SCIENCE AND TECHNOLOGY DATA — 2004

Government of Canada
Gouvernement du Canada

Canada

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CONTENTS

ACRONYMS AND ABBREVIATIONS

AAFC — Agriculture and Agri-Food Canada
AECL — Atomic Energy of Canada Limited
AUCC — Association of Universities and Colleges of Canada
BERD — Business enterprise expenditure on research and development
CFI — Canada Foundation for Innovation
CIHR — Canadian Institutes of Health Research
CRC — Communications Research Centre Canada
CSA — Canadian Space Agency
DND — National Defence
EC — Environment Canada
F&O — Fisheries and Oceans Canada
GDP — Gross domestic product
GERD — Gross domestic expenditure on research and development
GOVERD — Government intramural expenditure on research and development
HERD — Higher education expenditure on research and development
IC — Industry Canada
ICT — Information and communication technology
M&E — Machinery and equipment
NRC — National Research Council Canada

NRCan — Natural Resources Canada
NSERC — Natural Sciences and Engineering Research Council of Canada
OECD — Organisation for Economic Co-operation and Development
R&D — Research and development
SSHRC — Social Sciences and Humanities Research Council of Canada

DEFINITIONS

Knowledge investment — The sum of expenditures on R&D, total higher education (public and private) and software (computed to avoid double counting).

R&D — Research and development is creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of humankind, culture and society, and the use of this stock of knowledge to devise new applications.

Scientific publications — Publications in the areas of health, pure and applied sciences.

Triadic patent family — An invention for which a patent application has been filed at the European Patent Office, Japanese Patent Office and United States Patent and Trademark Office.

4 NATIONAL

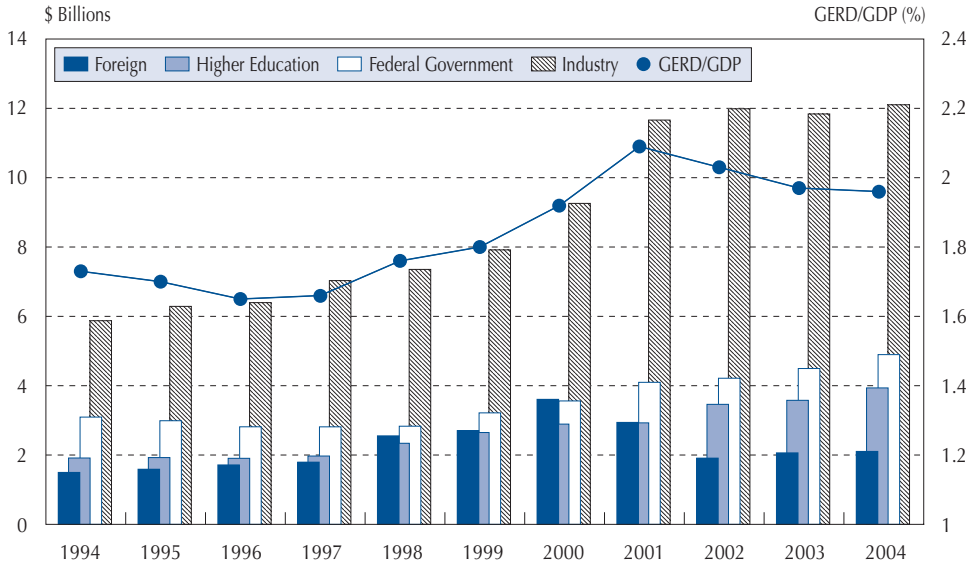
GERD represents total R&D expenditures performed in the country. In Canada, as in other major OECD countries, the industrial sector plays an important role as it is usually the major spender and performer of R&D.

A standard indicator for measuring the national effort in innovation is the ratio of GERD over GDP. In Canada, this ratio increased steadily during the last part of the 1990s, peaking in 2001 at almost 2.1 percent of GDP, and declining in subsequent years.

Benchmarking its performance against other countries, Canada ranked 12th among OECD countries in 2002, well behind the top OECD countries. Some emerging economies, such as Israel and Singapore, also outpaced Canada in 2002. Disaggregating the Canadian performance by province shows that only Quebec and Ontario have an R&D intensity comparable to the OECD average.

While R&D is certainly an important part of any country's science and technology efforts, R&D is only part of the knowledge required to be an innovative nation. Using a more broadly defined measure (investment in knowledge as a percentage of GDP) shows that while Canada still lags top OECD countries, the gap between these countries and Canada has decreased considerably.

Canada's GERD by Major Source of Funds, 1994 to 2004



Source: Statistics Canada, *Science Statistics*, Vol. 29, No. 08, December 2005.

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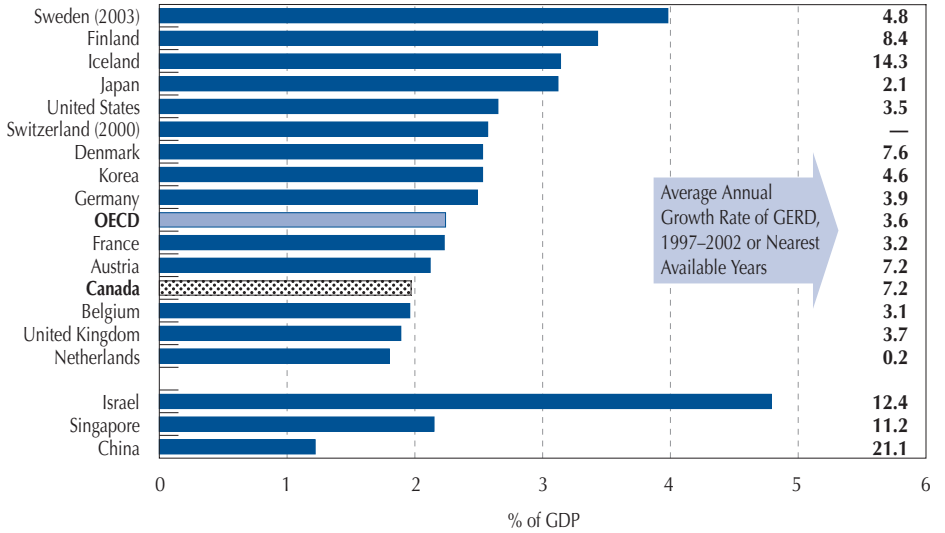
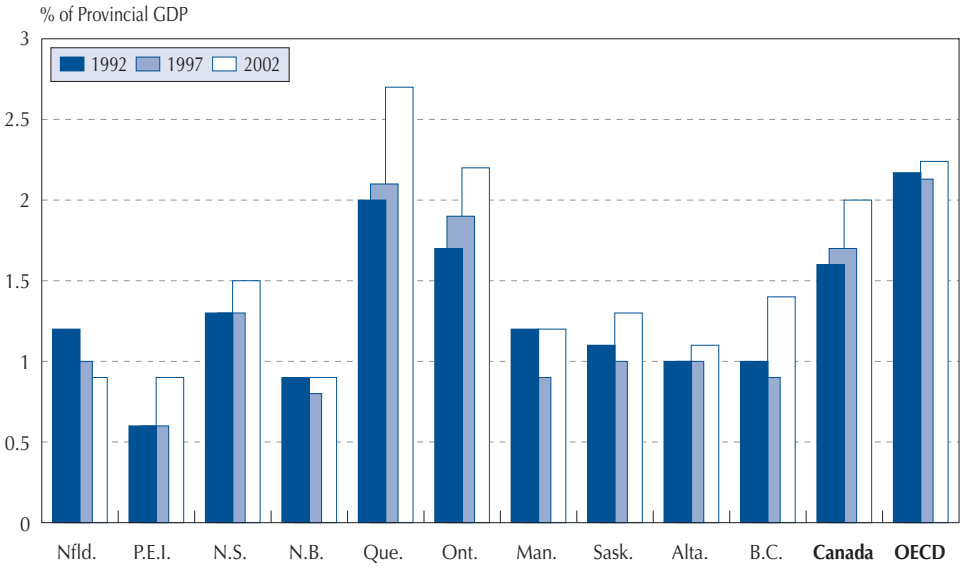
GERD as a Percentage of GDP, Top OECD and Selected Non-OECD Countries, 2002



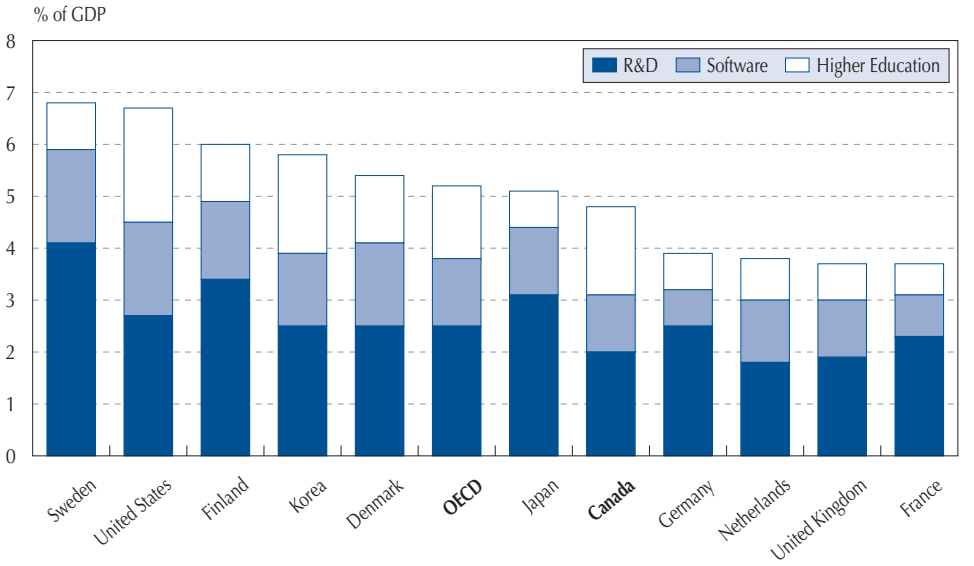
Source: OECD, *Main Science and Technology Indicators 2005/2*, November 2005.

R&D Intensity at the Provincial Level, 1992, 1997 and 2002



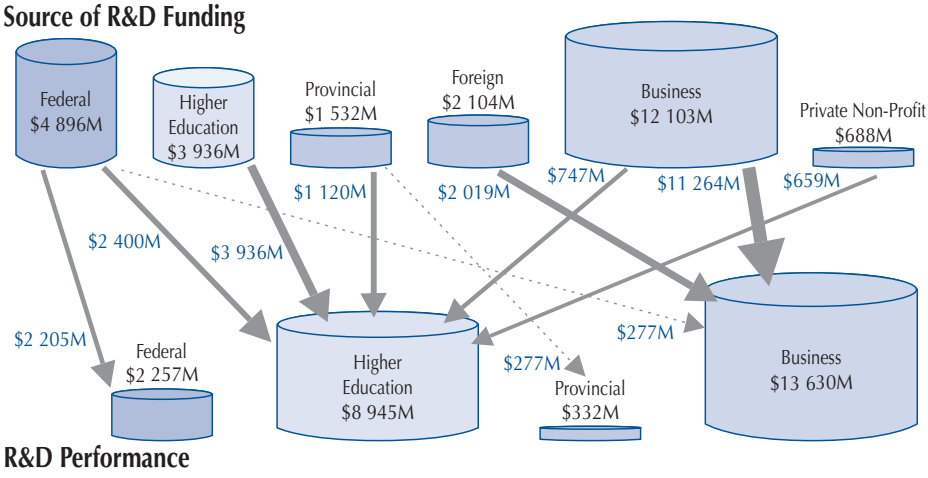
Source: Statistics Canada, *Science Statistics*, Vol. 29, No. 08, December 2005.

Investment in Knowledge as a Percentage of GDP, Selected OECD Countries, 2002



Source: OECD, *Science, Technology and Industry Scoreboard 2005*.

Major Flows of R&D Funding in Canada, 2004*



*Only flows higher than $100M are shown in the figure.

Source: Statistics Canada, *Estimates of Canadian Research and Development Expenditures (GERD) Canada, 1994 to 2005, and by Province 1994 to 2003*, Cat. No. 88F0006XIE No. 020, December 2005.

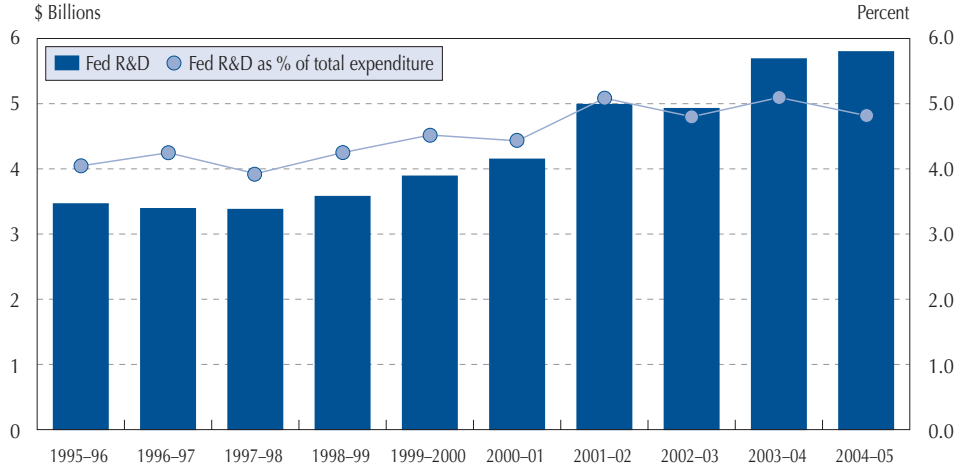
10 GOVERNMENT

The Government of Canada is the second most important funder of R&D in Canada, behind the business sector. Since the end of the 1990s, federal R&D expenditures have increased steadily, mostly through funding of higher education. In the past decade, the shares of federal funding for higher education and the intramural sector have been converging, both being at around 40 percent in 2004–05.

R&D performed by government (federal, provincial and local governments) as a percentage of GDP is below that of the United States and most OECD countries. The same can be said about the financing of R&D in which Canada trails the United States and other major OECD countries.

In 2004–05 the three granting councils (NSERC, CIHR, and SSHRC), the NRC, and DND were the top five (departments or agencies) R&D spenders. Most departments and agencies increased their R&D funding in the past 10 years, with the exception of NRCan and AAFC.

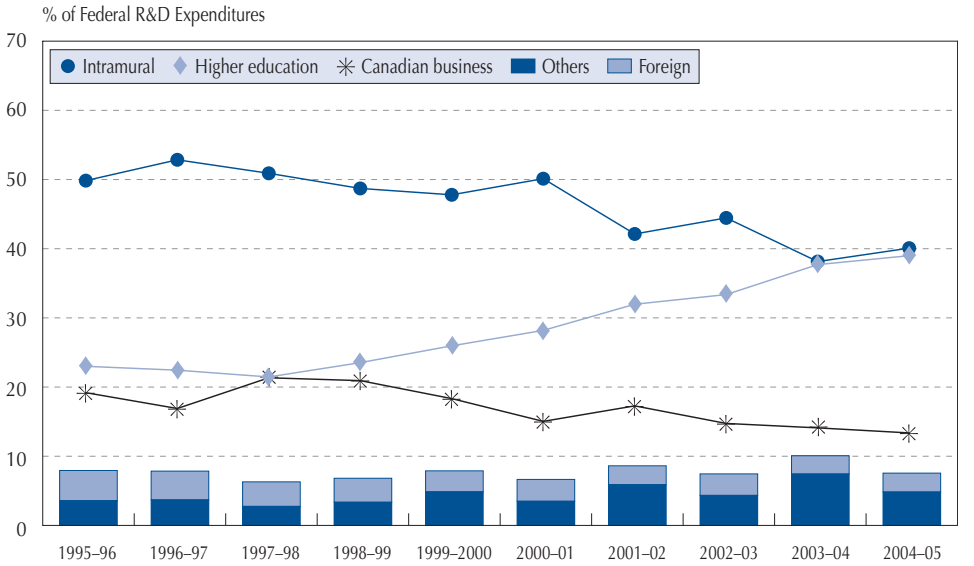
Federal Expenditures on R&D and as a Share of Total Federal Expenditures, 1995–2004



Note: Total expenditures excludes debt charges and transfers to other governments.

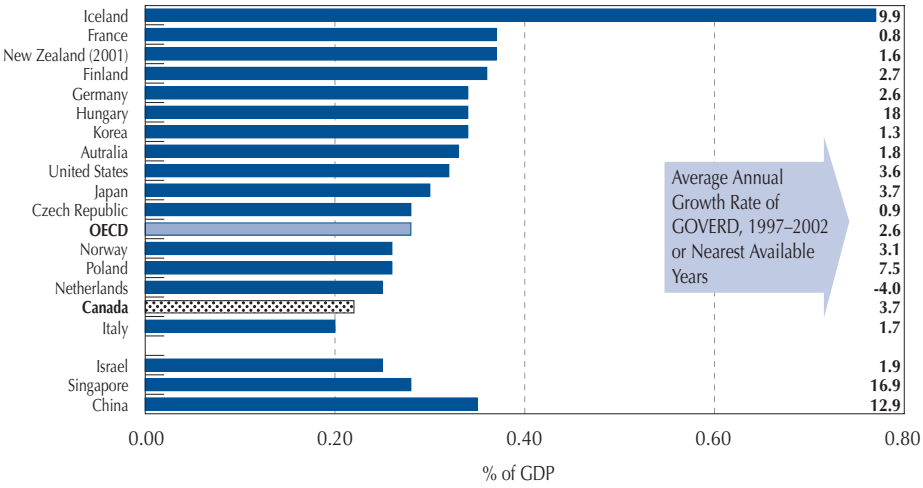
Sources: Finance Canada, *Fiscal Reference Tables*, September 2005.
Statistics Canada, *Federal Scientific Activities*, Cat. No. 88-204-XIE, December 2005.

Federal R&D Expenditures by Performer Type, 1995 to 2004



Source: Statistics Canada, *Science Statistics*, Vol. 29, No. 7, December 2005.

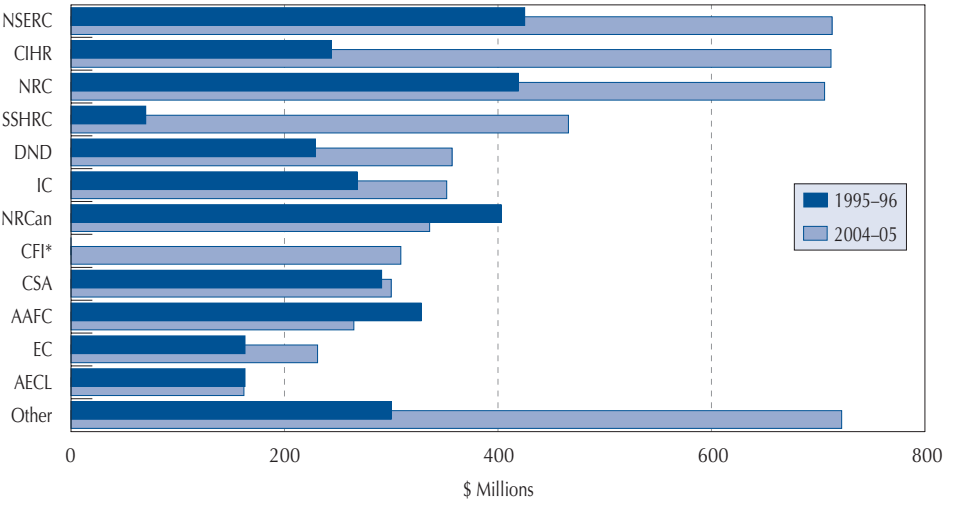
GOVERD as a Percentage of GDP, Top OECD Countries and Selected Non-OECD Countries, 2002



Note: Government expenditures include those from federal, provincial and local governments.

Source: OECD, *Main Science and Technology Indicators 2005/2*, November 2005.

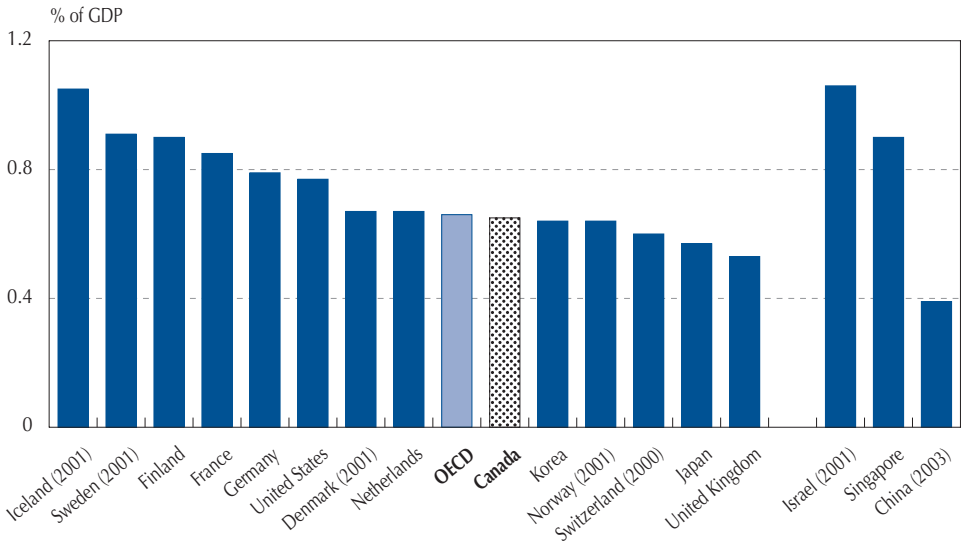
Federal R&D Expenditures by Major Spenders, 1995–96 and 2004–05



*CFI was created in 1997.

Source: Statistics Canada, *Science Statistics*, Vol. 29, No. 07, December 2005.

Government-Financed GERD as a Percentage of GDP, Selected OECD and Non-OECD Countries, 2002



Source: OECD, *Main Science and Technology Indicators 2005/2*, November 2005.

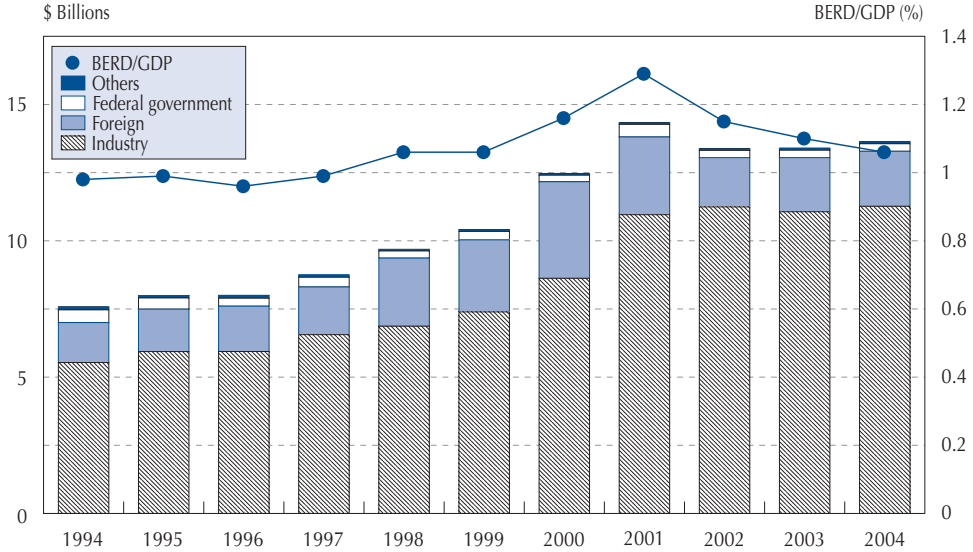
16 INDUSTRY

Business accounts for about half of all R&D performed in Canada. Therefore, a significant decrease of R&D expenditures in this sector might easily translate into a decrease in the overall national performance. Such a decrease occurred in 2002, mostly from the slowdown in ICT.

Canada's BERD over GDP ratio is low compared to that of top OECD countries, and is also below the OECD average. Only Quebec had an R&D intensity higher than the OECD average in 2002, while Ontario was slightly behind. British Columbia's ratio had significantly increased in 2002, but was still only half the OECD average.

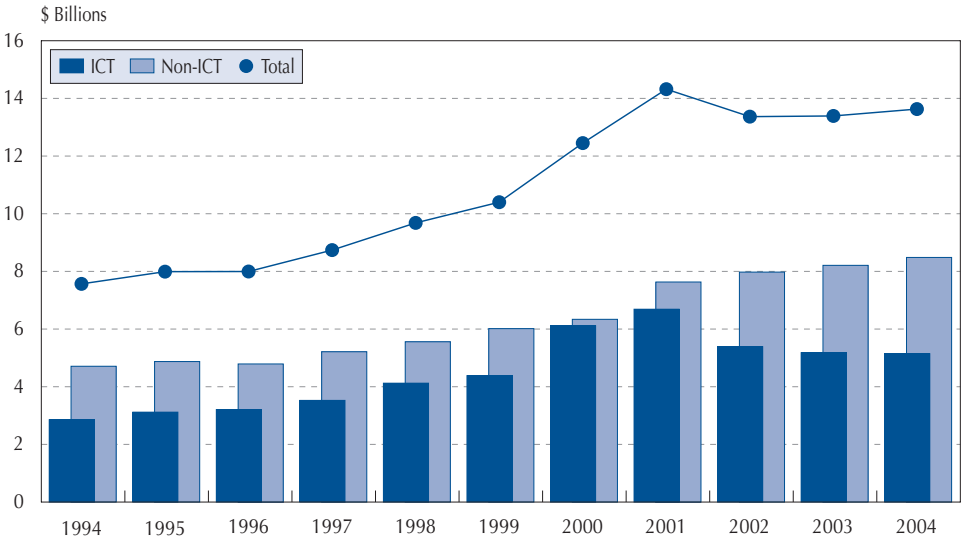
Firms can use channels other than R&D expenditures to stay competitive. Investing in M&E is another way to get access to state-of-the-art technology. However, Canadian firms are also lagging in investment in M&E as a percentage of GDP.

Canada's BERD by Major Source of Funds, 1994 to 2004



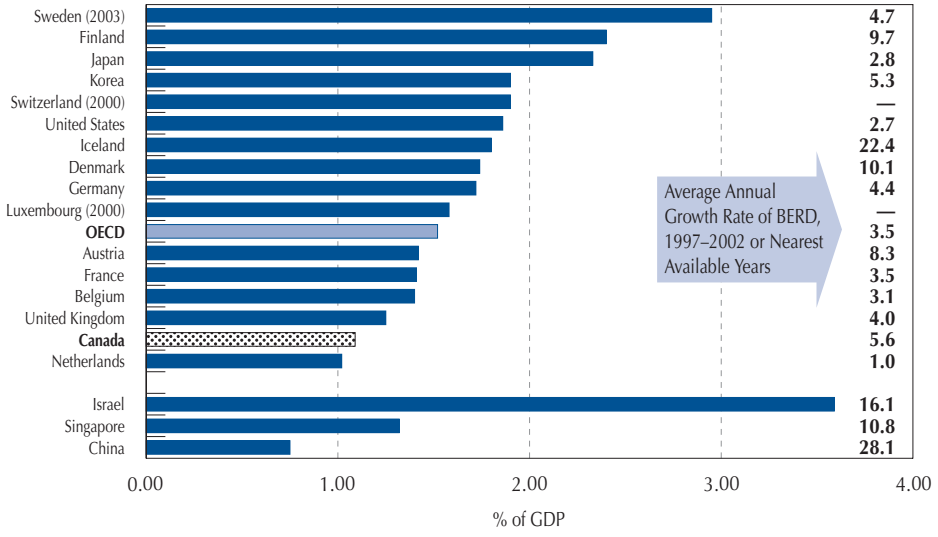
Source: Statistics Canada, *Estimates of Canadian Research and Development Expenditures (GERD), Canada, 1994 to 2005, and by Province 1994 to 2003*, Cat. No. 88F0006XIE No. 20, December 2005.

Business R&D by ICT and Non-ICT Sectors, 1994 to 2004



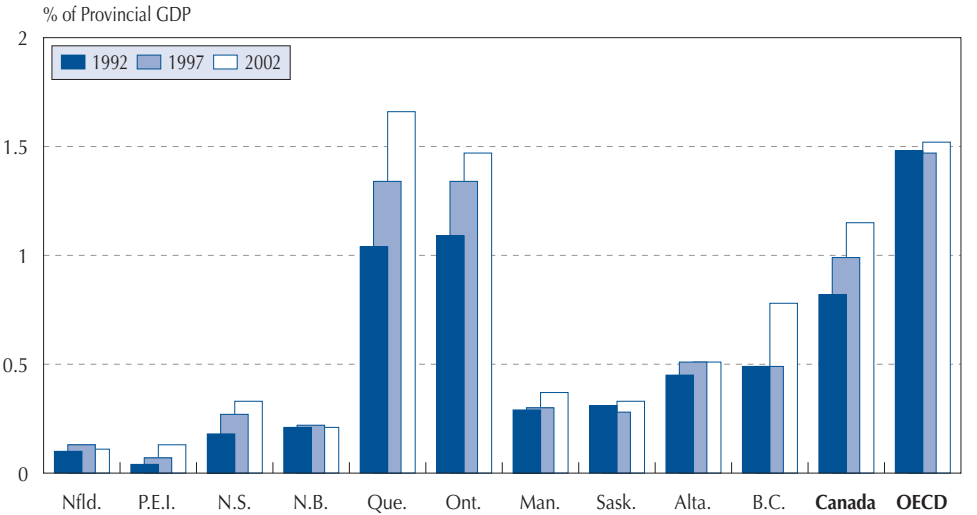
Sources: Statistics Canada, *Science Statistics*, Vol. 29, No. 4, June 2005.
(Data for 1994 to 2000: private conversation with Statistics Canada.)

BERD as a Percentage of GDP, Top OECD Countries and Selected Non-OECD Countries, 2002



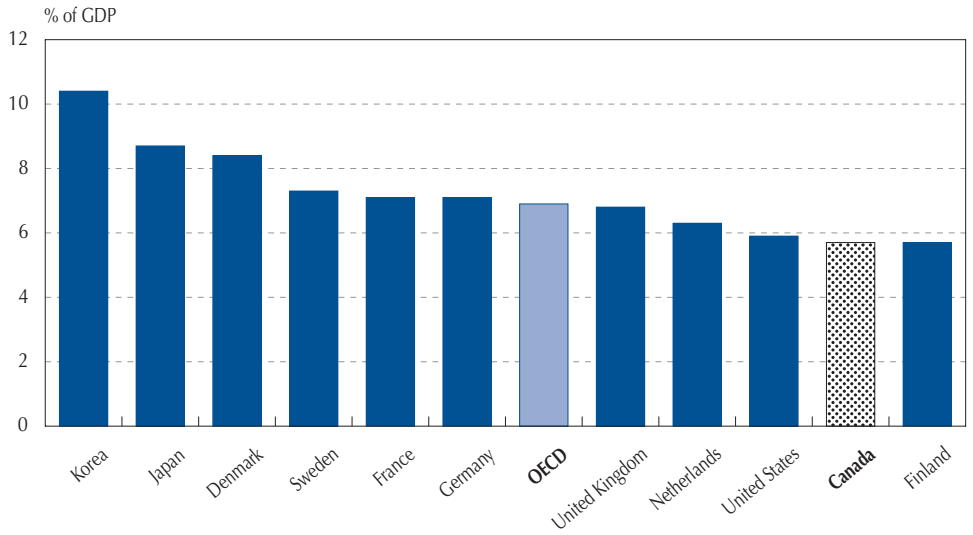
Source: OECD, *Main Science and Technology Indicators 2005/2*, November 2005.

BERD Intensity at the Provincial Level, 1992, 1997 and 2002



Sources: Statistics Canada: *Science Statistics*, Vol. 29, No. 08, December 2005; *Canadian Economic Observer*, Cat. No. 11-210, 2004–05; and OECD, *Main Science and Technology Indicators, 2005/2*, November 2005.

Investment in Machinery and Equipment as a Percentage of GDP, Selected OECD Countries, 2002



Source: OECD, *Science, Technology and Industry Scoreboard 2005*.

22 HIGHER EDUCATION

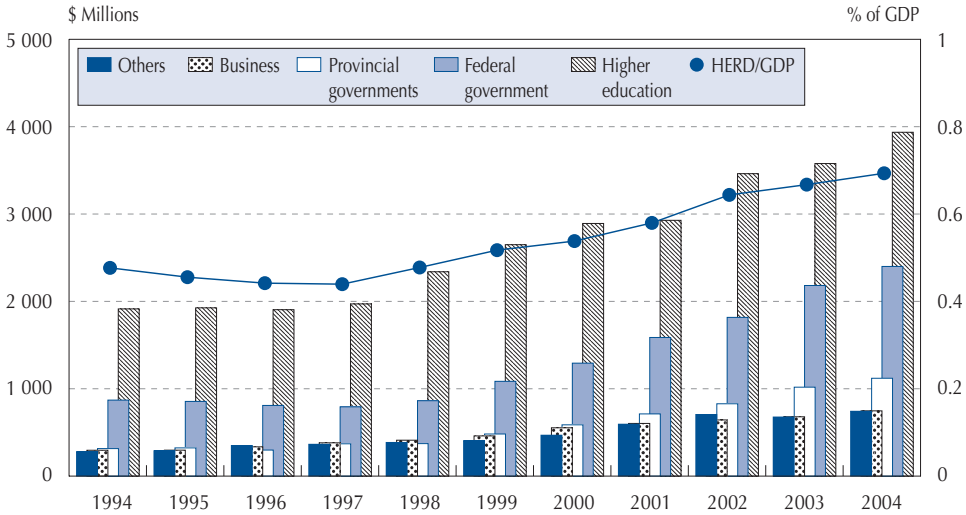
Universities and colleges are important parts of any national innovation system. Not only do they train highly skilled workers, but they also perform the basic research that sets the stage for future technology fields and expands the knowledge frontier.

Contrary to the business sector, the higher education sector has seen a steady increase in R&D expenditures, even during the 2000–04 period. Canada is now one of the top OECD countries in terms of HERD over GDP ratio. While most of the funding for HERD comes from universities and federal and provincial governments, Canadian businesses contribute proportionally more than businesses in other OECD countries.

Canada has a higher than OECD average proportion of university graduates in the adult population, but the ratio of science and engineering degrees over total new degrees is below that of the top countries and below the OECD average.

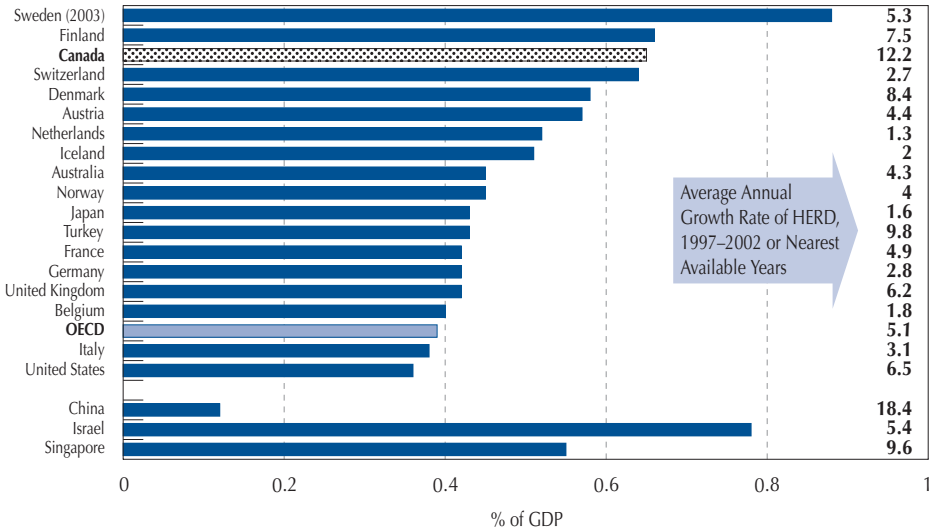
Attracting the best and the brightest students from all over the world will be an important part of Canada's future growth. Canada, with foreign students accounting for a little less than 20 percent of its doctoral enrolment, is doing well compared to other OECD countries.

Canada's HERD by Major Source of Funds, 1994 to 2004



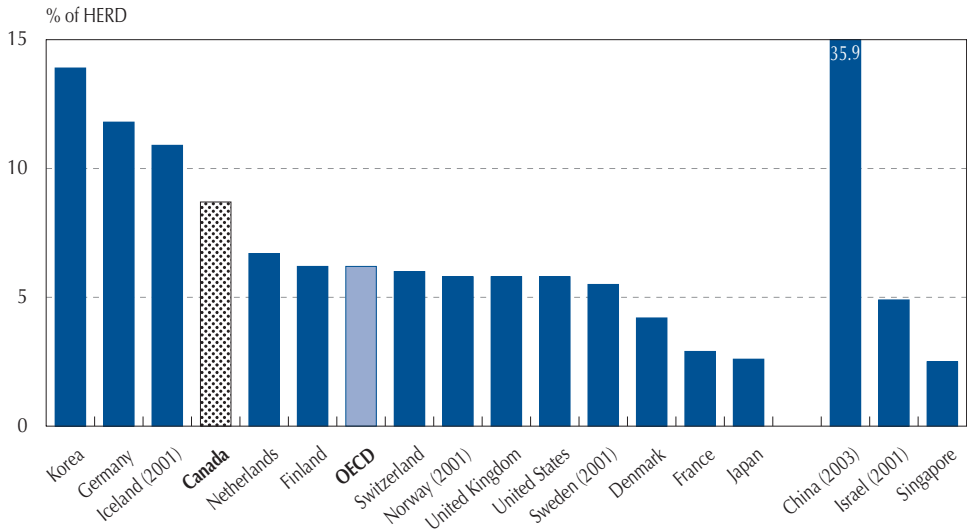
Source: Statistics Canada, *Estimates of Canadian Research and Development Expenditures (GERD), Canada, 1994 to 2005, and by Province 1994 to 2003*, Cat. No. 88F0006XIE No. 20, December 2005.

HERD as a Percentage of GDP, Top OECD and Selected Non-OECD Countries, 2002



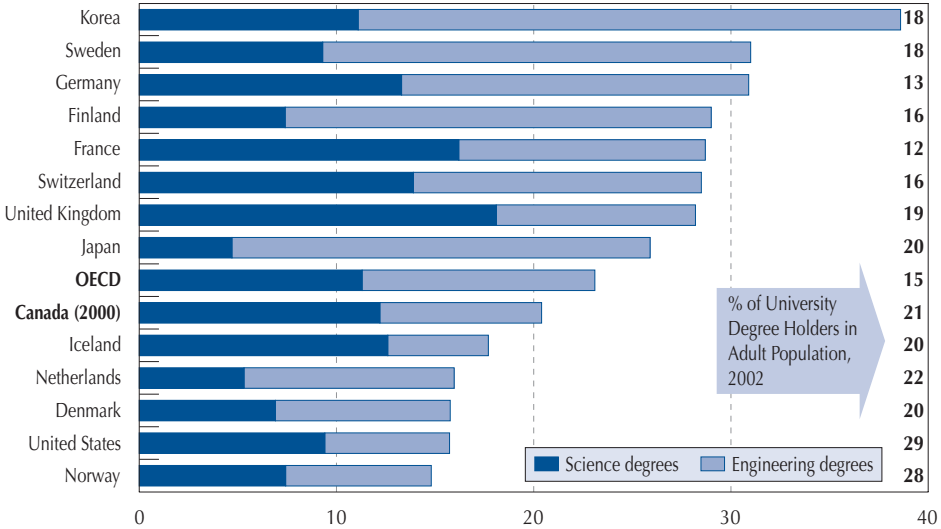
Source: OECD, *Main Science and Technology Indicators 2005/2*, November 2005.

Percentage of HERD Financed by the Business Sector, Selected OECD and Non-OECD Countries, 2002



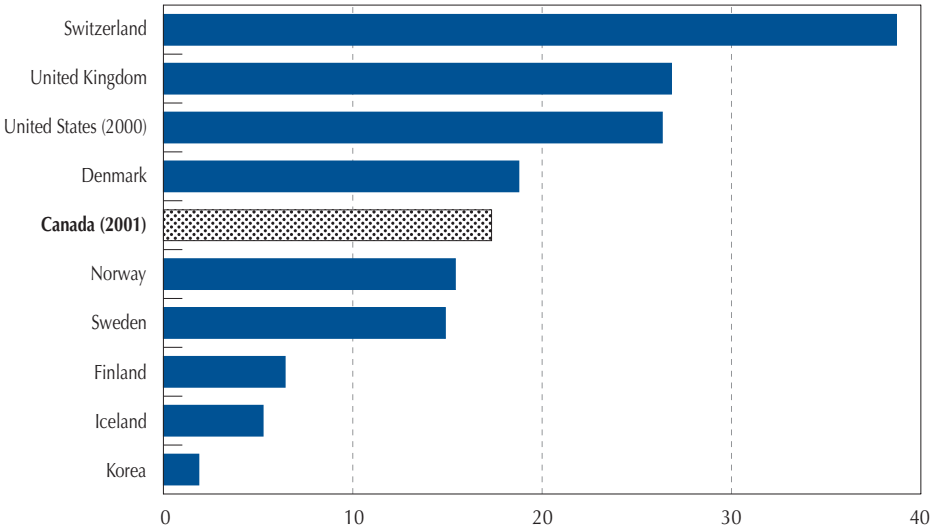
Source: OECD, *Main Science and Technology Indicators 2005/2*, November 2005.

Science and Engineering Degrees as a Percentage of Total New Degrees, Selected OECD Countries, 2002



Sources: OECD, *Science,Technology and Industry Scoreboard 2005*; and OECD, *Education at a Glance 2004*.

Foreign Doctoral Students as a Percentage of Total Doctoral Enrolment, Selected OECD Countries, 2002



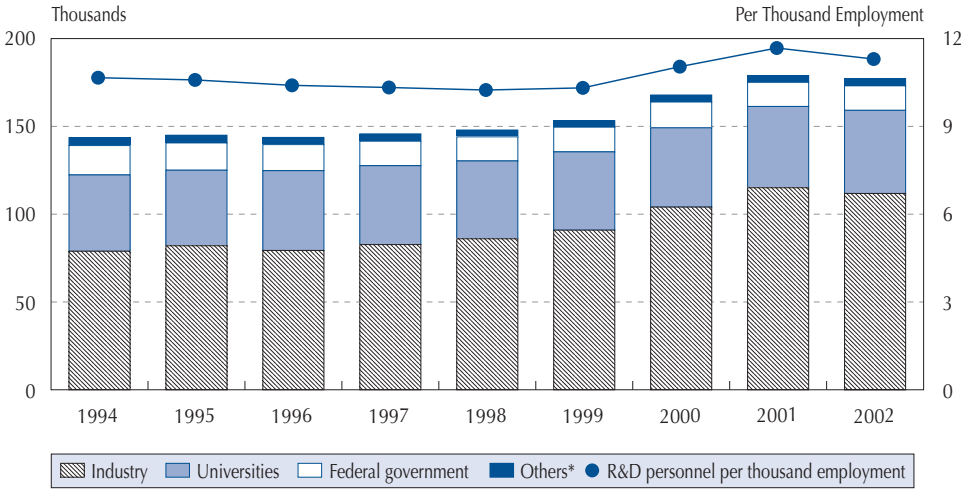
Source: OECD, *Science, Technology and Industry Scoreboard 2005*.

28 HUMAN RESOURCES

The quality of the workforce is increasingly seen as the most powerful tool a country can possess. R&D personnel over total labour force measures to what extent a country devotes resources to developing new ideas and improving existing technologies. The ratio of R&D personnel over the total labour force stayed constant during the 1990s, then increased slightly in the first years of the 2000s. The increase came largely from the business sector. Internationally, Canada ranks behind most Scandinavian countries, as well as behind large economies such as Japan, Germany and France.

The number of highly skilled workers (tertiary-level graduates) is another standard indicator to measure the quality of a country's workforce. Using this measure, Canada ranks first in OECD countries. Note the importance of workers from abroad, particularly from the United Kingdom, United States, China, India and the Philippines.

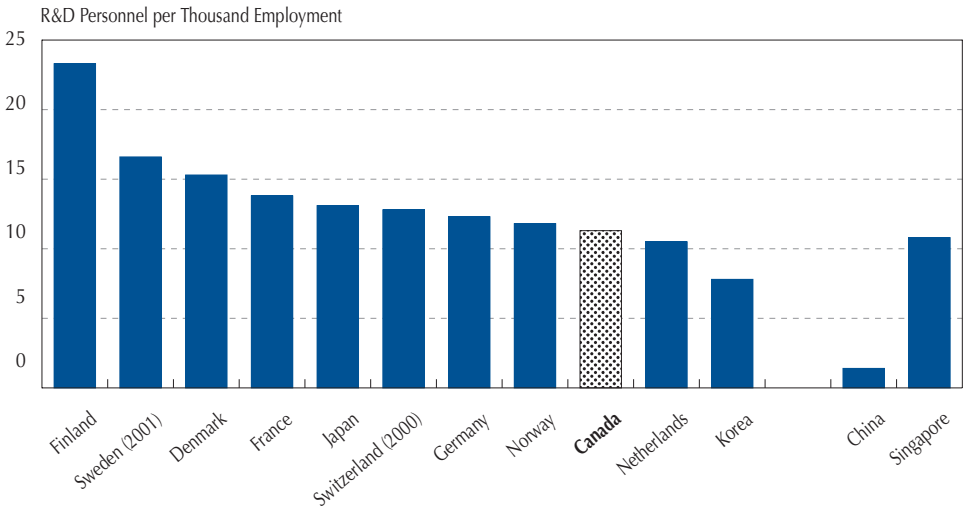
R&D Personnel by Sector of Performance, 1994 to 2002



*Others refers to provincial governments plus private non-profits.

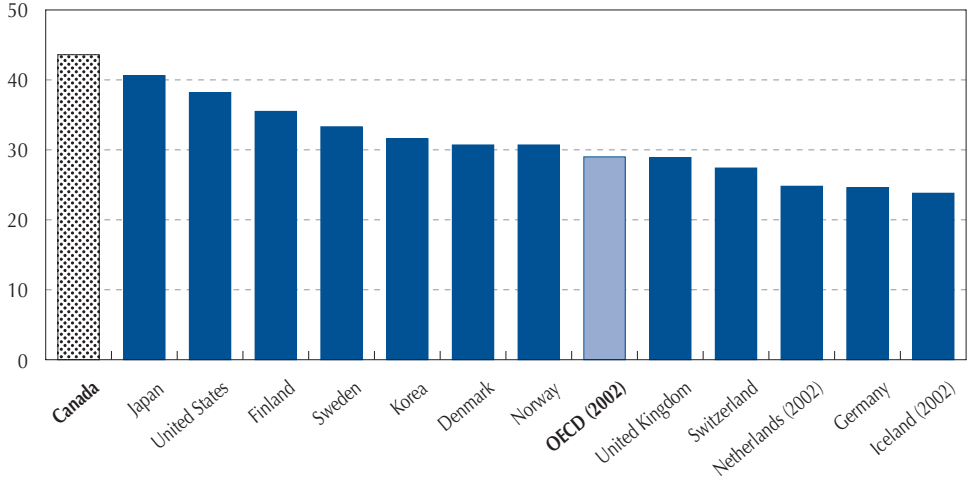
Source: Statistics Canada, *Estimates of Research and Development Personnel in Canada, 1979 to 2002*, Cat. No. 88F0006XIE – No. 008, May 2005.

R&D Personnel as a Percentage of Total Employment, Selected OECD and Non-OECD Countries, 2002



Source: OECD, *Main Science and Technology Indicators 2005/2*, November 2005.

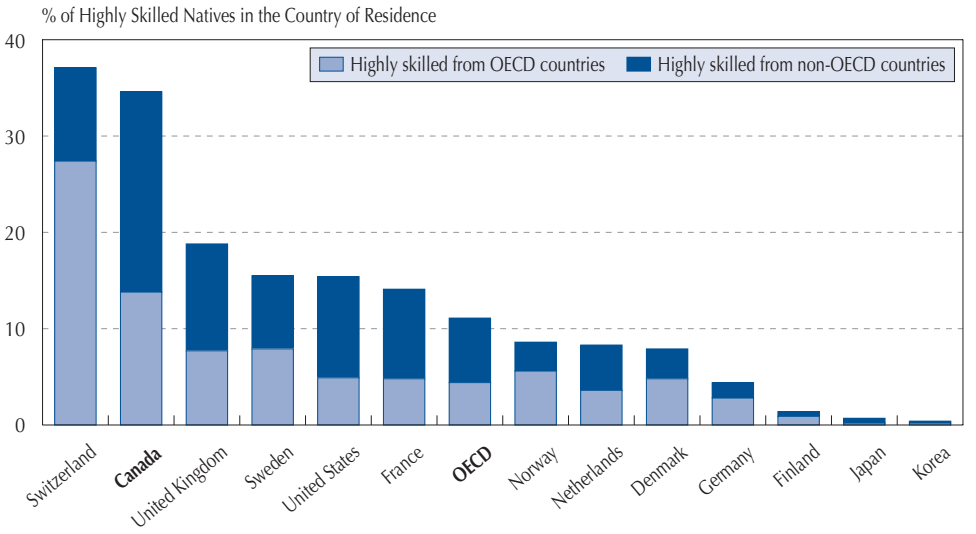
Highly Skilled Workers as a Percentage of Total Employment, Selected OECD Countries, 2003*



*Highly skilled refers to tertiary level of education graduates.

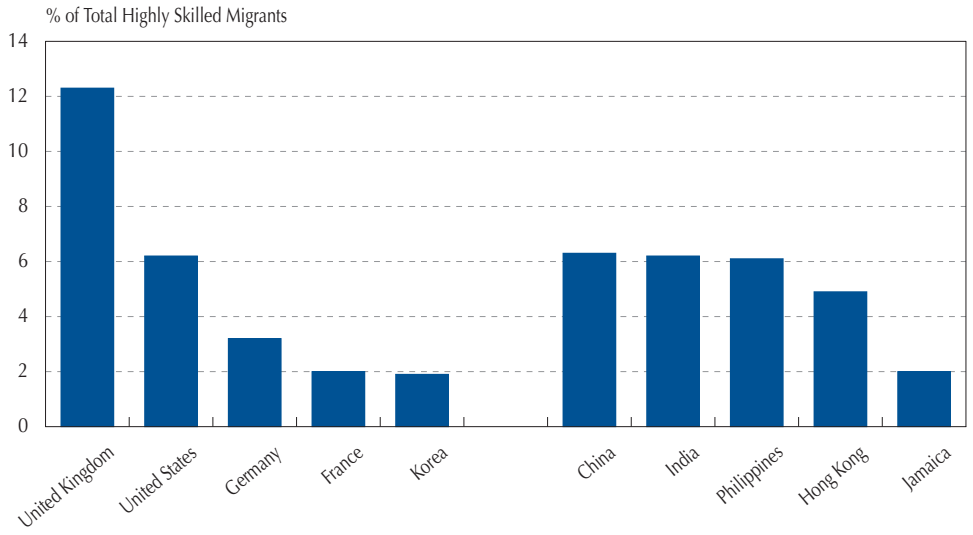
Source: OECD, *Science, Technology and Industry Scoreboard 2005*.

Highly Skilled Migrants as a Percentage of Highly Skilled Natives, by Selected OECD Countries of Residence, 2001



Source: OECD, *Science, Technology and Industry Scoreboard 2005*.

Place of Birth of Highly Skilled Migrants in Canada, Top OECD and Non-OECD Countries, 2001



Source: OECD, *Science, Technology and Industry Scoreboard 2005*.

34 COMMERCIALIZATION AND OUTPUT

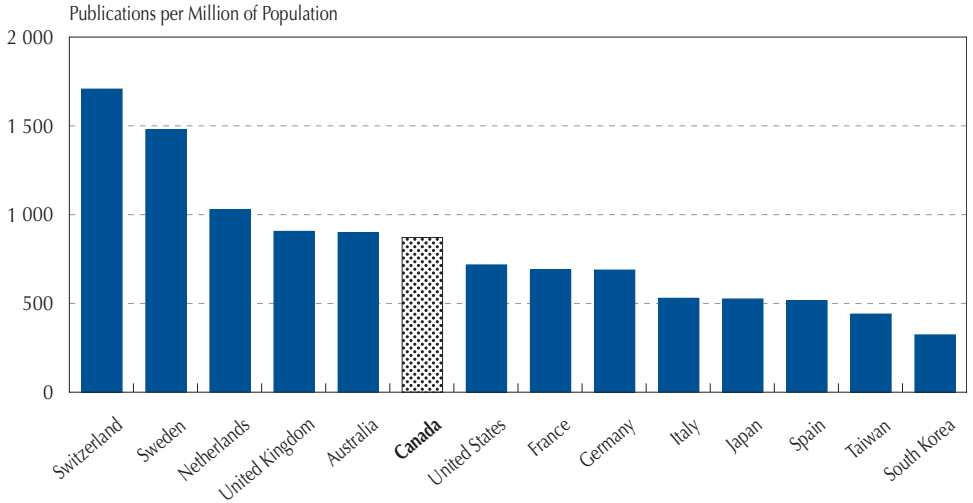
Canada stands sixth in the world for its number of scientific publications per million of population — ahead of the United States but behind Switzerland, Sweden, the Netherlands, the United Kingdom and Australia. Another measure, the percentage of highly cited publications, accounts for the quality of the publications and here Canada also ranks sixth in the world.

Counting patents is another main indicator to measure scientific output. To account for quality, the OECD developed a measure called the "triad patent," where an invention has to be filed in the three major patent offices, namely those of the United States, Europe and Japan. The number of Canadian patents granted in the United States and the number of Canadian inventions in the triadic families have increased steadily in the last decade.

Nearly 80 percent of establishments in ICT service industries described themselves as innovators in 2003. The novelty of innovation (whether the innovation was a world-first or Canada-first) is another indicator allowing for the quality of the innovation.

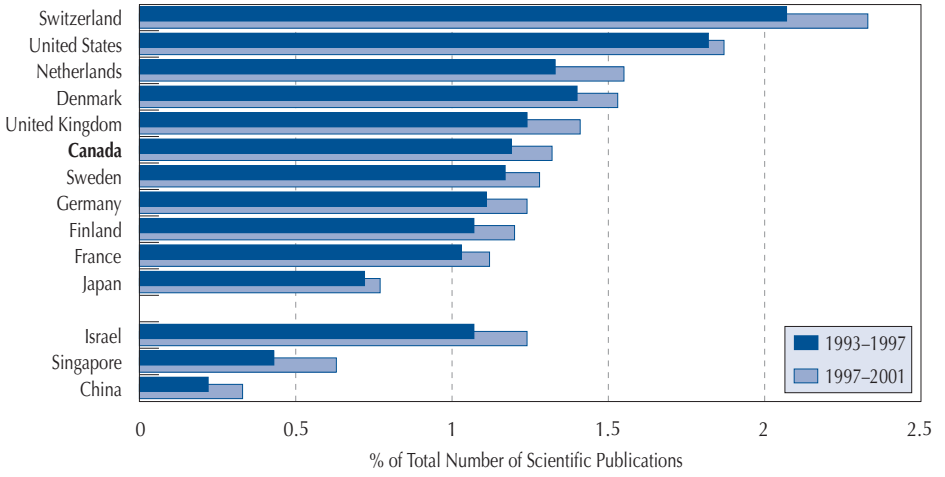
Commercialization income has more than doubled during the last five years in federal departments and agencies as well as in universities (over the last four years).

Number of Scientific Publications per Million of Population, Top Countries Producing More Than 10 000 Publications, 2003



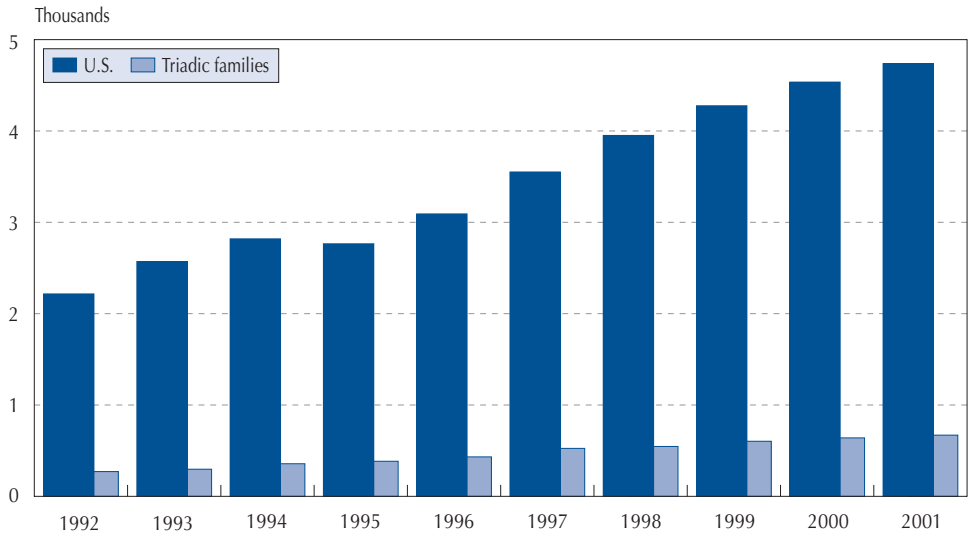
Source: Observatoire des sciences et des technologies, "Moderate Growth of Scientific Publications in Canada," *S&T Observation Note 13*, March 2005.

Highly Cited Papers (Top 1%) as Percentage of Total Number of Scientific Publications, Selected OECD and Non-OECD Countries, 1993–97 and 1997–2001



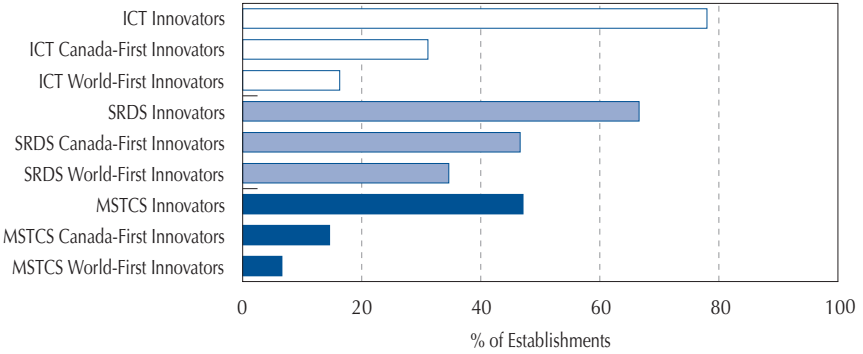
Source: Calculations based on David A. King, "The Scientific Impact of Nations," *Nature* Vol. 430, July 2004.

Canadian Patents Granted in the United States and Canadian Patents Filed in the United States, Europe and Japan (Triadic Families), 1992 to 2001



Source: OECD, *Main Science and Technology Indicators 2005/2*, November 2005.

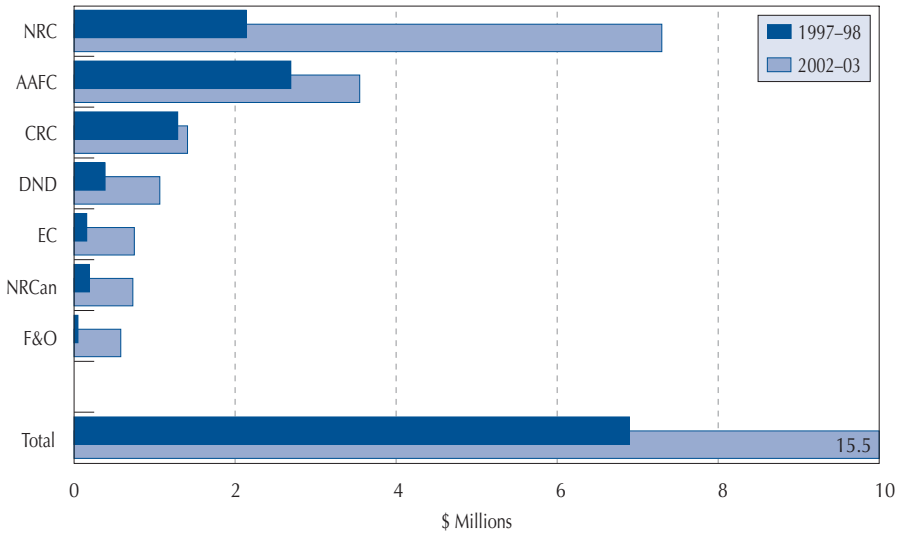
Share of Innovators in Selected Service Industries, by Novelty of Innovation, 2003



Notes: Canada-first innovator category includes world-first innovator category.
ICT: information and communication technology services.
SRDS: scientific R&D services.
MSTCS: management, scientific and technical consulting services.

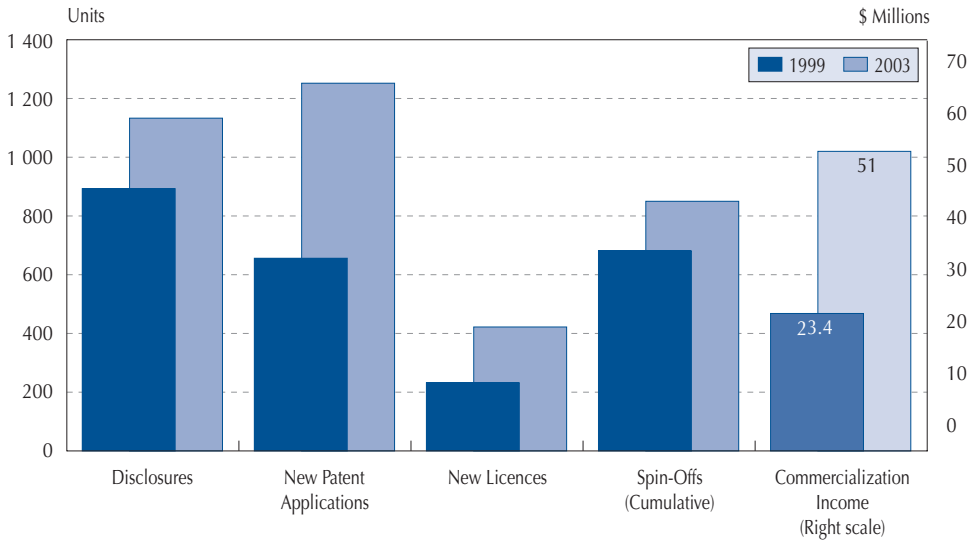
Sources: Calculations derived from Statistics Canada, *Innovation in Information and Communication Technology (ICT) Sector Service Industries: Results from the Survey of Innovation 2003*, Catalogue No. 88F0006XIE No. 012, October 2005; and *Innovation in Selected Professional, Scientific and Technical Services: Results from the Survey of Innovation 2003*, Cat. No. 88F0006XIE No. 013, October 2005.

Royalties from Top Federal Departments and Agencies, 1997–98 and 2002–03



Source: Statistics Canada, "Federal Science Expenditures and Personnel," *Intellectual Property Management Annex*, various years.

Indicators of Some Commercialization Outputs of University Research, 1999 and 2003



Source: AUCC, *Momentum: The 2005 report on university research and knowledge transfer*, 2005.

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