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Estimation of Research and Development Expenditures in the Higher Education Sector, 1998-99

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ESTIMATION OF RESEARCH AND DEVELOPMENT EXPENDITURES IN THE HIGHER EDUCATION SECTOR, 1998-99

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Symbols

- nil or zero
r revised numbers

Note

Since publication release of Higher Education Research and Development values in catalogue 88-001-XIB Vol. 24, No. 7, minor adjustments have been made between science type in the province of Québec and are reflected in this working paper. Totals have not changed.

Due to rounding of data, the tables may not add to the sum of their components.

Working Paper on Estimation of Higher Education R&D Estimates

Introduction

In the spring of 1999, the Science, Innovation, and Electronic Information Division of Statistics Canada (SIEID) decided to review the methods it uses to estimate Higher Education R&D Expenditures (HERD) and Gross Expenditures on R&D in the health field (Health GERD). Both HERD and Health GERD are components of a larger ongoing statistical series maintained by SIEID to measure Canadian expenditures on R&D as reported by the main R&D performing sectors. In constructing the GERD (Gross Expenditures on Research and Development) series, SIEID conducts actual surveys of all of the main R&D performing sectors[1] except for Higher Education whose R&D performance figures are estimated. The manner in which research is performed and funded in Canadian universities and research hospitals has evolved in recent years, and current estimation methodologies may not take these changes into account.

More and more, budget allocation decisions are based on the research performance of higher education institutions (measured in large part by national statistics). Also, with the transition to a knowledge-based economy, the way knowledge is generated has changed; more university research is performed outside traditional academic departments in affiliated centres, institutes, or hospitals, often by full time researchers who do not hold a traditional academic appointment and whose research activities may not be fully captured in current data. Thus, quality estimates of R&D activities in the Higher Education sector are of increasing importance to policy developers, to the major funders of these activities, and also to the performing institutions.

Funders of HERD include the Federal Government through the three major granting councils[2], the Canada Foundation for Innovation, and other federal departments and agencies; the provincial governments and provincial research organizations; the business sector; the private non-profit sector; foreign sources; and of course the universities and affiliated institutions (such as teaching hospitals) themselves. The HERD portion of the GERD series may be of assistance in answering various questions for policy analysts, HERD funders and others. These questions include: Is our national or provincial university research effort expanding or declining? What proportion of R&D is performed by this sector compared to other sectors (business, government, and private non-profit)? In what proportions under the major science fields, and by source of funds, are R&D being performed?

Following an initial study[3] and a positive reaction to its recommendations from a group of professionals in the university and health research fields in September 1999, SIEID created a Working Group and hired a facilitator[4] to examine current HERD and health GERD estimation methods, to recommend revisions where appropriate, and to produce a framework for an improved estimation program. This work was completed in April 2000 and based upon it, SIEID developed a three-year Operational Plan to see to the implementation of as many recommendations as possible, with financial and consultation help from a partnership of interested data users.[5]

This Working Paper, which outlines a new method for calculating higher education R&D expenditures, is part of the initiative to improve estimates in an area that also includes estimates of the numbers of personnel engaged in higher education R&D, health GERD, and U.S. and international comparisons.

[1] The performing sectors are the federal government, the provincial governments, provincial research organizations, business enterprise, higher education, and private non-profit organizations.
[2] In the past, the three federal granting councils were the Medical Research Council (MRC), the Natural Sciences and Engineering Research Council (NSERC), and the Social Sciences and Humanities Research Council (SSHRC). Now the Canadian Institutes of Health Research (CIHR) have assumed the programs and responsibilities of the MRC but CIHR is technically not a "Council". Even so, references in this paper to the three federal granting councils will be to CIHR, NSERC, and SSHRC.
[3] Statistics Canada 1999. Review of HERD and Health GERD--Report to Statistics Canada, Mireille Brochu.
[4] Mireille Brochu
[5] CIHR, NSERC, SSHRC, Industry Canada, the Association of Universities and Colleges of Canada(AUCC), and the Canadian Association of Business Officers.

Estimation Expenditures in Higher Education

The material which follows is an explanation of the new estimation procedures used for the first time for the fiscal year 1998-99 to calculate R&D expenditures in the Higher Education sector. Further refinements are also expected over the next two years based upon investigations into many of the assumptions used to derive the estimates. These areas of further investigation will be summarized in the section "Future Work" toward the end of this paper. Plans to maintain continuity in the historical series will also be presented in the closing section.

In order to understand the new estimation formula, it may be useful to examine the old formula and the weaknesses detected in it by the Working Group. Between 1979-80 and 1997-98, Statistics Canada employed the following techniques to estimate higher education R&D:

a) Total university expenditures (minus ancillary costs) were obtained from the financial reports of the Canadian Association of University Business Officers (CAUBO).

b) Estimations were then made for each institution of the total expenditures devoted to R&D. This calculation was a complicated one based on the total number of faculty members, estimates of the time each member devoted to research (using a formula that varied by discipline and size of institution), and finally estimates of the research resources consumed by each member (again using a formula that varied by discipline and size of institution). Next, estimations were made of the R&D taking place in three science fields: natural sciences and engineering, social sciences and humanities, and health sciences.

c) Finally, the sources of research revenues were estimated using the CAUBO sponsored research data to attribute sponsored research to sponsors, and then the residual amount was attributed to the institutions themselves.

The chief weakness of the older formula was that, while it gave a reasonably good approximation of total research costs at an aggregate level (by province and nationally), it assumed that the total costs of R&D at the institution level (step b, above) was independent of sponsored research revenues. Thus, two universities with roughly the same program mix and the same number of faculty were assumed to have the same R&D expenditures even if one was more successful at obtaining sponsored research funds than the other. Earlier HERD calculations estimated that both institutions had the same total R&D expenditures, entailing the following embedded assumption: the one with higher amounts of sponsored research did not devote much of its own resources to R&D, while the less successful solicitor of sponsored research did.

This assumption is contrary to that of research intensive universities who insist that each incremental dollar of sponsored research adds to university costs. Indeed, not all costs are accounted for by sponsored research grants and contracts, requiring that proportionally more of the institution's own resources must go to research to make up the difference. More research means the involvement of more people (students, technician, associates, etc.), more space, more utilities, more consumption of common services such as libraries, computing, administration, plant, and the like. The earlier estimation technique, on rare occasion, resulted in an institution with high sponsored research values having a negative value for its own contributions to research. This was because the total value of estimated research was capped (step b above) at a value below that of the sponsored research received from the outside.

The new estimation technique, proposed by the Working Group and applied in the 1998-99 HERD data in this report, addresses the above problem in the following manner. The sponsored research value is the first ingredient of the total, with additional estimations of expenditures added to this value. The method thus assumes that the total expenditures are equal to:

a) sponsored research expenditures (available from CAUBO sources);
b) indirect expenditures on sponsored research (those not reimbursed by sponsors);
c) a value for the fraction of faculty members' time assumed to be devoted to sponsored and non-sponsored research (correcting for cases where sponsored research covers salaries of principal investigators); and
d) indirect expenditures related to faculty members' time on research (c above).

The advantage in this new method is that no institution will have a negative value assigned to its own R&D activities, and those that do report more sponsored research will generally have higher R&D estimates than those reporting less. The challenges posed by the new HERD estimation methodology have mainly been in developing

a credible estimate of those three values which we add to the sponsored research values (more readily accessible through CAUBO), and also partitioning the final HERD estimates into the three fields of science.

1.1 HERD Matrix

Before detailed explanations of the new methodology are offered, it is necessary to understand the traditional format requirement for HERD data, called the HERD matrix, presented in Table 1 below.

Table 1. Higher Education Expenditures on R&D by Source of Funds and Major Teaching Field 1998-99

Source of Funds	Social Sciences & Humanities	Health Sciences	Other Natural Sciences & Engineering	Total
		millions of dollars		
Federal Government	111.7	274.8	474.6	861.1
Provincial Government	74.0	111.0	184.9	369.9
Business Enterprise	17.3	145.0	245.4	407.7
Higher Education	445.6	802.2	692.3	1,940.1
Private Non-Profit	57.3	213.0	64.3	334.6
Foreign	-	19.8	29.7	49.5
Total	**705.9**	**1,565.8**	**1,691.2**	**3,962.9**

Two of the main areas of interest in HERD are the sectors funding R&D and the fields of science being funded. In the sections below are described the methods by which **source of fund** allocations are made and also those by which allocations to the three fields of science are determined. There are no surveys of these sectors designed precisely to meet the needs of the HERD matrix, but the methodologies described below are an initiative to make reasonable allocations.

1.2 Sponsored Research

Sponsored research accounts for more than half of all higher education R&D in most universities and affiliated institutions in Canada. For sponsored research, the principal source of data are the annual tables prepared by Statistics Canada (Centre for Education Statistics) from data collected and provided to CAUBO. The CAUBO survey provides revenue data on sponsored research for member institutions and classified by source of funds as follows:

- Federal Government:

- Social Sciences and Humanities Research Council
- Health Canada
- Natural Sciences and Engineering Research Council
- Medical Research Council (Now Canadian Institutes of Health Research)
- Canada Foundation for Innovation
- Other
- Governments Provincial
- Municipal Governments
- Foreign
- Bequests, donations and non-government grants (subdivided into a) individuals, b) business enterprise, c) foundations, and d) not-for-profit agencies)
- Sale of services and products
- Investment income
- Miscellaneous

Most of these revenue data may be used to create the funding distribution needed to complete the HERD matrix. There are five funding categories in the matrix into which these CAUBO revenue data may be allocated by making certain assumptions: the categories are federal government; provincial governments; business enterprise; private non-profit organizations; and foreign sources. The sixth funding category, higher education, is estimated by using a combination of CAUBO data and faculty data provided by the Centre for Education Statistics at Statistics Canada.

First, it is assumed that there is exact correspondence between HERD funding sources and CAUBO revenues for the following three HERD areas:

HERD Funding Source	**CAUBO Reported Revenues**
Federal Government	Federal Government
Provincial Governments	Provincial Governments Municipal Governments
Foreign	Foreign

The challenge is to allocate by **source of funds** the remaining sponsored research funds reported to CAUBO. "Bequests, donations and non-government grants" are now relatively easily allocated because of the use of reporting subdivisions. Funds reported to CAUBO under "individuals" and "business enterprises" are allocated to "business enterprises" in Table 1; and "foundations" and "not-for-profit" are reported under "private non-profit" in Table 1. Further, CAUBO reported "sale of services and products" is not relevant to research and is not distributed. Similarly, CAUBO reported "investment income" is not allocated. Finally, CAUBO reported "miscellaneous" funds are allocated to Business Enterprise and Private Non-Profit categories (Table 1) in the same ratio as that used for "bequests, donations, and non-government grants".

Having distributed sponsored research by funding source, the next goal is to estimate which fraction of sponsored research funds should be assigned to the three major **fields of science**. A number of assumptions, based upon those used in the current method, are employed as follows:

- NSERC funding is in the Natural Sciences and Engineering (NSE);
- SSHRC funding is in the Social Sciences and Humanities(SSH);
- CIHR (which now includes MRC and NHRDP) are in Health;
- Other federal funding is estimated to be: 60% in the NSE, 30% in the SSH and 10% in health (based on survey of federal expenditures);
- Provincial funding is estimated to be: 50% in the NSE, 20% in the SSH and 30% in Health (based on data reported by provincial government);
- Business and not-for-profit funding and miscellaneous funding (this is estimated using data supplied by CIHR, SSHRC and NSERC, based on the 1989-90 university reports on "matching funding");
- Foreign (60% to health and 40% to NSE, based on National Science Foundation U.S.A. data).

These allocations of funds address our HERD needs only for the sponsored research component of higher education R&D. To complete the HERD expenditure estimates, we now have to turn to the formula components dealing with the contributions of the higher education institutions themselves to HERD. The first of these is the indirect expenditures generated by sponsored research revenues.

1.3 Indirect Expenditures for Sponsored Research

There are two terms of special note that the reader should be familiar with to better understand the detail that follows. They are **direct** and **indirect** expenditures. **Direct** expenditures are those that can be directly attributed to a research project or activity. Examples include salaries of researchers and research assistants, equipment, supplies, travel costs, fees for services, publication and patenting expenditures, and the like. **Indirect** expenditures are those that are incurred by an institution by virtue of the fact that researchers conduct sponsored or intramural research with the support of the institution. They are expenditures that cannot be identified readily and specifically with a particular project, instructional or other activity of the institution. Examples include the costs of the office of research or intellectual property management services, departmental administration, utilities, physical plant operation and maintenance, library, laboratory furniture and permanent equipment.

The steps below describe the methodology for arriving at a direct to indirect expenditure ratio for operating a university which is then applied to sponsored research to obtain a value for the additional expenditures required of a university when it conducts this research. It is generally recognized that the bulk of sponsored research funds is direct in nature. Our working assumption is that only about 5% of reported sponsored research are reimbursements for indirect expenditures. Institutions do receive some indirect cost reimbursements from industry, some provincial governments and other sources, but they are not generally reported under sponsored research.

The first step in the calculation, using a CAUBO methodology going back to 1982, is to come up with a satisfactory ratio of indirect to general operating expenditures for the institution. The CAUBO data on university expenditures break out “general operating” from “other” expenditures as follows:

General Operating Expenditures:

- Instruction and non-sponsored research (the largest of all categories and consisting mainly of academic and support salaries)
- Non-credit instruction
- Library
- Computing
- Administration
- Physical plant
- Student Services

Other Expenditures:

- Sponsored research
- Trusts and Endowments
- Ancillary enterprises (this is a separate, self-supporting activity)
- Capital (these are one time as opposed to ongoing costs).

Of general operating expenditures, the following are deemed under the new estimation model to be indirect expenditures:

- 11% of instruction and non-sponsored research and non-credit instruction (based on the assumption that 11% of the time of academic and support staff is for various administrative duties that support teaching and research)
- 100% of Library
- 100% of Computing
- 100% of Administration
- 100% of Physical Plant

While it is believed that some of “Student Services” can be considered as “indirect”, it is not known how much. So this item is removed from the calculation for the moment. The ratio of the above five indirect expenditures over general operating expenditures (minus “Student Services”) gives an indirect to total expenditure ratio for general operating expenditures (again minus “Student Services”).

The next step is to apply this ratio to the “trusts and endowments” portion of “other” expenditures, based on the assumption (in the absence of survey data) that the indirect portion here is the same as that for general operating expenditures. Also, we reintroduce “Student Services” at this point and apply the same ratio, in the absence of better information about what this ratio might be.

Ancillary enterprises (includes ”sales producing” operations ancillary to the normal univesity functions of instruction and research) and capital are excluded from total expenditures, the former because they are self-supporting, and the latter because they are not ongoing.

By adding together the estimates of indirect expenditures for each of sponsored research (5%), general operating, trusts and endowments, and student services, we now have a value for indirect expenditures for operating a university. Subtracting this total value from total operating expenditures gives us a total direct expenditure value. The end result is a total indirect to total direct expenditure value for operating a university.

The above calculation is not made on an individual university basis but made, rather, for three clusters of universities – small, medium, and large institutions – by aggregating the appropriate values in each of the categories of expenditure discussed above by university size. In this manner we arrive at a working ratio by university size for the next step in the calculation (the assumptions used to classify universities by size are described in Section 1.4 below).

To estimate the additional indirect expenditures an institution likely makes in performing sponsored research, one simply removes that small portion (estimated at 5%) of indirect costs included in reported sponsored research funds (so as not to double count), and multiplies the remainder by the total indirect to total direct expenditure ratio referred to above, based on university size. This gives us an estimated value for those indirect expenditures picked up by the university in the performance of sponsored research.

A question may be asked about why a cluster direct-to indirect expenditure ratio for small, medium, and large institutions (university size) was used rather than individual institution ratios in this step. The answer has two parts. First, the estimated ratio for indirect expenditures using the above method shows a strong correlation to university size. We use the three university sizes to estimate the costs of the time faculty members spend on research, backed by studies that show that time spent on research is proportional to discipline and size of institution. So, the first reason is to remain consistent in our estimation approach throughout. The second reason is that using the cluster values for each group of institutions should make it much easier for readers to reproduce our results since they are accessible while individual institutional numbers may not be so.

Concerning the distribution of this value across the three major fields of science (in Table 1 above), it is assumed that the same percentages should apply as one has calculated above for sponsored research.

1.4 Estimation of Faculty Time on R&D

This part of the HERD estimation formula is little changed from that used in previous years.

It is generally accepted that higher education faculty divide their time among the three main missions of a university: teaching, research, and community service work. In order to estimate the value in dollar terms of the research fraction, it is necessary to have data on the numbers and salaries of faculty in Canada’s universities and affiliated institutions, and if possible, estimates of the research fraction. The faculty counts by each of the eight teaching disciplines in the three major fields of science are available from the University and Colleges Annual Staff Survey conducted by the Centre for Education Statistics at Statistics Canada. Also, academic salary data are available from the annual CAUBO Survey.

However, few data exist, and accurate data are difficult and costly to obtain on the breakdown by activity of faculty time. Faculty members teach, supervise graduate students, conduct research, and perform community service as a “joint activity”. Therefore, Statistics Canada makes assumptions about these breakdowns based on surveys in Canada and elsewhere, and has come up with the following coefficients for faculty time by university size for the eight discipline groups:

Table 2. Statistics Canada Time Coefficients for Research

Institution Size	Éducation	Fine arts	Humanities	Social sciences	Agriculture and biological sciences	Engineering and applied sciences	Health professions	Mathematics and physical sciences
Small	0.10	0.00	0.00	0.10	0.10	0.10	0.10	0.10
Medium	0,.0	0.10	0.20	0.20	0.25	0.25	0.25	0.25
Large	0.30	0.20	0.30	0.30	0.35	0.35	0.35	0.35

Table 2 reflects the assumption that, depending on the size of the university, some universities spend relatively more time on R&D than others, and also that R&D is a more important activity in some teaching fields than in others. The exact ratios are open to debate. However, this working paper provides all the information necessary for a reworking of the estimates with different ratios should the reader wish. In reviewing the ratios, it should be noted that R&D as used here is rather narrower than much scholarly activity might suggest, for example improving one's own knowledge of a field outside of a research project.

As an example of how the coefficients are applied, take a professor of health sciences from a medium size university who probably works in an affiliated teaching hospital. Table 2 is based on the assumption that for every $1,000 in salary, 25% of that amount is paid for R&D activities. Were he/she to work in a large institution, the amount would be 35%, and in a small institution, 10%. These coefficients are applied against the number of faculty in each of the eight teaching disciplines and the total salaries reported by CAUBO for each institution. It is further assumed that all faculty members are at the same salary levels in the absence of more detailed salary information from existing sources.

The classification of universities into three categories of size is based on the following criteria: 1) the amount of expenditures on sponsored research (reported by CAUBO); 2) the proportion of sponsored R&D expenditures as a percentage of general operating expenditures; and 3) the number of doctoral programs. A university is classified as *small* if its expenditures on sponsored R&D are less than $10 million and less than 10% of general operating, and whose doctoral programs are less than ten in number. A *medium* size university is one in which the dollar range is between $10-30 million, the percentage of general operating is from 10% to less than 20%, and whose doctoral program counts are between 10 and 30. A *large* university is one whose sponsored research dollar value is greater than $30 million, whose general operating percentage is more than 20%, and whose doctoral programs are greater than 30. It is worthy of note that the final objective is not to create an individual ranking for universities but rather to group them into three size groups to make possible R&D expenditure estimates at the aggregate level.

In applying the above assumptions to the teacher counts to arrive at values for teacher time spent on R&D, it should be noted that, where the salaries of primary researchers are already reported by CAUBO as part of sponsored research, they are removed from the estimate to avoid double counting. Also, regarding the distribution of teacher salary values across the three science fields in the HERD matrix, this is done by attributing the R&D portion of salaries of teachers found in each field to that field.

Other sources of information for the distribution of faculty time include the National Science Foundation in the United States which reported in a 1984[6] that for the U.S. institutions surveyed, R&D accounted for 22% of the total faculty time in engineering, 23% for physical scientists, 33% for agricultural and biological scientists, 26% for medical scientists, 8% for psychologists and social scientists, and 6% for mathematicians.

The Australian Bureau of Statistics estimated in 1990 that HERD was 32.6% of total higher education expenditures.

A more recent technical paper produced for the Ontario Council on University Affairs and published in 1994 set out a model, using existing financial information on revenues and expenses in the Ontario university system, that distributed the university functions of teaching, research, and community service in the proportions of 53%, 36%, and 11% respectively. Finally, a faculty workload study conducted by the University of Western Ontario in 1996 found that R&D activities corresponded to an R&D coefficient of 31.9%. Variations by faculty included 10% for business, about 20% for education, journalism and nursing, and about 38% for medicine.

[6] Academic Science/Engineering: Scientists and Engineers, January 1983, National Science Foundation , Washington D.C., 1984, page 16 (Table B-18 divided by Table B-17).

1.5 Indirect Expenditures Related to Faculty Time

Similar to the assignment of a value for indirect expenditures connected with sponsored research, a value must now also be calculated for the indirect expenditures connected with faculty time spent on R&D within the institutional setting. The time of faculty spent on sponsored research is netted out of this calculation. To make this calculation, it is assumed that the same direct-to-indirect ratio used to calculate the indirect values for sponsored research will apply in this case. Also, the distribution of this estimate across the three science fields in Table 1 will be in the same proportion as that found for the salary component above.

1.6 HERD Total

It is now possible to calculate the national and provincial values for higher education R&D as follows:

i) sponsored research, plus
ii) (sponsored research minus 5% for indirect) multiplied by (average ratio by university size of indirect to direct total operating expenditures), plus
iii) faculty salaries devoted to sponsored and non-sponsored research (correcting for cases where sponsored research covers salaries of principal investigators), plus
iv) indirect expenditures related to faculty time (iii above multiplied by the ratio by university size of indirect to direct total operating expenditures).

It is also possible, based on the above estimates, to complete all cells of both the HERD matrix and the GERD matrix appropriate to Higher Education. These data together with those of the other performing and funding sectors make it possible to compare HERD performance with that of other R&D activity centres (business; private non-profit; government) and to identify the flow of funds among them.

2. Selection of Institutions

A list of the institutions retained for the estimation of R&D expenditures for 1998-99 is presented in Appendix List 1. Selection is based on payments (grants and contracts) awarded to institutions or their faculty for sponsored research and reported in the annual CAUBO survey.

3. Future Work

3.1 Sponsored Research:

The Working Group made a number of recommendations to Statistics Canada concerning future activities in the area of sponsored research that the Agency intends to pursue in consultation with Project partners. First, the Project will continue to rely on the annual report of the Centre for Education Statistics prepared from CAUBO data to estimate R&D breakdowns by three major fields rather than conduct an expensive and burdensome survey of universities for this purpose. However, the Group did recommend that the current estimation methods be improved by conducting **occasional** surveys of **typical** universities via the research offices to obtain estimates of research funding by field of science. Further, Statistics Canada will work closely with CAUBO in its efforts to improve the reporting of financial information, particularly with respect to sponsored research funding and inter-institutional awards. The latter is necessary to avoid double counting where several institutions working on the same project may report the same funds.

3.2 Indirect Expenditures:

The assumptions concerning what constitutes indirect expenditures and also the assumption that sponsored research expenditures include 5% in indirect cost reimbursement will remain open to discussion, particularly among the established users of these data and those who have constituted the review and support partnership. The 5% estimate is particularly arbitrary because CAUBO does not have any information on the amount of indirect costs covered by reported sponsored research grants and contracts. These may be reported by universities as sponsored research or elsewhere under other types of expenditures. It is known that some of the indirect costs are covered by business and private not-for-profit awards and that Quebec covers 15% of indirect

costs in its awards (but universities do not necessarily report these funds under sponsored research). The Quebec figure suggests that the 5% estimation overall for that province is likely low. Project staff will work more closely with CAUBO and the universities and related associations in the future to improve estimates in this area.

3.3 Faculty Expenditures on R&D:

Better data concerning the time allocations of higher education faculty by activity type and discipline would immeasurably improve user confidence in HERD estimations. Part of the Work Plan for this Project in the coming two years is to explore with the Project partners the ways and means of doing so. The obvious solution is to conduct a survey of faculty members in all eight teaching disciplines stratified by university size. Taking advantage of occasional surveys conducted by the granting councils of their grant recipients to ask questions about these matters will also assist in improving knowledge about these activities.

The criteria used for establishing the size of a university (which are then used in estimating faculty expenditures on R&D) will be modified on a three year running average in subsequent reviews of this estimation procedure. Also, additional criteria may be added to fine tune this procedure.

3.4 Historical Continuity of Data Series:

This working paper contains ten years of revised HERD estimates based on the new formula used for 1998-99.

Appendix Tables

TABLE 1. Estimated Costs of R&D in the Higher Education Sector, by Source of Funds and by Major Teaching Field, 1998-99

Sources of funds	Social sciences and humanities	Health sciences	Other natural sciences and engineering	Total
		millions of dollars		
Federal government	111.7	274.8	474.6	861.1
Provincial governments	74.0	111.0	184.9	369.9
Business enterprise	17.3	145.0	245.4	407.7
Higher education	445.6	802.2	692.3	1,940.1
Private non-profit organizations	57.3	213.0	64.3	334.6
Foreign	-	19.8	29.7	49.5
Total	**705.9**	**1,565.8**	**1,691.2**	**3,962.9**

TABLE 2. Estimated Costs of R&D in the Higher Education Sector, by Source of Funds, 1988-89 to 1998-99

Year	Federal government	Provincial governments	Business enterprise	Higher education	Private non- profit organizations	Foreign	Total
			millions of dollars				
1988-89[r]	624.9	261.2	115.1	1,481.5	172.8	13.2	2,668.7
1989-90[r]	669.4	285.5	139.7	1,571.9	165.2	11.8	2,843.5
1990-91[r]	782.9	282.7	151.1	1,618.4	185.8	12.1	3,033.0
1991-92[r]	813.3	288.9	229.3	1,734.6	215.2	11.0	3,292.3
1992-93[r]	848.7	294.2	293.1	1,886.2	196.2	20.1	3,538.5
1993-94[r]	872.7	312.4	313.9	1,866.1	248.3	20.3	3,633.7
1994-95[r]	869.8	314.7	296.1	1,881.9	259.2	21.3	3,643.0
1995-96[r]	854.8	323.2	296.7	1,935.4	265.7	24.3	3,700.1
1996-97[r]	809.0	297.6	335.6	1,927.1	312.7	36.4	3,718.4
1997-98[r]	792.7	369.9	381.0	2,032.1	324.5	39.5	3,939.7
1998-99	861.1	369.9	407.7	1,940.1	334.6	49.5	3,962.9

TABLE 3. Estimated Costs of R&D in the Higher Education Sector, by Source of Funds and by Province, 1998-99

Province	Federal government	Provincial governments	Business enterprise	Higher education	Private non- profit organizations	Foreign	Total
			millions of dollars				
Newfoundland	18.1	1.2	8.4	34.2	-	-	61.9
Prince Edward Island	1.5	0.4	0.4	3.9	0.7	--	6.9
Nova Scotia	28.9	4.5	8.3	78.4	4.5	8.4	133.0
New Brunswick	12.1	3.8	5.7	32.9	5.7	0.9	61.1
Québec	246.7	111.6	111.1	546.8	87.6	19.8	1,123.6
Ontario	329.6	136.7	187.4	763.6	168.8	13.0	1,599.1
Manitoba	24.8	8.2	7.0	60.2	12.8	0.5	113.5
Saskatchewan	19.7	16.1	8.3	70.5	6.0	0.8	121.4
Alberta	81.3	65.3	39.3	172.4	23.9	0.8	383.0
British Columbia	98.4	22.1	31.8	177.2	24.6	5.3	359.4
Canada	**861.1**	**369.9**	**407.7**	**1,940.1**	**334.6**	**49.5**	**3,962.9**

TABLE 4. Estimated Costs of R&D in the Higher Education Sector, by Province, 1988-89 to 1998-99

	Province										
Year	Nfld.	P.E.I.	N.S.	N.B.	Qué.	Ont.	Man.	Sask.	Alta.	B.C.	Canada
					millions of dollars						
1988-89[r]	50.9	3.9	116.8	41.3	707.6	1,044.3	110.7	84.9	264.3	244.0	2.668.7
1989-90[r]	52.8	4.0	117.3	43.4	788.4	1,108.2	110.8	89.0	270.6	259.0	2,843.5
1990-91[r]	54.8	4.1	117.9	45.7	878.5	1,176.1	110.8	93.2	277.0	274.9	3,033.0
1991-92[r]	57.5	5.1	127.5	49.7	1,033.7	1,211.3	113.8	100.7	290.4	302.6	3,292.3
1992-93[r]	60.5	4.8	121.2	53.2	1,169.4	1,280.1	116.8	103.3	294.7	334.5	3,538.5
1993-94[r]	60.9	4.4	119.0	52.5	1,169.0	1,390.6	110.7	116.3	296.8	323.6	3,633.8
1994-95[r]	58.5	3.8	113.1	53.8	1,136.1	1,409.5	114.8	108.2	309.0	336.2	3,643.0
1995-96[r]	58.4	3.7	117.0	56.2	1,107.6	1,443.7	113.5	113.9	238.5	357.6	3,700.1
1996-97[r]	56.6	4.2	117.6	56.2	1,095.3	1,479.3	111.3	113.6	330.2	354.1	3,718.4
1997-98[r]	61.2	5.9	124.9	57.4	1,163.7	1,578.1	108.3	118.9	359.4	362.1	3,939.7
1998-99	61.9	6.9	133.0	61.1	1,123.6	1,599.1	113.5	121.4	383.0	359.4	3,962.9

TABLE 5. Estimated Costs of R&D in the Social Sciences and Humanities in the Higher Education Sector by Source of Funds and by Province, 1998-99

Province	Federal government	Provincial governments	Business enterprise	Higher education	Private non- profit organizations	Foreign	Total
			millions of dollars				
Newfoundland	2.8	0.3	-	9.8	-	-	12.9
Prince Edward Island	0.2	0.1	-	1.0	0.4	-	1.7
Nova Scotia	4.3	0.9	0.1	17.8	0.2	-	23.3
New Brunswick	2.3	0.8	0.1	10.5	0.2	-	13.9
Québec	32.8	22.3	6.8	114.5	16.3	-	192.7
Ontario	42.0	27.3	8.5	161.7	28.1	-	267.6
Manitoba	3.4	1.7	0.4	18.3	2.0	-	25.8
Saskatchewan	2.3	3.2	0.1	20.3	0.2	-	26.1
Alberta	8.5	13.0	0.7	36.2	3.8	-	62.2
British Columbia	13.1	4.4	0.6	55.5	6.1	-	79.7
Canada	**111.7**	**74.0**	**17.3**	**445.6**	**57.3**	**-**	**705.9**

TABLE 6. Estimated Costs of R&D in the Social Sciences and Humanities in the Higher Education Sector, by Province, 1988-89 to 1998-99

	Province										
Year	Nfld.	P.E.I.	N.S.	N.B.	Qué.	Ont.	Man.	Sask.	Alta.	B.C.	Canada
					millions of dollars						
1988-89[r]	13.7	1.0	24.8	11.7	158.7	227.5	23.8	17.8	58.1	56.6	593.7
1989-90[r]	15.8	1.0	24.6	12.4	173.8	239.7	23.8	19.0	56.1	59.8	626.0
1990-91[r]	15.9	1.1	23.8	13.0	188.6	256.4	23.6	19.0	56.9	56.1	654.4
1991-92[r]	17.2	1.4	26.1	13.2	198.5	265.4	24.8	20.7	59.8	60.8	687.9
1992-93[r]	15.9	1.3	27.6	13.2	211.3	287.5	25.5	21.2	60.3	74.8	738.6
1993-94[r]	15.6	1.1	25.1	14.2	216.6	282.6	23.8	21.1	61.3	69.1	730.5
1994-95[r]	15.6	0.9	23.5	13.9	217.5	278.9	24.2	21.9	58.7	70.4	725.5
1995-96[r]	15.4	0.9	23.0	13.8	213.5	269.1	24.7	23.8	64.5	76.0	724.7
1996-97[r]	15.2	1.1	21.3	13.2	204.9	259.6	24.5	23.9	61.1	80.4	705.2
1997-98[r]	14.7	1.5	21.9	12.8	203.6	285.6	23.8	26.9	62.2	78.7	731.7
1998-99	12.9	1.7	23.3	13.9	192.7	267.6	25.8	26.1	62.2	79.7	705.9

TABLE 7 Estimated Costs of R&D in the Health Sciences in the Higher Education Sector, by Source of Funds and by Province, 1998-99

Province	Federal government	Provincial governments	Business enterprise	Higher education	Private non- profit organizations	Foreign	Total
			millions of dollars				
Newfoundland	2.9	0.4	5.4	9.6	-	-	**18.3**
Prince Edward Island	0.1	0.1	-	0.3	-	--	**0.5**
Nova Scotia	7.9	1.4	5.9	35.0	4.0	3.3	**57.5**
New Brunswick	0.8	1.1	--	3.1	-	0.4	**5.4**
Québec	89.7	33.5	40.4	230.4	53.2	8.0	**455.2**
Ontario	104.7	41.0	63.4	359.5	115.6	5.2	**689.4**
Manitoba	9.5	2.5	1.5	20.0	8.0	0.2	**41.7**
Saskatchewan	3.5	4.8	-	19.7	3.7	0.3	**32.0**
Alberta	28.2	19.6	19.6	76.9	15.7	0.3	**160.3**
British Columbia	27.5	6.6	8.8	47.7	12.8	2.1	**105.5**
Canada	**274.8**	**111.0**	**45.0**	**802.2**	**213.0**	**19.8**	**1,565.8**

TABLE 8 Estimated Costs of R&D in the Health Sciences in the Higher Education Sector, by Province, 1988-89 to 1998-99

	Province										
Year	Nfld.	P.E.I.	N.S.	N.B.	Qué.	Ont.	Man.	Sask.	Alta.	B.C.	Canada
					millions of dollars						
1988-89[r]	12.8	0.4	35.6	2.0	248.3	367.0	44.2	22.4	93.8	68.6	895.1
1989-90[r]	12.5	0.5	36.7	3.1	279.3	403.2	44.0	24.7	103.2	72.9	980.1
1990-91[r]	12.9	0.6	32.9	3.4	324.8	417.1	44.3	25.1	103.9	84.3	1,049.3
1991-92[r]	14.6	0.7	36.6	3.3	404.5	429.2	44.2	26.9	110.7	88.8	1,159.5
1992-93[r]	13.8	0.5	34.7	3.1	462.6	448.6	46.4	27.3	115.7	95.3	1,248.0
1993-94[r]	15.3	0.5	39.1	3.6	466.4	529.8	44.2	28.0	120.0	94.0	1,340.9
1994-95[r]	15.6	0.3	38.8	3.6	458.6	539.5	44.9	27.8	123.7	97.4	1,350.2
1995-96[r]	15.3	0.3	45.7	4.7	448.5	617.1	43.8	30.4	127.5	103.9	1,437.2
1996-97[r]	15.0	0.3	46.3	4.6	445.0	637.3	42.7	27.3	131.4	102.2	1,452.1
1997-98[r]	17.3	0.6	52.8	4.8	489.5	685.4	40.8	31.1	148.8	105.6	1,576.7
1998-99	18.3	0.5	57.5	5.4	4455.2	689.4	41.7	32.0	160.3	105.5	1,565.8

TABLE 9 Estimated Costs of R&D in the Natural Sciences and Engineering [(1)] in the Higher Education Sector, by Source of Funds and by Province, 1998-99

Province	Federal government	Provincial governments	Business enterprise	Higher education	Private non- profit organizations	Foreign	Total
			millions of dollars				
Newfoundland	15.2	1.0	8.4	24.4	-	-	49.0
Prince Edward Island	1.2	0.3	0.4	2.9	0.4	--	5.2
Nova Scotia-	24.6	3.6	8.1	60.7	4.3	8.4	109.7
New Brunswick	9.8	3.0	5.7	22.4	5.4	0.9	47.2
Québec	213.9	89.2	104.3	432.3	71.3	19.9	930.9
Ontario	287.6	109.4	178.9	601.9	140.8	12.9	1,331.5
Manitoba	21.5	6.6	6.5	41.9	10.7	0.5	87.7
Saskatchewan	17.4	12.9	8.2	50.2	5.8	0.8	95.3
Alberta	72.8	52.2	38.7	136.2	20.1	0.8	320.8
British Columbia	85.4	17.7	31.2	121.6	18.5	5.3	279.7
Canada	**749.4**	**295.9**	**390.4**	**1,94.5**	**277.3**	**49.5**	**3257.0**

[1)] Includes "health" and "other natural sciences and engineering".

TABLE 10 Estimated Costs of R&D in the Natural Sciences and Engineering [(1)] in the Higher Education Sector, by Province, 1988-89 to 1998-99

	Province										
Year	Nfld.	P.E.I.	N.S.	N.B.	Qué.	Ont.	Man.	Sask.	Alta.	B.C.	Canada
					millions of dollars						
1988-89[r]	37.2	2.9	92.0	29.6	548.9	816.8	86.9	67.1	206.2	187.4	2,075.0
1989-90[r]	37.0	3.0	92.8	31.1	614.6	868.6	86.9	69.9	214.5	199.1	2,217.5
1990-91[r]	38.8	3.1	94.1	32.7	689.9	919.6	87.2	74.2	220.2	218.8	2,378.6
1991-92[r]	40.4	3.7	101.3	36.5	835.2	945.9	89.0	80.0	230.7	241.7	2,604.4
1992-93[r]	44.6	3.6	93.6	39.9	958.0	992.6	91.3	82.2	234.4	259.7	2,799.9
1993-94[r]	45.3	3.3	93.9	38.3	952.4	1,108.0	86.9	85.1	235.5	254.5	2,903.2
1994-95[r]	42.9	3.0	89.7	39.8	918.6	1,130.6	90.5	86.3	250.3	265.7	2,917.4
1995-96[r]	43.0	2.8	94.0	42.3	894.1	1,174.7	88.8	90.1	264.0	281.6	2,975.4
1996-97[r]	41.4	3.1	96.3	43.0	890.4	1,219.7	86.8	89.7	269.1	273.7	3013.2
1997-98[r]	46.5	4.3	103.1	44.5	960.2	1292.5	84.5	92.1	297.0	283.4	3,208.1
1998-99	49.0	5.2	109.7	47.2	930.9	1,331.5	87.7	95.3	320.8	279.7	3,257.0

[1)] Includes "health" and "other natural sciences and engineering".

List 1. Classification of Universities, by Size, 1998-99

Province	Institution	Size
Newfoundland	Memorial University of Newfoundland	Medium
Prince Edward Island	University of Prince Edward Island	Small
Nova Scotia	Acadia University	Small
	University College of Cape Breton	Small
	Dalhousie University	Large
	Kings College	Small
	Mount Saint Vincent University	Small
	Nova Scotia Agricultural College	Small
	Nova Scotia College of Art and Design	Small
	St. Francis Xavier University	Small
	Saint Mary's University	Small
New Brunswick	Université de Moncton	Small
	Mount Allison University	Small
	St. Thomas University	Small
	University of New Brunswick	Medium
Québec	Bishop's University	Small
	Concordia University	Medium
	Université Laval	Large
	McGill University	Large
	École des Hautes Études Commerciales	Small
	École Polytechnique de Montréal	Medium
	Université de Montréal	Large
	École de Technologie Supérieure	Small
	Université du Québec en Abitibi-Temis.	Small
	Université du Québec à Hull	Small
	Université du Québec à Montréal	Medium
	Université du Québec àRimouski	Small
	Université du Québec à Trois-Riviéres	Small
	École nationale d'administration publique	Small
	Télé-Université	Small
	Université de Sherbrooke	Large
Ontario	Brock University	Small
	Carleton University	Medium
	University of Guelph	Large
	King's College	Small
	Lakehead University	Small
	Laurentian University of Sudbury	Small
	McMaster University	Large
	Nipissing University	Small
	University of Ottawa	Large
	Queen's University at Kingston	Large
	Redeemer College	Small
	St. Jerome's University	Small
	St. Michael's College	Small
	Ryerson Polytechnic University	Small
	University of Toronto	Large
	University of Sudbury	Small
	University of Trinity College	Small
	Université Saint Paul	Small
	Trent University	Small
	University of Waterloo	Large
	University of Western Ontario	Large
	Victoria University	Small
	Wilfrid Laurier University	Small
	University of Windsor	Small
	York University	Medium

Classification of Universities, by Size, 1998-99 (continued)

Manitoba	Brandon University	Small
	The University of Manitoba	Large
	The University of Winnipeg	Small
Saskatchewan	The University of Regina	Small
	St. Thomas More College	Small
	University of Saskatchewan	Large
Alberta	The University of Alberta	Large
	The University of Calgary	Large
	The University of Lethbridge	Small
	The King's College	Small
British Columbia	The University of British Columbia	Large
	Simon Fraser University	Medium
	University of Northern British Columbia	Small
	University of Victoria	Medium

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