AN OVERVIEW OF STATISTICAL INDICATORS OF REGIONAL INNOVATION IN CANADA: A PROVINCIAL COMPARISON

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THE INFORMATION SYSTEM FOR SCIENCE AND TECHNOLOGY PROJECT

The purpose of this project is to develop useful indicators of activity and a framework to tie them together into a coherent picture of science and technology in Canada.

To achieve the purpose, statistical measurements are being developed in five key areas: innovation systems; innovation; government S&T activities; industry; and human resources, including employment and higher education. The work is being done at Statistics Canada, in collaboration with Industry Canada and with a network of contractors.

Prior to the start of this work, the ongoing measurements of S&T activities were limited to the investment of money and human resources in research and development (R&D). For governments, there were also measures of related scientific activity (RSA) such as surveys and routine testing. These measures presented a limited and potentially misleading picture of science and technology in Canada. More measures were needed to improve the picture.

Innovation makes firms competitive and more work has to be done to understand the characteristics of innovative, and non-innovative firms, especially in the service sector which dominates the Canadian Economy. The capacity to innovate resides in people and measures are being developed of the characteristics of people in those industries which lead science and technology activity. In these same industries, measures are being made of the creation and the loss of jobs as part of understanding the impact of technological change.

The federal government is a principal player in science and technology in which it invests over five billion dollars each year. In the past, it has been possible to say how much the federal government spends and where it spends it. The current report, Federal Scientific Activities (Catalogue 88-204), released early in 1997, begins to show what the S&T money is spent on with the new Socio-Economic Objectives indicators. As well as offering a basis for a public debate on the priorities of government spending, all of this information will provide a context for reports of individual departments and agencies on performance measures which focus on outcomes at the level of individual projects.

By the final year of the Project in 1998-99, there will be enough information in place to report on the Canadian system on innovation and show the role of the federal government in that system. As well, there will be new measures in place which will provide a more complete and realistic picture of science and technology activity in Canada.

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Working Papers

The Working Papers publish research related to science and technology issues. All papers are subject to internal review. The views expressed in the articles are those of the authors and do not necessarily reflect the views of Statistics Canada.

PREFACE

The results of this paper, An Overview of Statistical Indicators of Regional Innovation in Canada: A Provincial Comparison, contribute to the analysis of regional differences in science and technology activity in Canada, as part of the Information System for Science and Technology Project at Statistics Canada. This working paper presents estimates of R&D expenditure and personnel for universities, for the federal government, for industry and for provincial research organizations, as well as providing general provincial statistics.

The objective of the Project is to develop useful indicators of activity and a framework to tie them together into a coherent picture of science and technology in Canada. The indicators can provide the picture at the national level or at provincial or sub-provincial levels to reflect regional differences. A previously published working paper, R&D Tax Treatment in Canada: A Provincial Comparison, uses a method developed by the Conference Board of Canada to compare the tax incentives to do R&D in each of the provinces. Six out of ten provinces have their own incentive programmes and tax rates which differ from province to province. The 'B-Index' analysis of the Conference Board provides a means of comparing tax incentives and of providing an indicator.

A single indicator does not provide a coherent picture. It must be supplemented by other indicators and information, and some examples of regional indicators are found in other issues of this working paper series and in the catalogue publications of the Project (The papers and publications are listed on the last two pages.). Indicators of the innovative activities of firms in the provinces are being developed, both at Statistics Canada and in academic groups in various parts of the country.

To advance the knowledge of regional innovation in Canada, the Project sponsored a workshop at the University of Ottawa in March of 1997 which brought together measurement experts, policy makers, and academics. Some of the papers given at the workshop will appear in this series, or the Research Paper Series, and others will be published in a book to be released in 1998.

The objective of all of this work is to highlight regional differences in R&D and innovation and to pose questions about why these differences arise.

An Overview of Statistical Indicators of Regional Innovation in Canada: A Provincial Comparison

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The innovation process involves a number of different elements concerned with the generation, transmission and use of knowledge. Statistical indicators of innovation at the national and regional level exist for only a very limited number of these elements.

The most developed set of indicators exist for the generation of knowledge, i.e. R&D indicators. These indicators were developed in the 1960's and are currently collected by all OECD countries. The internationally accepted standard for the collection of these statistics is found in the OECD's *Frascati Manual: Proposed Standards Practice for Surveys of Research and Experimental Development*. In Canada, Statistics Canada has been producing R&D indicators since the 1960's in two on-going series, *Federal Scientific Activities (Catalogue 88-204-XPB)* and *Industrial Research and Development (Catalogue 88-202-XPB)*. Additional indicators can be found in the *Service Bulletin, Science Statistics (Catalogue 88-001-XPB)* and in the *Working Paper Series* of the Science and Technology Redesign Project.

In the 1980's, work began on the development of statistical indicators of innovation and of the diffusion of technology. A number of OECD countries have carried out innovation and diffusion of technology surveys. This collective experience has led to the formulation of international standards for the collection of these statistics in the OECD's *Oslo Manual: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data (1997)*. In Canada, several studies of advanced manufacturing technology and innovation in the manufacturing sectors have been carried out. The most recent results for the 1993 innovation and technology survey do not include regional breakdowns. The last regional results were for technology use in 1989.

Two new surveys have been undertaken by the Science and Technology Redesign Project on innovation in the service sector and the diffusion of biotechnologies. The results of these surveys will support the production of regional indicators to the extent this is possible without compromising confidentiality.

New types of indicators of innovation are under development in Canada and in other countries. This search for new statistical indicators is motivated, in large part, by the "national systems of innovations approach" which stresses that the flows of technology and information among people and institutions are key to the innovative process. There is increasing recognition that innovation is the result of a complex set of relationships among actors in the system, which includes enterprises, universities and government research institutes. To date the development of these new statistics has focused on:

interactions among firms; interactions among enterprises, universities and government research institutions; technology diffusion; and personnel mobility. (See OECD (1997)) The Science and Technology Redesign Project is currently undertaking the development of such new indicators. Of particular interest from a regional innovation perspective is the analysis of linkages using bibliometric data which can be presented at a provincial and sub-provincial basis. The Bureau de la statistique (1996) has developed a set of indicators for Quebec. The Science and Technology Redesign Project is currently developing a set of production and knowledge flow indicators for Canada, including bibliometric indicators of collaborations between provinces, between provinces and other countries, as well as indicators of collaboration within provinces.

This document, after presenting some general provincial statistics, will provide an overview of currently available R&D statistics which are broken down by province and in one case by metropolitan areas. The reader is referred to the bibliography at the end of this document for reference to other provincial/regional statistics.

Highlights

Provincial Gross Domestic Product (Figure 1)

- Ontario and Quebec together account for 63% of the total Canadian Gross Domestic Product (41% and 22% respectively). The western provinces account for 30% of the total and the eastern provinces account for 6%.

Provincial Population (Figure 2)

- Ontario and Quebec together account for 62% of the total Canadian population (37% and 25% respectively). The western provinces account for 30% and the eastern provinces account for 8%.

Ratio of Provincial GERD to Provincial GDP (Figure 3)

- The GERD/PGDP indicator is a general indicator of the investment a province makes in R&D (Gross Expenditures on Research and Development) relative to the provincial gross domestic product (PGDP). Ontario and Quebec have GERD/PGDP ratios (1.8 and 1.9 respectively) above the Canadian average of 1.6. Three provinces have ratio 1.0 and above, Nova Scotia (1.3), Manitoba (1.1) and Alberta (1.0).

Provincial GERD per Capita (Figure 4)

- The GERD per capita is another general indicator of the investment a country (or a province) makes in R&D. Ontario and Quebec have GERD per capita that are above the Canadian average. Alberta is the only other province with more than $300 per capita, followed by Manitoba, British Columbia, Nova Scotia, and Saskatchewan with more than $200 per capita.

Distribution of R&D by Performing Sectors (Figure 5 and 6)

- In terms of performing R&D, the Canadian profile is as follows: Business: 60%; Higher Education: 24%; Federal Government: 14%; and the Provincial Governments: 2%. In general terms, this Canadian profile is similar to the profiles of 4 provinces: Ontario, Quebec, Alberta and British Columbia where Business R&D is dominant in the range of 51% (Alberta) to 74% (Ontario); Higher Education is the second largest performer in the range of 20% (Ontario) to 33% (Alberta); and Government in the range of 6% (Ontario) and 16% (Alberta).

- The profile of Manitoba and Saskatchewan are similar where the dominant performer is the Higher Education (41% and 46% respectively); followed by Business (30% and 26%); and then by Government (29% and 28%).

- The profiles of Newfoundland and Nova Scotia are similar where the dominant performer is Higher Education (54% and 41% respectively) followed by Government (35% and 38%); and then by Business (11% and 21%).

- The profiles of Prince Edward Island and of New Brunswick are unique cases. In Prince Edward Island, the Federal Government is the dominant performer with 56% of the total, followed by Higher Education (25%) and by Business (19%). In New Brunswick, Business accounts for 39%, Higher Education for 36% and Government for 25%.

Distribution of R&D by Funding Sectors (Figure 7 and 8)

- In terms of funding R&D, the Canadian average is as follows: Business: 47%; Federal Government: 24%; Others (Non-profit institutions and foreign sector): 15%; Higher Education: 9%; and the Provincial Governments: 5%. In general terms, this Canadian profile is similar to the profile of one province: British Columbia.

- Three provinces other than British Columbia have the business sector as the largest funder: Quebec (57%); Ontario (52%); and Alberta (45%). The second largest funder in Quebec and Alberta is the federal government (17% and 24% respectively); and in Ontario, it is Other (24%).

- In the 6 other provinces, the federal government is the largest funder, in the range from 75% in Prince Edward Island to 35% in Saskatchewan. Of these provinces, business is the second largest funder in PEI (13%) and New Brunswick (26%); higher education in the case of Newfoundland (29%) and Nova Scotia (19%); and in Saskatchewan funding by business and higher education are at the same level (25%).

Industrial Intramural R&D Expenditures (Figure 9)

- Ontario and Quebec account for 83% of all industrial intramural R&D performed in Canada (55% and 28% respectively).

- Two metropolitan areas, Toronto and Montreal, together account for 50% of industrial intramural R&D performed in Canada. More industrial intramural R&D is carried out in each of these two metropolitan areas than in the eight other provinces.

- In Quebec, 84% of industrial intramural R&D is carried out in Montreal and, in Ontario, 47% is carried out in Toronto.

Increase in Industrial Intramural R&D Expenditures, 1993 to 1994 (Figure 10)

- The largest increases in industrial intramural R&D expenditures are in Quebec (20%) and in Montreal (19%), followed by British Columbia (17%), Ontario (17%) and Alberta (14%).

- The increase in Ontario (17%) as a whole is greater than in the Toronto area (11%).
- Among the Atlantic provinces, New Brunswick has the greatest increase (10%). (Note: The figures for PEI are too low to be reliable.)

- Manitoba is the only province with a decrease (-2%).

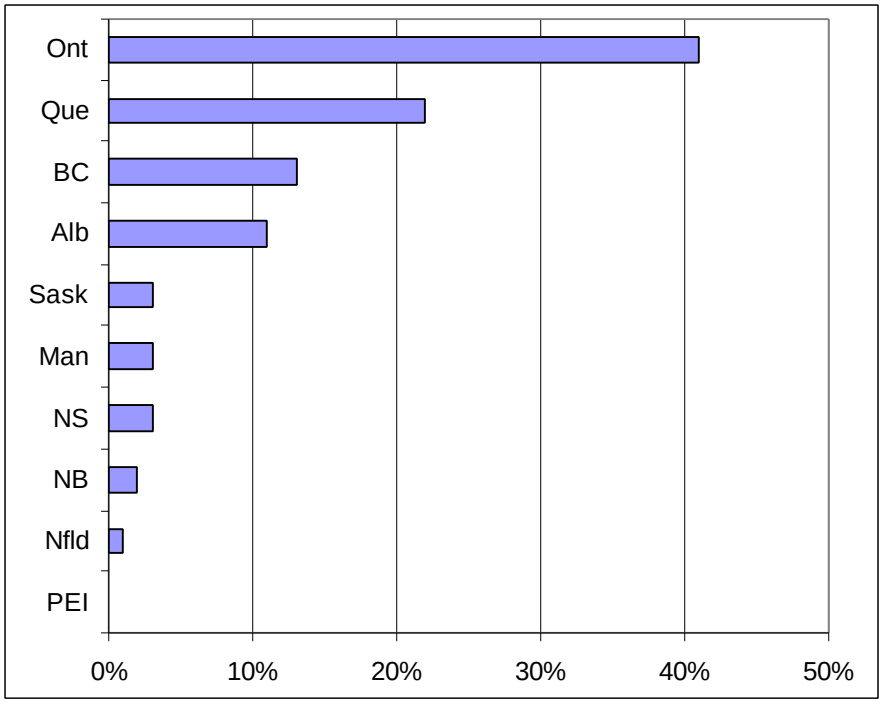
Distribution of Industrial Intramural R&D Expenditures (Figure 11)

- Ontario has the largest industrial intramural R&D expenditures on telecommunications; computer and related services; pharmaceutical and medicine; wholesale trade and other industries.

- Quebec has the highest industrial intramural R&D expenditures on aircraft and parts, and engineering and scientific services.

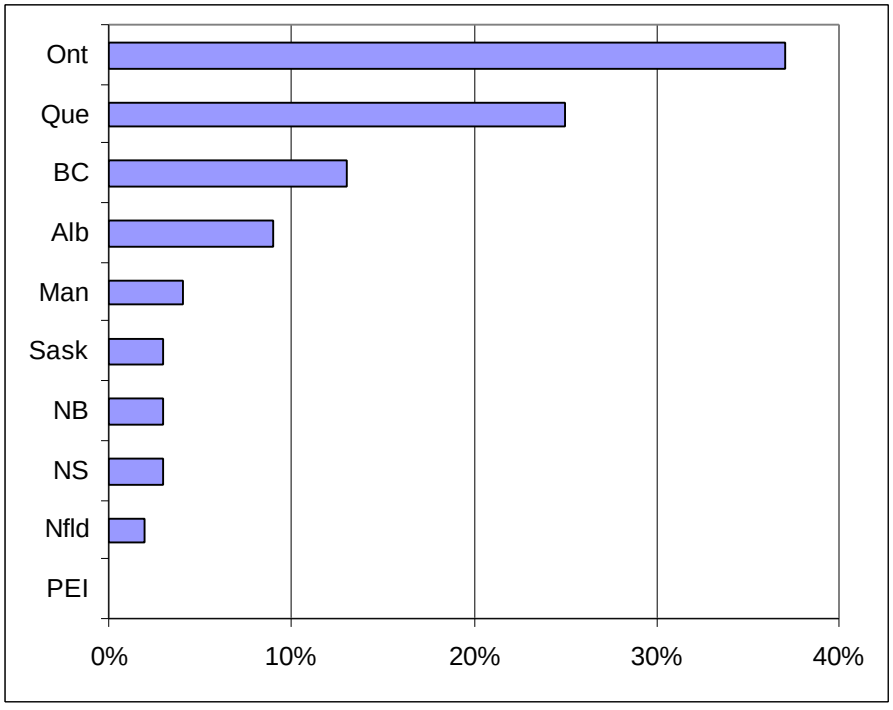
- Industrial intramural expenditures in provinces other than Ontario and Quebec are concentrated in other industries, engineering and scientific services, and computer and related services.

Figure 1: Provincial Gross Domestic Product as a Percentage of Total Canadian Gross Domestic Product, 1995



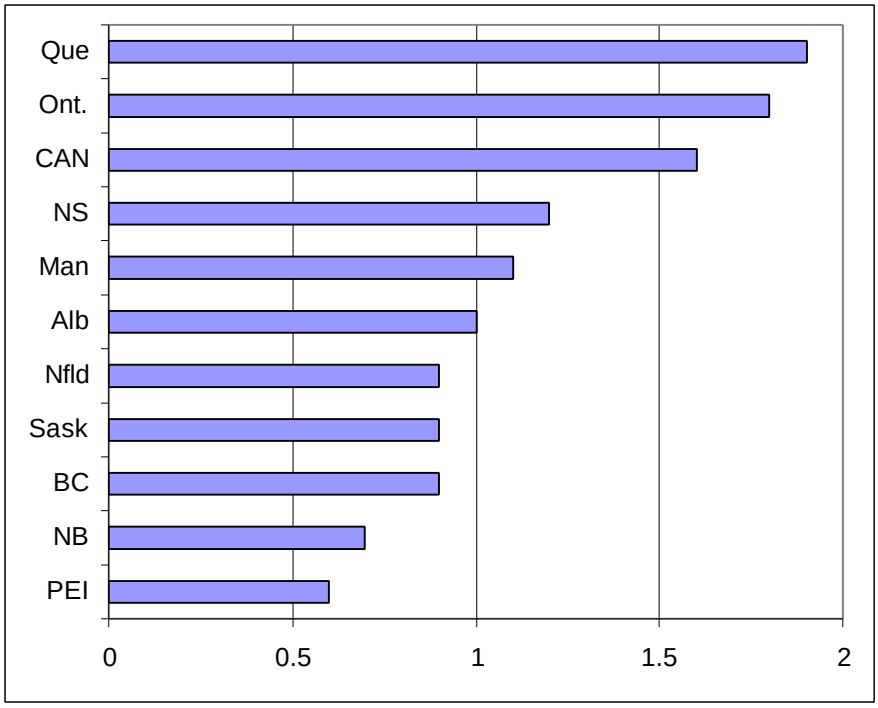
Source: See Table 1

Figure 2: Provincial Population as a Percentage of Total Canadian Population, 1995



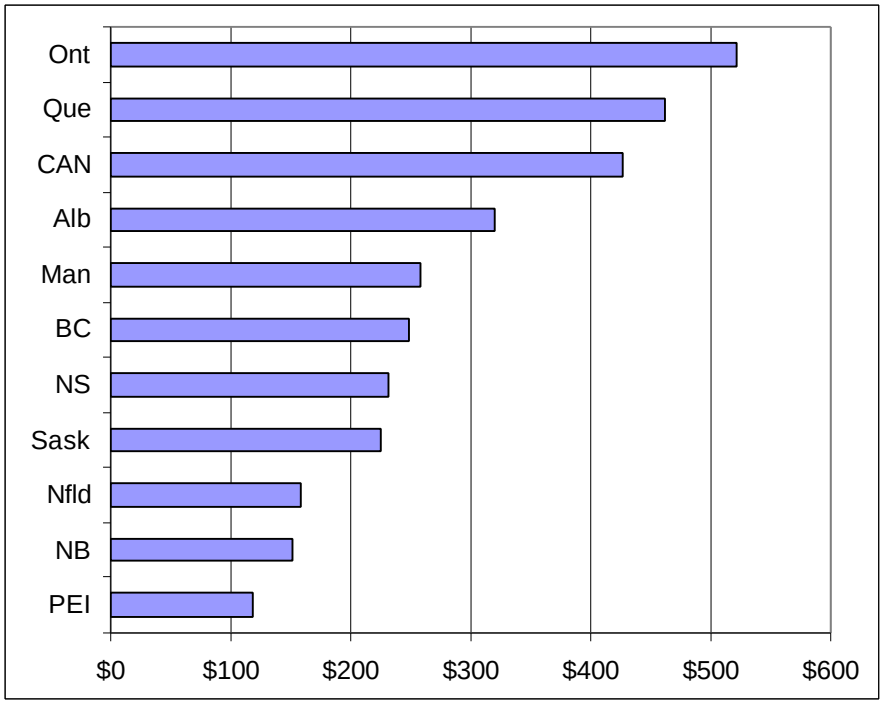
Source: See Table 1

Figure 3: Ratio of Provincial Gross Domestic Expenditure on Research and Development (GERD) to Provincial Gross Domestic Product, 1995



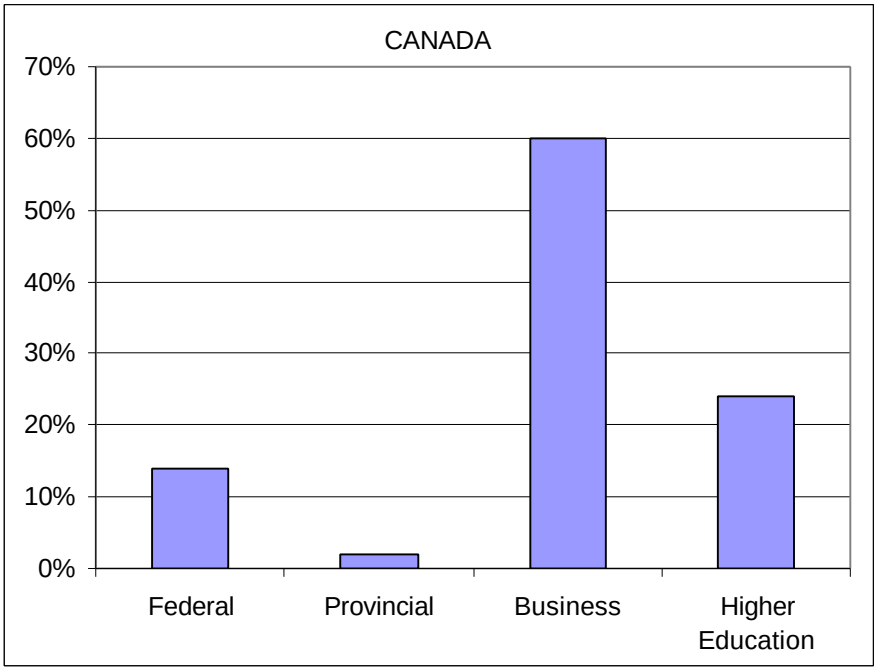
Source: See Table 1

Figure 4: GERD per Capita, by Province, 1995



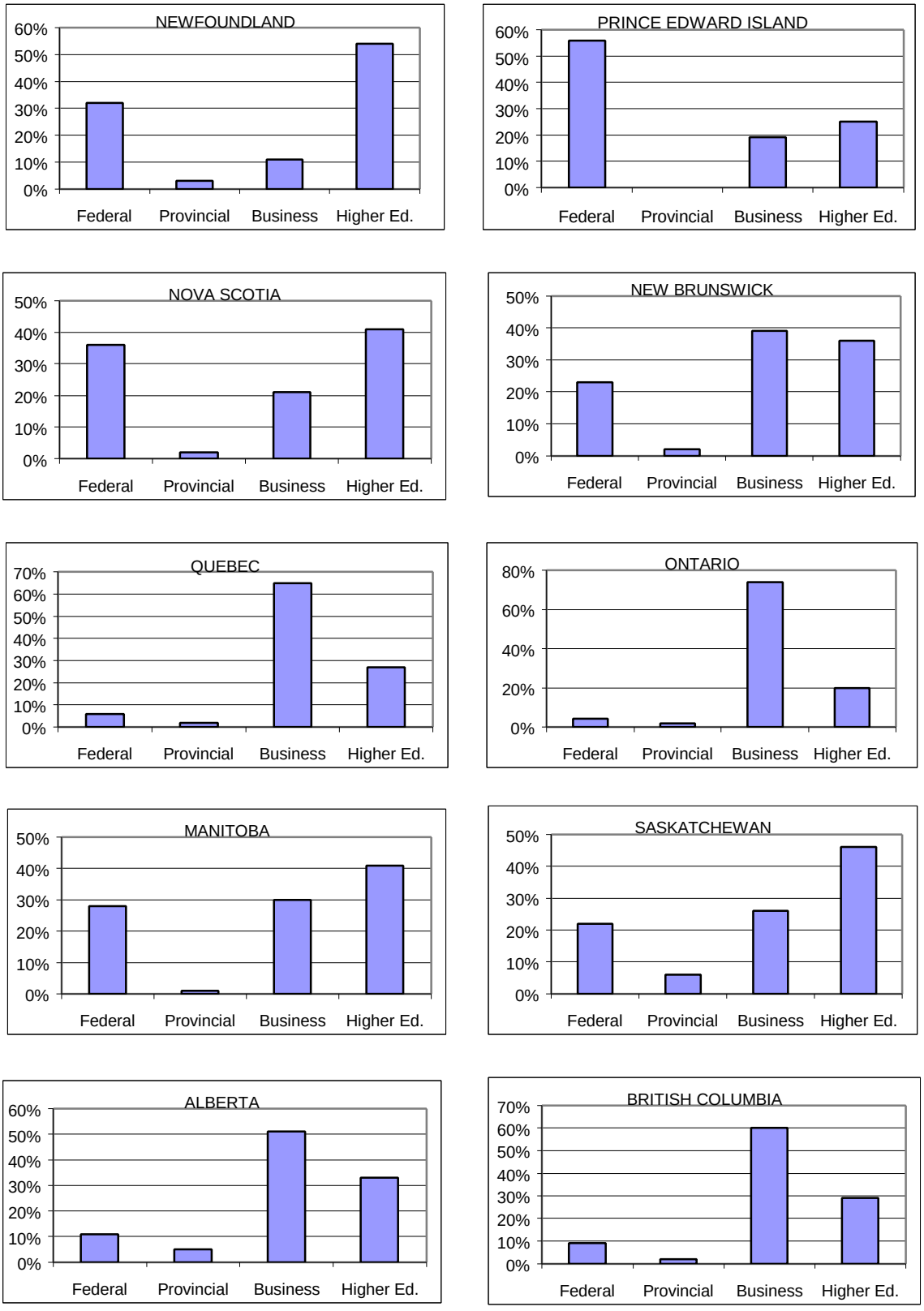
Source: See Table 1

Figure 5: Distribution of R&D in Canada, by Performing Sectors, 1995



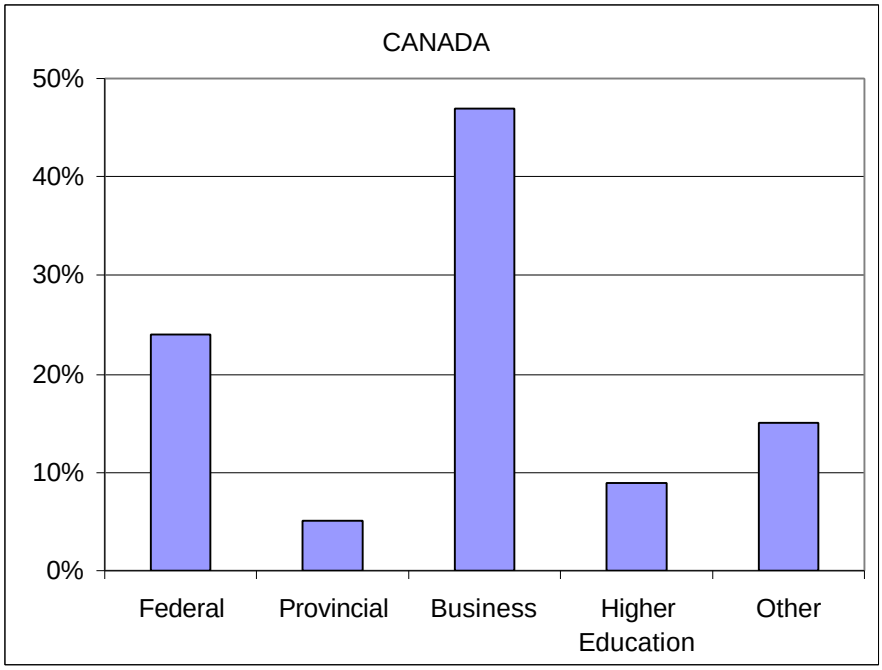
Source: See Table 2

Figure 6: Distribution of R&D in the Provinces, by Performing Sector, 1995



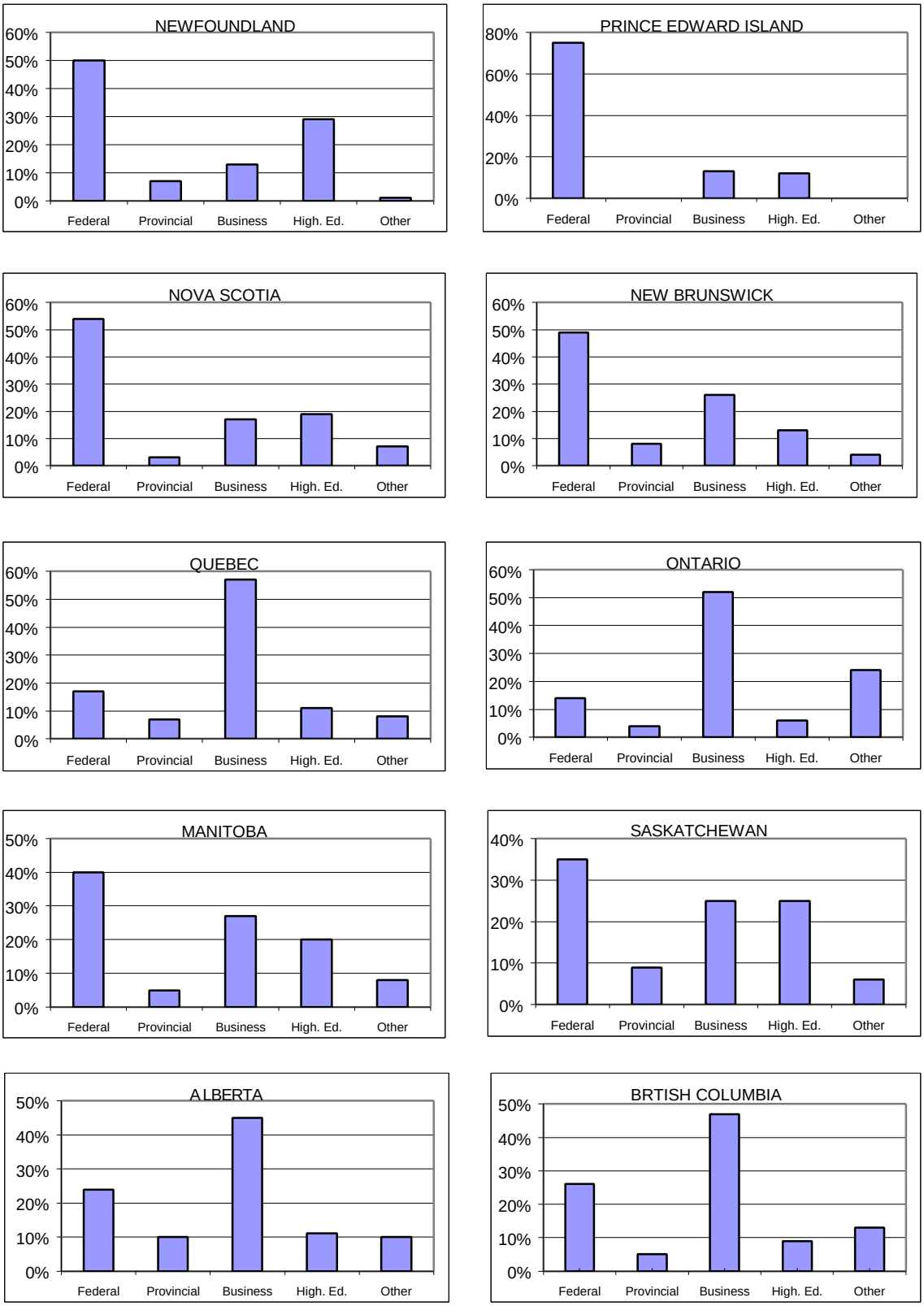
Source: See Table 2

Figure 7: Distribution of R&D in Canada, by Funding Sectors, 1995



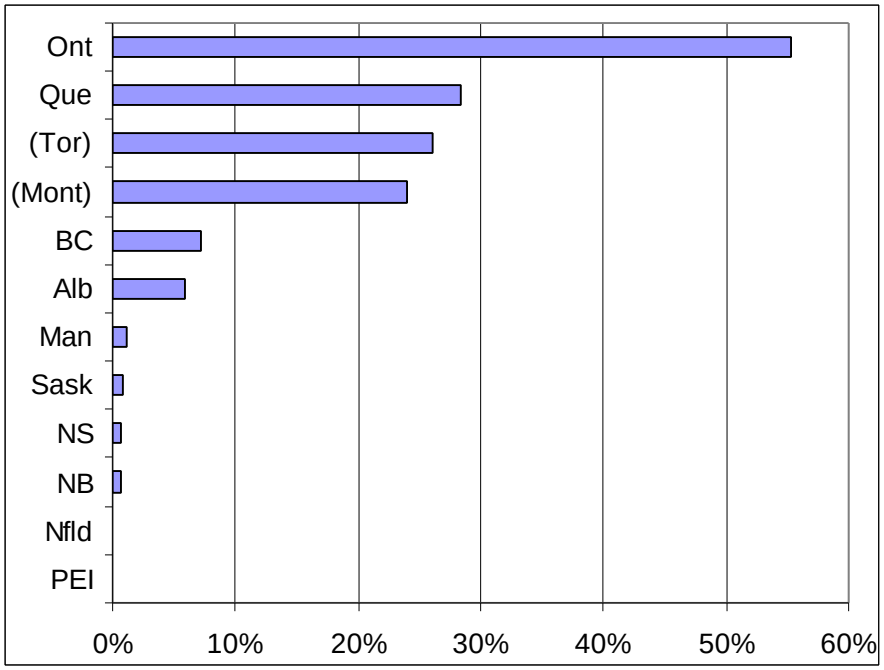
Source: See Table 3

Figure 8: Distribution of R&D in the Provinces, by Funding Sectors, 1995.



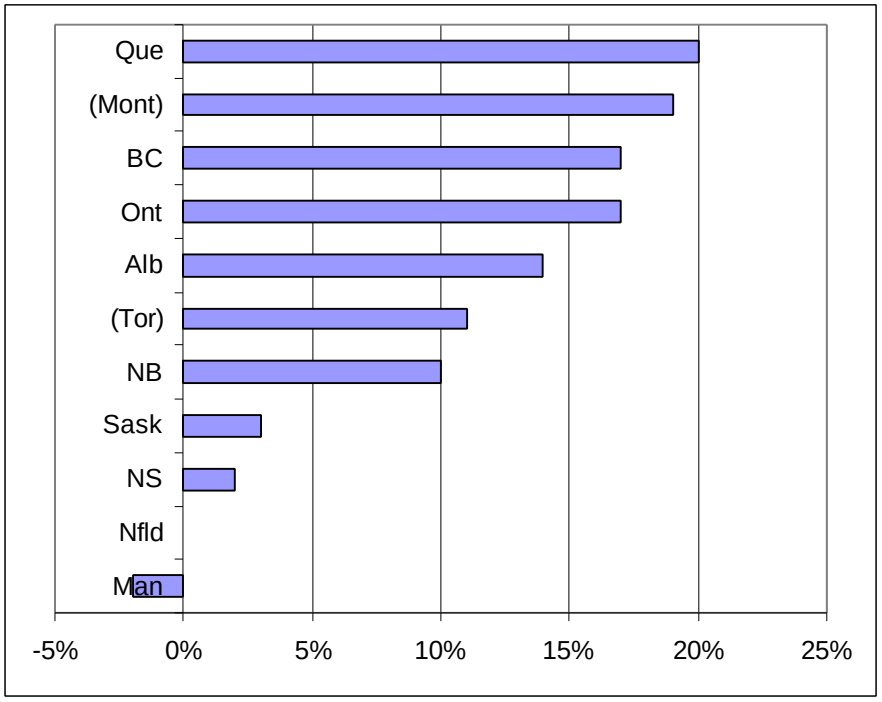
Source: See Table 3

Figure 9: Total Industrial Intramural R&D Expenditures, by Province and by two Metropolitan Areas, 1995



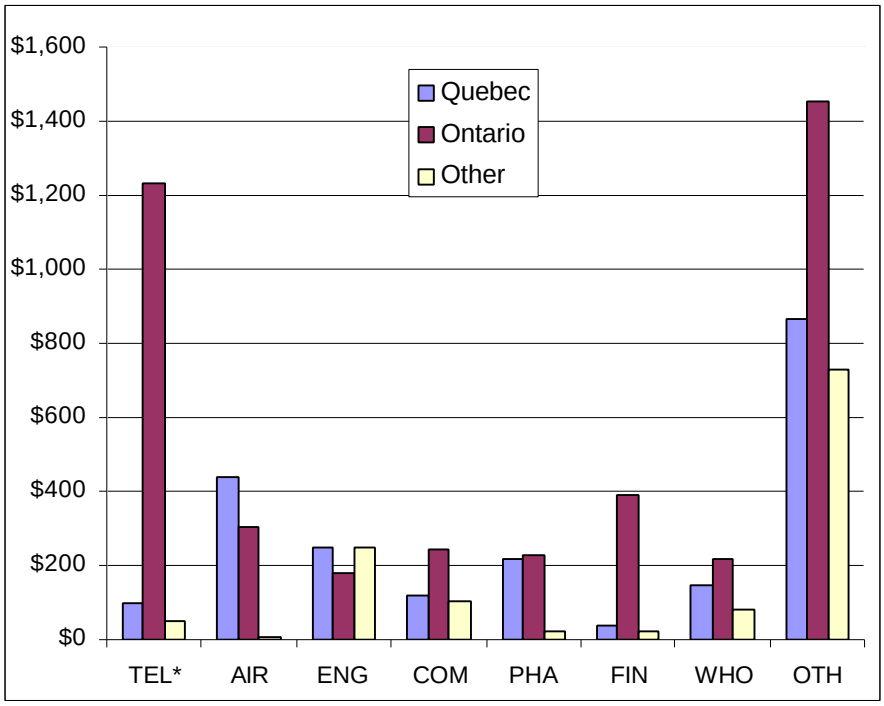
Source: See Table 4

Figure 10: Increase in Total Industrial Intramural R&D Expenditures between 1993 and 1995, by Province and by two Metropolitan Areas



Source: See Table 4

Figure 11: Distribution of Industrial Intramural R&D Expenditures for Quebec and Ontario, for Selected Industries, 1995



* TEL= Telecommunication equipment; AIR= Aircraft and parts; ENG= Engineering and scientific services; COM= Computer and related services; PHA= Pharmaceutical and medicine; FIN= Finance, insurance and real estate; WHO= Wholesale Trade; and OTH= Other industries
Source: See Table 5

Table 1
Provincial Background, 1995

Province	Provincial Gross Domestic Product[1] (PGDP)		Gross Expenditures on Research and Development (GERD)[e]		Population[2]		GERD/ PGDP	GERD Per capita
	millions of dollars	percent	millions of dollars	percent	thous-ands	percent	ratio	dollars
Newfoundland	10,145	1	92	1	579	2	0.9	159
Prince Edward Island	2,506	--	16	--	135	--	0.6	119
Nova Scotia	18,784	3	217	2	936	3	1.2	232
New Brunswick	16,172	2	115	1	759	3	0.7	152
Québec	173,085	22	3,363*	27	7,301	25	1.9	461
Ontario	314,077	41	5,740*	45	10,989	37	1.8	522
Manitoba	26,176	3	293	2	1,131	4	1.1	259
Saskatchewan	24,550	3	228	2	1,013	3	0.9	225
Alberta	84,864	11	871	7	2,722	9	1.0	320
British Columbia	101,945	13	924	7	3,706	13	0.9	249
National Capital Region								
Quebec	…	…	27	--	…	…	…	…
Ontario	…	…	772	6	…	…	…	…
Canada[3]	**776,299**	**100**	**12,660**	**100**	**29,615**	**100**	**1.6**	**427**

[1] Table 39, *Canadian Economic Observer (Catalogue No. 11-010-XPB)*, Monthly, July 1997.
[2] *Quarterly Demographic Statistics* (*Catalogue No. 91-002)*, Vol. 10, No.1.
[3] Includes Yukon and Northwest Territories.
* Québec and Ontario figures exclude Federal Government Expenditures performed in the National Capital Region.
-- amount too small to be expressed
… figure not appropriate or not applicable

Source: Statistics Canada, "Total Spending on Research and Development in Canada, 1986[e] to 1997, and Provinces, 1986 to 1995", *Service Bulletin: Science Bulletin (Catalogue 88-001-XPB)*, Vol. 21, No.8, p.5.

Table 2
Provincial Distribution of R&D by Performing Sectors, 1995

Performing Sector	Nfld	PEI	NS	NB	Qué*	Ont*	Man	Sask	Alta	BC	NCR	Total[1]
In millions of dollars												
Federal government	29	9	79	26	212	255	81	50	95	86	799	1,723
Provincial government[2]	3	--	4	2	69	85	3	13	47	22	…	248
Business Enterprise	10	3	45	45	2,172	4,239	88	60	446	551	…	7,659
Higher Education[3]	50	4	89	42	910	1,161	121	105	283	265	…	3,030
All Sectors	**92**	**16**	**217**	**115**	**3,363**	**5,740**	**293**	**228**	**871**	**924**	**799**	**12,660**
As a percentage of the provincial total												
Federal government	32	56	36	23	6	4	28	22	11	9	..	14
Provincial government[2]	3	--	2	2	2	2	1	6	5	2	…	2
Business Enterprise	11	19	21	39	65	74	30	26	51	60	…	60
Higher Education[3]	54	25	41	36	27	20	41	46	33	29	…	24
All Sectors	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	…	**100**

[1] Includes the Yukon and Northwest Territories.
[2] Includes provincial research councils and foundations.
[3] Includes private non-profit institutions
*Quebec and Ontario figures exclude Federal Government expenditures performed in the National Capital Region (NCR).
-- amount too small to be expressed
.. figures not available
… figures not appropriate or not applicable

Source: Statistics Canada, "Total Spending on Research and Development in Canada, 1986[e] to 1997, and Provinces, 1986 to 1995", *Service Bulletin: Science Bulletin (Catalogue 88-001-XPB)*, Vol. 21, No.8, p.9.

Table 3
Provincial Distribution of R&D by Funding Sectors, 1995

Funding Sector	Nfld	PEI	NS	NB	Qué*	Ont*	Man	Sask	Alta	BC	NCR	Total[1]
In millions of dollars												
Federal government	46	12	116	56	575	794	118	79	205	237	783	3,023
Provincial government[2]	6	-	7	9	244	252	16	21	88	47	…	690
Business Enterprise	12	2	37	30	1,900	2,957	78	58	394	438	16	5,922
Higher Education	27	2	41	15	359	367	59	56	93	79	…	1,098
Other[3]	1	-	16	5	285	1,370	22	14	91	123	…	1,927
All Sectors	**92**	**16**	**217**	**115**	**3,363**	**5,740**	**293**	**228**	**871**	**924**	**799**	**12,660**
As a percentage of the provincial total												
Federal government	50	75	54	49	17	14	40	35	24	26	…	24
Provincial government[2]	7	-	3	8	7	4	5	9	10	5	…	5
Business Enterprise	13	13	17	26	57	52	27	25	45	47	…	47
Higher Education	29	12	19	13	11	6	20	25	11	9	…	9
Other[3]	1	-	7	4	8	24	8	6	10	13	…	15
All Sectors	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	…	**100**

[1] Includes the Yukon and Northwest Territories.
[2] Includes provincial research councils and foundations.
[3] Includes private non-profit institutions
*Quebec and Ontario figures exclude Federal Government expenditures performed in the National Capital Region (NCR).
- nil or zero
… Figures not appropriate or not applicable

Source: Source: Statistics Canada, "Total Spending on Research and Development in Canada, 1986[e] to 1997, and Provinces, 1986 to 1995", *Service Bulletin: Science Bulletin (Catalogue 88-001-XPB),* Vol. 21, No.8, p.10.

Table 4
Total Intramural Industrial R&D Expenditures, by Province, 1993 to 1995

Province	1993[r]	1994[e]	1995
	in millions of dollars		
Newfoundland	10	12	10
Prince Edward Island	2	2	3
Nova Scotia	44	45	45
New Brunswick	41	46	45
Québec	1,811	1,940	2,172
Ontario	3,620	3,954	4,239
Manitoba	90	92	88
Saskatchewan	58	57	60
Alberta	391	452	446
British Columbia	471	520	551
Yukon and Northwest Territories	-	1	--
Total	**6,539**	**7,121**	**7,659**
Metropolitan areas			
Montreal	1,538	1,633	1,834
Toronto	1,794	1,902	1,999

- nil or zero
-- amount too small to be expressed

Source: Statistics Canada, *Industrial Research and Development: 1997 Intentions (Catalogue No. 88-202-XPB*), 1997, p.64.

Table 5
Distribution of Intramural Industrial R&D for Quebec, Ontario and Other Provinces/Territories, for Selected Industries, 1995

Selected industries	Québec	Ontario	Other provinces/ territories	Canada
	in millions of $			
Telecommunication equipment	99	1,233	47	1,379
Aircraft and parts	438	302	3	742
Engineering and scientific services	249	180	247	676
Computer and related services	119	243	102	464
Pharmaceutical and medicine	216	227	19	462
Finance, insurance and real estate	39	388	22	448
Wholesale trade	148	214	81	443
Other industries	864	1,453	729	3,046
Total	**2,172**	**4,239**	**1,248**	**7,659**

Source: Statistics Canada, *Industrial Research and Development: 1997 Intentions (Catalogue No. 88-202-XPB)*, 1997, p.29.

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