Catalogue No. 88-003-XIE

Innovation Analysis Bulletin

A report from Statistics Canada with statistical and analytical updates on:

- **Government science and technology activities**
- **Industrial research and development**
- **Intellectual property commercialization**
- **Advanced technology and innovation**
- **Biotechnology**
- **Information society**
- **Telecommunications and broadcasting**
- **Electronic commerce**

Innovation Analysis Bulletin
Vol. 9, no. 2 (October 2007)
Catalogue Number 88-003-XIE
Aussi disponible en français, n° 88-003-XIF au catalogue

In this issue

The purpose of this article is to examine which funding sources have the greatest influence on firm growth.

Dropping the Internet: Who and why? (p. 20)

Internet use is an important hallmark for participation in an information society. Although 68% of adult Canadians went online for personal, non-business reasons in 2005, digital inequality persists both geographically and among certain population groups. While much research and policy attention has been aimed at understanding the barriers to Internet use, there were an estimated 850,000 Canadians who had used the Internet at one time but were no longer doing so in 2005. Who are these former users and why have they discontinued their use of the Internet?

How does firm size affect the perceived benefits of Internet business? (p. 23)

Although small firms were less likely than large firms to identify benefits from conducting business online, there has been growth in the proportion of firms indicating perceived benefits over the past five years in all size categories.

Scientific research and development services: Profile of a young and dynamic industry (p. 25)

The scientific research and development services industry is arousing growing interest among analysts and researchers. This interest is due in part to its major contribution to total industrial expenditures on research and development (R&D) in Canada.

Research and development outsourcing and innovation: Evidence from micro-data (p. 27)

Recent improvements in information and communications technologies (ICTs), coupled with the rise of new global players such as China and India, have enabled firms to outsource a growing share of their activities. This has allowed them to benefit from cost savings and to focus on their core competencies. While domestic and foreign outsourcing of certain manufacturing functions have been prevalent for decades, only recently has the trend extended significantly to services such as legal, accounting, data entry, and research and development (R&D).

A profile of Canada's highly qualified personnel (p. 29)

Highly qualified human resources in science and technology are vital for innovation and economic growth. Both are dependent on the stock of human capital which supplies the labour market with highly skilled workers and helps in the diffusion of advanced knowledge. This article profiles Canada's highly qualified personnel based on immigrant status and place of birth, field of study, and selected demographic and employment characteristics.

Retirement of Lloyd Lizotte (p. 33)

In September 2007, colleagues and friends said good bye and good luck to Lloyd Lizotte as he ended his 36-year career with Statistics Canada, of which 34 years were spent in the field of science and technology.

What's new? (p. 34)

Read about recent releases, updates and new activities in the areas of information and communications technology, and science and technology.

New economy indicators (p. 38)

Innovation analysis bulletin

ISSN 1488-433X

Please address all inquiries to the Editor, Innovation Analysis Bulletin

E-mail: sieidinfo@statcan.ca
TTY: 1 800 363-7629
Fax: 613-951-9920
Post: SIEID, Statistics Canada
7th Floor, R.H. Coats Building
100 Tunney's Pasture Driveway
Ottawa, Ontario, Canada K1A 0T6

The **Innovation Analysis Bulletin** is an occasional publication of the Science, Innovation and Electronic Information Division (SIEID) of Statistics Canada. It is available, free of charge, on the Statistics Canada Web site (http://www.statcan.ca) under *Publications*, in the area *Free internet publications*, under the category **Science and technology**.

The **Innovation Analysis Bulletin** is produced under the direction of Fred Gault, Director, SIEID, and edited by Heidi Ertl. Special thanks to the contributing authors and reviewers, as well as Rad Joseph, Heather Berrea and Claire Racine for their assistance with production and coordination.

Published by authority of the Minister responsible for Statistics Canada

Note of appreciation

Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued cooperation and goodwill.

Standards of service to the public

Statistics Canada is committed to serving its clients in a prompt, reliable and courteous manner. To this end, the Agency has developed standards of service which its employees observe in serving its clients. To obtain a copy of these service standards, please contact Statistics Canada toll free at 1-800-263-1136. The service standards are also published on www.statcan.ca under About us > Providing services to Canadians.

Downloadable publications

All electronic publications on Statistics Canada's Web site are available free of charge.

To obtain PDF versions of the papers and questionnaires mentioned in this bulletin, please visit the Statistics Canada Internet site www.statcan.ca:

- Our publications are in:

  Publications

  Free internet publications (PDF or HTML)

  Documents are under the categories:

  Information and communications technology and

  Science and technology

- Sample questionnaires are in:

  Definitions, data sources and methods, in the area

  - *Questionnaires – List by subject*, under
    - *Information and communications technology* and
    - *Science and technology*

Subscription request

If you would like to receive a printed version of the *Innovation Analysis Bulletin*, please contact the Editor by e-mail.

To get notifications of new releases of the *Innovation Analysis Bulletin* and other related publications, subscribe to *The Daily by Subject*. From www.statcan.ca,

The Daily

- Free Subscription → Subscribe now
  - *Information and communications technology* and
  - *Science and technology*

Get connected with us

Besides the articles to which we refer in this bulletin, Statistics Canada's Web site provides a wealth of statistics, facts and research papers on a variety of related topics. As well, the questionnaires we have used to collect the information are available for research purposes.

Symbols

.	not available for any reference period
..	not available for a specific reference period
...	not applicable
p	preliminary
r	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
E	use with caution
F	too unreliable to be published

Five types of innovation in Canadian manufacturing: First results from the Survey of Innovation 2005

The most recent Statistics Canada Survey of Innovation (2005) distinguished five types of innovation. The questions on types of innovation were redesigned in response to the 1997 revision of the Oslo Manual, which incorporated new insights on innovation in the service industries, and broadened the concept of process innovation to include not only production processes but also methods of product delivery. This article examines the five different types of innovation in Canadian manufacturing establishments and industry groups.

The Oslo Manual, first published in 1992 by the OECD, provides international guidelines for the collection and interpretation of innovation data. As a better understanding of the innovative process was achieved, and as innovation survey results were analyzed, two important revisions to the Oslo Manual were implemented; the first in 1997 and the most recent in 2005.

The questions asked of firms about the types of innovation have changed over time, both in Statistics Canada innovation surveys, as well as in the European Community Innovation Surveys (CIS), which also adopt the Oslo Manual guidelines. In Statistics Canada's 1999 Survey of Innovation, which surveyed manufacturing and logging firms, two types of innovation were distinguished: 1. new or significantly improved products, and 2. new or significantly improved production/manufacturing processes.

The most recent Statistics Canada Survey of Innovation (2005) distinguished five types of innovation. The questions on types of innovation were redesigned in response to the 1997 revision of the Oslo Manual, which incorporated new insights on innovation in the service industries, and broadened the concept of process innovation to include not only production processes but also methods of product delivery. Questions about types of innovation will, in the future, undergo further modification as a result of the 2005 revision to the Oslo Manual, which recognized two new categories of innovation: organizational and marketing.

The 2005 Survey of Innovation surveys manufacturing and logging industries for the reference period 2002 to 2004. The statistical unit of observation is the establishment. Innovative establishments are those that indicated in the Survey of Innovation that they introduced a new or significantly improved product or process during the reference period.

More information about the Survey of Innovation is available at: http://www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=4218&lang=en&db=IMDB&dbg=f&adm=8&dis=2.

Five types of innovation

Statistics Canada's Survey of Innovation 2005 asked establishments to identify which of five different types of innovation were introduced during the period 2002 to 2004. The innovations must have been new to the establishment and, in the case of product innovations, the simple resale of new goods purchased from other plants and changes of a solely aesthetic nature were excluded. The five types of innovation are:

Product Innovation

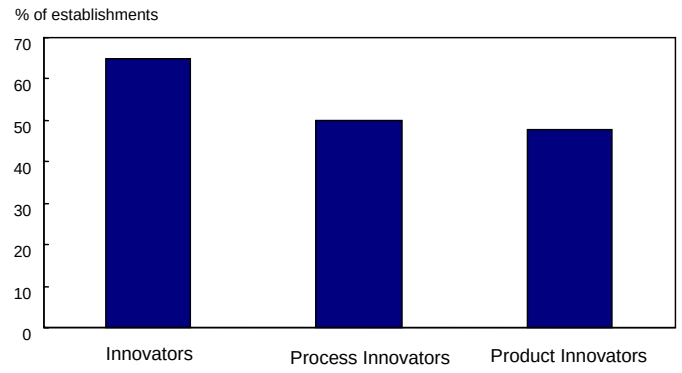
1. Introduced a new or significantly improved good
2. Introduced a new or significantly improved service

Process Innovation

3. Introduced a new or significantly improved method of manufacturing or producing goods or services
4. Introduced new or significantly improved logistics, delivery or distribution methods for inputs, goods or services
5. Introduced new or significantly improved supporting activities for processes, such as maintenance systems or operations for purchasing, accounting, or computing

The Survey of Innovation 2005 found that two-thirds (65%) of manufacturing establishments were innovative, while approximately one-half of all establishments indicated that they introduced a new or significantly improved product innovation and one-half indicated that they introduced a new or significantly improved process innovation (Chart 1).

Chart 1 Percentage of innovators in Canadian manufacturing establishments, 2002 to 2004

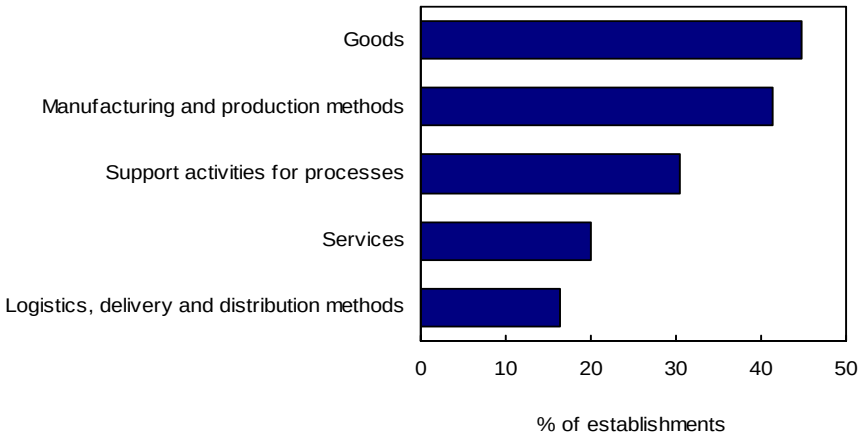


Source: Statistics Canada, Survey of Innovation, 2005.

In terms of the different types of innovation introduced, the highest percentage of establishments indicated the introduction of a new or significantly improved good or a new or significantly improved manufacturing/production method—slightly more than 40% of establishments in both cases (Chart 2).

It is interesting to note that one-third of establishments indicated that they introduced organizational innovation as it related to the support activities for processes, and one in five introduced new or significantly improved services. New or significantly improved logistics, delivery and distribution methods were introduced by 16% of establishments.

Chart 2 Five types of innovation in Canadian manufacturing establishments, 2002 to 2004



Source: Statistics Canada, Survey of Innovation, 2005.

Does industry matter?

The percentage of establishments introducing different types of innovation did vary by industry group[1]. Table 1 shows that the computer and electronic products industry group had the highest percentage of establishments introducing innovative goods. The printing industry group had the highest percentage of establishments introducing innovative services, as well as innovative methods of manufacturing or producing goods or services. For innovative logistics, delivery or distribution methods, the highest percentage of establishments was found in the textile mills and textile products industry group, and for innovative supporting activities for processes, it was the transportation equipment industry group with the highest percentage of establishments.

1. The industry groups that are compared reflect the 3-digit NAICS sub sectors with the exception of the following aggregated groups: 1. Food manufacturing (NAICS 311) is aggregated with Beverage and tobacco products (NAICS 312); 2. Textile mills (NAICS 313) is aggregated with Textile product mills (NAICS 314); and 3. Clothing manufacturers (NAICS 315) and Leather and allied product manufacturing (NAICS 316). A total of nineteen industry groups are compared.

Table 1 Top three industry groups by type of innovation, based on percentage of establishments, 2002 to 2004

	Goods	Services	Production methods	Logistics	Support activities
Industry groups[1]			rank		
Computer and electronic products (NAICS 334)	1	2	…	2	2
Electrical equipment (NAICS 335)	2	3	…	…	3
Machinery manufacturing (NAICS 333)	3	…	…	…	…
Printing (NAICS 323)	…	1	1	3	…
Plastics and rubber products (NAICS 326)	…	…	2	…	…
Paper (NAICS 322)	…	…	3	…	…
Textile mills and Textile products mills (NAICS 313 and 314)	…	…	…	1	…
Food manufacturing and Beverage and tobacco products (NAICS 311 and 312)	…	…	…	3	…

Source: Statistics Canada, Survey of Innovation, 2005.

Industry group innovation strategies

It is interesting to note that the top three industry groups introducing new or significantly improved goods were completely different from the top three industry groups introducing improved methods of manufacturing or producing goods or services. It is also interesting to note that two industry groups which are usually not considered to be among the most innovative, had the highest percentage of establishments introducing new or significantly improved logistics, delivery or distribution methods for inputs, goods or services (textile mills and textile products), and the highest percentage of establishments introducing new or significantly improved supporting activities for processes, such as maintenance systems or operations for purchasing, accounting, or computing (transportation equipment manufacturers).

Summary

The revisions to the Oslo Manual have led to the ability to measure a broader range of innovation types than the more restrictive definition that existed in the first version of the Oslo Manual. In the coming years, one can expect to see more types of innovation being measured as new questions on organizational and marketing innovation are designed and incorporated into innovation surveys. The results of the top three users by type of innovation suggest that more analysis at the industry group level could shed light on the issue of innovation strategies for different industries.

References

OECD/Eurostat (2005). *Oslo Manual—guidelines for collecting and interpreting innovation data, 3rd edition*. Paris, France.

Frances Anderson, SIEID, Statistics Canada

Motives for co-operation in innovation: Evidence from the 2005 Canadian Survey of Innovation

This article summarizes the findings of an econometric study using data from the 2005 Canadian Survey of Innovation. The study looked at the decision of firms in the Canadian manufacturing sector to co-operate on innovation projects. The analysis reveals that the factors influencing the decision to co-operate in order to access external knowledge are very similar to those influencing cost-sharing motives. It also finds that public funding leads firms to co-operate in order to access external knowledge and research and development (R&D).

"Yahoo!, eBay link up for online showdown" (The Gazette 2006) and "Ebay talks to Microsoft, Yahoo about foe" (Wall Street Journal Europe 2006) were the headlines that accompanied the discussions about a possible co-operative arrangement between some of the major players in the Internet and online search business. This is just one example of the growing importance of co-operation between firms in recent years. Co-operation between firms, and between firms and public research institutes, have not been confined to marketing or sales alliances; they have increasingly been targeted at R&D and innovation activities as well. Shorter product-life cycles, more complex technologies and increased possibilities to share knowledge and research results have led firms to seek partners for their R&D and innovation activities.

Initiated by this increase in inter-firm co-operation, a large body of empirical and theoretical literature on firms' motives to co-operate on R&D and innovation activities has accumulated (for example, see Hagedoorn 1993). The starting point for the analysis presented here is the firm's motives for conducting joint innovation activities. The model used is similar to that used in other studies which differentiate between different co-operation partners (Kaiser 2002, Belderbos et al. 2004). The focus here, however, is not on investigating the motives for cooperating with a certain partner, but rather to develop a typology of firms that co-operate for a given reason. To be more precise, this study looks at how firms' characteristics and measures of innovation activities influence their decision to co-operate on innovation with respect to their underlying motives.

This study was conducted while the author was visiting Statistics Canada as a visiting researcher in September 2006. Without the support of Fred Gault and his team in SIEID, as well as the financial support of the ZEW Mannheim, this study would not have been possible. The results of the analysis were published as a ZEW Discussion Paper (No. 07 - 018), available at: http://www.zew.de/de/publikationen/publikation.php3?action=detail&nr=3322

More information about the Survey of Innovation is available here http://www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=4218&lang=en&db=IMDB&dbg=f&adm=8&dis=2.

The statistical unit of the survey is the establishment. In the text that follows "establishments" are referred to as "firms".

Since the study addresses co-operation with external partners only, six firms which were co-operating only with other firms within their larger firm were excluded.

Motives for innovation co-operation

Statistics Canada's Survey of Innovation 2005 contains a number of questions on firms' innovation co-operation behaviour, like the type of partner and their geographical location, and the motives for innovation co-operation. The latter is the main focus of this study. The survey asked firms to indicate their motives for innovation co-operation between 2002 and 2004 in two broad categories: development of innovation and commercialization of innovation. The first category covers sharing of costs, accessing R&D and accessing critical expertise, prototype development and scaling up production processes. The second category contains two commercialization motives: access to new markets and access to new distribution channels.

Table 1 presents some expanded figures for the different motives for innovation co-operation. The most important motive for co-operation across all industry types is to access external knowledge (R&D and critical expertise). Over 81% of all firms that co-operated between 2002 and 2004 did so for this reason. By comparison, commercialization motives (sharing costs and scaling up production processes) were less important; however cost-sharing was relevant to more than half of co-operating firms in the science industries (53.7%) and specialized industries (64.2%), while scaling up production processes was cited as an important motive for R&D co-operation by 53.3% of co-operating firms in scale-intensive industries.

Table 1 Percentage of firms that co-operated on innovation activities for a given motive between 2002 and 2004, by industry type

Industry type	Sharing the cost of developing innovations	Accessing research and development (R&D), accessing critical expertise	Scaling up production processes	Accessing new markets, new distribution channels
		%		
Resource-intensive	46.1	83.4	47.4	46.4
Labour-intensive	45.4	74.5	35.0	44.1
Scale-intensive	49.3	78.3	53.3	47.4
Science	53.7	87.9	49.3	44.9
Specialized	64.2	90.1	22.0	49.1
Total	49.8	81.4	42.5	45.9

Source: Statistics Canada, Survey of Innovation, 2005.

Factors influencing motives for innovation co-operation

In order to be able to characterize firms that co-operate in innovation and R&D for various reasons, an econometric analysis was performed. The value of the dependent variable was set to one if a specific motive was used, while a set of firm characteristics and measures of innovation activities were used as the independent variables. Since a single firm may co-operate for many reasons, the decision to co-operate by the various reasons was estimated together rather than separately (using a multivariate probit). The weight of each observation was also taken into account in the empirical model. Regressions were performed on 4,021 observations, representing 10,860 firms.

The findings indicate that firms which co-operated in order to share the costs of developing innovative products and processes, and those that co-operated on innovation activities in order to access external knowledge are quite similar. Both have R&D activities that are relatively more oriented towards basic than applied research, and both are large and more often belong to industries related to science. Both also assign a high importance to strategic and formal protection methods. In other words, these firms are more research-oriented than other firms.

Firms that co-operated in order to scale up production processes and to commercialize innovations are more difficult to describe. For both groups, only a few significant variables were found. Both groups are similar in that the innovation intensity—measured as the share of innovation expenditures in total sales—has a positive effect after a certain threshold is reached, while the share of employees with university degrees and the share of employees involved in R&D activities do not.

Some evidence that public funding increases the flow of knowledge between actors in the national system of innovation was also found. Innovators are more likely to co-operate in order to get access to external R&D and expertise if they receive public funding than if they do not receive public funding.

References

Belderbos, R., M. Carree, B. Diederen, B. Lokshin and R. Veugelers (2004). Heterogeneity in R&D Cooperation Strategies, *International Journal of Industrial Organization,* 22 (8-9), 1237-1263.

Hagedoorn, J. (1993). Understanding the Rationale of Strategic Technology Partnering: Interorganizational Modes of Cooperation and Sectoral Differences. *Strategic Management Journal,* 14 (5), 371-385.

Kaiser, U. (2002). An Empirical Test of Models Explaining Research Expenditures and Research Cooperation: Evidence for the German Service Sector. *International Journal of Industrial Organization,* 20 (6), 747-774.

The Gazette (2006). *Yahoo! eBay link up for online showdown*. B6, Issue: May 26.

Wall Street Journal Europe (2006). *Ebay talks to Microsoft, Yahoo about foe*. p. 5, Issue: April 24.

At the time this article was written, the author, Tobias Schmidt, was with the Department of Industrial Economics and International Management, ZEW Mannheim, Germany

Innovation and global supply chains: Findings from the Survey of Innovation 2005

This article sheds light on selected characteristics of firms, both innovators and non-innovators that participated in a global supply chain. Using results from the Survey of Innovation 2005, four indicators of global supply chain participation are explored: sales; source of raw materials and components; source of new machinery and equipment; and contracting out of R&D services.

What is a global supply chain?

According to the OECD guidelines a supply chain is "a network of facilities and distribution channels that encompasses the procurement of materials, production and assembly, and delivery of product or service to the customer" (OECD 2002). If this network is international then it can be referred to as a global supply chain. For the purposes of this analysis, engaging in trade with the United States is not sufficient for a plant to be considered part of a global supply chain. A plant is considered as part of a global supply chain if it satisfies at least one of the following criteria:

- The plant had some (more than 0%) of their revenues from sales to customers in Mexico, Europe, Asia Pacific or another country (not including the United States or Canada); or
- The plant had some (more than 0%) of their expenditures on raw materials and components from a supplier in Mexico, Europe, Asia Pacific or another country (not including the United States or Canada); or
- The plant had some (more than 0%) of their expenditures on new machinery and equipment from a supplier in Mexico, Europe, Asia Pacific or another country (not including the United States or Canada); or
- The plant had some (more than 0%) of their expenditures R&D services from a supplier in Mexico, Europe, Asia Pacific or another country (not including the United States or Canada).

An innovation is defined as the introduction of new or significantly improved goods or services to the market, or the introduction of new or significantly improved processes, including new or significantly improved ways of delivering goods or services (OECD/Eurostat 1997). Only innovations occurring between 2002 and 2004—the survey reference period—were included in this analysis.

The sample unit for the Survey of Innovation 2005 was the statistical establishment. The questionnaire substituted the more familiar word "plant" for statistical establishment, which is also the term used in this article.

Estimates contained in the charts include the confidence intervals[1] as a double-ended line extending above and below the estimate itself. This reflects the level of confidence that the estimate lies within the indicated range of values 95% of the time. Where confidence intervals for individual estimates overlap, these estimates are said to not be statistically significantly different from each other. Where confidence intervals do not overlap, estimates are statistically significantly different from each other. All estimates presented in this article have been evaluated for statistically significant differences.

Findings in this article were presented at the Statistics Canada Socio-Economic Conference, May 28-29, 2007.

More information about the Survey of Innovation is available at: http://www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=4218&lang=en&db=IMDB&dbg=f&adm=8&dis=2.

Preliminary results from the 2005 Survey of Innovation are now available at: http://www.statcan.ca/Daily/English/060602/d060602d.htm.

Please contact susan.schaan@statcan.ca for more information.

In 2004, more than half of all manufacturing plants participated in a global supply chain

Of the 53.1% of manufacturing plants that participated in a global supply chain, 30.1% sold goods or services to global customers, while 34.0% purchased raw materials and components from global suppliers. Among the nearly two-thirds of plants (64.6%) that purchased new machinery or equipment in 2004, one-quarter (23.8%) of these did so from a global supplier. In addition, of the one in ten manufacturing plants (10.8%) that contracted out for research and development (R&D) services, 11.3% did so from global suppliers.

Large plants were more likely than both small and medium-sized plants to participate in a global supply chain

In 2004, 78.3% of large manufacturing plants (those with at least 250 employees) were part of a global supply chain, compared with 63.5% of medium-sized plants (those with 100-249 employees), and less than half (47.6%) of small plants (those with 20 to 99 employees).

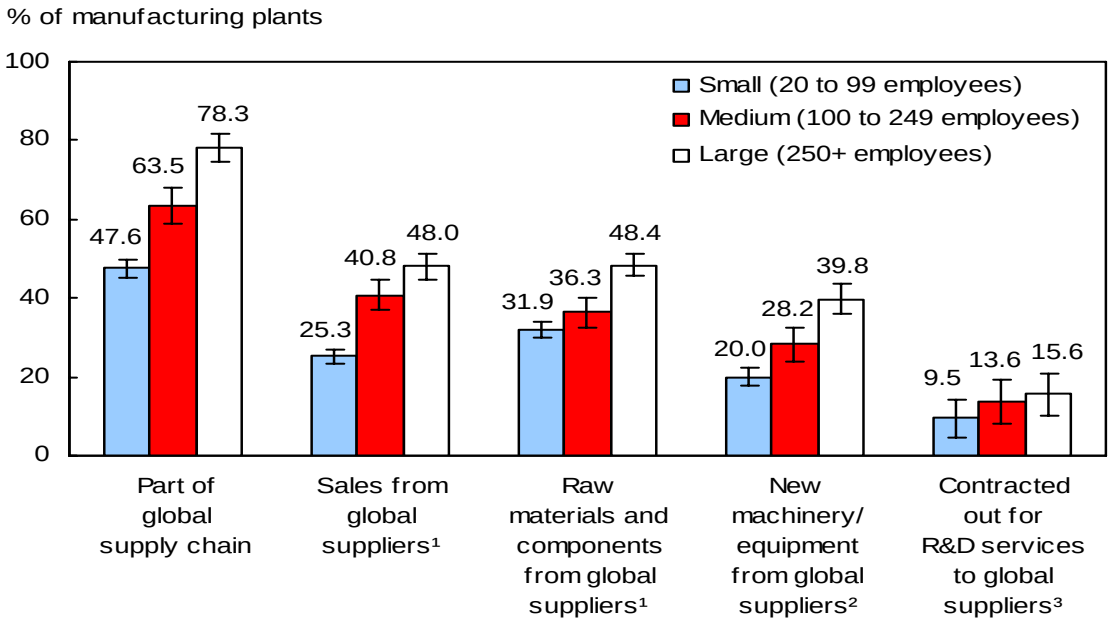
Large plants were more likely to be involved in a global supply chain than either small or medium-sized plants for three of the four indicators examined (Chart 1). The contrast is most striking for plants with global sales and among those that purchased new machinery or equipment from global suppliers; large plants were almost twice as likely as small plants to have global customers and global suppliers of new machinery or equipment.

The exception is among the one in ten plants (10.8%) that contracted out for R&D services in 2004, where large plants were no more likely than small or medium-sized plants to contract out to global suppliers.

Innovative plants were more likely to participate in a global supply chain than non-innovative plants

Almost two-thirds (61.4%) of innovative plants participated in a global supply chain in 2004 compared with slightly more than one-third (37.7%) of non-innovative plants. Innovative plants were more likely to participate in a global supply chain in 2004 that non-innovative plants for each of the four indicators examined (Chart 2). The contrast is most striking for the one in ten (10.8%) plants that contracted out for R&D services in 2004—innovative plants were four times more likely to contract out to a global supplier than non-innovative plants.

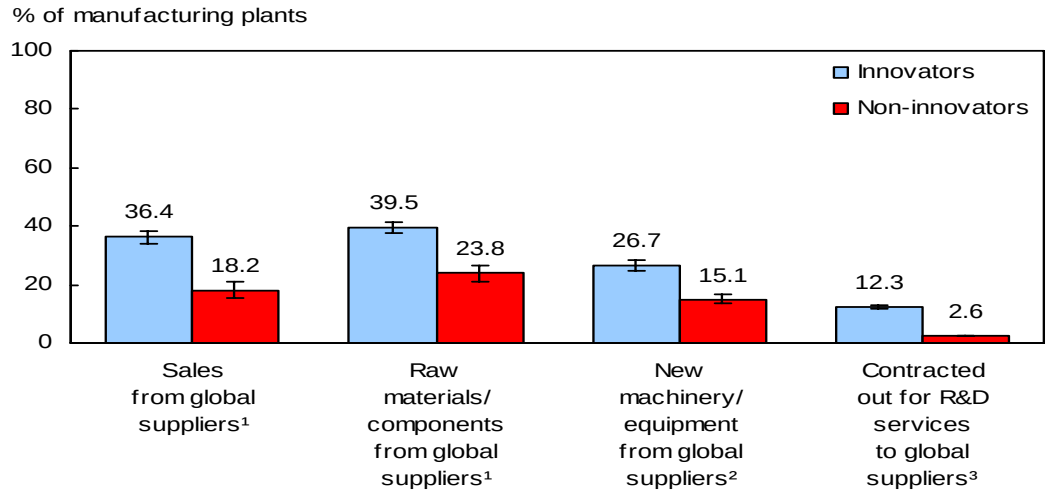
Chart 1 Percentage of manufacturing plants by selected global supply chain indicators and size of plant, 2004



Notes: 1. Applies to all plants. 2. Applies only to plants that purchased new machinery/equipment. 3. Applies only to plants that contracted out for R&D services. R&D – research and development.

Source: Statistics Canada, Survey of Innovation, 2005.

Chart 2 Percentage of manufacturing plants by selected global supply chain indicators, innovators and non-innovators, 2004



Notes: 1. Applies to all plants. 2. Applies only to plants that purchased new machinery/equipment. 3. Applies only to plants that contracted out for R&D services. R&D – research and development.

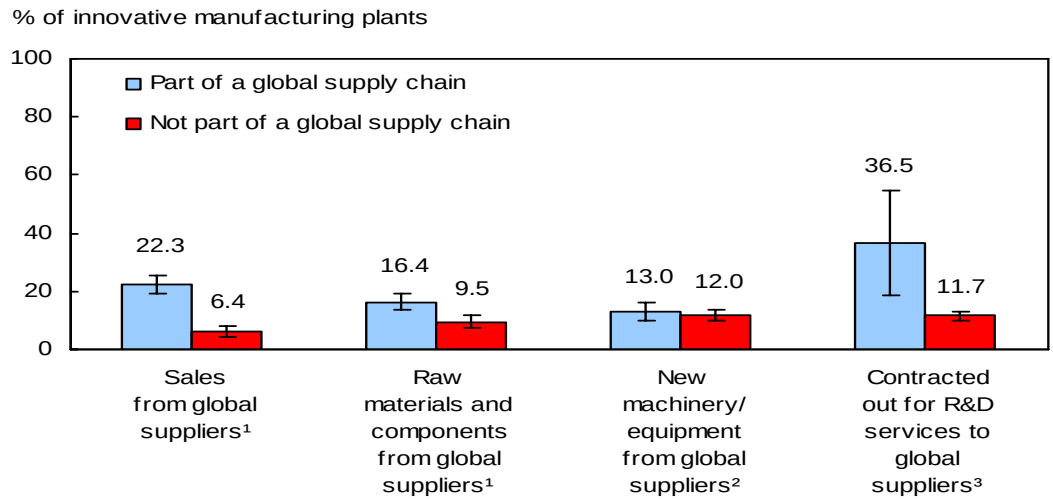
Source: Statistics Canada, Survey of Innovation, 2005.

Innovative plants that were part of a global supply chain more likely to have world-first innovations than those that were not

Innovative plants that were part of a global supply chain in 2004 were three times more likely to have a world-first innovation (16.3%) than those that were not part of a global supply chain (5.6%). This was the case for three of the four indicators examined (Chart 3). The contrast is greatest for plants with global sales; an innovative plant was three and a half times more likely to have a world-first innovation if it had sales to a global client than if sales were not global.

An exception to greater likelihood for world-first innovations is among the two-thirds of plants that purchased new machinery or equipment in 2004; there was an equal likelihood that such a plant had a world-first innovation regardless of whether or not they were part of a global supply chain.

Chart 3 Percentage of innovative manufacturing plants with world-first innovations, by global supply chain participation and selected indicators, 2004



Notes: 1. Applies to all plants. 2. Applies only to plants that purchased new machinery/equipment. 3. Applies only to plants that contracted out for R&D services. R&D – research and development.

Source: Statistics Canada, Survey of Innovation, 2005.

Summary

This article provides some insights into global supply chain participation, however there is much more work that can be done in this area. The analysis could be expanded to examine other characteristics of plants that participated in global supply chains. Firm structure, including geographic location of other plants and operations of the firm (multinational or domestic), as well as the propensity to be part of a global supply chain, could be explored. As the survey provides data on the geographical location of clients and suppliers, it would also be possible to explore whether some countries/regions are more active in global supply chains than others.

The analysis of global supply chain participation is important to appreciating the influence and impact of globalization. Although the Survey of Innovation 2005 provides indicators of global supply chain participation, opportunity exists for new survey questions and indicators to be developed. For example, data from the Survey of Advanced Technology 2007 will be available in the spring of 2008 and will provide information on geographical sources of advanced technologies.

References

OECD/Eurostat (1997). *Oslo Manual—guidelines to interpreting innovation data, 2nd edition.* Paris, France.

OECD (2002). *Supply Chains and the OECD Guidelines for Multinational Enterprises*. Paris, France, page 82.

Susan Schaan, SIEID, Statistics Canada

Results of the pilot survey on nanotechnologies

Although nanotechnology can be thought of as a sector of its own, it is clear that nanotechnology is a cross-sector phenomenon with potentially significant impacts. Nanotechnologies can be found in areas as diverse as biotechnology and health, agriculture, electronics and computer technology, environment and energy, optics, and in materials and manufacturing.

Nanotechnology is likely approaching the stage when an organized statistical program would benefit stakeholders representing a cross-section of perspectives. Canada has been very active in leading discussions on nanotechnology definitions and statistical methods at the Organisation for Economic Cooperation and Development (OECD). Nanotechnologies have generated much interest, and the development of statistics has been identified as one of the priorities amongst participating nations.

A challenge in the measurement of nanotechnology activities lies in their diversity. As nanotechnologies shift from the research laboratories to the commercial front, their impacts on economic and social fronts may become more significant. Statistics Canada used the following definition in its initial steps towards collecting information on nanotechnology:

Nanotechnology is a suite of technologies which enable the direct manipulation, study or exploitation of systems or structures where at least one dimension is on the nanometre (nm) length scale (typically less than 100 nm). The ability to control matter within this regime allows us to exploit phenomena which predominate at these length scales, leading to the production of novel materials and devices which exhibit qualitatively different properties than that of the corresponding bulk material.

Respondents to the pilot survey were also provided a more detailed list of nanotechnologies. The results of the survey should be viewed in the context of a pilot survey where new concepts are tested and evaluated. While accurate given the context, a full survey process dedicated to nanotechnologies would result in more robust results.

Questions on nanotechnology are included in the Survey of Advanced Technology 2007 (results expected in 2008), while information about nanotechnology R&D expenditures is included in the 2006 Research and Development in Canadian Industry (RDCI) survey, which uses a combination of tax and survey data. These surveys are intended to provide concrete information on nanotechnologies as well as to test concepts and definitions, with the intent to implement dedicated nanotechnology surveys in the future. Inclusion of nanotechnology in the Federal S&T survey and other existing surveys is also being explored.

For more detailed information, see the SIEID Working Paper at: http://www.statcan.ca/bsolc/english/bsolc?catno=88F0006XIE2007005.

A profile of the nanotechnology sector in Canada

Distribution

In 2005, 88 firms reported involvement in nanotechnology; the vast majority (91%) was active in research and development (R&D), while 27% reported that they were in the production or market stage. Firms reported the greatest involvement in nanomaterials (43%) and nanobiotechnology (42%), followed by nanomedicine, nanophotonics and nanoelectronics. Some firms reported activities, primarily R&D, in more than one category.

Small firms accounted for 81% of all respondents, with large and medium-sized firms accounting for 10% and 8% of firms, respectively. Provincial distribution of the firms revealed 30 firms in Ontario (34%), followed by Quebec with 25 (28%), British Columbia with 19 (21%) and Alberta with 12 (14%) firms. The remaining firms were spread across Canada. The size and provincial distributions of stage of development and nanotechnology category followed patterns similar to those observed for Canada as a whole.

Financial details

Firms reported $28 million in nanotechnology revenues in 2005, an increase of 19% over revenues in 2004. However this is far less than the near-doubling of revenues ($55.8 million) forecast by respondents for the year 2007. Quebec accounted for the majority of revenues (52%), with Ontario following at 22%, British Columbia at just under 14% and Alberta at 12%. Financial data for the rest of the provinces are not available due to the small number of respondents in those provinces. The 72 small firms earned 88% of all nanotechnology revenues in 2005.

Nanotechnology R&D expenditures totaled just over $40 million in Canada. Again, Ontario led the provinces with 38% of nanotechnology related R&D, followed closely by British Columbia at 35%, Quebec at 22%, and Alberta at just under 5%. Total Canadian nanotechnology R&D expenditures rose 12% between 2004 and 2005, with firms forecasting additional expenditures of $18 million a year by 2007. R&D which was contracted out made up about 6% of total nanotechnology R&D expenditure in 2005; this could almost double to just under 10% with the expenditures forecast for 2007. Not surprising is the fact that 93% of nanotechnology R&D is undertaken by small firms, since they account for 82% of all firms and 88% of all nanotechnology revenues.

In 2005, 22 firms attempted to raise capital for nanotechnology-related activities. Of these, only eight small firms were successful in raising just over $16.5 million. This demonstrates a fairly significant failure rate and could be of importance to the future growth of the nanotechnology sector and a concern to stakeholders. Provincial data are not available.

Surprisingly, given the early stage of development of the nanotechnology sector, 34 firms reported a total of 559 intellectual property (IP) instruments in 2005. Patents made up 60% of the total and pending patents comprised 28%, followed by technology transfer agreements at 26% of the IP activity. Licensing agreements accounted for 20% with the balance comprised of the 'other' category. The majority of firms were in Quebec, with 14 firms reporting 112 IP instruments—almost all were patents or pending patents. In Ontario, 13 firms reported 226 IP instruments, of which 56% were patents or pending patents. Four British Columbian firms reported 177 IP instruments, of which 77% were patents and an additional 15% were pending patents. Other provincial data are not available.

The unexpectedly high number of patents has been investigated and verified. The survey question asked firms about the number of patents and other IP instruments without geographic parameters. Therefore, it is possible that some double counting may have occurred raising the total number reported. In addition, these patents may not be unique to Canada.

Human resources

In 2005, 88% of the 380 nanotechnology employees were found in small nanotechnology firms. The majority (76%) of these employees has full-time duties as nanotechnology employees and the remaining 25% were employees with part-time nanotechnology duties. Ontario led with 36% of nanotechnology employees, followed by Quebec with 32%, British Columbia with 22% and finally Alberta with just over 8%. Overall 15% of firms, virtually all small firms, reported having difficulty attracting nanotechnology employees, with scientists and technical staff the most commonly cited areas of difficulty. Provincial data availability is limited; 40% of firms in British Columbia reported difficulty finding nanotechnology staff, more than double the percentage of the next highest province (Quebec at 19%) and Canada as a whole. In British Columbia, scientist and technical shortages were again the most common difficulty reported.

Summary

These results illustrate the level of nanotechnology activity in Canada and although it is a relatively small sector at the moment, nanotechnologies are believed to hold the ability to develop into the next transformative technology. A single pilot survey is not robust enough to definitively address all the issues surrounding nanotechnologies. But by placing the results of the survey in the context of a framework for the development of indicators[1], it is clear that the results begin to shed light on some key questions:

- **What is nanotechnology?** For statistical purposes further discussion of definitions is required, but this survey provided an empirical test of one definition which was reasonably understood by respondents.

1. For more information about the framework mentioned here and used by the Science, Innovation and Electronic Information Division, see Statistics Canada (1998). Science and Technology Activities and Impacts: A Framework for a Statistical Information System, Catalogue Number 88-522. Ottawa, Canada.

- **Who are the actors in nanotechnology?** There are 88 mainly small firms concentrated in four provinces, but distributed across Canada.

- **Where is nanotechnology?** Nanotechnology seems to be concentrated in nanomaterial and nanobiotechnology, however much work remains to further refine where in the economy nanotechnology will be found. This is a primary challenge facing all emerging technologies.

- **Why use nanotechnology? What are the outcomes?** Firms reported $28 million in nanotechnology revenues. However the more than $40 million in nanotechnology R&D could be viewed as an investment in the firm, as well as hope for future revenues. The longer-term impacts are areas for future work.

- **How many resources have been committed to nanotechnology?** With 380 employees and over $40 million in R&D (with a further 46% increase forecasted for 2007), there is a small but growing commitment of resources to nanotechnology. Of significance is that only 8 of 22 small firms that attempted to raise capital were successful. They did however report raising over $16 million to further their efforts in nanotechnology.

- **How connected?** Over 70% of nanotechnology firms reported collaborative arrangements with universities, other firms and government. As the needs of the firms change so too will these connections.

Despite the challenges facing systematic measurement of nanotechnology, precedent can be found in the approaches undertaken and results seen. The measurement of nanotechnology is in its infancy and much work and many challenges remain with respect to monitoring, measuring and analyzing this emerging technology, however the pilot survey on nanotechnology has successfully begun to address some of the critical questions.

Chuck McNiven, SIEID, Statistics Canada

International activities on the development of nanotechnology statistics

Statistics Canada is actively involved with the international community in developing statistical information on nanotechnologies. This article summarizes the ongoing work of the OECD's newly-established Working Party on Nanotechnology, with particular emphasis on the role of Statistics Canada.

The Working Party on Nanotechnology

The OECD's Working Party on Nanotechnology (WPN) held its first meeting in Leuven, Belgium, on May 8th and 9th, 2007. The role of the WPN is to advise on emerging policy issues of science, technology and innovation related to the development of nanotechnology. At the meeting, the WPN developed a program of work with the aim of promoting international co-operation to facilitate research, development, and the responsible commercialization of nanotechnology in member countries and certain non-member economies. The WPN established steering groups for potential projects for implementation in 2007 and 2008:

- Project A: Statistics and Measurement
- Project B: Impacts and Business Environment
- Project C: International Research Collaboration
- Project D: Outreach and Public Engagement
- Project E: Dialogue on Policy Strategies
- Project F: The Contribution of Nanotechnology to Global Challenges

Canada was selected to lead the steering group for Project A: Statistics and Measurement. This article summarizes objectives and activities associated with this work, based on the project proposal.

Objectives and activities

The first objective is to develop an overview of the importance of nanotechnology and the international comparability of the statistics used to indicate the importance. Measures are expected to include R&D spending, other science and technology activities and the use of nanotechnology by firms. This overview would draw on available national and international sources, including member-country government reports. It would also draw on private sources, where relevant, and assess the quality and comparability of such statistics and indicators. This overview would be published as an OECD report entitled "Nanotechnology at a Glance". The report would be a building block for further efforts in developing internationally comparable statistics and indicators.

The second objective of the project is to develop a framework for the collection of internationally comparable statistics, according to agreed definitions and classifications, and supported by possible firm-level model surveys. A critical first step in the collection of nanotechnology statistics is for stakeholders to agree on one or more definitions of nanotechnology for statistical purposes so that government, university and industry researchers and managers in each sector can consistently collect, report, and analyze data using the same language.

Establishing a systematic and consistent process for investments in nanotechnology research will provide key stakeholders, policy analysts and decision makers with reliable, validated and comparable information to help inform strategy and policy decision making on the scientific, economic, health, environmental and social impacts of nanotechnology. Some discussion may centre on the definition of a nanotechnology firm, however it may be useful, in the early stages, to focus on nanotechnology in a broad sense and collect information on all firms engaged in nanotechnology activities. As the nature of these firms is better understood, a definition of a nanotechnology firm will emerge.

Member-country and OECD experiences with biotechnology statistics can serve as workable models for the creation of systematic statistical approaches for collecting data on nanotechnologies. An example of a lesson learned is the use of a list-based definition in addition to a general statement defining nanotechnology. Nanotechnology could be transformed into a list of measurable products and processes based on the unique characteristics of nanotechnology, which, as an added benefit, addresses, in part, the cross-sectoral nature of nanotechnology. All these potential steps would benefit from the early and active participation of stakeholders, and the creation of definitions and concepts that are rigorous enough for international comparisons, but flexible enough to capture and reflect the evolving and multi-sector nature of nanotechnology.

Chuck McNiven, SIEID, Statistics Canada

Firm characteristics and fund-raising activities of biotech firms in Canada

Innovative biotechnology firms are science-based firms which attempt to bring an application of biotechnology to the market. However, it is clear that a significant proportion of these firms derive no revenue from product sales while their products proceed through the various phases of testing and regulatory approval. In order to support their operations they must look to other sources of funding.

Compared with many other areas of science, biotechnologies based on DNA, protein sequencing and synthesis, cell and tissue engineering, etc., are fairly recent, moving from the university lab to the firm only over the last 30 years. As a result, many innovative biotechnology firms are quite young, but others are older, previously established firms with a history of operating in other areas of business. These older firms have found a biotechnology application which either fits in with their other business activities or presents opportunities to build on their established business activities.

This profile of innovative biotechnology firms in Canada uses data from the Biotechnology Use and Development Survey (BUDS) 2005. More information about the Biotechnology Use and Development Survey is available at: http://www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=4226&lang=en&db=IMDB&dbg=f&adm=8&dis=2.

For more detailed information on Canada's innovative biotechnology firms, see the forthcoming SIEID Working Paper at: http://www.statcan.ca/bsolc/english/bsolc?catno=88F0006X&CHROPG=1.

In addition, most biotechnology firms are small, with less than 50 employees and most are in the human health biotechnology sector.

As can be observed from Table 1, some very different profiles of biotech firms emerge based on their size and the sector to which they belong.

Firms in the human health sector are younger than those in the other sectors and only three-quarters of these firms have any revenue. However, revenue reported by firms in the human health sector is more likely to come from biotechnology activities compared with revenue reported by innovative biotechnology firms in the agriculture and food processing or in the environment sectors. Almost half of firms in the human health sector are spin-offs from some other entity, typically from universities or hospitals.

Firms belonging to the other sectors are relatively older, with the oldest in the environmental biotechnology sector. These non-human health biotech firms are consistently more likely to report having some revenue, but their revenue is typically from sources other than biotechnology. There are some spin-offs, but not nearly the proportion reported by firms in the human health sector.

Table 1 Key variables for innovative biotechnology firms, by sector and size, 2005

Sector and size	All firms	Average number of years of operation (as of 2005)	Firms with revenue	Firms with revenue from biotechnology	Firms with spin-offs
	number			%	
Total	**532**	**14**	**82**	**8**	**34**
Biotechnology sector					
Human health	310	10	75	39	43
Agriculture and food processing	146	18	92	5	25
Environment	60	24	95	1	13
Other	16	13	94	39	19
Size					
Small (less than 50 employees)	399	9	71	56	38
Medium (50 to 149 employees)	82	19	91	50	27
Large (150 or more employees)	51	44	92	6	10

Note: Data are preliminary and may be subject to change.
Source: Statistics Canada, Biotechnology Use and Development Survey, 2005.

Small firms averaged less than 10 years of operation while the largest firms, with 150 or more employees, averaged over 40 years of operation. Given the recent nature of developments in biotechnology, these larger firms may have adopted new technologies to either adapt their previous practices or to expand into newer fields. For example, some established firms in various natural resource sectors (mining and oil and gas) appear to be developing biotechnology-based means of environmental remediation.

By contrast, the smaller, younger firms are more likely to be start-ups which have been established to exploit a particular biotechnology discovery. Consistent with this view, a much greater proportion of smaller firms reported they were spin-offs of some other entity, be it a university, government lab or other firm. Smaller and medium-size firms also reported a much higher concentration of revenue from biotechnology, about half their income, while for the larger firms the figure is less than ten percent.

Almost one-half of innovative biotechnology firms reported attempting to seek funds from sources outside of their revenue stream from products (Table 2). Of those firms, 173, or 73% were successful in raising some money. A total of 118 firms—about one-half of all firms that attempted to raise funds—were able to achieve their targets.

Table 2 Fund-raising by innovative biotechnology firms, by sector and size, 2005

Sector and size	Firms	Firms attempting to raise funds	Firms that successfully raised funds	Firms that met their targets	Funds raised
		number			millions of dollars
Total	**532**	**238**	**173**	**118**	**1,350**
Biotechnology sector					
Human health	310	155	110	85	1,129
Agriculture and food processing	146	59	45	28	198
Environment	60	21	x	x	x
Other	16	3	x	x	x
Size					
Small (less than 50 employees)	399	194	137	88	664
Medium (50 to 149 employees)	82	35	30	25	518
Large (150 or more employees)	51	9	6	5	167

Note: Data are preliminary and may be subject to change.
Source: Statistics Canada, Biotechnology Use and Development Survey, 2005.

Altogether, innovative biotechnology firms raised $1.35 billion, with a large majority being raised by firms in the human health sector. Funds were raised primarily by small and medium-size firms.

Charlene Lonmo, SIEID, Statistics Canada

Start-up funding sources and biotechnology firm growth

Although private investors and government funding agencies have learned that the biotechnology sector requires a funding model different from that of traditional manufacturing, there is a paucity of empirical research investigating the links between characteristics of the funding model and firm performance. The purpose of this article is to examine which funding sources have the greatest influence on firm growth.

Biotechnology is one of the world's fastest growing sectors, expanding almost four times faster than the G-7 average for all sectors. Canadian biotechnology revenue grew from $1.9 billion in 1999 (25% more than in 1998) to more than $3.6 billion in 2001. In 2001, there were 375 biotechnology companies operating in 10 Canadian provinces, up from 358 in 1999 (Statistics Canada 2001, McNiven 2001). Furthermore, in 1999 biotechnology firms raised $2.147 billion; $644.1 million (or 30%) from venture capitalists, $579.7 million (or 27%) from angel investors, $493.8 million (or 23%) from collaborative alliances, $150.3 million (7%) from government sources, $150.3 million (7%) from conventional sources such as banks, $42.9 million (2%) from initial public offerings (IPO), and the remaining $85.9 million (4%) from 'other' sources (Traore 2005).

Using data from the 1999 and 2001 Biotechnology Use and Development Surveys, this article examines the effect of funding sources on firm growth in the Canadian biotechnology sector.

R&D investment and capital structure

Biotechnology is a young sector where new firms face unknown markets for their products. The success of each stage of development, whether R&D, pre-clinical trials, regulatory or production, is subject to great uncertainty and the firm itself has little or no prior track record on which to base forecasts. Explanations for financing preferences of the owner/manager corroborate the static tradeoff and pecking order frameworks of Myers and Majluf (1984). In this context, 'pecking order' means that firms exhibit an explicit preference ordering over the set of possible financing sources.

According to the pecking order hypothesis, internal sources are preferred to debt, and debt is preferred to external equity (Myers and Majluf 1984). This result is borne out by the above funding data for Canadian biotechnology firms—the bulk of their financing comes from venture capitalists and angel investors; collaborative alliances and conventional funding sources are tied for third place, 'other' sources are fourth, while initial public offerings are last. Jeng and Wells (2000) also predict that such a sector is best suited to venture capital financing.

For the purpose of this analysis, data from the Biotechnology Use and Development Surveys (BUDS) 1999 and 2001 were used to examine firms that raised capital and their subsequent performance. The 1999 survey was mailed to the 3,377 Canadian biotechnology firms from selected North American Industry Classification System (NAICS) codes. After accounting for non-respondents, 358 firms remained[1]. Observations were retrieved based on two criteria. First, firms must have raised capital in 1999, so that their subsequent performance in 2001 could be assessed. It turned out that 178 firms attempted to raise capital, but only 138 were successful. Second, of those 138, only those firms sampled in BUDS 2001 were retained. After the above selection procedures, 52 firms remained for analysis.

More information about the Biotechnology Use and Development Survey is available at:

http://www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=4226&lang=en&db=IMDB&dbg=f&adm=8&dis=2, choose 'Other reference periods' for 1999 and 2001 questionnaires and metadata.

All financial variables are in millions of 2001 Canadian dollars adjusted by the Industrial Product Price Index for the pharmaceutical industry. All coefficients have been corrected for heteroskedasticity[2].

1. Firms with fewer than five employees and less than $100,000 in R&D expenditures were excluded from the sample.
2. Heteroskedasticity is a common problem with survey data. It means that when survey responses are taken across different firms the resulting data appear to be drawn from different distributions (as opposed to all responses being drawn from the same distribution, which is usually assumed to be normal). The regression estimates in Tables 1 and 2 have been corrected for this problem.

Empirical model

To estimate the effect of funding sources on firm growth the following two regression equations were modelled:

$$\text{RevenueGrowth} = ß_0 + ß_1\text{TotalCapital} + ß_2\text{Public} + \sum_j ß_j\text{Fund}_j + \sum_k ß_k\text{Stage}_k + \varepsilon_1$$

$$\text{RevenueGrowth / R\&DCapital} = ß_0 + ß_1\text{TotalCapital} + ß_2\text{Public} + \sum_j ß_j\text{Fund}_j + \sum_k ß_k\text{Stage}_k + \varepsilon_2$$

The dependent variables for the regressions were: revenue growth and the ratio of revenue growth to R&D capital (hereafter denoted as revenue growth/R&D capital). The revenue growth variable was constructed by subtracting total revenue in 1999 from 2001. Since R&D capital is not directly observable, it was constructed via three methods using the values for total R&D spending in each year reported in BUDS 1999 and 2001. The methods included summation of total R&D spending, adjustment by straight-line depreciation and adjustment by double-declining balance depreciation (see text box). Although the summation method was adopted in the estimation of R&D capital and works well, the other methods are conceptually more sound.

Three methods for calculating R&D capital

In the **summation** method, the variable was calculated simply by summing the values of total R&D spending from 1998 to 2001 without considering depreciation. In the **straight-line depreciation** method, it was assumed that the salvage value of total R&D capital available in each year was 10% of the total R&D spending in each year, as there was no direct information available. Usually the salvage value of R&D capital ranges from 10% to 20% of R&D capital in R&D intensive firms but the results would not differ significantly if it were set to 20% (Hall et al. 1998).

For **double-declining balance depreciation**, it was assumed that the salvage value of R&D capital available in each year was 10% of the total R&D spending in each year, and that the estimated useful life of R&D capital was only four years. The value of total R&D capital available in 2001 was obtained by summing the values of total R&D spending of the firms in each year after depreciation adjustment in 2001.

The independent variables included six firm-level funding sources in 1999—angel investors or family or friends; government loans or grants; venture capital; conventional sources such as banks and/or trust companies; initial public offering (IPO); and collaborative alliance. They also included the total amount of capital raised in 1999, and ownership type (public or private). Biotechnology products and processes were identified by four different stages of development (ranging from least developed to fully commercialized): R&D; pre-clinical trials or confined field trials; regulatory phase/unconfined release assessment; and approved or on the market or in production[3]. If a firm had an IPO in any year between its establishment year and 2001, then the variable 'Public' was set to one, otherwise it was zero.

Findings

For the first regression model (revenue growth), the results show that of the six funding sources only the coefficients on angel, venture, and conventional capital are significant (Table 1). Conventional capital has the greatest impact on revenue growth between 1999 and 2001. Angel capital has the second greatest impact, while venture capital is third. The results also show that of the four stages of product or process development, only the coefficient on R&D is not significant. The coefficients on the remaining stages (i.e., pre-clinical, regulatory, and on the market) are all significant at the 10% level and have the expected signs. Likewise the results for total capital raised in fiscal year (FY)99 and whether the firm is publicly traded are positive and statistically significant.

Table 1 Ordinary least squares (OLS) regression results (dependent variable is firm RevenueGrowth)

Independent variable	Estimated coefficients
Source of funding	
Angel capital	0.1197*
Government capital	0.016
Venture capital	0.1012**
Conventional capital	0.4751*
Initial public offering (IPO)	0.0979
Alliance capital	0.0753
Total capital raised in FY99	0.0373**
Public	1.1255**
Stage of biotechnology product or process	
Research and Development (R&D)	0.2219
Pre-clinical	0.2647*
Regulatory	0.2412*
Market/production	0.3466*

* Statistically significant at 10% level.
** Statistically significant at 5% level.
Source: Statistics Canada, Biotechnology Use and Development Survey, 1999 and 2001 and author's calculations.

Table 2 presents the regression results for the second model (revenue growth/R&D capital). Of the six funding sources only the coefficients on angel, venture, and conventional capital are significant and have positive signs. If we exclude the summation method (because it is less conceptually sound), in order of importance it is conventional capital, angel capital and venture capital that contribute the most to firm growth.

3. The stages-of-development variables were the total number of products or processes at each stage of development (R&D, pre-clinical, regulatory, and on the market) for all firms in 1999.

Table 2 Ordinary least squares (OLS) regression results (dependent variable is firm RevenueGrowth/R&DCapital)

Independent variable	R&D capital - 1	R&D capital - 2	R&D capital - 3
Source of funds		estimated coefficients	
Angel capital	0.0679**	0.0233*	0.0127**
Government capital	0.0833	0.0216	0.0134
Venture capital	0.0110*	0.0108**	0.01147**
Conventional capital	0.0220*	0.0747*	0.0340**
Initial public offering (IPO)	0.0103	0.0355	0.0202
Alliance capital	0.0145	0.0452	0.0259
Total capital raised in FY99	0.0172*	0.0171**	0.0136**
Public	0.5205*	0.1973*	0.1515*
Stage of biotechnology product or process			
Research and Development (R&D)	0.014	0.0525	0.0308
Pre-clinical	0.1465*	0.5402*	0.3097*
Regulatory	0.2662*	0.6328*	0.3819*
Market/production	0.1882**	0.8876*	0.4466*

* Statistically significant at 10% level
** Statistically significant at 5% level
Note: R&D capital -1 is calculated by summing the total R&D spending from FY98 to FY01. In method 2, it is calculated by the straight-line depreciation method using the total R&D spending. In method 3, it is calculated by the double-declining balance depreciation method using the total R&D spending.
Source: Statistics Canada, Biotechnology Use and Development Survey, 1999 and 2001 and author's calculations.

Of the four stages of product or process development only the coefficient on R&D is not significant under all three methods of R&D capital. The coefficients on pre-clinical, regulatory, and on the market are all significant and have positive signs. In order of magnitude, the on the market/in production stage, followed by the regulatory stage and finally the pre-clinical stage affects sales growth the most. This finding seems to make more sense theoretically than the results in Table 2, since products and/or processes that are closer to the market/in production stage should contribute more to firm growth. The coefficients on total capital raised in 1999 and public or private ownership are significant and have positive signs.

Summary

The results indicate that of the funding sources, only angel, venture, and conventional capital have contributed significantly to R&D capital formation and revenue growth. Conversely, the contribution of funding from government, IPO, and alliance capital sources were found to be less important for the given sample of biotechnology firms. There are counter intuitive results on the importance of conventional capital for firm growth rates. It was expected that venture capital would be most important; however, it may be that older firms with more mature products or products ready for market are chosen by banks. In that case, perhaps it makes sense that bank capital is correlated with higher growth rates.

The results provide insights for policy makers and investors (both private and public)—angel capital, venture capital and conventional capital all have a significant role to play in biotechnology firm growth. One caveat is that venture capitalists, angel investors and banks may use superior selection criteria to pick prospective start-ups. It may also be that once chosen, these firms receive critical managerial input (not available from government, alliance capital or an IPO) to the new venture which accounts for their success. These caveats can only be answered with further research.

References

Hall, B. H., J. Mairesse, L. Branstetter and B. Crepon (1998). *Does cash flow cause investment and R&D: an exploration using panel data for French, Japanese, and United States scientific firms*, University of California at Berkeley, Working Paper, January.

Jeng, L.A. and P.C. Wells (2000). The determinants of venture capital funding: evidence across countries. *Journal of Corporate Finance*, 6(3): 241-289.

Jensen, M.C. (1993). Presidential address: the modern industrial revolution, exit and failure of internal control systems. *Journal of Finance*, 48(3): 831-880.

McNiven, C. (2001). *Practices and activities of Canadian biotechnology firms: Results from the biotechnology use and development survey 1999*. Statistics Canada, Catalogue no. 88F0006XIE, no. 011, August.

Modigliani, F. and Miller, M.H. (1959). The cost of capital, corporation finance and the theory of investment. *The American Economic Review*, 49(4): 655-669.

Myers, S.C. and Majluf, N.S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics*, 13: 187-221.

Statistics Canada (2001). Biotechnology use and development survey 2001. Science, Innovation and Electronic Information Division.

Traore, N. (2005). *Access to financing capital by Canadian innovative biotechnology firms*. Statistics Canada, Catalogue no. 88F0006XIE, no. 010, April.

Brian Cozzarin, Associate Professor, University of Waterloo

Dropping the Internet: Who and why?

Internet use is an important hallmark for participation in an information society. Although 68% of adult Canadians went online for personal, non-business reasons in 2005, digital inequality persists both geographically and among certain population groups. While much research and policy attention has been aimed at understanding the barriers to Internet use, there were an estimated 850,000 Canadians who had used the Internet at one time but were no longer doing so in 2005. Who are these former users and why have they discontinued their use of the Internet?

As technology is diffused across the country and over time, the measures used to monitor the access and use of this technology must also evolve. While early research examined the readiness of Canadians to adopt the Internet, focusing on rates of household connectedness (Dickinson and Ellison 2000), subsequent work began to examine why and how individual Canadians used the Internet (Dryburgh 2001), the barriers to access (Lenhart 2002), and the factors influencing the 'digital divide', or the gap in Internet use between certain groups (Sciadas 2002).

More recent studies have begun to investigate the impact of the Internet on Canadian society, including the daily time-use patterns of Canadians (Veenhof 2006) and the expected outcomes of the information society, which have so far not materialized, such as the 'paperless office', the demise of traditional retail, and 'the death of distance' (Sciadas 2006). Less research and policy attention has been directed towards former users of the Internet (Crompton, Ellison and Stevenson 2002).

From access to impacts

Using data from the 2005 Canadian Internet Use Survey (CIUS), this study examines three groups of Canadian adults (see text box). The Internet users group includes the 68% of adult Canadians who went online during 2005 for personal, non-business reasons. Those who did not use the Internet during 2005 were further divided into two groups: non users (28%); and former users or 'Internet dropouts' (4%). In particular, this article compares the three groups on the basis of selected socio-economic characteristics, and examines the reasons for the discontinued use of the Internet by the group of former users.

Canada's Internet dropouts

While being a former Internet user is a temporary state for some—the result of changing jobs or leaving school, for example—it appears to be more permanent for others. More than half (55%) had stopped using the Internet within the last two years. Almost one-third (31%) had used the Internet between two and five years prior to the reference period, while the remainder (13%) had used it more than five years ago. During their past Internet use, almost one-quarter (24%) of former users reported being online daily, while 30% used it at least once a week; the remaining 47% of former users accessed it less often. This suggests that at the time of their Internet use, former users included both regular and more occasional users.

Former users were also asked about the location of their past use. Over 60% had used it from home, significantly less than the 90% of Internet users reporting use from home. Less than 20% had used it from work in the past and 13% from school. About 15% reported using the Internet from another location, particularly at the home of a relative, friend or neighbour.

This article uses data from the 2005 Canadian Internet Use Survey (CIUS), conducted as a supplement to the Labour Force Survey (LFS) in November 2005. More than 30,000 Canadians aged 18 years and over, excluding residents of the territories, inmates of institutions, persons living on Indian reserves, and full-time members of the Canadian Forces, were asked about their Internet use for a 12 month period. CIUS replaces the Household Internet Use Survey (HIUS), conducted from 1997 to 2003, which focused on households. The new focus on individuals conforms more closely to international standards but precludes comparisons with previous estimates in many cases.

More information about the Canadian Internet Use Survey is available at:

http://www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=4432&lang=en&db=IMDB&dbg=f&adm=8&dis=2

Definitions

Internet users – Respondents who reported using the Internet for personal, non-business reasons during the previous 12 months from any location including home, work, school, library or elsewhere.

Former users/Internet dropouts – Respondents who reported using the Internet for personal, non-business reasons in the past, but not during the previous 12 months.

Non users – Respondents who reported never using the Internet for personal, non-business reasons.

Who?

It appears that former users fall somewhere in between the other groups with respect to selected socio-economic characteristics (Table 1). Former users were somewhat older on average than Internet users but significantly younger than non users. However, they were made up of a disproportionate number of men compared to either of the other two groups. As for level of education, former users were significantly less likely than Internet users to hold a university degree but more likely than non users. Likewise, former users were more apt to live in a household with lower income then were users. Perhaps less surprising, given their older age on average, former users were less likely to live in households with children but, again, more likely than non users.

Table 1 Percentage of Canadians aged 18 and older by selected socio-economic characteristics and Internet status, 2005

	Internet status		
Socio-economic characteristics	Users	Former users	Non users
		% of individuals	
Canadians aged 18 and older	68	4	28
Average age (years)	40	45	59
Male	49	55	48
With university education	27	11	6
With household income > $80,000	39	19	12
Living in household with no children under 18 years	42	47	54
Living in urban location	80	70	69

Source: Statistics Canada, Canadian Internet Use Survey, 2005.

It appears that the residential location of former users was quite similar to that of non users. In both groups there is a larger proportion living in smaller towns and rural areas (i.e. non-urban) compared with the Internet users group. On balance, while there are certain characteristics among former users, they appear not to represent a homogeneous group; different types of people dropped the Internet, but why did these former users stop their Internet use?

Why?

Former Internet users were asked to report the reasons for their discontinued use. Over 85% cited just one main reason why they no longer used the Internet.[1] In order to examine these responses, a typology of four categories of reasons was adopted based on Lenhart's (2002) analysis of the American experience (Chart 1).

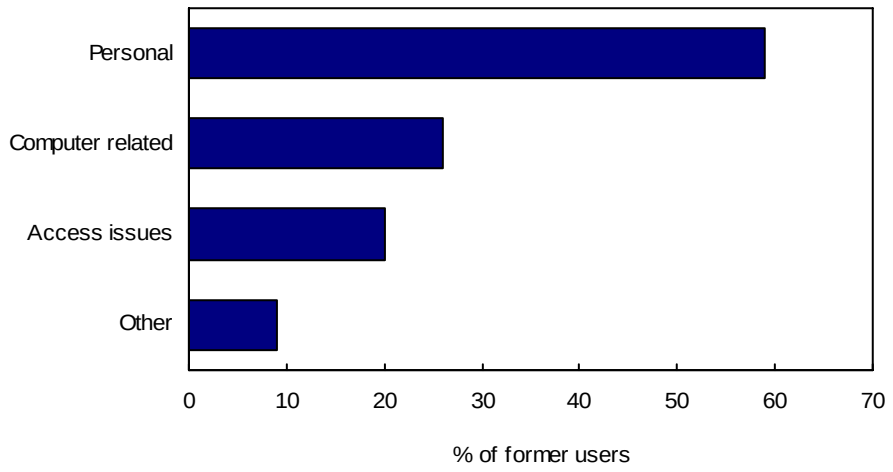
The first category is personal reasons: These include 'no need, no interest, no time or Internet use was too difficult'; more than half (59%) of former users gave such reasons. About one in four (26%) former users reported a computer-related reason for no longer using the Internet, including the 'unavailability of a device or broken equipment'. One in five (20%) reported an access issue, such as 'too costly, changed jobs or left school' as the reason they no longer used the Internet. Finally, less than one in ten reported another reason such as 'privacy concerns, fear of disclosing personal information or objectionable content' (denoted as 'other' in Chart 1).

Of the former users, males were more likely than females to report personal reasons (61% versus 56%) for no longer using the Internet and less likely to report reasons related to access (18% versus 22%). And on average, former users who reported 'other reasons' for no longer going online tended to be slightly older (49 years) than those who reported computer-related reasons (42 years). Almost one-third of former users indicated they planned to start using the Internet for personal non-business reasons from any location in the next 12 months. The average age of former users with such plans was 42 years, compared to 46 years for those with no such plans.

More than 70% of those who stopped using the Internet within the last two years planned to start again during the next 12 months. Again, this may suggest that many former users consist of younger adults who find themselves in transition and have stopped using the Internet on a temporary basis (e.g. due to changing employment or living arrangements, unavailability of a device). Other former users are from an older demographic group that reported no need or interest in using the Internet. It is possible that these former users may have stopped using the Internet on a more permanent basis.

1. Reasons given by respondents were checked off from a list of twelve by the Interviewer (the list was not read aloud to the respondents). Since more than one reason could be provided, the total sums to more than 100%.

Chart 1 Percentage of former users citing reasons for no longer using the Internet, 2005



Source: Statistics Canada, Canadian Internet Use Survey, 2005.

Summary

The Internet has become part of the everyday life of many Canadians. This study examined a small group of Canadian adults who used the Internet in the past, but have since stopped using it for a number of reasons. Despite the enormous growth of the Internet, there remain some former users who no longer need or wish to use the Internet, do not have the necessary equipment, or for whom the costs may outweigh the benefits. Compared to current Internet users, these former users are slightly older on average, more likely to be male than female, and have lower levels of income and education. In addition, this group is over-represented by those residing in smaller towns and rural areas, where the Internet can potentially be used to help overcome distance.

References

Crompton, S, J. Ellison and K. Stevenson (2002). Better things to do or dealt out of the game? Internet dropouts and infrequent users. *Canadian Social Trends,* Statistics Canada, Catalogue no. 11-008-XIE.

Dickinson, P. and J. Ellison (2000). Plugging in: The increase of household Internet use continues into 1999. *Connectedness Series*, Statistics Canada, Catalogue no. 56F0004MIE, no. 1.

Dryburgh, H. (2001). *Changing our ways: Why and how Canadians use the Internet.* Statistics Canada, Catalogue no. 56F0006XIE.

Lenhart, A. (2002). *Barriers to Internet access: From the non-user and new-user perspective*. Pew Internet and American Life Project.

Sciadas, G. (2006). Our lives in digital times, *Connectedness Series,* Statistics Canada, Catalogue no. 56F0004MIE, no. 14.

Sciadas, G. (2002). Unveiling the digital divide, *Connectedness Series,* Statistics Canada, Catalogue no. 56F0004MIE, no. 7.

Veenhof, B. (2006). The Internet: Is it changing the way Canadians spend their time? *Connectedness Series*, Statistics Canada, Catalogue no. 56F0004MIE, no. 13.

Larry McKeown and Cathy Underhill, SIEID, Statistics Canada

How does firm size affect the perceived benefits of Internet business?

Although small firms were less likely than large firms to identify benefits from conducting business online, there has been growth in the proportion of firms indicating perceived benefits over the past five years in all size categories.

Over the past five years, substantial changes have occurred in the way many aspects of business are conducted. The instigator for many of these changes has been the emergence of the Internet as a mainstream business tool for firms of all sizes.

During this time period, not only have business processes changed, but so too have the perceptions firms have about conducting business over the Internet. This article examines these changes with a focus on the differences in perceptions held by small and large Internet-using firms. While a gap has been identified between small and large firms in their perceived benefits of using the Internet for business, the two size classes are generally moving in the same direction.

Small firms less likely to perceive benefits of business over the Internet

Overall, large firms were more likely to perceive benefits from Internet business than their smaller counterparts. In accordance with this finding, small firms were more likely to identify no benefits to e-business than large firms. In 2006, 9% of small firms responded that there were no perceived benefits while only 3% of large firms did so.

The Survey of Electronic Commerce and Technology (SECT) asks Canadian firms about four particular perceived benefits of conducting business over the Internet: lower costs, reaching potential customers, better co-ordination with suppliers/customers/partners and reducing time to market. Respondents may select all that apply. Conversely, respondents may also answer that they have perceived no benefits from conducting business over the Internet.

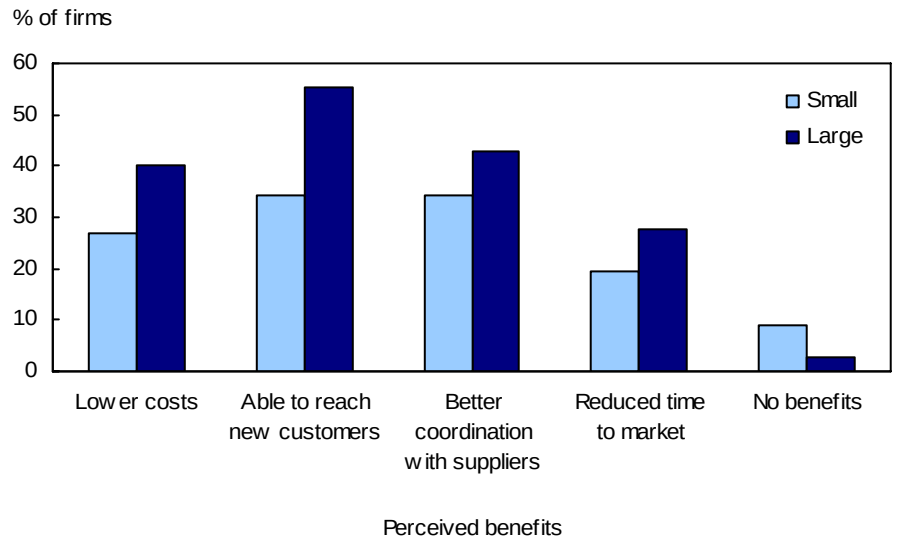
For the purposes of this study, small firms are defined as those with less than twenty employees. Large firms are those with more than 100 employees, with the exception of the manufacturing industry, where this covers firms with more than 500 employees.

More information about the Survey of Electronic Commerce is available at:

http://www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=4225&lang=en&db=IMDB&dbg=f&adm=8&dis=2

While many of the early expectations surrounding the Internet were about cutting costs for firms of all sizes, this reality does not seem to have played out for the majority of firms. In 2006, only 27% of small firms felt that their costs were lowered by doing business over the Internet. Just over 40% of large firms perceived lower costs to be a benefit (Chart 1).

Chart 1 Perceived benefits of Internet business for Canadian firms by size, 2006



Source: Statistics Canada, Survey of Electronic Commerce and Technology, 2006.

Another expectation at the turn of the century was that the Internet would allow private firms to attract consumers from around the globe as their physical location would be supplemented, or replaced, by a virtual one. More than 55% of large firms in Canada believed that conducting business over the Internet has allowed them to reach potential customers while 34% of small firms felt this was a benefit.

The greater ability of larger firms to reach out to potential customers may be explained by a number of factors, including greater resources for the development of web sites, brand name recognition, and the use of web advertising in conjunction with traditional means.

Perceived benefits grow across size classes

Although small firms were less likely than large firms to identify benefits from conducting business online, there has been growth in the proportion of firms indicating perceived benefits over the past five years in all size categories.

In 2002, only 20% of all firms believed that the Internet provided better coordination with their suppliers, customers and/or partners. By 2006, this had risen to 35%. Likewise for large firms, the proportion that recognized better coordination with suppliers rose from 34% to 43%. The increased levels of coordination between suppliers, customers and partners can be explained by the greater number of Canadian firms using the Internet to communicate and transact.

In a similar vein, both large and small Canadian firms perceive that they were able to reach new customers by using online means for business practices. From 2001 to 2005, this proportion had stagnated for all firm sizes, as about 29% of small firms and 45% of large firms perceived it to be a benefit. However, in 2006, 34% of small firms and 56% of large firms thought this was a benefit to having an online presence. It should be noted that no information is available on how firms are reaching these new customers, but it may be through web advertising, providing information on a website, conducting sales through an online portal, or a combination of these elements.

Nearly all firms recognize benefit of business online

In 2006, less than one in ten small firms conducting business online perceived no benefit from this activity. This has fallen slightly since 2002 when 16% of small firms who used the Internet for business activities indicated that they perceived no benefit. This falling trend line is the same for large firms, of which only 3% perceived no benefit from conducting business over the Internet in 2006.

Mark Uhrbach, SIEID, Statistics Canada

Scientific research and development services: Profile of a young and dynamic industry

The scientific research and development services (SRDS) industry is arousing growing interest among analysts and researchers.[1] The interest is due in part to the industry's major contribution to total industrial expenditures on research and development (R&D) in Canada.

In 2003, the scientific research and development services industry generated more than $922 million in R&D expenditures, the fourth highest in Canadian industry. The R&D expenditures of this industry account for almost 7% of total R&D expenditures in Canadian industry.

Many research activities and leading-edge technologies are related to the scientific research and development services industry. Enterprises whose principal activity consists of performing research and development in the physical sciences, genetics, biotechnologies, mathematics, life sciences, demography, etc. are classified under the North American Industry Classification System (NAICS) 5417 (see text box).

An industry whose R&D expenditures have grown substantially since 1997

It is not surprising that since 1997, the scientific research and development services industry has experienced a significant and rapid increase in the number of performers and R&D expenditures. Between 1997 and 2003, the number of enterprises performing R&D in the industry nearly tripled, going from 264 in 1997 to 675 in 2003, an average annual growth rate of 14%. Over the same period, R&D expenditures went from $211 million in 1997 to $922 million in 2003, an advance of annual growth rate of 34% (Chart 1).

This article uses data from the Research and Development in Canadian Industry (RDCI) survey. More information about this survey is available at: http://www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=4201&lang=fr&db=IMDB&dbg=f&adm=8&dis=2.

For more results about firms in the scientific research and development services industry, see the forthcoming SIEID working paper at:

http://www.statcan.ca/bsolc/english/bsolc?catno=88F0006X&CHROPG=1.

NAICS Definitions

5417 – Scientific Research and Development Services
This industry group comprises establishments primarily engaged in conducting original investigation, undertaken on a systematic basis to gain new knowledge (research), and in the application of research findings or other scientific knowledge for the creation of new or significantly improved products or processes (experimental development).

541710 – Research and Development in the Physical, Engineering and Life Sciences
Includes:
Laboratories conducting research in biotechnology, entomology, genetics, engineering, mathematics, medicine, life sciences, physical sciences, bacteriology.

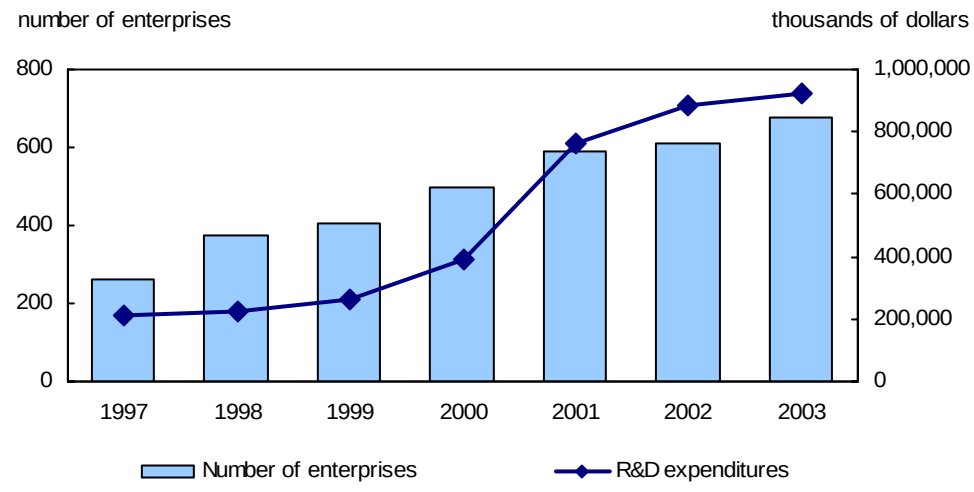
541720 – Research and Development in the Social Sciences and Humanities
Includes:
Research and development services in behaviour, demography, cognitive development, education, economic studies, humanities, social sciences, archeological sites, excavations, sociology.

Exclusions

Research and development activities performed by establishments belonging to enterprises whose primary activity is classified under another NAICS code, such as aerospace. Also excluded are laboratories performing clinical, medical and diagnostic analysis tests or veterinary

1. Statistics Canada is currently conducting an exploratory project including several studies on understanding the classification system and the characteristics of activities in the scientific research and development industry.

Chart 1 Research and development (R&D) expenditures and number of enterprises in the scientific R&D services industry, 1997 to 2003



Source: Statistics Canada, Research and Development in Canadian Industry.

A young and dynamic industry

The number of new enterprises in the scientific research and development services industry becoming active from one year to the next more than offset the number of enterprises ceasing their research activities. In part, these new enterprises explain the growth of expenditures in this industry. In 2003, 188 enterprises performed R&D that were not active in 2002. Not much more than half that number (122 enterprises), were performing, but were no longer active in 2003 (Table 1).

Table 1 Number of enterprises entering and exiting the scientific R&D services industry, 1998 to 2003

	Entries	Exits	Difference (entries less exits)
Year	number of enterprises		
1998	172	62	110
1999	109	76	33
2000	181	90	91
2001	196	103	93
2002	178	160	18
2003	188	122	66

Source: Statistics Canada, Research and Development in Canadian Industry.

Start-up enterprises[2] accounted for a major share of the industry's activities. In 2003, 44% of enterprises in the scientific R&D services industry had revenues lower than their R&D expenditures. Even so, these enterprises accounted for 57% of total R&D expenditures in the industry (Table 2). The share of start-up enterprises grew from 36% in 1997 to 44% in 2003.

Table 2 Contribution of start-up enterprises to the total for the scientific R&D services industry, 1997 to 2003

	Number of start-up enterprises/ total enterprises (NAICS 5417)	R&D expenditures of start-up enterprises/total R&D expenditures (NAICS 5417)
Year	% of enterprises	% of R&D expenditures
1997	36	49
1998	31	48
1999	38	43
2000	37	51
2001	41	61
2002	40	58
2003	44	57

Source: Statistics Canada, Research and Development in Canadian Industry.

Summary

The scientific R&D services industry has seen rapid growth in its expenditures and the number of R&D performers since 1997. This industry is dynamic, as seen not only by the increase in new R&D performers but also by the major contribution of start-up enterprises in terms of R&D expenditures and jobs devoted to R&D.

Julio Miguel Rosa, SIEID, Statistics Canada

2. A start-up enterprise is defined as an enterprise whose revenues are less than or equal to its total R&D expenditures. Such an enterprise has probably not yet reached a sufficient production scale to generate a profit on the investment in R&D. It therefore appears reasonable to consider such a firm as a young or start-up enterprise.

Research and development outsourcing and innovation: Evidence from micro-data

Statistics Canada's 2005 Survey of Innovation included questions on the outsourcing of research and development. This article presents the main findings of a study[1] that tested whether establishments that outsource research and development are better innovators than establishments that do not.

Recent improvements in information and communications technologies (ICTs), coupled with the rise of new global players such as China and India, have enabled firms to outsource a growing share of their activities. This has allowed them to benefit from cost savings and to focus on their core competencies. While domestic and foreign outsourcing of certain manufacturing functions have been prevalent for decades, only recently has the trend extended significantly to services such as legal, accounting, data entry, and research and development (R&D).

Context

The impact of R&D outsourcing on the performance of firms has attracted some attention in the literature, especially with regard to its impact on innovation. Is the purchase of R&D services from arm's length providers a substitute for R&D conducted in-house, or does it complement internal R&D? If the former is true, then the impact on innovation performance should be neutral; if the latter holds, then establishments that outsource at least some of their R&D should experience a better innovation performance than those that do not. The inclusion of questions related to R&D outsourcing in the 2005 Survey of Innovation allowed for an assessment of this important question using Canadian establishment-level data for the first time.

Over the period 2002 to 2004, 10.7% of Canadian manufacturing establishments outsourced at least a share of their R&D. Of these, 68.4% outsourced within Canada only. In fact, 65.2% outsourced within their own province only and 1.7% outside of Canada only. A further 29.9% had a mixed R&D outsourcing strategy, combining both domestic and foreign suppliers of R&D services.

The analysis was restrained to either establishments that outsourced R&D and/or those that had the potential to conduct R&D. The sample is a cross-section of 4,420 manufacturing establishments of which 840 outsourced R&D, either domestically or internationally. In order to ensure that the impact of R&D outsourcing (as opposed to R&D expenditures) was measured, 1,723 establishments that did not conduct R&D were excluded from the analysis. These establishments did not outsource R&D, did not have any R&D employees and did not receive any governmental support for R&D; thus, they were not considered to be in the R&D business.

Moreover, differences in innovation performance between establishments that outsourced domestically versus abroad were not considered, as the framework and the data available only allowed for a comparison of establishments that conducted domestic or foreign R&D outsourcing with those that conducted neither.

The survey covered the reference period 2002 to 2004. This study was done through the Statistics Canada facilitated access program. For more information about facilitated access, contact Frances Anderson (frances.anderson@statcan.ca).

More information about the Survey of Innovation 2005 is available at:

http://www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=4218&lang=en&db=IMDB&dbg=f&adm=8&dis=2.

Examining the data using a matching estimator

In order to compare the innovation performance of establishments that outsourced R&D with establishments that did not, a matching estimator technique was used. This technique aimed to match each individual R&D outsourcing establishment with another establishment that closely resembled it, but that did not outsource its R&D. After matching, the performance of the two groups of establishments showed similar characteristics with respect to size, industry, geographical location, share of employees with a university degree, etc., and their innovation

1. The complete study can be found at: Bérubé, C. and Sabbagh, M. (2006) "R&D Outsourcing and Innovation: Evidence from Micro-Data", Industry Canada, pp. 1-26.

performance could therefore be directly compared. In a separate analysis, estimations were conducted on innovators only. All estimations were weighted to reflect population figures rather than sample results.

The study found that outsourcing R&D is generally associated with a better innovation performance. Establishments that outsourced R&D produced significantly more innovations than their counterparts. The survey asked whether establishments' new or significantly improved products (goods or services) or processes were a first in their Province, Canada, North America or the World. Establishments that outsourced R&D produced more world-first innovations and were more successful in commercializing their innovations. Nearly three-quarters (73.6%) of R&D outsourcing establishments produced more than one innovation during the reference period (2002 to 2004), compared with 67.3% of non-outsourcing establishments. For those that produced at least five innovations, the difference is even larger; 45.3% of those establishments outsourced R&D compared with 37.4% establishments that did not (Table 1).

Table 1 Outcome measures after matching, 2002 to 2004

	Did not outsource R&D	Out-sourced R&D	P-value
Outcome measures	% of establishments		
Province first	50.8	59.2	0.0034*
Canada first	43.2	48.9	0.0929
North America first	30.4	36.6	0.039*
World first	16.1	21.8	0.0018*
New innovation > 0	67.3	73.6	0.0111*
New innovation > 4	37.4	45.3	0.0067*
New innovation > 9	21.5	26.9	0.0135*
New innovation > 19	10.3	14.3	0.0168*
% Revenue first-to-market > 0	49.6	55.7	0.0232*
% Revenue already-on-market > 0	36.7	49.5	<0.0001*

R&D - research and development.
* Denotes that the data points (percentage of establishments) are significantly different at the 5% level.
Note: In statistical hypothesis testing, the p-value is the probability of obtaining a result at least as extreme as a given data point, assuming the data point was the result of chance alone.
Source: Statistics Canada, Survey of Innovation, 2005, and authors' calculations.

Differing results when considering only innovators

Slightly different results emerged when only innovators were considered (Table 2). Within this sub-sample, R&D outsourcing establishments were not found to produce more innovations. However, they certainly produced more world-first innovations than establishments that did not outsource R&D: 24.4% compared with 18.7%. Similar to the full sample, the innovators sub-sample revealed that R&D outsourcing establishments had a greater share of their revenue coming from already-on-market innovations. This suggests that once an establishment is innovating, R&D outsourcing may be more of a strategy to improve competitiveness than to be first on the market. In other words, establishments that already innovate do not produce more innovations when they outsource their R&D, but they do appear to be more competitive; that is outsourcing R&D allows them to concentrate on other activities.

Table 2 Outcome measures after matching innovators only, 2002 to 2004

	Did not outsource R&D	Out-sourced R&D	P-value
Outcome measures	% of innovating establishments		
Province first	60.9	66.2	0.1074
Canada first	49.6	54.5	0.219
North America first	32.5	40.8	0.0048*
World first	16.8	24.2	0.0002*
New innovation > 0	82.3	82.3	1
% Revenue first-to-market > 0	56.9	62.3	0.0518
% Revenue already-on-market > 0	43.9	55.5	<0.0001*

R&D - research and development.
* Denotes that the data points (percentage of establishments) are significantly different at the 5% level.
Note: In statistical hypothesis testing, the p-value is the probability of obtaining a result at least as extreme as a given data point, assuming the data point was the result of chance alone.
Source: Statistics Canada, Survey of Innovation, 2005, and authors' calculations.

Summary

Establishments are increasingly relying on external or quasi-external forms of R&D such as joint ventures, licensing agreements, and R&D outsourcing. Focussing on R&D outsourcing, and using data from the Canadian Survey of Innovation 2005, this study found that establishments that outsourced part or all of their R&D activities were more prone to innovating than establishments that did neither. In addition, establishments involved in R&D outsourcing produced more world-first innovations than establishments that did not outsource their R&D.

Charles Bérubé and Michel Sabbagh, Industrial Research and Analysis, Industry Canada

A profile of Canada's highly qualified personnel

Highly qualified human resources in science and technology are vital for innovation and economic growth. Both are dependent on the stock of human capital which supplies the labour market with highly skilled workers and helps in the diffusion of advanced knowledge. This article profiles Canada's highly qualified personnel based on immigrant status and place of birth, field of study, and selected demographic and employment characteristics.

The demand for knowledge and skills is not only due to an ageing labour force population, but also to the changes in advanced technologies and the global knowledge-based economy. There appears to be a growing reliance on immigration as a source of skills and labour force growth. Between 1991 and 2001, nearly one-half of the labour force growth occurred in highly skilled occupations that normally require university qualifications.[1] During the same period, foreign-born individuals with university degree qualifications at the bachelor's level or higher contributed to one-quarter of the growth in Canada's labour force.

According to the 2001 Census of Population, there were approximately 3.7 million highly qualified persons (HQPs) in Canada—over 15% of the 24 million labour market population, aged 15 years and over.[2] The majority of HQPs (2.6 million) were non-immigrants, while about 1.1 million were immigrants, and nearly 52,000 were non-permanent residents. Four out of ten immigrant HQPs arrived in Canada between 1991 and 2000, the most recent decade of immigration studied (Table 1). During the early 1990s there were changes to immigration policies that favoured the entrance of immigrants with higher levels of education. This, combined with the high technology boom of the mid to late 1990s, encouraged the immigration of HQPs to Canada. What is striking is that all degree categories examined saw significant increases in the number of HQPs who immigrated between 1991 and 2000, compared with the previous decade. The immigrant and non-permanent resident HQPs include those who had a degree when they immigrated to Canada as well as those who earned their degree after they arrived.

This study is based on data from the 2001 Census of Population. More information is available at:

http://www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SurvId=3901&SurvVer=0&InstaId=13723&InstaVer=2&SDDS=3901&lang=en&db=IMDB&dbg=f&adm=8&dis=2.

A related study entitled 'Where are the Scientists and Engineers', was published in Statistics Canada Catalogue No. 88F0006XIE, April 2007:

http://www.statcan.ca/bsolc/english/bsolc?catno=88F0006XIE2007002

The vast majority (69%) of Canada's highly qualified persons were born in Canada, while the percentage of foreign-born HQPs in Canada was 31% in 2001. As Table 2 demonstrates, there were striking differences by degree categories within certain fields. In the science and engineering (S&E) field, for instance, Canadian-born HQPs were in the minority at the graduate degree level. Foreign-born individuals comprised 54% of the science and engineering HQPs with a master's degree and 61% of the science and engineering doctorates.[3] Foreign-born HQPs are individuals with university qualifications at the bachelor's level or higher who were not born in Canada, including immigrants and non-permanent residents.

Overall, the proportions of male and female HQPs were almost even at 51% and 49%, respectively. There were however gender differences by field of study as well as by degree category. Males dominated the HQPs in science and engineering fields, especially at the doctorate degree level where the ratio was four to one in favour of male PhDs. Female HQPs were in the majority (55%) in the non-science and engineering fields, however a higher proportion of male HQPs were found at the master's and doctorate levels.

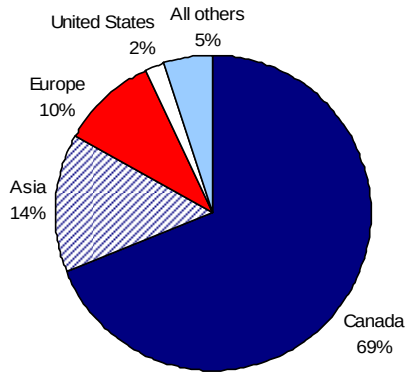
1. Highly skilled occupations normally require a university education; skilled occupations normally require a college diploma or certificate, or apprenticeship training; and, low skilled occupation normally require a high school diploma or less. See, Statistics Canada (2003). *2001 Census: analysis series: The changing profile of Canada's labour force*. Catalogue No. 96F0030XIE2001009, February.

2. Total labour market population (in reference week) refers to the labour market activity of the population 15 years of age and over in the week (Sunday to Saturday) prior to Census Day (May 15, 2001). Respondents were classified as either employed, or unemployed, or as not in the labour force.

3. Approximately 100,000 doctorates were employed in 2001, 47,000 were born in Canada while 53,000 were foreign-born. Of the Canadian-born PhDs, 22,000, or 46% were science and engineering doctorates, while the rest had doctorates in other fields. Of the 53,000 foreign-born employed doctorates, 35,000 or 60% were science and engineering doctorates. For more detailed analysis of Canada's doctorates, please see, McKenzie M. (2007). Where are the Scientists and Engineers, *SIEID Working Papers Series*, Statistics Canada, Catalogue No. 88F0006XIE-no. 002, April.

One-quarter of the foreign-born contingent of highly qualified persons in Canada was from Asia and Europe combined; those born in the United States represented only 2% of the total (Chart 1).

Chart 1 Distribution of highly qualified persons, place of birth by selected country or region, 2001



Source: Statistics Canada, 2001 Census of Population.

In terms of foreign country of birth, the United Kingdom led with over 106,000 of Canada's foreign-born HQPs, followed by India, China, United States and the Philippines (Table 3). Comparisons among the top five foreign countries reveal that more HQPs with doctorates were born in the U.S., while more with master's degrees were born in India, and more with bachelors degrees were born in the Philippines. The United Kingdom, on the other hand, led in HQPs with medical degrees, as well as certificates or diplomas above the bachelor's degree level.

HQPs born in the U.K. and the U.S. were much older due to their earlier arrival compared with the younger more recent arrivals born in India, the Philippines, and China. The median age of those born in the UK was 53 and 47 for the U.S., in contrast to 41 for India and the Philippines and 38 for those born in China.[4]

Definitions

Canada's **highly qualified personnel** (HQP) are defined as individuals with university degrees at the bachelors' level and above.

The **immigrant population** refers to people who are, or have been, landed immigrants in Canada. The **period of immigration** refers to ranges of years based on the year of immigration. The **year of immigration** refers to the year in which landed immigrant status was first obtained.

Non-permanent residents refer to people from another country who had an employment authorization, a student authorization, or a Minister's permit or who were refugee claimants at the time of the Census, and family members living here with them.

The **non-immigrant population** refers to people who are Canadian citizens by birth. Although most were born in Canada, a small number of them were born outside Canada to Canadian parents which accounts for the slight differences between the non-immigrant and Canada figures shown in Table 1 and Table 3, respectively. In the aggregate, the figures for non-immigrants in Table 1 and those born in Canada shown in Table 3 are almost identical.

The **university certificate or diploma above the bachelor level** is obtained following a first degree in the same field of study or following a masters' or first professional degree. In addition to teaching certificates such as a Bachelor of Education qualification, these certificates are also found in applied engineering and high technology areas along with degree programs that have medical specializations.

4. The median age as well as the figures for China in Table 3 refer to the People's Republic of China and do not include S*pecial Administrative Regions*: Hong Kong and Macao. Hong Kong and Macao are included in the overall Asia total. When Hong Kong and Macao are added to China (sometimes referred to as China and Special Administrative Regions) the total university degrees (BA or higher) figure is 152,390 individuals which includes 96,620 with bachelor's degrees, 32,850 with master's degrees, 9,770 with earned doctorate degrees, 8,195 with certificates or diplomas above BA, and 4,945 with medical degrees.

Summary

Canada competes with many other industrialized countries in educating, attracting and retaining highly qualified persons in order to maintain, as well as to augment, the supply of highly skilled individuals to fuel economic growth and prosperity. The end of the high-tech boom, as well as the events of September 11, 2001 has influenced human resources mobility worldwide. Future work based on 2006 Census data is planned to examine in more detail the movement of HQP. If, for example, governments set new targets for research and development and innovation activities, additional research scientists and engineers will be required. Indeed, the analysis of 2006 data will be quite rich in that for the first-time information will be available as to where (province, territory or country) an individual completed their highest degree, certificate or diploma.

Michael McKenzie, SIEID, Statistics Canada

Table 1 Highly qualified persons by immigrant status and period of immigration, 2001

Immigrant status	Total university degrees (BA or higher)	Earned doctorate degree	Master's degree(s)	Bachelor's degree(s)	Degree in medicine, dentistry, veterinary medicine, or optometry	University certificate or diploma above bachelor
				number		
Total	**3,687,645**	**128,625**	**642,055**	**2,411,475**	**122,535**	**382,955**
Non-immigrants	2,567,590	60,070	400,460	1,763,095	74,750	269,210
Immigrants	1,068,275	64,750	229,030	621,120	45,100	108,270
1960 and earlier	95,030	6,690	20,865	50,200	4,400	12,875
1961 to 1970	133,895	12,750	29,740	69,675	6,930	14,790
1971 to 1980	202,140	11,190	37,765	124,000	10,225	18,960
1981 to 1990	201,005	10,250	39,700	124,815	8,245	17,990
1991 to 2000	413,325	22,900	95,310	239,385	14,510	41,215
Non-permanent residents	51,785	3,805	12,565	27,250	2,680	5,475

Notes: Although most non-immigrants were born in Canada, a small number were born outside Canada to Canadian parents which accounts for the slight differences between the non-immigrant and Canada figures shown in Table 1 and Table 3, respectively. In the aggregate, the figures for non-immigrants in Table 1 and those born in Canada in Table 3 are almost identical. Immigrants and non-permanent residents' degrees include those who had a degree when they immigrated to Canada as well as those who earned their degree after they arrived. The 2001 figures for the first 5 months prior to the Census are included in the total. Figures may not add to totals due to rounding.

Source: Statistics Canada, 2001 Census of Population.

Table 2 Highly qualified persons by selected demographic characteristics and field of study, 2001

Field of study	Total university degrees (BA or higher)	Earned doctorate degree	Master's degree(s)	Bachelor's degree(s)	Degree in medicine, dentistry, veterinary medicine, or optometry	University certificate or diploma above bachelor
			number			
Total	**3,687,645**	**128,625**	**642,055**	**2,411,475**	**122,535**	**382,955**
Canadian-born % of total	69	47	62	73	61	70
Foreign-born % of total	31	53	38	27	39	30
Female % of total	49	27	44	52	35	53
Male % of total	51	73	56	48	65	47
Ages 25 to 64	3,207,430	109,415	584,745	2,079,645	102,340	331,280
Median age	41	49	44	39	44	44
Science & Engineering	**1,248,525**	**72,775**	**197,555**	**774,945**	**115,980**	**87,265**
Canadian-born % of total	58	39	46	64	60	48
Foreign-born % of total	42	61	54	36	40	52
Female % of total	38	20	35	41	34	39
Male % of total	62	80	65	59	66	61
Ages 25 to 64	1,072,840	62,940	182,015	657,770	96,790	73,315
Median age	40	47	41	38	45	43
Non-Science & Engineering	**2,439,120**	**55,845**	**444,505**	**1,636,530**	**6,560**	**295,690**
Canadian-born % of total	76	57	70	78	75	77
Foreign-born % of total	24	43	30	22	25	23
Female % of total	55	36	48	58	50	57
Male % of total	45	64	52	42	50	43
Ages 25 to 64	2,134,590	46,475	402,730	1,421,875	5,545	257,965
Median age	41	52	46	39	40	44

Note: Figures may not add to totals due to rounding.
Source: Statistics Canada, 2001 Census of Population.

Table 3 Highly qualified persons, place of birth by selected country or region, 2001

Place of birth by selected countries and regions	Total university degrees (BA or higher)	Earned doctorate degree	Master's degree(s)	Bachelor's degree(s)	Degree in medicine, dentistry, veterinary medicine, or optometry	University certificate or diploma above bachelor
				number		
Total	**3,687,645**	**128,625**	**642,055**	**2,411,475**	**122,540**	**382,955**
Canada	2,552,285	59,365	397,435	1,753,270	74,300	267,920
Asia (excluding China, India, and Philippines)	267,865	10,345	50,080	174,305	11,870	21,260
Europe (excluding United Kingdom)	245,930	17,900	66,355	116,275	11,000	34,400
United Kingdom	106,175	8,730	21,535	58,345	5,425	12,135
India	93,200	4,360	24,140	53,760	3,410	7,530
China	90,115	8,305	23,195	51,090	2,795	4,740
Rest of the world	86,595	6,100	17,670	47,325	5,565	9,940
United States	84,660	9,385	22,485	44,070	2,445	6,275
Philippines	74,790	400	3,880	61,540	1,950	7,020
Central and South America (including the Caribbean)	77,450	2,870	13,600	46,925	3,380	10,675
Australia and New Zealand	8,575	865	1,685	4,575	390	1,060

Notes: Although most non-immigrants were born in Canada, a small number were born outside Canada to Canadian parents which accounts for the slight differences between the non-immigrant and Canada figures shown in Table 1 and Table 3, respectively. In the aggregate, the figures for non-immigrants in Table 1 and those born in Canada in Table 3 are almost identical. The figures in Tables 1, 2 and 3 represent the total stock of HQPs which includes the employed, unemployed and those not in the labour force at the time (reference week) of the 2001 Census. Figures may not add to totals due to rounding.
Source: Statistics Canada, 2001 Census of Population.

Retirement of Lloyd Lizotte

In September 2007, colleagues and friends said good bye and good luck to Lloyd Lizotte as he ended his 36-year career with Statistics Canada, of which 34 years were spent in the field of science and technology.

Known for his friendly personality and easy going manner, Lloyd was well liked by colleagues and clients alike. He was an early bird, arriving at the office everyday at 6:00 a.m., and worked tirelessly in the areas of Research and Development in Canadian Industry (RDCI) and Federal Science Expenditures and Personnel (FSEP).

Congratulations and best wishes are certainly in order for Lloyd. Lloyd will be keeping busy while he waits for his wife to retire. He'll be spending time with his dog at the cottage and renewing himself with his guitar.

Enjoy your retirement Lloyd! Certainly, we will miss you and your contributions to the science and technology program.

What's new?

Read about recent releases, updates and new activities in the areas of information and communications technology, and science and technology.

Information and communications technology

WPIIS Notes

The 11th Session of the OECD Working Party on Indicators for the Information Society (WPIIS) took place in London on May 21, 2007. A significant part of the session was devoted to the upcoming 2008 OECD Ministerial meeting "The Future of the Internet Economy" to be held in Seoul, Korea, 17-18 June 2008.
http://www.oecd.org/document/19/0,3343,en_2649_33757_38051667_1_1_1_1,00.html

The WPIIS agreed that its main contributions to the Ministerial meeting would be a statistical compendium of relevant indicators currently available for OECD and non-OECD countries, an assessment of the most important data gaps in this domain and suggestions for future indicator development and analytical studies.

The agenda also addressed a variety of topics including the development of ICT related definitions and classifications http://www.oecd.org/dataoecd/49/17/38217340.pdf, measuring security and trust in the online environment, measuring user generated content on the web, assessing the impact of ICTs with official statistics and new indicators of e-business and e-government deployment and use. It is expected that final versions of selected documents discussed at the meeting will be released on the OECD web site late in 2007, including:

- Using official statistics to measure the impact of ICT [DSTI/ICCP/IIS(2007)1];
- Security and Trust in an online environment, DSTI/ICCP/IIS(2007)4;
- Measuring user created content, DSTI/ICCP/IIS(2007)3.

Workshop on the economic and social impacts of broadband communications, London, May 22, 2007

The workshop "Economic and Social Impacts of Broadband Communications: from Measurement to Policy Implications" was attended by academics, policy analysts and statisticians.

The morning session focused on reviewing recent evidence and ongoing work examining the impact of broadband on productivity and economic performance. The afternoon session first focused on ICT-enabled changes in production location and impacts on employment. This was followed by a review of the impacts of broadband roll-out on digital content, households and time-use, and on e-inclusion.

The workshop agenda, selected papers and presentations are available at this address:

http://www.oecd.org/document/48/0,3343,en_2649_33757_38697712_1_1_1_1,00.html

The outcomes of this workshop will feed into the Working Party on the Information Economy (WPIE) contributions to the 2008 Ministerial.

Upcoming events

OECD week in Ottawa, October 1-5, 2007:

October 1-2: Meeting of the Working Party on Information Security and Privacy
(WPISP)

October 3: Technology Foresight Forum on the Participative Web
(http://www.oecd.org/site/0,3407,en_21571361_38620013_38620440_1_1_1_1,00.html)

October 4-5: ICCP (Committee for Information, Computer and Communications Policy) Meeting—Mid-term review

WPIE meeting

December 5 and 6, 2007, Paris

ICCP meeting

March 13-14, 2008, Seoul. Approval of final deliverables for the Ministerial

WPIIS meeting:

April 29-30, 2008, Paris

Information Society research and analysis

Over the last year, several studies have been conducted on the factors associated with Internet use, based on data from the 2005 Canadian Internet Use Survey (CIUS):

A paper entitled 'Factors associated with Internet use: Does rurality matter?' was released in the Rural and Small Town Canada Analysis Bulletin (Catalogue no. 21-006, Vol. 7, no. 3) on September 13, 2007.

A second paper 'A new benchmark for Internet use: A logistic modeling of factors influencing Internet use in Canada, 2005' will be published in the Government Information Quarterly (Vol. 24, no. 4).

'Connecting Canadians: Use of the Internet for government on-line', is set to be published in the Connectedness Series (Catalogue no. 56F0004MIE, no. 15), Fall 2007.

Other planned releases include a study on the use of the Internet for learning (Education Matters, Catalogue no. 81-004), as well as a detailed gender analysis of Internet use (Connectedness Series, Catalogue no. 56F0004MIE).

Telecommunications and broadcasting

Annual Survey of Telecommunications Service Providers

The 2005 data will be released in **The Daily** in the fall 2007.

Quarterly Survey of Telecommunications Service Providers

Selected statistics on telecommunications services industries for the third and fourth quarters of 2006 were released on March 5, 2007 and May 14, 2007. The next release is planned for the first quarter of 2008 and will cover the first two quarters of 2007. The release will be based on a redesigned survey.

Annual Surveys of the Radio, Television and Cable Industries

The 2006 statistics for the television and radio industries were released on July 4, 2007 and August 8, 2007. In both cases the release was accompanied by a new and more detailed publication, that is, 'Television Broadcasting Industries, 2006' (56-207-XWE, free) *and* 'Radio Broadcasting Industry, 2006' (56-208-XWE, free).

The processing of 2006 data for program distribution industries is on-going and the next release is planned for October 2007.

Canadian Internet Use Survey

The 2007 CIUS will be conducted in October and November 2007, with findings released in two stages: Internet use in the spring 2008 and electronic commerce in the fall 2008.

Survey of Electronic Commerce and Technology

The 2007 Survey of Electronic Commerce and Technology is currently underway. Collection will take place over the winter and results are expected in the spring 2008.

Science and technology

NESTI Notes

The 2007 meeting of the OECD's Working Party of National Experts on Science and Technology Indicators (NESTI) was held in Paris, June 11th and 12th. There were over 110 participants from 32 countries, as well as a number of international organizations. For the first time, the meeting welcomed delegates from Chile and the participation of NEPAD (New Programme for African Development).

After six years as the Chair of NESTI, Dr. Fred Gault (Canada) will step down to allow rotation in the leadership of this challenging group. While this was Fred's last meeting as the NESTI Chair, he will continue to be involved in the preparation of the 2008 meeting.

Implications of Blue Sky Forum for NESTI agenda

The main messages from the Blue Sky II conference held in Ottawa (September 2006) were discussed, as well as the decision at the May OECD Ministerial to adopt and implement an Innovation Strategy along the lines of the OECD Job Strategy.

There was support for existing work and the improvement of methodological guidelines in the areas of science, technology and innovation, as well as for engaging in analytical activities, such as the exploitation of micro-data sources to conduct impact analysis. The need for initiatives to promote a closer collaboration with policy groups (such as the joint NESTI-TIP workshop) was stressed. Resources, human and financial were a recurring issue, which raised the need for priority setting, especially in light of the potential burden of the Innovation Strategy on NESTI's work programme.
www.oecd.org/sti/blueskyconference.

Innovation

An update of the joint NESTI-WPIA project on exploiting innovation survey micro-data to develop policy relevant indicators and carry out empirical analysis was presented. The four analytical topics on which teams of researchers are working are: (1) innovation and productivity (led by Norway); (2) international channels of knowledge transfer (led by Belgium); (3) technological and non-technological innovation (led by the UK); and (4) innovation and IPRs (led by France).

Results of this work will be presented at a technical workshop on November 13, 2007, followed by a one-day policy oriented conference on November 14. Reports will be published in 2008 and a possible second phase for this work is already being discussed.

The work on the patent Manual is proceeding well and NESTI delegates were invited to get directly involved in its review. A survey of the use of patents by businesses is being coordinated. The survey is run by the European Patent Office in EU countries and by Tokyo University in Japan.

Human resources in science and technology (HRST)

A building-blocks approach to the development of HRST measurement guidelines was discussed, as well as initial proposals for two work modules: one on researchers and post-docs and one on exploiting the potential of existing surveys and administrative data to analyze the role of human S&T resources in innovation and economic performance. There is general support for a building-blocks approach to developing indicators and methodological guidelines in this area, as well as a wish to see a conceptual framework developed into which these blocks would fit.

There was also support for new projects, but limited commitment due to a lack of resources. With the exception of Russia and Belgium, most interventions supported efforts on the exploitation of existing data rather than developing new surveys. It was proposed that an inventory of HRST measurement practices and data sources could be useful to identify gaps and help

set priorities. The US National Science Foundation offered resources to compile such an inventory.

Biotechnology statistics

The template for a regular biennial collection of biotechnology statistics was presented. The template was well received and delegates look forward to the publication of a new OECD Biotechnology Statistics in 2008/09. In view of the recent methodological developments in biotech, as witnessed by the results of the December 2006 Biotech impacts workshop, NESTI approved a proposal for a 2008 meeting of the Ad Hoc group on Biotechnology Statistics.

Nanotechnology measurement

An OECD Working Party on Nanotechnology has recently been created. Its first meeting was held on May 8th and 9th in Leuven, Belgium. A proposal to develop statistics and indicators on nanotechnology, as a co-operative effort of NESTI and the newly created Working Party, was discussed.

NESTI agreed to participate in a workshop on nanotechnology involving policy analysts and statisticians with a view to creating an ad hoc group on nanotechnology statistics to serve the newly created Nanotechnology Working Party.

Internationalization of R&D

A summary of work carried out to date by the task force on R&D internationalization and others was presented and some options for future work were discussed. It was agreed that the work of the task force should continue, in order to extend the 2006 pilot exercise to other countries, to look closely at the ongoing collection of R&D inward and outward data in the context of the OECD Activity of Foreign Affiliates (AFA) database, and to develop methodological recommendations for the measurement of international R&D transactions. Italy has agreed to lead this work.

Research and Development (R&D)

NESTI celebrated 50 years of R&D statistics at the OECD.

The UNSC has approved the capitalization of R&D and work will continue to implement it in National Accounts. A meeting of the joint Task Force of NESTI and the Canberra II group was held in April 2007 and discussed the latest developments in countries (in particular R&D Satellite Accounts), as well as the contents of the new Handbook on Measuring Intellectual Property (HMIP) that is being drafted by the OECD and which includes a chapter on the treatment of R&D in National Accounts.

Having completed its mandate the Canberra II Group will no longer exist as such, but a joint expert group with members from both NESTI and the OECD Working Group on National Accounts will be set up to pursue this work.

The group expressed great interest in the results of the NESTI questionnaire on R&D tax incentives and options for future work, as well as in continuing to compile statistics on indirect government support to R&D. This will be done in close collaboration with taxation experts and innovation policy colleagues. France has proposed to organise a workshop on R&D tax incentives in collaboration with the OECD (December 2007) and this initiative was welcomed by NESTI.

Science and technology activities

Research and development in Canada

The service bulletin 'Estimates of total expenditure on research and development in the health field in Canada, 1989 to 2006 (Catalogue no. 88-001-XIE Vol. 31, no. 2) was released on March 30, 2007.

Industrial research and development

The annual publication 'Industrial Research and Development: Intentions 2006' (Catalogue no. 88-202-XIE) was released on July 31, 2007.

Federal science expenditures

The service bulletin 'Biotechnology scientific activities in federal government departments and agencies, 2005/2006' (Catalogue no. 88-001-XIE Vol. 31, no. 3), was released on May 11, 2007.

Higher education sector research and development

No updates to report.

Human resources and intellectual property

No updates to report.

Federal science expenditures and personnel, intellectual property management annex

No updates to report.

Intellectual property commercialization in the higher education sector

The 2006 survey is now in the field.

Innovation

Innovation in manufacturing

Tables presenting results from the Survey of Innovation 2005 are being prepared and will be made available on CANSIM.

The following two presentations were made available at the Statistics Canada Socio-economic Conference 2007 presenting results from the Survey of Innovation 2005:

> Characteristics of firms that participate in global supply chains: Evidence from the Survey of Innovation 2005 (Susan Schaan, SIEID, Statistics Canada).
>
> R&D outsourcing and innovation: Evidence from micro-data (Charles Bérubé and Michel Sabbagh, Industry Canada).

Analysis of the micro-data of the Survey of Innovation 2005 by external facilitated access researchers has begun and results of two studies have been published:

Are firms that received R&D subsidies more innovative? (Charles Bérubé and Pierre Mohnen, UNU-MERIT Working Paper Series, no. 2007-015).

Motives for innovation co-operation: Evidence from the Canadian Survey of Innovation (Tobias Schmidt, ZEW Mannheim, Centre for European Economic Research Discussion Paper no. 07-018).

SIEID, in collaboration with Industry Canada, is participating in an OECD sponsored project to compare innovation in selected OECD countries. Researchers in the participating countries are developing common econometric models. Canadian researchers are participating in two of the projects, one studying the relationship between innovation and productivity and the other on the sources of international technology transfer.

Innovation in services

A presentation was made at the Statistics Canada Socio-Economic Conference 2007 which proposed the use of NAICS 5417: Scientific Research and Development Services firms in the RDCI database to determine venture firms:

Developing statistical indicators of venture firms (Cindy Bennett and Frances Anderson, SIEID, Statistics Canada).

The working paper 'Innovation and export orientation among establishments in knowledge-intensive business services, 2003' (Catalogue no. 88F0006XIE2007, no. 001), was released in the Daily on April 3, 2007.

Innovation in advanced technologies in manufacturing

Final preparations are underway for the mail-out of the Survey of Advanced Technologies in Manufacturing 2007 which will be in the field in September 2007.

External facilitated access researchers have published an analysis of data from the 1998 Survey of Advanced Technology in Canadian Manufacturing which was linked to the 1998 Annual Survey of Manufacturers:

Productivity, Business Practices and Advanced Technologies in the Canada Manufacturing Sector (Anik Dufour, Industry Canada, Alice Nakamura, University of Alberta and Jianmin Tang, Industry Canada in Industry Canada Working Paper Series, no. 2006-07).

Community Innovation

No updates to report.

Commercialization

A working paper titled 'Report on Interviews on the Commercialization of Innovation' (Catalogue no. 88F0006XIE2007, no. 004) was released on July 16, 2007.

Consultation on the redesign of the Survey of Business Incubators 2005 is currently underway. The redesigned survey is expected to be mailed out in November with preliminary data available in March 2008.

Biotechnology

Results from the 2006 Bioproducts Development and Production Survey are scheduled for release in the fall 2007.

Technological change

No updates to report.

Knowledge management practices

No updates to report.

Another Statistics Canada innovation…

Readers may also be interested in: ***EnviroStats*** (Catalogue no. 16-002-XIE/XWE)

EnviroStats is Statistics Canada's quarterly bulletin of environmental and sustainable development statistics.

EnviroStats provides regular statistical analysis of environmental topics written for a broad audience. At the core of each issue is a feature article. Shorter articles highlight new statistical developments or introduce new concepts. "Updates" cover recent and upcoming events such as releases of new statistical products or overviews of surveys underway. An extensive data table ensures that readers have the most recent statistics available. Each issue will also feature a map illustrating and analyzing a current topic. Statistics Canada http://www.statcan.ca/bsolc/english/bsolc?catno=16-002-X.

New economy indicators

We have compiled some of the most important statistics on the new economy. The indicators will be updated, as required, in subsequent issues. For further information on concepts and definitions, please contact the Editor.

Table 1a General economy and population	2001	2002	2003	2004	2005	2006
Gross Domestic Product (GDP) ($ millions)	1,108,048	1,152,905	1,213,408	1,290,788	1,371,425	1,439,291
GDP implicit price index (1997=100)	106.7	107.8	111.3	114.7	118.4	121.0
Population (thousands)	31,021	31,373	31,676	31,989	32,299	32,624

Source: Statistics Canada, 2007, Canadian Economic Observer, Catalogue no. 11-010-XWB.

Table 1b Gross domestic expenditures on research and development (GERD)	2001	2002	2003	2004	2005	2006
GERD ($ millions)	23,169	23,539	24,337	26,003	27,174	28,357
"Real" GERD ($ millions 1997)	21,714	21,836	21,866	22,670	22,971	..
GERD/GDP ratio	2.09	2.04	2.01	2.01	1.98	1.97
"Real" GERD per capita ($ 1997)	699.98	696.01	690.30	708.68	711.20	..
GERD funding by sector			**% of GERD**			
Federal government	17.7	18.1	18.6	17.9	18.3	18.4
Provincial governments	4.5	5.0	5.7	5.4	5.6	5.8
Business enterprise	50.3	51.3	49.5	49.0	47.9	46.7
Higher education	12.6	14.7	14.7	15.9	16.6	17.4
Private non-profit	2.3	2.7	2.6	2.8	2.9	3.1
Foreign	12.6	8.2	8.7	9.0	8.7	8.5
GERD performance by sector						
Federal government	9.1	9.3	8.6	8.0	8.0	7.6
Provincial governments	1.2	1.2	1.2	1.2	1.1	1.1
Business enterprise	61.6	57.4	56.3	55.5	53.9	52.4
Higher education	27.7	31.7	33.5	34.8	36.4	38.4
Private non-profit	0.3	0.3	0.4	0.4	0.4	0.4
Federal performance as a % of federal funding	51.3	51.5	46.0	44.6	43.4	41.0
"Real" federal performance of research and development ($ millions 1997)	1,972	1,971	2,032	1,872	1,816	1,828

Source: Statistics Canada, CANSIM Table 358-0001 "Gross domestic expenditures on research and development, by science type and by funder and performer sector, annual".

Table 1c Information and communications technology (ICT) sector	2001	2002	2003	2004	2005	2006
ICT sector contribution to GDP[1]						
ICT, manufacturing ($ millions 1997)	11,069	8,619	9,239	9,516	10,261	10,711
% of total ICT sector	20.6	15.9	16.1	16.0	16.5	16.5
ICT, services ($ millions 1997)	42,349	44,982	47,522	49,037	51,325	53,513
% of total ICT sector	78.6	82.9	82.7	82.7	82.3	82.3
Total ICT sector ($ millions 1997)	53,857	54,288	57,482	59,298	62,359	65,029
Total economy GDP ($ millions 1997)	957,258	982,843	1,002,936	1,034,024	1,062,951	1,091,648
ICT as a % of total economy	5.6	5.5	5.7	5.7	5.9	6.0
Total business sector GDP ($ millions 1997)	808,810	831,293	847,701	875,777	902,519	927,625
ICT as a % of business sector	6.7	6.5	6.8	6.8	6.9	7.0

1 Data are in basic prices using chained-Fisher methods of deflation (1997 chained dollars), CANSIM Tables 379-0017 "Gross Domestic Product (GDP) at basic prices, by North American Industry Classification System (NAICS), annual" and 379-0020 "GDP at basic prices, special industry aggregations based on NAICS, annual", www.statcan.ca.

Sources: Statistics Canada, Gross Domestic Product by industry (National) (Annual and Monthly) (various years).

Table 1d Information and communications technology (ICT) access and use	2001	2002	2003	2004	2005	2006
ICT adoption rates (private sector)			**% of enterprises**			
Personal computer	83.9	85.5	87.4	88.6	..	..
E-mail	66.0	71.2	73.8	76.6	76.2	77.5
Internet	70.8	75.7	78.2	81.6	81.6	82.8
Have a website	28.6	31.5	34.0	36.8	38.3	39.7
Use the Internet to purchase goods or services	22.4	31.7	37.2	42.5	43.4	44.8
Use the Internet to sell goods or services	6.7	7.5	7.1	7.4	7.3	8.0
Value of sales over the Internet ($ millions)	10,389	13,339	18,598	26,438	36,268	46,492
ICT adoption rates (public sector)						
Personal computer	100.0	99.9	100.0	100.0	..	..
E-mail	99.7	99.6	99.8	99.9	99.6	99.9
Internet	99.7	99.6	100.0	99.9	99.6	99.9
Have a website	86.2	87.9	92.7	92.4	94.9	94.4
Use the Internet to purchase goods or services	54.5	65.2	68.2	77.4	82.5	79.5
Use the Internet to sell goods or services	12.8	14.2	15.9	14.0	15.2	15.9
Value of sales over the Internet ($ millions current)	354.8	327.2	511.4	1,881.5	2,924.7	3,424.3
ICT adoption rates (individuals aged 18 years and over)			**% of individuals**			
Personal (non-business) Internet use from any location	..	..	..	..	67.9	..
Personal (non-business) Internet use from home	..	..	..	..	60.9	..
Use the Internet to order or purchase goods or services (% of Internet users)	..	..	..	..	41.1	..
Total value of e-commerce orders or purchases ($ billions)	..	..	..	..	7.9	..
Average value of e-commerce orders or purchases (dollars per consumer)	..	..	..	..	1,150	..

Sources: Statistics Canada, Canadian Internet Use Survey; Survey of Electronic Commerce and Technology.

Table 1e Telecommunications services indicators	2001	2002	2003	2004	2005	2006
Teledensity indicators			**per 100 inhabitants**			
Wired access - Voice Grade Equivalent (VGE)	67.1	64.7	63.4	60.7	58.6	55.3
Wireless access (VGE)	34.3	37.9	41.8	46.5	51.4	55.1
Total public switched telephone network (PSTN) (VGE)	101.4	102.6	105.2	107.2	110.0	110.4
			thousands			
Homes with access to cable	11,068.6	11,378.9	11,694.4	11,908.2	12,119.0	..
Homes with access to Internet by cable	9,339.3	10,046.0	10,685.9	11,124.2	11,504.8	..
Access indicators						
Total wired access lines (VGE)	20,805.1	20,300.8	20,067.6	19,470.5	18,976.5	18,108.8
Residential access lines (VGE)	12,854.2	12,752.1	12,648.2	12,488.1	11,948.5	11,147.7
Business access lines (VGE)	7,950.9	7,548.7	7,419.3	6,982.4	7,028.0	6,961.1
Total mobile subscribers	10,648.8	11,872.0	13,227.9	14,912.5	16,642.0	18,041.6
Digital cable television subscribers	808.4	1,146.5	1,403.9	1,810.5	2,281.1	..
Satellite and MDS subscribers	1,609.2	2,018.6	2,205.2	2,324.6	2,494.8	..
High speed Internet by cable subscribers	1,384.8	1,868.8	2,363.2	2,838.8	3,375.7	..
Investment indicators						
Investments by the telecommunications services industries (NAICS 517) ($ millions current)	10,652.8	7,357.2	6,217.8	7,128.4	7,398.9	7,402.5
Investments by the telecommunications services industries (NAICS 517) ($ millions constant)	10,387.4	7,269.6	6,646.5	8,317.8	8,859.9	9,828.1

MDS - multipoint distribution system

Source: Statistics Canada, Telecommunications statistics (various years).

Table 1f Characteristics of biotechnology innovative firms	2001	2002	2003	2004	2005
			number		
Firms	375	..	496	..	532
Total biotechnology employees	11,897	..	11,931	..	13,433
Firms that were successful in raising capital	134	..	178	..	..
Existing patents	4,661	..	5,199	..	..
Pending patents	5,921	..	8,670	..	..
Products on the market	9,661	..	11,046[E]	..	..
Products/processes in pre-market stages	8,359	..	6,021	..	..
			$ millions		
Total biotechnology revenues	3,569	..	3,820	..	4,191
Expenditures on biotechnology research and development	1,337	..	1,487	..	1,703
Export biotechnology revenues	763	..	882	..	..
Import biotechnology expenses	433	..	422[E]	..	..
Amount of capital raised	980	..	1,695	..	..

Source: Statistics Canada, Biotechnology Use and Development Survey (various years).

Table 1g Intellectual property (IP) commercialization	2001	2002	2003	2004	2005
Federal government					
Number of new patents received	109[r]	133[p]	142[r]	..	..
Royalties on licenses ($ thousands)	16,467	16,284[r]	15,509[r]	..	..
Universities and hospitals					
Number of new patents received	381	..	347	396	..
Income from intellectual property ($ thousands)	52,510	..	55,525	51,235	..

Sources: Statistics Canada, Federal Science Expenditures and Personnel Survey, and Survey of Intellectual Property Commercialization in the Higher Education Sector (various years).