R&D IN A SERVICE ECONOMY: CANADIAN STATISTICS

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1. INTRODUCTION

Canada has a service economy. Over two thirds of Gross Domestic Product(GDP) and three quarters of employment result from service activity and over 60% of the measured research and development is performed in the service sector.

The service economy is not new to Canada. In 1891, 31% of employment came from service industries, rising to 47% in 1951. Since the 50s, the economy has been dominated by the service sector and, not surprisingly, research and development reflects that dominance. Government and higher education account for 45% of R&D performance, an additional 16% is performed in private sector service industries, and some in private non-profit(PNP) institutions. Primary and secondary industries account for less than 40% of Canadian R&D.

This note looks at the economic structure of Canadian R&D and identifies areas of growth in private sector service industries. Measurement and definitional issues are discussed and the question is raised of how service sector R&D performers and funders influence other economic sectors.

2. THE SERVICE ECONOMY

In 1993, 67% of GDP was attributed to services[1]. Public services, education, health and government, accounted for 19% and 40% resulted mainly from services which could be sold in the market place. The distribution of GDP attributed to these services is given in Table 1.

Table 1: Percentage of 1993 GDP by Service Industry

Industry	Percentage of GDP	
Distributive Services	16.8	
Transportation and Storage		4.6
Wholesale Trade		6.1
Retail Trade		6.1
Producer Services	16.9	
Communications		3.8
Finance, Insurance and Real Estate		8.8
Business Services		4.3
Consumer Services	4.9	
Accommodation and Food		2.2
Amusement and Recreation		1.1
Personal and Household		1.6
Other Services	1.4	

3. R&D SHARE OF GDP AND SECTOR OF PERFORMANCE

The gross domestic expenditure on R&D (GERD) has been a stable share of the total GDP for ten years, within a range of 1.4% to 1.5% of the total. Moreover, the allocation of the GERD to sectors has been stable, certainly for the last seven or eight years. The distribution is summarized in Table 2.

Table 2: Percentage of 1993 GERD by Sector

	Govern-ment	Business	Higher Education	PNP	Foreign
Performance	19	54	26	1	
Funding	36	41	11	3	10

Of the 54% of GERD performed in the business sector, almost 30% (16% of GERD) is in service industries. However, this is R&D in the natural sciences and engineering only. Estimates are published on the performance of R&D in social sciences in the government[2], higher education[3] and the PNP[4] sectors, but no such data are collected for the business sector[5].

4. R&D IN BUSINESS SECTOR SERVICE INDUSTRIES

4.1 Classification of Survey Units and Survey Coverage

In the period 1983 to 1986, there was a revision of the classification of R&D units which led to some being reclassified from manufacturing to services. This affected wholesale trade and finance, insurance and real estate particularly. Since 1986, the data on R&D performed in service industries have been relatively stable.

In Canada, since 1944[6], a performer or funder of R&D in natural sciences and engineering has been able to apply for income tax benefits. As a result, there is a register of claimants, classified by industry, which can be used to augment the survey frame. As the definition of R&D now used for tax purposes is close to that used by Statistics Canada, this register facilitates almost complete coverage of R&D performers in business. The use of the tax register by Statistics Canada began in 1986 and was an integral part of the programme by 1987.

As both the Statistics Canada survey and the tax programme collect information on R&D only in the natural sciences and engineering, including software R&D, there is no information available on the performance of R&D in the social sciences by Canadian business. As social science R&D is more likely to be performed in service industries than in other parts of the business sector, the present surveys are expected to underestimate the value of R&D done in service industries. This gap could be significant.

Research into industrial organization, which is not being captured, may well drive innovative activity throughout the business sector[7]. There are, however, proposals to examine organizational change in service industries through surveys of innovation[8], rather than R&D. This still misses research into organizational change which may be applied to any industry, including those in services. While this will address the need for information on innovative activity, it does not measure the research which may or may not lead to innovation.

4.2 Industrial Distribution and Growth of R&D in Services

Table 3 shows the industrial distribution of the services component of business enterprise R&D (BERD)for the period 1987 to 1994. The final column is an average annual compound growth rate from 1987 to 1994. Two things are evident from the table: services R&D grew faster than R&D in the other sectors; and, as a result, the share of services R&D increased at the expense of R&D in other sectors.

The strong growth in services R&D was driven, in part, by distributive services, specifically by wholesale trade. This may be due in part to work on inventory and just-in-time delivery systems and systems for electronic data interchange with clients and suppliers.

In Business Services, Management Consultants have grown comparatively rapidly although they remain at less than 10% of the total. As this research is in the natural sciences and engineering, including software systems, it will not include research leading to organizational innovation.

As the services share of GERD has been 60% for the last three years for which data are available, and GERD has been an almost constant share of a growing GDP during that period, there has been real growth in services R&D, as there has in R&D in other sectors of the economy.

Table 3: R&D in Service Industries

R&D in Services	87	88	89	90	91	92[e]	93[e]	94[e]	Average Growth Rate per cent
	Year BERD in $Millions								
Distributive Services	147	166	198	207	232	263	288	311	11.3
Transportation and Storage	21	21	20	21	23	24	26	27	3.7
Wholesale Trade	118	127	159	164	179	212	244	266	12.3
Retail Trade	8	18	19	22	30	27	18	18	12.3
Communications	116	100	118	140	152	185	185	200	8.1
Finance, Insurance and Real Estate	191	177	216	228	242	271	267	270	5.1
Business Services	630	647	660	753	832	891	963	989	6.7
Computer and Related	208	206	215	233	232	256	279	297	5.2
Engineering and Other Scientific	355	360	363	426	477	498	531	532	5.9
Management Consultants	22	24	25	33	40	57	70	73	18.7
Other	45	57	57	61	83	80	83	87	9.9
Total Services	**1083**	**1089**	**1193**	**1328**	**1458**	**1610**	**1703**	**1770**	**7.3**
Total Non-Services	**3259**	**3535**	**3642**	**3916**	**3981**	**3963**	**4053**	**4232**	**3.8**
Total BERD	**4342**	**4624**	**4835**	**5244**	**5439**	**5573**	**5756**	**6002**	**4.7**

R&D in Services	87	88	89	90	91	92[e]	93[e]	94[e]
	Year Percentage of BERD							
Distributive Services	3.4	3.6	4.1	3.9	4.3	4.7	5.0	5.2
Transportation and Storage	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.4
Wholesale Trade	2.7	2.7	3.3	3.1	3.3	3.8	4.2	4.4
Retail Trade	0.2	0.4	0.4	0.4	0.6	0.5	0.3	0.3
Communications	2.7	2.2	2.4	2.7	2.8	3.3	3.2	3.3
Finance, Insurance and Real Estate	4.4	3.8	4.5	4.3	4.4	4.9	4.6	4.5
Business Services	14.5	14.0	13.7	14.4	15.3	16.0	16.7	16.5
Computer and Related	4.8	4.5	4.4	4.4	4.3	4.6	4.8	4.9
Engineering and Other Scientific	8.2	7.8	7.5	8.1	8.8	8.9	9.2	8.9
Management Consultants	0.5	0.5	0.5	0.6	0.7	1.0	1.2	1.2
Other	1.0	1.2	1.2	1.2	1.5	1.4	1.4	1.4
Total Services	**24.9**	**23.6**	**24.7**	**25.3**	**26.8**	**28.9**	**29.6**	**29.5**
Total Non-Services	**75.1**	**76.4**	**75.3**	**74.7**	**73.2**	**71.1**	**70.4**	**70.5**
Total BERD	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

[e] Estimates. Figures for 1992 and 1993 are based on reported actual expenditures and two years of reported spending intentions For 1994, totals are based mainly on reported intentions, with some estimates for firms not surveyed for even reference years.

4.3 Contracting Out by Manufacturing?

One of the questions about the growth in services R&D is the extent to which it is due to manufacturing firms contracting out their R&D to service firms, at the expense of their own intramural R&D. The extreme case or this is the elimination of the intramural R&D unit and the creation, or 'spinning off', of a new R&D firm, which would then be classified to the service sector.

Between 1987 and 1994, the number of R&D performers in manufacturing dropped by 214 from 1,865 to 1,651, while services performers increased by 128, from 1825 to 1953. The total number of R&D performers dropped by 68 from 3,883 to 3,815. These figures are net of entries and exits from the industries and the period includes an economic recession.

The service industries with a significant increase in the number of performers, in this period, were wholesale trade and management consultants. However, the available data do not indicate whether or not the wholesale trade units or the management consulting firms were created from existing firms in other sectors, such as manufacturing. No conclusions can be drawn on the question of contracting out, but it does raise the question of how R&D funders and performers connect across sectoral boundaries.

4.4 The R&D Network in the Business Sector

The Research and Development in Canadian Industry survey uses two questionnaires, a long form and a short form. The long form is sent to firms with a history of performing more than a million dollars worth of R&D and it asks about the source of funds received and the recipients of funds given for the performance of R&D. The short form requests less information on the source of funds and substantially less on the recipients of funds. For the 1991 survey, 3,566 performers of R&D were identified, of which 1,239 reported some kind of financial link, Canadian or foreign, not including those with governments. Of these, there were 988 links among Canadian firms and with research institutes. In this last category, there were only 272 performers who used the long form and provided data of sufficient detail for analysis. The resulting data on R&D alliances of large R&D performers were analysed[9] and it is clear that service industries play a pivotal role in promoting R&D and the diffusion of new ideas. However, the 1991 data cannot address the question of contracting out from manufacturing, at the expense of intramural R&D.

As a consequence of this work, the 1993 questionnaires were modified to improve the data quality and to secure more information on donors and recipients of R&D funds. The resulting data base could be used, with a follow-up survey, to examine the contracting out issue. However, the principal purpose of the data base is to provide better information on the network of R&D performers in Canada.

4.5 Software R&D

A candidate for contracting out is software R&D which accounted for almost a quarter of industrial R&D when figures were last produced for 1989[10]. For that year, 30% of software R&D was performed in service industries, including distributive services, up from 28% in 1988. No inference can be drawn that this gain was at the expense of intramural software R&D in manufacturing, although its share of the total did decline slightly between 1989 and 1988. The data could equally well be accounted for by growth of intramural R&D in the services sector.

4.6 Classification of R&D

Software R&D is just one field of science and technology activity which could be carried out, either in the industry which plans to use the results, or in the industry which performs the work on contract. The Frascati Manual[11] recommends that R&D be classified by field of science and technology activity and that the classification be used in the government, the higher education and the PNP sectors. The Australians[12] go beyond the recommendation and apply their field of research (FOR) classification to the business sector. To minimize burden on respondents, Canada has never asked for a complete field of science and technology classification in any of its sectors. However, an abbreviated version would be of use in following the movement of particular types of R&D from one sector to another.

The classification of intramural R&D by socio-economic objective (SEO) is another way of following changes from one sector to another. However, it is also burdensome. An example is R&D for the control and care of the environment, which is one of two priorities recommended by the Frascati Manual; the other is defence. In the case of Canada, no data are published on socio-economic objectives.

5. INTERNATIONAL COMPARISON

Table 4 provides a international comparison of the percentage of the value of business enterprise R&D performed in service industries. The wide variation in the services percentage of BERD for 1981, and for 1991, suggests that there may be differences in the coverage of service industries from country to country. The large change between 1981 and 1991 in some countries may be due to reclassification rather to a real growth of the services percentage of BERD. This is a matter for the consideration of the OECD Committee of National Experts on Science and Technology Indicators (NESTI) which sets the standards for the collection and international comparison on R&D statistics.

The differences in Table 4 suggest that care be taken when using national measures of R&D in service industries as the standards are still evolving. As R&D statistics have been standardized and collected for decades, the differences also suggest that newer measurements, such as those of innovative activities of firms in service industries, may take some years before they are truly internationally comparable.

Table 4: R&D in Service Industries

	% of BERD	
	1981	1991
AUSTRALIA	17.1	33.8
AUSTRIA (89)	6.1	4.0
BELGIUM	11.6	5.8
CANADA	9.2	26.8
DENMARK	18.8	28.5
FINLAND	3.9	12.8
FRANCE	2.4	4.2
GERMANY (89)	1.5	2.1
GREECE	5.7	30.0
ICELAND	0.0	18.3
IRELAND	3.6	3.4
ITALY	7.1	9.0
JAPAN	3.1	2.1
NETHERLANDS	6.0	6.7
NEW ZEALAND	..	35.2
NORWAY	38.8	41.8
PORTUGAL (82.90)	9.7	27.2
SPAIN	7.9	16.4
SWEDEN	5.6	3.7
SWITZERLAND	1.9	..
TURKEY	..	4.5
UNITED KINGDOM		16.1
UNITED STATES (82.92)	4.2	24.8

1. Coverage varies between countries
2. Some growth may be due to wider survey coverage or the transfer of units from other sectors

Source: OECD/DIRDE data base December 1994 plus additional national sources

6. CONCLUSIONS

In Canada, R&D is principally a service sector activity, and close to 30% of industrial R&D is performed by service industries. While this is not surprising in a service economy, the present measurement of performance fails to address the sector of application of the R&D and its impact on primary and secondary industries, as well as on the increasingly more important industries of the service sector, such as engineering and scientific services, and computer services.

While it is important to measure the level of R&D performance in service industries, it is also important to identify the links in the R&D network of funders and performers in all sectors. It is this network which forms part of the innovation system and, as such, is a key element in understanding the creation of jobs and wealth from ideas.

International comparisons of R&D in service industries must be treated with some care.

REFERENCES

1. Statistics Canada, Gross Domestic Product by Industry, Catalogue 15-001, Statistics Canada, Ottawa, 1994.

2. Statistics Canada, Federal Scientific Activities 1993-94, Catalogue 88-204, Statistics Canada, Ottawa, 1994.

3. Statistics Canada, Estimation of Research and Development Expenditures in the Higher Education Sector, 1992-93, Service Bulletin, Science Statistics, Vol. 18, no. 4, Catalogue 88-001, Statistics Canada, Ottawa, 1994.

4. Statistics Canada, Research and Development(R&D) Expenditures of Private Non-Profit (PNP) Organizations, 1993, Service Bulletin, Science Statistics, Vol. 18, no. 8, Catalogue 88-001, Statistics Canada, Ottawa, 1994.

5. Statistics Canada, Industrial Research and Development: 1993 Intentions, Catalogue 88-202, Statistics Canada, Ottawa, 1993.

6. G. Lalonde, 1992 Proposals for SR&ED Tax Incentives - A Ten Year Retrospective, Report of Proceedings, Ontario Tax Conference, 1992, Canadian Tax Foundation, Toronto, 1993.

7. Ian Miles, Innovation in Services, in The Handbook of Industrial Innovation, Mark Dodgson and Roy Rothwell, eds., Edward Elgar Publishing Limited, Aldershot, 1994.

8. F.D. Gault and W. Pattinson, Model Surveys of Service Industries: The Need to Measure Innovation, Voorburg Group Meeting, Sydney, Australia, October 17-21, 1994.

9. A. Rose, Strategic R&D Alliances, Services Indicators, 4th Quarter 1994, Vol. 1, no. 3, Catalogue 63-016, Statistics Canada, Ottawa, 1995.

10. Statistics Canada, Software Research and Development(R&D) in Canadian Industry, 1989, Service Bulletin, Science Statistics, Vol. 15, no. 7, Catalogue 88-001, Statistics Canada, Ottawa, 1991.

11. OECD, Proposed Standard Practice for Surveys of Research and Experimental Development: The Frascati Manual 1993, OECD, Paris, 1994.

12. Australian Bureau of Statistics, Australian Standard Research Classification, 1993, ABS Catalogue No. 1297.0, Australian Bureau of Statistics, Canberra, 1993.