful in the 1993 competition and never received any NSERC funding subsequently (Group 3), publish in journals of the same quality.

To review the results obtained so far:

- Funding from NSERC is correlated with higher scientific productivity (among both established researchers and new ones);
- A higher-than-median funding level (quartiles 3 and 4) is associated with higher scientific productivity;
- The level of funding is not correlated with the quality of the journals in which the researchers publish.

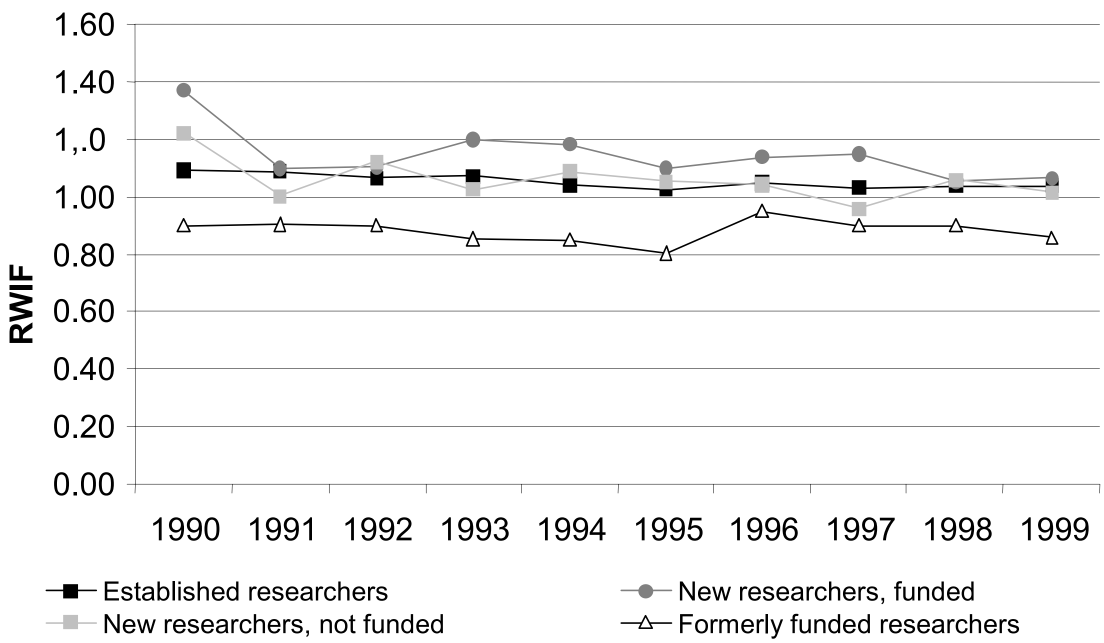



**Figure 12. Relative weighted impact factor (RWIF) for researchers with different funding histories**

One final confirmation of these results is provided in figures 13 and 14 (and Table 14 in Appendix 3), which show the levels of scientific production and the RWIF according to whether the researchers receive funding from more than one program. Researchers funded through the Research Grants Program (RGP) publish an average of 1.44 papers per year. When they receive additional funding from another program, they publish an average of 2.12 papers per year. This figure rises to 2.29 in the case of the university/industry program and 2.7 for the strategic grants program. On the other hand, the RWIF changes only a few percentage points, regardless of whether a researcher participates in more than one program.

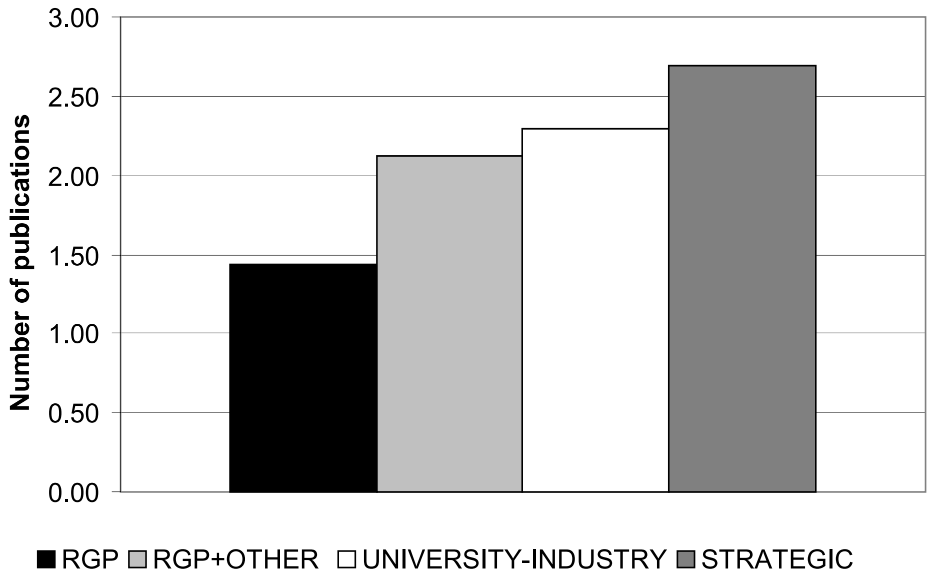



**Figure 13. Average number of papers per researcher by program**

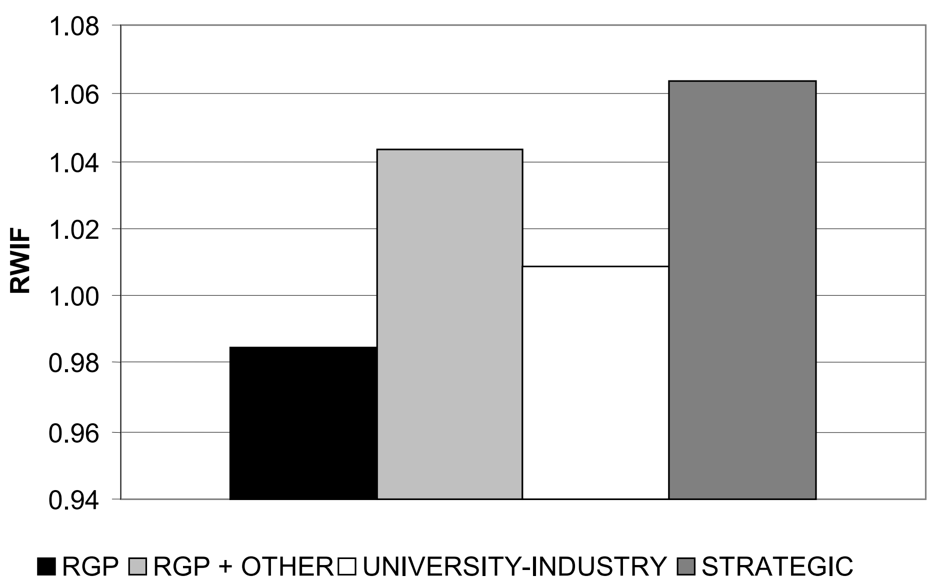



**Figure 14. Relative weighted impact factor (RWIF) for researchers by program**

## 5. Conclusion

The conclusions that emerge from the present analysis allow us to position NSERC and the impact of its funding in two ways. First, this analysis illustrates the place of NSERC and NSERC-funded researchers in Canadian scientific production as a whole and in the scientific production of Canadian universities specifically. Second, this analysis assesses NSERC's contribution to the productivity of the researchers whom it funds and to the impact of their papers.

We will not recapitulate here all of the findings discussed in this report, but in conclusion, here are the main ones:

I. NSERC's place in Canadian scientific production

- Researchers funded by NSERC produce a total of about 12 000 papers per year, and this output grew by 13.3% over the period 1990-1999.
- NSERC-funded researchers are responsible for 70% of all Canadian papers in natural sciences and engineering, and 85% of all papers in natural sciences and engineering from Canadian universities (this latter percentage has risen by 2 points since 1990).
- NSERC-funded researchers produce 35.6% of their papers in collaboration with foreign co-authors, and 20% in collaboration with Canadian researchers from industry and government.
- The impact factor of the journals in which NSERC-funded researchers publish is, overall, greater than or equal to that for researchers in the university sector and in the rest of Canada and, to a lesser extent, that for researchers in the G7 countries as a whole.

II. NSERC's contribution to the productivity of researchers and the impact of their research

- The funding that researchers obtain from NSERC is correlated with increased scientific productivity, and more strongly correlated when the level of this funding is high (with high defined as "above the median").
- The absence of NSERC funding and the level of funding have no impact on the quality of the journals in which the researchers publish.
- NSERC funding does not seem to have any effect on international collaboration by NSERC-funded researchers, because they co-sign with foreign authors slightly less than do other Canadian researchers who do not receive NSERC funding.

To sum up, the present study indicates that NSERC plays a central role in Canadian university research in natural sciences and engineering. It finances 70% of Canadian university researchers in these disciplines, and these researchers produce 85% of all papers in these disciplines. What is also clear is that NSERC funding has a decisive effect on new researchers. Their productivity increases steadily as soon as they obtain a research grant and, over time, tends to compare favourably with that of established researchers. Conversely, the productivity of researchers whose grant applications are rejected tends to stagnate subsequently.

As regards the quality of the research produced by NSERC-funded researchers, NSERC's role is more limited. On the one hand, the level of funding received by researchers has no impact on the quality of the journals in which they publish. On the other, the impact factor of the journals in which NSERC-funded researchers publish is, overall, excluding the health sciences, greater than or equal to that for university researchers and Canadian researchers on average and, to a lesser extent, that for the G7 countries as a whole. In conclusion, researchers who have NSERC grants publish in high-calibre journals, regardless of their level of funding. The difference between the indexes is too small to give a precise idea of the impact of the funding on the quality of the research published. The main effect of NSERC funding is on productivity.

There is still another question that the present study cannot answer, and it deals with the policy or philosophy behind the distribution of grants. The highest productivity in this study was found among those researchers who had what were classified as high levels of funding. On the one hand, a policy designed to participate in and influence this productivity even further could offer greater funding to all researchers. In this case, NSERC would need far greater financial resources than are currently available to it for the Research Grants Program. Conversely, and on the other hand, NSERC could decide to concentrate its resources on the most productive researchers, and fund only those who performed the best. However, this would represent a complete change in the program's orientation. It would also mean betting on the notion that the "less productive" researchers are not essential to the research system. The validity of such an assumption is not obvious, given that these researchers still publish research that is of high quality, at least if the quality of the journals in which they publish is any indication.

## Appendix 1

## Main Points of Methodology

*Reconstituting the publication records*

The first step in the bibliometric analysis was to constitute the corpus of papers written by researchers who are funded by NSERC. This corpus was identified by tracing the papers published by NSERC-funded researchers in journals indexed in the *Science Citation Index* (SCI). The list of funded researchers provided by NSERC comprises 14 837 names, each of whom has received at least one grant from the agency between 1990 and 1999, as well as certain other information, such as the researcher's institution and department, the years that the grants were awarded, the amounts of the grants, the program, etc. Matching was done manually using a computer interface that let us crosscheck this information against the information in the OST database. For each of the researchers, the interface located all of the Canadian papers for which one of the authors' names was the same as that of the funded researcher. The matching was done mainly by crosschecking the name, institution, and department and was relatively easy, but it did not allow us to reconstitute the researchers' publication records completely and accurately. This problem, which had two sources, was corrected as follows.

*Problems related to researchers' mobility*

Though any given researcher generally submits a grant application from only one university and one department, it is still necessary to check whether that researcher has also published under the name of another institution. Some researchers are affiliated with more than one institution. For example, a medical researcher may be affiliated with both a hospital and a university, and may signs some articles with one institution's name and others with the other's, or a visiting researcher may sign under the host institution's name, etc. Thus, to complete a researcher's publication record, we had to check whether, in addition to papers attributed to the right institution and the right department, we ought to include certain papers bearing the address of another institution or department. To make each such verification, we obtained a precise understanding of the researcher's research topics and career history by searching the Internet, analyzing the titles of the papers, and applying various other triangulation procedures such as cross-checking data from various sources.

*Problems related to variants in authors' names*

Sometimes the name that a researcher provided when applying for a grant differed from the name that same researcher had used when signing an article (for example, the author may have used initials in one case but not in the other). When this happened, the computer interface could not select the appropriate articles, and automatic attribution was impossible. For all cases where no paper was attributed, or where certain elements suggested that the number of papers attributed was too low, an Internet search was performed to find out more about the researcher's exact signature.

When this process was completed, the publication records of 12 975 researchers had been constituted. For the 1 862 remaining researchers, however, the effort to identify papers failed. We therefore again searched the Internet to make sure that these researchers had actually not published anything in the journals covered by the database. The following table provides the statistics on the number of unmatched grant recipients in the database.

## Number of grant recipients not matched in the database, by grant selection committee

| Committee | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Animal biology | 19 | 15 | 14 | 12 | 12 | 10 | 10 | 8 | 7 | 8 | 9 | 12 |
| | 4.3% | 3.4% | 3.0% | 2.5% | 2.5% | 2.2% | 2.3% | 1.8% | 1.5% | 1.7% | 2.1% | 2.8% |
| Cell biology and genetics | 10 | 6 | 7 | 6 | 5 | 5 | 6 | 6 | 6 | 7 | 11 | 15 |
| | 2.2% | 1.3% | 1.5% | 1.4% | 1.2% | 1.1% | 1.4% | 1.4% | 1.3% | 1.5% | 2.3% | 3.1% |
| Plant Biology and Food Science | 17 | 14 | 12 | 8 | 9 | 6 | 7 | 6 | 5 | 8 | 7 | 17 |
| | 5.3% | 4.1% | 3.4% | 2.1% | 2.3% | 1.7% | 2.1% | 1.9% | 1.6% | 2.6% | 2.4% | 5.6% |
| Chemistry | 12 | 10 | 7 | 4 | 5 | 4 | 4 | 4 | 3 | 4 | 5 | 10 |
| | 2.4% | 2.0% | 1.4% | 0.8% | 0.9% | 0.7% | 0.7% | 0.7% | 0.5% | 0.7% | 0.9% | 1.7% |
| Evolution and ecology | 20 | 13 | 9 | 6 | 5 | 5 | 4 | 4 | 3 | 5 | 5 | 8 |
| | 4.9% | 3.1% | 2.2% | 1.4% | 1.1% | 1.1% | 0.9% | 0.9% | 0.7% | 1.1% | 1.2% | 1.8% |
| Chem.&Metallurgical Eng. | 31 | 26 | 21 | 15 | 12 | 12 | 11 | 11 | 12 | 11 | 14 | 20 |
| | 7.9% | 6.7% | 5.1% | 3.5% | 2.8% | 2.8% | 2.6% | 2.5% | 2.8% | 2.5% | 3.1% | 4.2% |
| Civil Engineering | 71 | 58 | 57 | 52 | 52 | 45 | 40 | 39 | 38 | 38 | 37 | 46 |
| | 15.9% | 12.9% | 12.3% | 10.9% | 10.5% | 9.1% | 7.9% | 7.7% | 7.4% | 7.4% | 7.3% | 9.2% |
| Electrical Engineering | 56 | 43 | 43 | 42 | 36 | 37 | 35 | 41 | 37 | 45 | 53 | 63 |
| | 11.4% | 8.6% | 8.3% | 7.7% | 6.6% | 6.6% | 6.3% | 7.3% | 6.6% | 7.8% | 9.0% | 10.4% |
| Industrial Engineering | 51 | 51 | 50 | 57 | 47 | 48 | 45 | 47 | 44 | 52 | 52 | 45 |
| | 28.8% | 25.9% | 24.4% | 24.7% | 20.1% | 20.4% | 19.4% | 21.3% | 19.8% | 22.7% | 22.1% | 19.7% |
| Mechanical Engineering | 69 | 53 | 52 | 50 | 48 | 49 | 52 | 58 | 59 | 56 | 62 | 74 |
| | 16.2% | 12.4% | 11.8% | 10.9% | 10.2% | 10.1% | 10.6% | 11.7% | 11.9% | 11.2% | 11.9% | 14.2% |
| Computing and Info. Science | 101 | 91 | 99 | 100 | 101 | 114 | 116 | 110 | 108 | 115 | 129 | 133 |
| | 25.6% | 22.5% | 22.2% | 21.5% | 21.4% | 22.9% | 23.1% | 21.9% | 21.6% | 22.4% | 23.7% | 23.7% |
| Interdisciplinary | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 6 | 9 |
| | 6.5% | 7.9% | 6.7% | 4.8% | 4.5% | 4.9% | 4.8% | 4.3% | 4.4% | 6.2% | 7.7% | 9.7% |
| Pure and Applied Math. | 81 | 73 | 67 | 53 | 50 | 41 | 33 | 27 | 26 | 27 | 29 | 33 |
| | 15.7% | 13.9% | 12.4% | 9.9% | 8.9% | 7.3% | 6.1% | 5.1% | 5.0% | 5.3% | 5.6% | 6.5% |
| Physics | 21 | 17 | 13 | 9 | 7 | 7 | 8 | 6 | 6 | 7 | 4 | 5 |
| | 4.5% | 3.6% | 3.1% | 2.3% | 1.9% | 1.8% | 2.0% | 1.6% | 1.6% | 1.9% | 1.1% | 1.4% |
| Subatomic Physics | 6 | 5 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 1 | 3 | 3 |
| | 3.6% | 3.2% | 2.0% | 1.5% | 1.4% | 1.4% | 0.9% | 1.4% | 0.9% | 0.5% | 1.4% | 1.4% |
| Psychology | 119 | 113 | 107 | 96 | 97 | 85 | 83 | 81 | 92 | 94 | 99 | 102 |
| | 32.6% | 30.6% | 29.8% | 27.9% | 28.3% | 25.3% | 24.7% | 23.8% | 26.3% | 26.3% | 27.0% | 27.5% |
| Space and Astronomy | 7 | 5 | 3 | 2 | | | | | 1 | 1 | 1 | 5 |
| | 4.0% | 2.9% | 1.8% | 1.2% | 0.0% | 0.0% | 0.0% | 0.0% | 0.6% | 0.6% | 0.6% | 3.0% |
| Earth Sciences | 27 | 23 | 19 | 16 | 15 | 14 | 15 | 15 | 16 | 14 | 18 | 23 |
| | 5.1% | 4.3% | 3.4% | 2.8% | 2.5% | 2.3% | 2.5% | 2.4% | 2.5% | 2.2% | 2.9% | 3.7% |
| Statistics | 35 | 34 | 29 | 33 | 31 | 27 | 28 | 29 | 33 | 37 | 38 | 46 |
| | 16.3% | 15.0% | 12.7% | 13.9% | 13.1% | 11.4% | 12.0% | 12.1% | 13.5% | 15.4% | 15.4% | 18.9% |

*Publication window*

For all of the statistics produced (number of papers, impact factor, collaboration rate), a paper was considered the result of funding from NSERC if it had been published by a researcher between the second year following the start of the grant and the second year after the end of the grant.

*Funding quartiles*

Quartiles divide the data in a rank distribution into four equal sets, each comprising one quarter of the population: Q1 = ¼ (25 %); Q2 = ½ (50% or median); Q3 = ¾ (75%); Q4 = 1 (100 %). In the present study, the quartiles for funding amounts were calculated for each grant selection committee. The table on the following page shows the intervals for each quartile for each committee, where Q1 is the lowest amount in the distribution and Q4 is the highest.

**Average annual funding quartiles for established researchers receiving grants from the Research Grants Program, by grant selection committee (all figures in dollars)**

| Commitee | [ Q1 | ] Q2 | ] Q3 | ] Q4 ] | |
|---|---|---|---|---|---|
| Animal Biology | 3 400 | to 22 940 | to 31 386 | to 42 063 | to 157 913 |
| Cell Biology and Genetics | 3 833 | 27 496 | 35 901 | 50 496 | 80 738 |
| Chem. & Metallurgical Eng. | 3 890 | 22 631 | 28 152 | 36 983 | 86 542 |
| Chemistry | 3 985 | 29 485 | 39 161 | 59 022 | 161 756 |
| Civil Engineering | 4 250 | 19 178 | 23 856 | 29 892 | 97 977 |
| Computing and Information Science | 3 190 | 16 593 | 22 677 | 33 826 | 80 259 |
| Earth Sciences | 7 051 | 19 576 | 28 081 | 39 122 | 129 272 |
| Electrical Engineering | 3 932 | 17 900 | 22 181 | 28 314 | 70 083 |
| Evolution and ecology | 4 879 | 21 242 | 30 186 | 42 324 | 104 833 |
| Industrial Engineering | 7 900 | 15 145 | 20 530 | 29 012 | 61 171 |
| Interdisciplinary | 7 051 | 17 157 | 25 021 | 40 987 | 64 549 |
| Mechanical Engineering | 9 226 | 19 181 | 23 812 | 30 726 | 71 486 |
| Physics | 5 754 | 20 081 | 28 587 | 37 786 | 97 873 |
| Plant Biology and Food Science | 10 319 | 21 791 | 32 707 | 44 927 | 118 343 |
| Psychology | 11 338 | 20 306 | 27 903 | 40 049 | 86 111 |
| Pure and Applied Mathematics | 5 338 | 10 355 | 14 420 | 20 963 | 97 873 |
| Space and Astronomy | 5 233 | 19 373 | 27 343 | 46 837 | 118 014 |
| Statistical Sciences | 3 234 | 9 055 | 12 978 | 17 909 | 135 614 |
| Subatomic Physics | 3 054 | 26 377 | 36 479 | 55 403 | 357 494 |

*Statistical tests*

Statistical correlations and tests were calculated to verify the statistical relationship between the researchers' funding level, their number of papers, and the impact factor. Since the distribution of funding levels with the population of researchers does not follow a normal curve, we employed non-parametric statistics, such as Spearman's correlation coefficient and the Mann-Whithney test, in these calculations (Tables 11 and 12).

## Appendix 2

## Definitions of Indicators

*Specialization Index (SI)*

As its name indicates, the specialization index is used to measure whether a grouping of researchers (such as a laboratory, a department, an institution, a region, or a country) is more or less specialized (meaning, active) in a particular discipline, compared with another group of researchers that serves as the basis for comparison in this particular instance. In this study, a specialization index was calculated for each of the discipline categories. Ordinarily, the group of researchers for which specialization indexes were being calculated was a sub-set of the group that it was being compared with and that served as the base for calculating the index. For example, the specialization index for a group of Canadian researchers X compared with all Canadian researchers would be calculated as follows:

$$\frac{\text{percentage of group X's papers that fall in discipline category Z}}{\text{percentage of all Canadian researchers' papers in discipline Z}}$$

A specialization index greater than 1.0 means that group X is specialized in the discipline in question, compared with the reference set chosen (in this case, Canada).

*Impact Factor (IF)*

A journal's impact factor is the number of citations that it receives in a year for articles that it published in the 2 preceding years, divided by the total number of articles that it published in the 2 preceding years. Strictly speaking, the IF thus actually measures the impact of the articles. When applied to the papers of a group of researchers, the mean impact factor is regarded as a legitimate indicator of the quality of their research. Indeed, researchers generally attempt to present their results in journals that have a high impact factor.

The impact factor for a journal for a given year–1996 in this example–is calculated as follows:

$$\frac{\text{Number of citations received in 1996 by articles published in the journal in 1994 and 1995}}{\text{Number of articles published in the journal in 1994 and 1995}}$$

To calculate the mean impact factor for a group of researchers, each of their papers is assigned the impact factor of the journal in which it appeared. Thus, an institution whose researchers publish in journals with high impact factors in a particular field will score a high mean impact factor in this field.

*Relative Impact Factor (RIF)*

The relative impact factor is used to compare, in each specialty, the impact factor for one group of researchers with the impact factor for another group of researchers. In general, the group of researchers for which the relative impact factor is being calculated is a subset of the group with which it is being compared, which serves as the basis for the calculation.

For example, if the basis for comparison is the set of all Canadian researchers, the relative impact factor for a group of researchers X in discipline Y is calculated as follows:

$$\frac{\text{Impact factor for group of researchers X in specialty Y}}{\text{Impact factor for all Canadian researchers in specialty Y}}$$

A relative impact factor greater than 1 means that the mean of the impact factors for the group in question is greater than that of the basis for comparison. Conversely, a relative impact factor less than 1 means that the mean of the impact factors for the group in question is less than that of the basis for comparison.

*Relative Weighted Impact Factor (RWIF)*

The relative weighted impact factor is used to summarize, in a single value, all of the relative impact factors scored by a group of researchers in their various specialties, while taking into account the relative proportion of this group's production in each of these specialties. This factor is calculated using only the disciplinary specialties as units, for two reasons. First, the impact factors in the disciplinary fields are actually the totals for the specialties composing them. Taking them into account would artificially inflate the relative weighted impact factor to twice its actual value. Second, publication practices vary quite widely from one specialty to another. In the following example, the basis for comparison is once again the set of all Canadian researchers, and the relative weighted impact factor for the group of researchers X is calculated as:

$$\sum\left( \frac{\text{Impact factor for group X in specialty Y}}{\text{Impact factor for Canada in specialty Y}} \times \frac{\text{Number of papers by group X in specialty Y}}{\text{Total number of papers by group X}} \right)$$

A relative weighted impact factor greater than 1 means that the mean of the impact factors for the group in question is greater by the corresponding number of percentage points than that of the basis for comparison. Conversely, a relative weighted impact factor less than 1 means that the mean of the impact factors for the group in question is less than that of the basis for comparison.

## Appendix 3

## Tables

### Table 1. Number of researchers funded annually (RGP), 1990-1999

| Year | Estab'd Researchers | Other | TOTAL |
|---|---|---|---|
| 1990 | 3 740 | 3 403 | 7 143 |
| 1991 | 3 750 | 3 594 | 7 344 |
| 1992 | 3 756 | 3 686 | 7 442 |
| 1993 | 3 766 | 3 715 | 7 481 |
| 1994 | 3 768 | 3 676 | 7 444 |
| 1995 | 3 781 | 3 670 | 7 451 |
| 1996 | 3 786 | 3 716 | 7 502 |
| 1997 | 3 784 | 3 762 | 7 546 |
| 1998 | 3 767 | 3 843 | 7 610 |
| 1999 | 3 759 | 3 917 | 7 676 |

Source: NSERC (OST compilation)

*: funded throughout the period

### Table 2. Average annual grant (RGP), 1990-1999 (all figures in dollars)

| Year | Estab'd Researchers | Other | TOTAL |
|---|---|---|---|
| 1990 | 30 160 | 20 487 | 25 552 |
| 1991 | 31 281 | 20 654 | 26 080 |
| 1992 | 32 137 | 21 054 | 26 648 |
| 1993 | 32 615 | 20 905 | 26 800 |
| 1994 | 32 469 | 20 884 | 26 748 |
| 1995 | 32 694 | 20 373 | 26 625 |
| 1996 | 32 774 | 20 548 | 26 718 |
| 1997 | 32 864 | 20 709 | 26 804 |
| 1998 | 36 035 | 23 000 | 29 452 |
| 1999 | 38 206 | 24 553 | 31 239 |

Source: NSERC (OST Compilation)

**Table 3. Number of papers, NSERC and Canada, all disciplines, 1990-1999**

| Year | NSERC | Universities | Canada | NSERC/Univ. | Univ./Can. | NSERC/Can. |
|---|---|---|---|---|---|---|
| 1990 | 10 559 | 18 261 | 22 701 | 58% | 80% | 47% |
| 1991 | 11 132 | 18 940 | 23 384 | 59% | 81% | 48% |
| 1992 | 12 027 | 20 142 | 24 593 | 60% | 82% | 49% |
| 1993 | 12 300 | 20 516 | 25 024 | 60% | 82% | 49% |
| 1994 | 12 626 | 21 231 | 25 764 | 59% | 82% | 49% |
| 1995 | 12 483 | 21 193 | 25 619 | 59% | 83% | 49% |
| 1996 | 12 657 | 21 529 | 25 768 | 59% | 84% | 49% |
| 1997 | 12 369 | 20 911 | 25 108 | 59% | 83% | 49% |
| 1998 | 12 152 | 20 790 | 24 770 | 58% | 84% | 49% |
| 1999 | 11 962 | 21 012 | 24 989 | 57% | 84% | 48% |

Source: Observatoire de sciences et technologies (OST)

**Table 4. NSERC share of Canadian papers, 1990-1999**

| | 1990-92 | 1993-95 | 1996-99 |
|---|---|---|---|
| **Biology** | 55.8% | 59.3% | 61.3% |
| **Chemistry** | 76.0% | 78.3% | 80.0% |
| **Engineering** | 70.0% | 72.4% | 74.4% |
| **Mathematics** | 74.9% | 75.3% | 73.6% |
| **Clinical Medicine** | 15.5% | 16.0% | 17.6% |
| **Physics** | 75.8% | 75.3% | 76.2% |
| **Biomedical Research** | 42.5% | 42.9% | 43.7% |
| **Earth Sciences** | 61.6% | 62.5% | 63.7% |

Source: Observatoire des sciences et des technologies (OST)

**Table 5. Papers in natural sciences and engineering, NSERC and Canada, 1990-1999**

| Year | NSERC | Universities | Canada | NSERC/Univ. | Univ./Can. | NSERC/Can. |
|---|---|---|---|---|---|---|
| 1990 | 7 970 | 9 620 | 12 199 | 83% | 79% | 65% |
| 1991 | 8 480 | 10 037 | 12 540 | 84% | 80% | 68% |
| 1992 | 8 851 | 10 365 | 12 881 | 85% | 80% | 69% |
| 1993 | 9 206 | 10 760 | 13 299 | 86% | 81% | 69% |
| 1994 | 9 519 | 11 124 | 13 679 | 86% | 81% | 70% |
| 1995 | 9 406 | 11 033 | 13 548 | 85% | 81% | 69% |
| 1996 | 9 401 | 10 974 | 13 425 | 86% | 82% | 70% |
| 1997 | 8 966 | 10 401 | 12 669 | 86% | 82% | 71% |
| 1998 | 8 700 | 10 034 | 12 113 | 87% | 83% | 72% |
| 1999 | 8 336 | 9 823 | 11 829 | 85% | 83% | 70% |

Source: Observatoire de sciences et technologies (OST)

**Table 6. NSERC share of Canadian university research papers, 1990-1999**

| | 1990-1992 | 1993-1995 | 1996-1999 |
|---|---|---|---|
| **Biology** | 77.6% | 81.3% | 81.2% |
| **Chemistry** | 90.2% | 91.0% | 91.2% |
| **Engineering** | 88.1% | 89.1% | 90.0% |
| **Mathematics** | 76.0% | 76.1% | 74.5% |
| **Clinical Medicine** | 19.2% | 19.6% | 21.1% |
| **Physics** | 85.7% | 84.4% | 85.9% |
| **Biomedical Research** | 49.7% | 49.5% | 49.6% |
| **Earth Sciences** | 84.5% | 85.0% | 85.2% |

Source: Observatoire des sciences et des technologies (OST)

**Table 7. Specialization Index by field (1990, 1995 and 1999)**

**(Base: World)**

| | NSERC | | |
|---|---|---|---|
| | **1990** | **1995** | **1999** |
| **Biology** | 2.1 | 1.9 | 1.9 |
| **Chemistry** | 1.1 | 1.2 | 1.1 |
| **Engineering** | 1.8 | 1.7 | 1.6 |
| **Mathematics** | 2.2 | 1.9 | 1.7 |
| **Clinical Medicine** | 0.3 | 0.3 | 0.4 |
| **Physics** | 1.1 | 1.1 | 0.9 |
| **Biomedical Research** | 0.8 | 0.9 | 1.0 |
| **Earth Sciences** | 2.1 | 2.1 | 2.2 |

Source : Observatoire des sciences et des technologies (OST)

**Table 8. International collaboration rate for NSERC-funded researchers, and for university researchers and other Canadian researchers excluding NSERC-funded researchers, all disciplines, 1990-1999**

| Year | NSERC | Universities | Canada |
|---|---|---|---|
| 1990 | 24.6% | 24.4% | 24.4% |
| 1991 | 25.8% | 24.3% | 24.8% |
| 1992 | 27.1% | 26.6% | 27.2% |
| 1993 | 28.2% | 28.6% | 29.3% |
| 1994 | 28.5% | 29.9% | 30.5% |
| 1995 | 29.6% | 31.6% | 32.1% |
| 1996 | 30.9% | 32.0% | 33.5% |
| 1997 | 33.7% | 33.9% | 35.7% |
| 1998 | 34.8% | 34.8% | 37.1% |
| 1999 | 35.6% | 35.5% | 37.8% |

Source: Observatoire de sciences et technologies (OST)

**Table 9. International collaboration rate by discipline, 1990-99**

| | NSERC | Universities | Canada | G7 |
|---|---|---|---|---|
| **Biology** | 20% | 26% | 23% | 12% |
| **Chemistry** | 25% | 39% | 33% | 11% |
| **Engineering** | 25% | 38% | 31% | 10% |
| **Mathematics** | 52% | 38% | 38% | 16% |
| **Clinical Medicine** | 25% | 26% | 28% | 8% |
| **Physics** | 42% | 53% | 49% | 18% |
| **Biomedical Research** | 29% | 33% | 36% | 11% |
| **Earth Sciences** | 37% | 45% | 41% | 17% |

Source: Observatoire de sciences et technologies (OST)

***: excluding NSERC-funded researchers**

**Table 10. Relative weighted impact factor (RWIF) for NSERC, Universities,* Canada, G7**

| | NSERC | Universities | Canada | G7 |
|---|---|---|---|---|
| **Biology** | 1.13 | 0.95 | 0.93 | 1.07 |
| **Chemistry** | 1.28 | 0.97 | 1.05 | 1.18 |
| **Engineering** | 0.97 | 0.93 | 0.84 | 1.04 |
| **Mathematics** | 0.99 | 0.95 | 0.96 | 1.05 |
| **Clinical Medicine** | 1.10 | 1.11 | 1.09 | 1.07 |
| **Physics** | 1.13 | 1.08 | 1.08 | 1.12 |
| **Biomedical Research** | 0.95 | 1.09 | 1.08 | 1.10 |
| **Earth Sciences** | 1.03 | 1.03 | 1.00 | 1.09 |

Source: Observatoire de sciences et technologies (OST)

***: excluding NSERC-funded researchers**

**Table 11. Average annual number of papers for established researchers (RGP), by funding quartile**

| Committee | Avg. Papers per Year by Quartile of Avg. Grant | | | | Spearman Correlation | Significance* p < 0.05 | Significance* of Mann-Whithney U Test, p < 0.05 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Q1 | Q2 | Q3 | Q4 | | | Q1 - Q2 | Q2 - Q3 | Q3 - Q4 | Q1 - Q3 | Q2 - Q4 | Q1 - Q4 |
| Animal Biology | 2.35 | 3.07 | 3.56 | 4.80 | 0.36 | S | N | N | N | **S** | **S** | **S** |
| Cell Biology & Genetics | 2.49 | 2.95 | 2.46 | 3.94 | 0.20 | S | N | N | **S** | N | N | **S** |
| Chem. & Metallurgical Eng. | 1.61 | 2.33 | 3.18 | 5.52 | 0.62 | S | **S** | **S** | **S** | **S** | **S** | **S** |
| Chemistry | 2.49 | 3.95 | 4.42 | 7.38 | 0.60 | S | **S** | N | **S** | **S** | **S** | **S** |
| Civil Engineering | 0.84 | 1.06 | 1.74 | 2.02 | 0.39 | S | N | **S** | N | **S** | **S** | **S** |
| Computing & Information Sci. | 0.33 | 0.41 | 0.59 | 0.97 | 0.40 | S | N | N | **S** | **S** | **S** | **S** |
| Earth Sciences | 1.51 | 1.81 | 2.13 | 3.30 | 0.40 | S | N | N | **S** | **S** | **S** | **S** |
| Electrical Engineering | 0.89 | 1.35 | 1.83 | 2.65 | 0.48 | S | N | N | N | **S** | **S** | **S** |
| Evolution & Ecology | 1.94 | 2.05 | 2.56 | 3.65 | 0.43 | S | N | N | **S** | N | **S** | **S** |
| Industrial Engineering | 0.39 | 0.53 | 0.69 | 1.16 | 0.44 | S | N | N | N | N | **S** | **S** |
| Interdisciplinary | 2.95 | 2.26 | 4.30 | 4.85 | 0.38 | S | N | N | N | N | N | N |
| Mechanical Engineering | 0.73 | 0.97 | 1.28 | 1.79 | 0.45 | S | N | N | N | N | **S** | **S** |
| Physics | 1.84 | 3.00 | 3.84 | 4.59 | 0.49 | S | **S** | N | N | **S** | **S** | **S** |
| Plant Biology & Food Science | 2.70 | 3.07 | 3.13 | 3.50 | 0.18 | S | N | N | N | N | N | N |
| Psychology | 0.91 | 1.13 | 1.39 | 2.58 | 0.35 | S | N | N | N | N | **S** | **S** |
| Pure & Applied Mathematics | 0.62 | 0.67 | 0.84 | 1.38 | 0.41 | S | N | N | **S** | N | **S** | **S** |
| Space & Astronomy | 1.76 | 2.22 | 3.40 | 4.21 | 0.54 | S | N | **S** | N | **S** | **S** | **S** |
| Statistical Sciences | 0.48 | 0.80 | 0.73 | 1.25 | 0.41 | S | N | N | N | N | N | **S** |
| Subatomic Physics | 1.94 | 3.98 | 5.05 | 8.91 | 0.42 | S | **S** | N | N | **S** | **S** | **S** |

Source: Observatoire des sciences et des technologies

* S = Significant; N = Non-Significant

**Table 12. Relative weighted impact factor (RWIF) for established researchers (RGP), by funding quartile**

| Committee | Average of Researchers' Relative Weighed Impact Factors by Quartile of Avg. Grant Q1 | Q2 | Q3 | Q4 | Spearman Correlation | Significance* at p < 0.05 | Significance* of Mann-Whithney U Test at p < 0.05 Q1 - Q2 | Q2 - Q3 | Q3 - Q4 | Q1 - Q3 | Q2 - Q4 | Q1 - Q4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Animal Biology | 0.91 | 0.95 | 0.96 | 0.99 | 0.16 | S | N | N | N | N | N | N |
| Cell Biology & Genetics | 0.97 | 1.02 | 1.14 | 1.14 | 0.26 | S | N | N | N | N | **S** | **S** |
| Chem. & Metallurgical Eng. | 0.91 | 0.98 | 0.98 | 1.07 | 0.23 | S | N | N | N | N | N | **S** |
| Chemistry | 1.18 | 1.25 | 1.28 | 1.41 | 0.29 | S | N | N | N | N | **S** | **S** |
| Civil Engineering | 0.63 | 0.70 | 0.70 | 0.63 | *-0.01* | *N* | N | N | N | N | N | N |
| Computing & Information Sci. | 0.98 | 0.96 | 1.07 | 1.13 | 0.18 | S | N | N | N | N | **S** | **S** |
| Earth Sciences | 1.02 | 0.97 | 1.06 | 1.08 | 0.17 | S | N | N | N | N | N | N |
| Electrical Engineering | 0.88 | 0.90 | 0.90 | 0.89 | *0.08* | *N* | N | N | N | N | N | N |
| Evolution & Ecology | 1.03 | 1.13 | 1.12 | 1.24 | 0.23 | S | N | N | N | N | N | **S** |
| Industrial Engineering | 0.85 | 0.77 | 0.99 | 0.95 | 0.27 | S | N | N | N | N | **S** | N |
| Interdisciplinary | 0.79 | 0.78 | 1.04 | 1.05 | 0.34 | S | N | N | N | N | N | N |
| Mechanical Engineering | 0.75 | 0.81 | 0.80 | 0.86 | 0.26 | S | N | N | N | N | N | **S** |
| Physics | 1.06 | 1.18 | 1.15 | 1.31 | 0.29 | S | N | N | **S** | N | N | **S** |
| Plant Biology & Food Science | 0.98 | 1.14 | 1.19 | 1.44 | 0.39 | S | N | N | N | **S** | **S** | **S** |
| Psychology | 0.83 | 1.00 | 1.06 | 1.11 | 0.34 | S | N | N | N | N | **S** | **S** |
| Pure & Applied Mathematics | 0.83 | 0.91 | 0.94 | 1.09 | 0.35 | S | N | N | N | N | **S** | **S** |
| Space & Astronomy | 1.00 | 1.02 | 1.16 | 1.13 | 0.28 | S | N | N | N | N | N | N |
| Statistical Sciences | 0.96 | 0.98 | 1.05 | 1.12 | 0.21 | S | N | N | N | N | N | N |
| Subatomic Physics | 1.14 | 1.15 | 1.29 | 1.28 | *0.15* | *N* | N | N | N | N | N | N |

Source: Observatoire des sciences et des technologies

* S = Significant; N = Non-Significant

## Table 13. Productivity (average number of papers per year) of researchers (RGP), by funding history

| Year | Established Researchers | New Funded | New Not Funded | Formerly Funded Researchers |
|---|---|---|---|---|
| 1990 | 2.22 | 0.53 | 0.75 | 1.34 |
| 1991 | 2.25 | 0.68 | 0.75 | 1.09 |
| 1992 | 2.38 | 0.81 | 0.81 | 0.98 |
| 1993 | 2.42 | 0.88 | 0.70 | 0.95 |
| 1994 | 2.48 | 1.02 | 0.76 | 0.79 |
| 1995 | 2.44 | 1.28 | 0.81 | 0.62 |
| 1996 | 2.38 | 1.69 | 0.87 | 0.53 |
| 1997 | 2.29 | 1.62 | 0.75 | 0.42 |
| 1998 | 2.16 | 1.61 | 0.76 | 0.36 |
| 1999 | 2.07 | 1.57 | 0.85 | 0.33 |

Source: Observatoire des sciences et technologies (OST)

## Table 14. Relative weighted impact factor for researchers (RGP) by funding history, 1990-1999

| Year | Esatblished Researchers | New Funded | New Not Funded | Formerly Funded Researchers |
|---|---|---|---|---|
| 1990 | 1.09 | 1.37 | 1.22 | 0.90 |
| 1991 | 1.09 | 1.10 | 1.00 | 0.91 |
| 1992 | 1.06 | 1.10 | 1.12 | 0.90 |
| 1993 | 1.07 | 1.20 | 1.03 | 0.85 |
| 1994 | 1.04 | 1.18 | 1.09 | 0.85 |
| 1995 | 1.03 | 1.10 | 1.05 | 0.80 |
| 1996 | 1.05 | 1.14 | 1.05 | 0.95 |
| 1997 | 1.03 | 1.15 | 0.96 | 0.90 |
| 1998 | 1.04 | 1.06 | 1.06 | 0.90 |
| 1999 | 1.04 | 1.06 | 1.01 | 0.86 |

Source : Observatoire des sciences et technologies

**Table 15. Average annual number of papers and RWIF by researcher and program**

| | No. of Papers | RWIF |
|---|---|---|
| RGP | 1,44 | 0,98 |
| RGP+OTHER | 2,12 | 1,04 |
| UNIVERSITY-INDUSTRY | 2,29 | 1,01 |
| STRATEGIC | 2,70 | 1,06 |

Source : Observatoire des sciences et technologies (OST)