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Innovation Analysis Bulletin

A tri-annual report from Statistics Canada with updates on:

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

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As of February, 2005 there were:

- 11 publications for sale
- 12 free publications
- 12 research papers
- 110 working papers, and
- 25 questionnaires.

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	estimated figures
E	use with caution
F	too unreliable to be published

"Commercialization" as a statistical concept?

While Statistics Canada has been measuring certain aspects of commercialization for a long time, the current usage of the word is challenging the statistical system. Universities and federal labs sometimes commercialize their technologies and we measure their license revenues and spin-off firms. In the private sector, commercialization is called "survival". How do we provide a framework and indicators of "everything"?

The beginnings

In 1998 Statistics Canada was asked to develop a survey of intellectual property commercialization in the higher education sector. The resulting surveys and analyses have led to a better understanding of the process of identifying, protecting and marketing ideas. The most recent results are presented in another article in this issue (Read, 2005).

In the same year, we were asked to conduct a similar survey on the management of intellectual property in federal science-based departments and agencies. This has also been an on-going and evolving process of better measuring and understanding how ideas flow from federal labs, how they are protected and how some of them are taken up by the private sector and turned into new products for consumption. New results from this survey are also presented elsewhere in this issue (Bordt, 2005).

In both of these cases, "commercialization" is a rare event. The end point of the commercialization process for the public institutions is usually the licensing of a technology or spinning off of a firm. To measure the benefits to society of those technologies transferred, we would have to ask the businesses themselves how the technologies benefited them. We have made some inroads into this approach by asking businesses whether or not they licensed from universities, hospitals or federal labs. These results are also reported elsewhere in this issue (Bordt and Earl, 2005).

A broader interpretation

The term "commercialization" has recently been the focus of heightened attention in all levels of government, in Canada and internationally. Statistics Canada has been asked to participate in the development of frameworks and indicators. There have been a variety of interpretations and approaches and to help us better understand the current state of the debate, we have brought together a variety of stakeholders on two separate occasions.

The first was a workshop, co-hosted with the University of Windsor, on *Intellectual property commercialization indicators*. The one-day event, held on the University of Windsor campus on November 4th, was an opportunity to establish a dialogue among government, universities and the private sector. The main messages from this workshop were that, as far as measurement was concerned, the universities were well underway in understanding and managing their commercialization activities. Several success stories were related that should serve as best-practice examples. There was little agreement, however on what aspects of commercialization in the private sector might be measured. A detailed summary of the November 4 event will be available shortly as a Statistics Canada working paper (Gault and McDaniel, forthcoming).

One striking characteristic of the Windsor workshop was the variety of interpretations of "commercialization". The three main ones were:

- Research-oriented: The **commercialization of research** was often portrayed as a linear chain of events beginning with research and ending with the commercial success of a product. This approach neglects the convergence of technologies that is often required to create new products.
- Innovation-oriented: The **commercialization of innovation** focuses on the contribution to the economy of *new and significantly improved* products. Although many innovations have a research component (according to our surveys of innovation, about 56% of ideas for innovation come from R&D staff), not all do.
- Competitiveness-oriented: This is the broadest perspective and includes knowledge generation (R&D and education), innovation and productivity. The perception is that improving all aspects of the **system of commercialization** will increase the nation's competitive advantage.

Priorities for measurement

A second meeting was held in Ottawa on December 13th to establish priorities for measurement. It was stressed at the meeting that to measure for the sake of creating indicators is inadequate; it is essential to understand the meaning behind each indicator (for example, "up is good"). The recommendations were to focus on the measurement of:

- the economic impacts of the technologies developed in universities and federal labs,
- the economic contribution of university graduates to the economy;
- the transfers of ideas, whether in the form of protected IP (licensing) or ideas (by collaboration and alliances),
- the relationships/linkages between private sector companies which result in the transfer of information (Stern *et al* 2000 note that "The strength of linkages determines the extent to which the potential for innovation induced by the common innovation infrastructure is translated into specific innovative outputs in nations industrial clusters"),

- the linkages and collaborations required for knowledge transfer and generation as well as its commercialisation,
- the global nature of knowledge generation, technology transfer and the commercialisation of that knowledge,
- the contribution of innovation (new and significantly improved products and processes) to the economy, and
- the quality and capacity of management to bring new ideas to the market.

It was stressed by several participants that the measurement and analysis of commercialization data from multiple sectors is quite different and should not be translated as global indicators for all sectors.

As with the Windsor workshop, a summary of this meeting will be available as a working paper shortly (Earl *et al*, forthcoming).

Future directions

Statistics Canada, with the cooperation of Industry Canada and other partners, is already working to continually improve statistics on intellectual property commercialization in the public sector. The Association of Universities and Colleges of Canada (AUCC) and the universities themselves have contributed to a new questionnaire that was administered in 2004 and detailed data will be released in mid-2005. The Federal Partners in Technology Transfer (FPTT) and the federal labs have a similar commitment to improving measurement of federal IP management.

We are also investigating the feasibility of adding a commercialization component to the 2005 Survey of Innovation. This component could help understand some aspects of the commercialization of new products. Past innovation surveys have always contained a question on the revenues generated from new and significantly improved products. New questions could detail the inputs and barriers to commercializing the innovation. Special studies have already been undertaken that link the surveys of innovation with other sources to obtain measures of growth (e.g., Anderson *et. al* 2004). This approach could be further exploited to better understand the relationships of innovation to productivity and competitiveness.

The contribution of publicly-funded research to private commercialization is not well understood. While the direct financial impacts in terms of numbers of patents and licenses are relatively small (Bordt and Earl, 2004), there is little information on the value of these benefits to the company itself. There is also little information on the contribution of graduates and public knowledge generated by public research.

To better measure the broader economic impacts of publicly-funded R&D, a new survey would be required. Such a survey would not only ask businesses whether they licensed or otherwise transferred technology from public institutions but from other businesses in the same region and internationally. It would possibly get businesses to estimate the proportion of their sales due to technologies licensed from these sources. Such a survey could also ask about sources and quantities of risk capital.

The challenge will still be to link all this together to better understand the contribution of R&D and innovation to the economy. One advisor suggested that we consider the development of a "satellite account"—an approach used to link to the System of National Accounts. Statistics Canada has successfully established satellite accounts for tourism, and materials and energy, for example.

A "competitiveness account" would have to take a new perspective on organizations, beyond the basic inputs and outputs, income and expenditures. Universities train graduates and, together with government labs, produce public knowledge. Companies use knowledge from universities and other sources to innovate and create competitive advantage. Government programs create the linkages that facilitate this transfer. Developing a set of accounts that brings this together would require not only existing data and our current understanding of competitiveness but would also require new data and new research.

Michael Bordt, Louise Earl and Fred Gault, SIEID, Statistics Canada.

Sharonne Katz, Marketplace Innovation, Industry Canada.

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Commercialization in federal science-based departments and agencies, 2002-03

A vast majority of the technology generated by federal research is destined to regulatory and stewardship applications. Some of it does have commercial applications and is licensed to the private sector. Figures for the government as a whole were presented in Vol. 6, no. 2 (June 2004). This issue presents revised data and details by department.

General trends

As reported in the June 2004 issue of the Innovation Analysis Bulletin (Bordt, 2004) patent applications and patents issued increased between 2001-02 and 2002-03, while revenues from licensing decreased slightly. Invention disclosures, which tripled over the two-year period from 1998-99 to 2000-01, also remained high through to 2002-03.

Revised government-wide data are shown in Table 1. The main impact of the revision was an upward adjustment of the total number of patents held for 2002-03. The patent portfolio was reported as decreasing based on preliminary data.

This article investigates some of the details of these trends and provides departmental-level data to help understand the phenomenon.

Departmental detail

Table 2 presents data for each department contributing to the aggregates.

The National Research Council (NRC) is the major contributor to most of the indicators in 2002-03. The NRC was responsible for

Table 1. Federal government intellectual property management indicators, 1997-98 to 2002-03[1]

	1997-98	1998-99	2000-01	2001-02	2002-03
Invention disclosures	128	113	343	216[p]	243[p]
Patents					
Patent applications	233	222	347[r]	356[r]	410[r]
Patents issued	130	89	101[r]	133[p]	142[r]
Patents in force	1,950	1,946	1,389[r]	1,474[r]	1,460[r]
Licenses					
New licenses	398	191	247[r]	181[r]	181[r]
Total licenses	1,112	1,130	1,518[r]	1,440[r]	1,403[r]
Royalties ($ millions)	6.9	12.0	15.5[r]	16.2[p]	15.5[r]
Spin-offs (total historical)	14[r]	44[r]	62[r]	77[r]	85[r]

Notes: There was no survey in 1999-00.

1. Data for 2001-02 and 2002-03 are partially based on estimated data. As an indicator, about 3% of the figure for royalties for 2001-02 are based on 2002-03 data. Similarly, about 27% of the figure for royalties in 2002-03 is based on 2001-02 data.

Sources: Statistics Canada, 2003, Federal science expenditures and personnel 2004/2005, Intellectual property management fiscal year 2002-03. Science, Innovation and Electronic Information Division.

Table 2. Federal government intellectual property management indicators, by department, 2002-03[1]

Department or agency	Inventions disclosed	Patents			Licenses		Royalties	Spin-offs
		applications	issued	total	new	total	$ thousands	number
AAFC	48	89	14	162	24	350	3,548	10
CFIA	1	..	2	2	3	5	25	..
CRC	18	16	17	225	51	298	1,409	5
CSA	37	5	2	30	13	58	49	..
DFO	..	13	1	18	..	13	580	..
DND	18	32	15	222	3	80	1,065	..
EC	..	6	1	35	6	47	748	2
HC	7	10	4	10	1	12	55	1
NRCan	14	19	14	153	32	236	730	3
NRC	100	219	72	603	48	304	7,300	64
Total	**243**	**410**	**142**	**1,460**	**181**	**1,403**	**15,509**	**85**

Notes: 1. Data are partially based on estimated data. As an indicator, about 27% of the figure for royalties in 2002-03 is based on 2001-02 data.

Sources: Statistics Canada, 2003, Federal science expenditures and personnel 2004/2005, Intellectual property management fiscal year 2002-03. Science, Innovation and Electronic Information Division.

55% of the federal government's patent applications, 55% of patents issued and 41% of all patents held. Not all inventions protected and licensed by the NRC are developed in its own labs. Several of the other departments and agencies collaborate with the NRC to commercialize their technologies.

In terms of inventions disclosed, Agriculture and Agri-food Canada (AAFC) contributes the largest share: 39%. AAFC include new plant varieties in their disclosures.

The Communications Research Centre (CRC), Department of National Defence (DND) and Natural Resources Canada (NRCan) also contribute greatly to the overall patent portfolio, licenses and royalties.

Future steps

Statistics Canada is collaborating with the Federal Partners in Technology Transfer and the departments and agencies in producing a more detailed analytical report based on these data.

The questionnaire itself is also under revision. One of the main objectives of the revision process is to better capture the contribution of the departments make in collaborative research.

Michael Bordt, SIEID, Statistics Canada.

Measuring nanotechnology: Small numbers = Large leaps?

Although modest in number, more Canadian firms are becoming involved in R&D development of nanotechnologies. In addition, there are selected service sectors providing goods or services to nanotechnology firms. This article presents data from both these perspectives.

Background

In the winter of 2003, exploratory work with 11,000 firms was conducted in order to identify nanotechnology, biotechnology and bioproduct involvement with the intent to facilitate future research in these three innovative sectors. Participants were asked if they were involved in nanotechnology research and development. Nanotechnology seeks construction of novel nanoscale devices possessing extraordinary properties. Through the development of such instruments and techniques it is becoming possible to study and manipulate individual atoms. This discussion appeared in Volume 5, No. 2 (June 2003)

Nanotechnology R&D

In 2003, an estimated 89 firms were involved in the development in R&D of nanotechnologies. Nanotechnology R&D activity was found in a total of 7 different industries. The most predominant industry sector of activity is Scientific Research and Development Services with 65% of all respondents, followed by Chemical Manufacturing with 11%, while 7% are found in Pharmaceutical and Medicine Manufacturing. It should be noted that no formal nanotechnology classifications exists and further research is required to fully identify sectors of the economy where potential respondents may be found.

Firms providing services to the nanotechnology sector

Evidence of activity in sectors related to nanotechnology firms can be found in data from the Survey of Innovation 2003 which asked firms in selected service sectors if they provided products (goods or services) to nanotechnology firms. In the Information Communication Technology (ICT) Services sector 5% of firms reported that they did provide products to nanotechnology firms. As a comparison, from the same survey 15% of ICT firms reported conducting business with biotechnology firms. The subsectors of Computer and Communications Equipment reported 12% of respondents conducting business with nanotechnology firms and 10% of Electronic and Precision Equipment Repair and Maintenance confirmed doing such business

Although modest in number, the data implies an appearance of firms involved in nanotechnology research and development. The scope of the surveys may not have encompassed all the areas or activities where nanotechnology can be found, but the results helps point us in the right direction of where to go next. Excluded from the survey are very small firms, non-profit, academic and government organizations.

A challenge to measure

Nanotechnologies are transforming techniques and processes that are not restricted to one sector—but a set that spreads across, and throughout the economy. The National Research Council characterizes nanotechnology as "convergence within convergence" Nanotechnology is a cross-sector phenomenon and its potential impacts could be pervasive. Nanotechnology activity is found in the areas as diverse as biotechnology and health, agriculture, electronics and computer technology, environment and energy, optics, and in materials and manufacturing.

The challenge to measuring nanotechnology activities lies in this diversity. As nanotechnologies shift from the research laboratories to the commercial front, their impact on economic and social fronts may become more significant. Further systematic examination is required to further understand the role and impact of nanotechnologies in the Canadian economy.

Chuck McNiven, SIEID, Statistics Canada.

Electronic commerce and Internet use increasing

In 2003 more Canadian households were paying for their goods and services online. Access is critical and households with a high-speed connection were more likely to be electronic commerce households.

More households participating and spending increases

On-line household spending jumped 25% from a year earlier to just over $3.0 billion in 2003, as Canadians bought everything from airplane tickets to books online.

An estimated 3.2 million Canadian households placed orders online in 2003, up from 2.8 million the year before. These households accessed the Internet from various locations, not just home. In total, they placed 21.1 million orders, up from 16.6 million the previous year. On average, e-commerce households spent $956 annually online, with an average dollar value per order of $144 in 2003

An additional 1.7 million households reported that they used the Internet only to window-shop, virtually unchanged from 2001. This group browsed online catalogues to narrow their purchasing decisions, but did not place orders or make purchases online.

More Canadian households were paying for their goods and services online. Despite many shoppers indicating concerns about security aspects of the Internet, they were still willing to use their credit cards online. In fact, the proportion of electronic commerce households that paid for their Internet orders online rose from 79% in 2001 to 85% in 2003.

Books, magazines still most popular purchase

As displayed in Table 1, reading materials such as books, magazines and newspapers were still the most popular online purchases in 2003. About 30% of e-commerce households reported purchasing these items. However, consumers are increasingly using the Internet to make travel arrangements. In 2003, 22% of households reported making travel arrangements over the Internet, up from 18% the year before.

Access the key

Households with a high-speed connection are more likely to be electronic commerce households. Over 7 of 10 commerce households have a high-speed connection.

Although total electronic commerce spending represents only a fraction of the $688 billion in total personal expenditure in Canada in 2003, the data confirms that households are increasingly using the Internet as a method of purchasing goods.

*The data in this article first appeared in Statistics Canada's **The Daily** on September 23, 2004*

The Household Internet Use Survey will not be conducted for the 2004 reference year and is targeted to be replaced by an individual level survey for reference year 2005.

Jonathan Ellison, SIEID

Table 1. Type of products and services for which electronic-commerce households shopped from any location, 2001, 2002 and 2003

Products and services	2001	2002	2003
	%		
Books, magazines and newspapers	28.1	26.9	29.8
Travel arrangements	16.2	18.2	21.9
Computer software	13.8	13.8	14.2
Automotive products	2.6	3.5	2.9
Music (CDs, tapes, MP3)	11.8	9.4	11.1
Clothing, jewellery and accessories	18.2	17.7	17.2
Computer hardware	6.4	6.5	6.0
Consumer electronics	6.7	6.4	10.5
Other entertainment (e.g., tickets)	10.6	10.4	10.0
Banking and financial	..	..	..
House wares (furniture and appliances)	5.6	6.4	7.0
Other	14.8	17.8	15.0
Videos, Digital Video Discs	5.0	5.5	8.0
Hobbies	3.6	3.8	4.5
Food, condiment and beverages	2.9	3.1	2.1
Toys and games	6.1	5.4	5.7
Real estate	0.4[E]	0.1[E]	0.4[E]
Health, beauty, vitamins	5.1	4.6	4.9
Flowers, gifts	4.8	3.7	3.5
Sports equipment	5.5	5.3	5.8

Examining extranet technology

The percentage of firms using an extranet in Canada remains low with just over 6% of private firms using an extranet in 2003. Nonetheless, extranets could become an important part of the e-business landscape in Canada. This article examines the functionality of extranets that Canadian firms are currently employing.

What is an extranet?

An extranet is an extension of a company's Intranet onto the Internet, which allows selected firms and individuals to access the company's private data and applications via the Internet. While an Intranet may improve communication within a firm, an extranet extends this with the ability to provide better communication between a firm and their customers and suppliers. An extranet is well-secured because of the sensitivity of information available. Access can only be attained by users who pass through a firewall by using a valid username and password.

An extranet, as defined by the Survey of Electronic Commerce and Technology (SECT), is a secure extension of an Intranet that allows external users to access some parts of an organization's Intranet.

Exploring the benefits of an extranet

While traditional methods of exchanging information electronically such as Electronic Data Interchange were costly and cumbersome, extranets provide even small firms with an efficient way to connect their business to trading partners. Since communications can be conducted using Internet protocol, the development of a proprietary system is no longer necessary. An extranet can transform the supply chain by eliminating paperwork, lowering costs and providing up-to-date information to firms that provide goods to, or purchase goods from, a given firm.

For example, a small business may be able to access the extranet of a large warehouse store to monitor the sale of their goods and to anticipate when they need to re-supply the firm. In addition, many large firms may now require that businesses they purchase from have an accessible extranet so they can re-order inventory from suppliers at a moment's notice on a twenty-four hours per day basis.

In addition to connecting firms to their customers and suppliers, extranets can also be beneficial in providing their own employees with access to information from remote locations. Employees are able to log into the company Intranet through the extranet interface.

High public sector, low private sector extranet use in Canada

As displayed in Table 1, the percentage of private firms using an extranet in Canada remains low with just over 6% of firms using one, a marginal increase from the 4% of overall firms that used one in 2001. However, firms in the public sector have put this technology into use more quickly with 42% of public-sector firms having implemented an extranet in 2003.

Large firms have most extensive extranet use in Canada

A sizeable portion, 33%, of large firms in Canada employed an extranet in 2003. These large firms, like their public sector counterparts, have the technical resources and financial capital to invest in an extranet. While still accessible to them, the percentage of small firms using an extranet is much lower. The technology may not be applicable to some small business and the monetary investment may be more of an obstacle. The initial adoption of this technology primarily by large firms is no different than with many other Internet Communication Technologies.

Table 1. Firms using an extranet (2001-2003)

Year	Private	Public
	%	
2001	4.2	35.0
2002	5.3	37.7
2003	6.1	41.9

Table 2. Private sector firms with an extranet in 2003

Firm Size	%
Small	4.22
Medium	16.06
Large	33.17
Overall	6.08

Types of firms using extranet

In 2003, the Financial Services sector had the highest percentage of firms using an extranet. Overall, 19% of firms in this sector had an extranet, and over 80% of large firms had an extranet. In the Information and Cultural Industries sector, 16% of all firms used an extranet. However, in both cases, the growth rate for this technology since 2001 has been low as firms in these sectors adopted this technology early in its growth cycle.

Not all firms need extranet technology

There are certain industrial segments for which growth in the use of extranets should not be expected. In some sectors the need for the technology does not exist for most firms in that sector and only a few will choose to adopt it.

The data in this article first appeared in Statistics Canada's The Daily on April 16, 2004

Mark Uhrbach, SIEID, Statistics Canada

Research and development intensity in Canada

The two most commonly used measures of R&D intensity are R&D spending as a percentage of total revenue, commonly applied at the firm level, and R&D spending as a percentage of value-added, when measuring R&D in the total economy. This article highlights the interval 1997 to 2002, a period for which consistent data are available, to compare the two measures.

Top five

Industries with high R&D spending tend to have high R&D intensities. In terms of dollars spent, data from the Research & Development in Canadian Industry survey[1] reveals the top five industries or industry groups in Canada in 2002 were:

- communications equipment manufacturing,
- pharmaceutical and medicine manufacturing,
- design, management, scientific and other professional and technical services,
- computer systems design and related services, and
- aerospace product and parts manufacturing.

These five industries accounted for just under half of all industrial R&D throughout that interval.

Pharmaceutical and medicine manufacturing

When measured as a percentage of GDP, or value-added[2], pharmaceutical and medicine manufacturers reported R&D intensities ranging from 21% to 28% between 1997 and 2002. When measured as a proportion of total sales of R&D performing firms, the intensity measure has increased from 7.7% in 1997 to 12.2% by 2002. This has occurred despite a rapid increase in revenues and value-added and is reflected in the shift in rank of the pharmaceutical industry in terms of R&D spending overall. The industry has traditionally ranked around fifth in terms of R&D spending. In 2002, it ranked second with the total amount spent more than doubling in real terms between 1997 and 2002. Other industries are part of a broader pharmaceutical industry and also account for significant R&D spending in this area. Multi-national pharmaceutical firms with no manufacturing facilities in Canada are frequently classified as pharmaceutical wholesalers. These firms account for a significant portion of all R&D performed by wholesalers. Also, some firms in R&D services and health care and social assistance are engaged in biotech or pharmaceuticals research.

Aerospace products and parts manufacturing

The aerospace industry has traditionally been second largest performer of R&D in Canada but the amount spent by firms in this industry has been dropping in real terms since 1999. The R&D intensity of this industry, whether measured in terms of GDP or revenues of R&D performing firms, has also dropped between 1997 and 2002 from 22.1% to 16.6% and 9.2% to 5.6%, respectively.

Computer systems design and related services

Computer systems design services has reported a substantial increase in real spending on R&D performance, almost doubling between 1997 and 2002. The R&D intensity of the industry however has dropped slightly by both measures from 14.5% to 11.5% for revenues and 10.3% to 8.8% for GDP. This illustrates the impact of even more rapid increases in the industry's value-added and the revenues of firms in the industry performing R&D.

Design, management, scientific and other professional and technical services

The R&D services industry is included in the industry grouping design, management, scientific and other professional and technical services which has grown rapidly over the period studied (there are no GDP data for R&D services). Like Computer systems design and related services, this industry has also reported rapid increases in R&D spending and R&D intensity, whether measured in terms of revenues or value-added. In 1997, this industry group accounted for 3.2% of all R&D spending. By 2002, it accounted for 7.6%. R&D intensity as a proportion of GDP increased from 4.6% to 9.6% while as a proportion of revenues of R&D performing firms it ranged from 23% in 1997 to 44% in 2001. What is not clear from the data at this time is the proportion of this work that is performed for the purpose of bringing a product to the market by the firm, what is performed on contract or speculatively in the hope of finding a buyer, and what is undertaken to attract a buyer to takeover the firm once the technology is viable.

Communications equipment manufacturing

Telecommunications has been the top R&D performing industry for many years in Canada. This industry was part of the "tech

1. For full details, see *Industrial Research and Development, 2004 Intentions*; Statistics Canada Catalogue no. 88-202-XIE, January 2005. Note, for this paper, total R&D spending has been used instead of current R&D spending. Total R&D spending includes capital spending, which is typically less than 5% of total R&D spending. The publication (Table 12) uses the current R&D spending as a percentage of total revenues of all R&D performers.
2. Value-added is outputs from an industry less intermediate inputs.

Table 1. R&D intensity by top 5 industries (R&D spending / Firm revenues of all R&D performers, %)

Industry (NAICS)[1]	1997	1998	1999	2000	2001	2002
Pharmaceutical and medicine manufacturing	7.7	7.7	7.2	8.9	10.2	12.2
Communications equipment manufacturing	17.5	19.3	17.7	16.1	13.6	31.1
Aerospace product and parts manufacturing	9.2	9.2	9.0	6.7	5.8	5.6
Computer systems design and related services	14.5	13.3	10.4	11.3	13.4	11.5
Design, management, scientific and other professional and technical services	22.7	33.5	27.1	35.2	44.0	23.8
All industries	**1.6**	**1.7**	**1.6**	**2.0**	**2.3**	**1.9**

Source: Statistics Canada, Research and Development in Canadian Industry.
Figures for the remaining 40 industries are available upon request.

Table 2. R&D intensity by top 5 industries (R&D spending / GDP by industry, %)

Industry (NAICS)	1997	1998	1999	2000	2001	2002
Pharmaceutical and medicine manufacturing	21.1	24.0	20.6	27.6	24.5	25.5
Communications equipment manufacturing	56.6	61.6	39.6	51.7	107.9	88.8
Aerospace product and parts manufacturing	22.1	24.7	20.9	14.2	15.9	16.6
Computer systems design and related services	10.3	9.5	6.8	8.5	10.6	8.8
Design, management, scientific and other professional and technical services	4.6	4.5	4.1	5.2	9.0	9.6
All industries	**1.1**	**1.1**	**1.1**	**1.3**	**1.4**	**1.3**

Source: Statistics Canada, Research and Development in Canadian Industry and CANSIM table 379-0017.
Figures for the remaining 40 industries are available upon request.

bubble" and its R&D intensity figures are, accordingly, unusual. Prior to 2001, the industry reported a high R&D intensity, both as a percentage of GDP (in the range of 50%) and as a percentage of firm revenues (around 17%). In 2001, however the R&D intensity as a percentage of GDP was over 100%. This means that R&D spending was greater than value-added in this year. The figure for 2002 was also very high, but under 100%. The figure for R&D intensity as a percentage of revenues, by contrast, increased dramatically, only in 2002.

Other industries

Other industries of interest include paper manufacturing, which reported R&D as percentage of GDP doubling between 1997 and 2002, from 1.2% to 2.4%. Chemicals other than pharmaceuticals reported increasing R&D intensities in terms of GDP, as did Machinery manufacturing, Instruments manufacturers, Motor vehicle manufacturers, Information and cultural services and Architectural, engineering and related services. All of these industries also experienced increases in R&D intensity as a percentage of revenues of R&D performing firms, with the exceptions of instruments and motor vehicles which held steady as a percentage of revenues.

The R&D intensity ratios measure the level of commitment firms and industries are prepared to devote to development of new products and processes. As a ratio, changes to either the numerator or the denominator can signal shifts in the industry. For example, in Aerospace product and parts manufacturing and Architectural, engineering and related services changes to R&D spending shifted the ratio. By contrast, in Computers and peripheral equipment, R&D performance held steady but revenues and value-added dropped. A steady ratio, however, does not mean that no change has taken place; rather, changes in value-added or revenues have mirrored changes in R&D spending, as illustrated by the computer systems design industry.

Charlene Lonmo, SIEID, Statistics Canada.

Biotechnology use and development

Preliminary data indicate the biotechnology sector continued its phenomenal growth in Canada between 2001 and 2003, generating almost $4 billion in revenues. Biotechnology companies have more than quadrupled their revenues since 1997, making biotech a quickly growing activity.

Number of firms growing

There were 496 innovative biotechnology firms in Canada in 2003, a 32% increase from 375 in 2001 and a 76% increase from 282 firms in 1997. Of note, half of the increase in the number of firms between 2001 and 2003 is explained by the creation of new firms during this period.

Revenues up; large firms equal large revenues

Canada's 496 biotechnology companies generated revenues of $3.8 billion in 2003, up 7% from 2001 (see Table 1). Their spending on research and development also increased by 11% to $1.5 billion.

Large biotech companies, or those with at least 150 employees, represented only 13% of the 496 biotech firms in 2003, but accounted for 64% of biotech revenues. Nearly three-quarters of all companies were small firms, that is, they had fewer than 50 employees.

Medium-sized firms, those with between 50 and 149 employees accounted for 47% of spending on biotechnology research and development.

Big three lead the way

More than 70% of the innovative biotechnology firms were in only three provinces: Quebec, Ontario and British Columbia. These provinces continue to comprise the bulk of Canadian biotechnology activity, accounting for more than 80% of biotechnology revenues in 2003.

Ontario firms led the way in biotechnology revenues, whereas those in Quebec accounted for the largest share of biotechnology firms, biotech employees and research and development spending.

Employment unchanged

Despite an increase in the number of firms, the number of employees working in biotechnology-related activities remained stable at about 11,900. The number of employees with biotech related activities increased for small and medium-sized firms (13% and 16% respectively) between 2001 and 2003; large firms were the only ones that saw a decrease (-16%) in their number of biotech employees during that period. Nevertheless, large firms continue to employ the largest share of biotech employees, contributing to 39% of biotech employees in Canada in 2003.

Table 1. Biotechnology key indicators, 2003

	Innovative biotechnology companies	Employees with biotechnology-related activities	Biotechnology revenues	Biotechnology R&D expenditures
	number		$ millions	
Canada	496	11,931	3,821	1,487
Sector				
Human Health	262	9,194	1,999	1,316
Agriculture biotechnology	89	1,155	448	66
Natural resources	21	120	X	13
Environment	40	290	36	37[E]
Aquaculture	15	167[E]	14[E]	7
Bioinformatics	16	244	X	26[E]
Food processing	54	761	1,266	23
Province				
Quebec	146	3,695	480	490
Ontario	130	3,557	2,026	453
Manitoba	21	1,213	145[E]	56[E]
Saskatchewan	35	380	71	23
Alberta	44	718	298	88
British Columbia	93	2,158	780	370
Atlantic	27	210	21	7
Size				
Small (0 to 49 employees)	355	3,557	469	495
Medium (50 to 149 employees)	77	3,746	909	699
Large (150 employees and over)	64	4,628	2,443	293

Source: Statistics Canada, Biotechnology Use and Development Survey 2003.
Notes: Preliminary data.

Whereas biotech revenues decreased in the human health sector (-19%) between 2001 and 2003, the number of employees with biotech related responsibilities increased by 6%. Inversely, while biotech revenues were up by 83% in the agriculture biotechnology sector, the number of employees was down by 8% during the same period. In fact, the number of biotech employees increased for all sectors between 2001 and 2003 except for firms in the agriculture biotechnology, the environment and the food processing sectors.

R&D expenditures

For 2003, Canadian biotech companies spent almost $1.5 billion on biotech research and development, representing an 11% increase. As displayed in the table above, biotech R&D is dominated by the human health sector. In fact, in 2001 and 2003, companies in the Human Health sector represented 88% of biotech R&D, followed by the agriculture sector (4% of Canadian biotech R&D in both years).

Conclusion

In 2003, most of the biotechnology key indicators were up from 2001: the number of biotechnology innovative firms increased by 32%, biotechnology revenues by 7% and biotech R&D by 11%. The number of employees with biotechnology-related activities remained rather stable at 11,931. A similar trend was observed between 1997 and 1999 where all biotech key indicators were up (number of biotech innovative firms, revenues, R&D) but the number of biotech employees was down by 15%.

This article is based on information originally released in ***The Daily*** *on December 14, 2004*

Lara Raoub, SIEID, Statistics Canada.

What's new?

Recent and upcoming events in connectedness and innovation analysis.

Connectedness

No updates to report.

Telecommunications

Annual survey of telecommunications service providers

The release of selected national and provincial statistics for 2003 is planned for February 2005 in *Broadcasting and Telecommunications*, Telecommunications 2003, Catalogue No. 56-001-XIE, Vol. 35, No. 1.

Quarterly survey of telecommunications service providers

Selected statistics on the telecommunications services industries for the second quarter of 2004 were released in *The Daily* on November 3, 2004. The second quarter 2004 issue of *Quarterly telecommunications statistics* (56-002-XIE) was released November 9, 2004.

The release of statistics for the third quarter of 2004 is planned for early February of 2005.

Broadcasting

The collection and processing of 2004 data for the radio, television and cable industries are underway. The release of data for these industries is planned for the summer of 2005.

Household Internet use

No updates to report.

Business e-commerce

Survey of electronic commerce and technology

The *2004 Survey of Electronic Commerce and Technology* was mailed out in November 2004. Results expected in April 2005.

Science and innovation

S&T activities

Research and development in Canada

The service bulletin and working paper *Total spending on research and development in Canada, 1990 to 2004p, and provinces, 1990 to 2002* (88-001 Vol. 28, No. 12 and 88F0006XIE2004020) were both released in *The Daily* on December 12, 2004. Table 358-0001 on CANSIM has also been updated with the newest GERD data.

A new heading has been added to the Economy section of the Canadian Statistics called ***Science and Technology***. We have included here some of our GERD data.

Industrial research and development

The annual publication 88-202XIE *Industrial Research and Development, 2004 Intentions* (with 2003 preliminary estimates and 2002 actual expenditures) was released in January 5, 2005.

A new industrial survey working paper, *Industrial R&D statistics by region 1994 to 2002* was released in the *Daily* on January 27, 2005.

Federal science expenditures

The service bulletin, Federal government expenditures on scientific activities, 2004-2005p (88-001, vol. 28, No. 11) was released in *The Daily* on November 24, 2004. The accompanying working paper, *Federal government expenditures and personnel in the natural and social sciences, 1994-95 to 2003-2004*, (88F0006XIE2005001) was released on January 19, 2005.

The service bulletin and working paper showing federal government regional data Provincial distribution of federal expenditures and personnel on science and technology, 1996-97 to 2002-2003 (88-001 Vol. 29, No. 1 and 88FOOO6XIE2005002) were released in *The Daily* on January 25, 2005.

Higher Education Sector R&D

The service bulletin and working paper, *Estimation of research and development expenditures in the higher education sector, 2002-2003* (88-001 Vol. 28, No. 10 and 88FOOO6XIE2004019) were released in *The Daily* on November 23, 2004.

Provincial research organizations

No updates to report.

Human resources and intellectual property

Federal intellectual property management

Federal science expenditures and personnel, intellectual property management annex

No updates to report.

The higher education sector

Intellectual property commercialization in the higher education sector

Preliminary results were released in *The Daily* on December 9th, 2004.

Innovation

Innovation in manufacturing

Preliminary consultations and questionnaire development have begun for a survey of innovation which will take place in the fall of 2005.

Innovation in services

The full set of tables from the Survey of Innovation 2003 was released in *The Daily* on January 26, 2005.

Several facilitated access projects analysing data from the Survey of Innovation 2003 have been approved. Jianmin Tang of Micro-Economic Policy Analysis Branch, Industry Canada will conduct two research projects, *Business Practices, ICT Adoption and Productivity in Canadian Manufacturing Firms* and *Government Support, Cooperation and Commercialization of Innovation in Canadian Manufacturing Industries.* Petr Hanel, of the University of Sherbrooke, will undertake a project, *Adjustments in Labour Markets for Skilled Workers*.

Community innovation

No updates to report.

Biotechnology

Preliminary data for the 2003 Biotechnology Use and Development Survey was released in *The Daily* on December 14, 2004. Additional data will be available throughout the winter of 2005.

Technological change

No updates to report.

Other

The working paper *Characteristics of Firms that Grow from Small to Medium Size: Growth Factors: Interviews and Measurability, 1999*, no. 21 was released in *The Daily* on December 12, 2004.

A working paper, *Characteristics of firms that grow from small to medium size: Innovation and growth in small manufacturing firms, 1997-1999*, no. 22 was released in *The Daily* on December 17, 2004.

In brief

In this section, we highlight articles of interest that have recently appeared in the Statistics Canada ***Daily*** and elsewhere.

Public sector technology transfer in Canada, 2003

Technology acquired from universities, hospitals or government labs has played a major role in the success of more than 4,400 Canadian companies. Of the $22 billion of R&D performed in Canada, about 10% is performed by federal government and 35% by universities. This report is a first Canadian attempt to view the impact of federally-funded research from the perspective of the whole economy.

This article first appeared in Statistics Canada's *The Daily* on November 2, 2004. The working paper *Public Sector Technology Transfer in Canada 2003* (88F0006XIE2004018, free) is available online.

Michael Bordt and Louise Earl, SIEID, Statistics Canada.

Renewing Canada's manufacturing economy

The driving force behind job renewal in manufacturing in Canada has not been the decisions of firms to establish new manufacturing plants. Rather, job renewal results from the decisions of new firms to establish new manufacturing plants. The paper indicates that job turnover in the manufacturing sector has a substantial long-term component. Moreover, it quantifies the size of this process decade by decade. Over a decade, almost 40% of jobs are renewed. Using a 20-year time frame, over 65%

of the economy is renewed; over a 30-year period, renewal amounts to just over 75%; and by 40 years, just over 85% of jobs are new.

This article first appeared in Statistics Canada's *The Daily* on October 21, 2004. The research papers *Four Decades of Creative Destruction: Renewing Canada's Manufacturing Base from 1961 and 1999*, no. 8 (11-624-MIE2004008, free) and *Renewing Canada's Manufacturing Economy: A Regional Comparison, 1973 to 1996*, no. 23 (11F0027MIE2004023, free) are now available online.

John Baldwin and Mark Brown, Micro-economic Analysis Division, Statistics Canada.

Commercialization of intellectual property in the higher education sector

Canadian universities and hospitals recorded moderate gains in commercializing inventions between 2001 and 2003, according to preliminary data from the Survey of Intellectual Property Commercialization in the Higher Education Sector.

Universities and their affiliated research hospitals make an important contribution to innovation in Canada's economy. Besides generating new knowledge and training highly qualified graduates, some of the technology they produce is patented and licensed to companies for incorporation into commercial products. Some of these companies are spin-offs, which are created specifically to license and commercialize technology developed at the institution. Income from intellectual property commercialization reached $51 million and new patent applications increased 35%.

The data in this article first appeared in Statistics Canada's *The Daily* on December 9, 2004.

Cathy Read, SIEID, Statistics Canada.

Export market participation, innovation and productivity growth

Canadian companies that participate in export markets show superior performance when it comes to growth in labour productivity and innovation than those that don't, according to a new study of trade liberalization. The findings suggest that trade policies that encourage the international orientation of Canadian firms will have a positive impact on the competitiveness and innovation performance of Canadian firms.

This article first appeared in Statistics Canada's *The Daily* on December 14, 2004. The research papers *Trade Liberalization: Export-market participation, Productivity Growth and Innovation*, no. 27 (11F0027MIE2004027, free) is available online.

John Baldwin and Wulong Gu, Micro-economic Analysis Division, Statistics Canada.

Whatever happened to Canada-U.S. economic growth and productivity performance in the information age?

Productivity growth in the U.S. economy jumped during the second half of the 1990s, a resurgence that the literature linked to information technology use. If a new way to increase productivity growth and economic growth has arisen in the U.S., it raises the potential for Canada to follow and ride the new productivity wave. It is therefore important to examine whether an information technology-related wave of productivity acceleration is already at work in Canada and which of production or use of information technology played the main role. Findings suggest that differences in the industrial structures explain much of the difference in the role of information technology between Canada and the U.S.

This article first appeared in Statistics Canada's *The Daily* on November 23, 2004. The research paper *Whatever happened to Canada-United States economic growth and productivity performance in the information age?* no. 25 (11F00027MIE2004025 free) is available online.

Tarek M. Harchaoui and Faouzi Tarkhani, Micro-economic Analysis Division, Statistics Canada.

Performance of Canada's youth in mathematics, reading, science and problem solving

Canadian 15 year-old students are among the best in the world when it comes to mathematics, reading, science and problem solving, according to a major international study that assesses the skill level of students nearing the end of their compulsory education. The study's goal was to identify whether students have the necessary skills and knowledge to participate fully in a knowledge-based economy and society. Factors such as advances in communication, information intensive service industries and the wide diffusion of information technologies have precipitated changes in skills required in the Information Age.

This article first appeared in Statistics Canada's *The Daily* on December 7, 2004.

The report, *Measuring up: Canadian Results of the OECD PISA Study: The Performance of Canada's Youth in Mathematics, Reading, Science and Problem Solving: 2003, First Findings for Canadian Aged 15*, no. 2 (81-590-XIE2004001, free) is now available online.

Patrick Bussière, Fernando Cartwright and Tamara Knighton, Culture, Tourism and the Centre for Education Statistics, Statistics Canada.

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.

	Units	1998	1999	2000	2001	2002	2003
General economy and population[1]							
GDP	$ millions	914,973	982,441	1,076,577	1,108,200	1,157,968	1,218,772
GDP implicit price index	1997=100	99.6	101.3	105.5	106.7	107.8	111.2
Population	thousands	30,157	30,404	30,689	31,021	31,372	31,660
Gross domestic expenditures on R&D (GERD)[2]	$ millions	16,089	17,638	20,531	22,733	22,370	23,293
"Real" GERD	$ millions 1997	16,154	17,142	19,461	21,306	20,751	20,947
GERD/GDP ratio	ratio	1.77	1.74	1.81	1.98	1.79	1.72
"Real" GERD/capita	$ 1997	535.27	572.45	628.82	668.16	641.99	638.29
GERD funding by sector							
Federal government	% of GERD	17.6	18.2	17.3	18.0	18.9	19.3
Provincial governments	% of GERD	4.0	4.3	4.3	4.6	5.3	5.5
Business enterprise	% of GERD	45.7	44.9	39.7	49.4	49.3	47.5
Higher education	% of GERD	14.5	15.0	14.1	12.9	15.4	16.5
Private non-profit	% of GERD	2.3	2.2	2.2	2.3	2.8	3.0
Foreign	% of GERD	15.9	15.3	17.6	12.8	8.4	8.1
GERD performance by sector							
Federal government	% of GERD	10.8	10.5	10.1	9.3	9.8	9.6
Provincial governments	% of GERD	1.3	1.3	1.2	1.4	1.4	1.4
Business enterprise	% of GERD	60.2	59.0	60.1	60.9	55.4	53.0
Higher education	% of GERD	27.2	28.8	28.2	28.3	33.2	35.7
Private non-profit	% of GERD	0.5	0.4	0.3	0.2	0.2	0.3
Federal performance as a % of federal funding	% of federal	61.6	57.8	58.4	51.4	51.9	49.8
"Real" federal performance of R&D	$ millions 1997	1,750	1,835	1,972	1,971	2,032	2,013
Information and communications technologies (ICT)							
ICT sector contribution to GDP - basic prices[3]							
ICT, manufacturing	$ millions	9,720	13,621	17,070	10,926	8,690	8,586
% of total ICT	% of total ICT	25.8	28.4	30.9	20.5	15.8	15.0
ICT, services	$ millions	28,020	34,355	38,316	41,887	44,616	46,540
% of total ICT	% of total ICT	74.3	71.7	69.4	78.6	81.1	81.5
Total ICT	$ millions	37,735	47,891	55,176	53,176	54,994	57,076
Total economy[4]	$ millions	848,414	896,0690	943,737	959,620	991,870	1,013,899
ICT % of total economy	%	4.4	5.3	5.8	5.6	5.5	5.6
Total business sector	$ millions	710,188	753,617	798,411	810,823	839,885	858,512
ICT % of business sector	%	5.3	6.4	6.9	6.6	6.5	6.6
ICT adoption rates (private sector)							
Personal Computer	% of enterprises	..	81.9	81.4	83.9	85.5	87.4
E-Mail	% of enterprises	..	52.6	60.4	66.0	71.2	73.8
Internet	% of enterprises	..	52.8	63.4	70.8	75.7	78.2
Have a website	% of enterprises	..	21.7	25.7	28.6	31.5	34.0
Use the Internet to purchase goods or services	% of enterprises	..	13.8	18.2	22.4	31.7	37.2
Use the Internet to sell goods or services	% of enterprises	..	10.1	6.4	6.7	7.5	7.1
Value of sales over the Internet	$ millions	..	4,180	7,246	10,389	13,339	18,598

1. Source: Statistics Canada, 2003, *Canadian Economic Observer*, Cat. No. 11-010-XIB, June 2004, Ottawa, Canada.
2. Source: Statistics Canada, 2003, *Science Statistics*, Cat. No. 88-001-XIB, various issues, Ottawa, Canada.
3. Source: Statistics Canada, 2002, *Beyond the information highway: Networked Canada (Information and communications technologies (ICT))*, Cat. No. 56-504-XIE, Ottawa, Canada.
4. The "total economy" is in chained-Fisher methods of deflation and therefore does not match GDP.

	Units	1998	1999	2000	2001	2002	2003
Information and communications technologies (ICT) continued							
ICT adoption rates (public sector)							
Personal Computer	% of enterprises	..	100.0	100.0	100.0	99.9	100.0
e-mail	% of enterprises	..	96.6	99.0	99.7	99.6	99.8
Internet	% of enterprises	..	95.4	99.2	99.7	99.6	100.0
Have a Web site	% of enterprises	..	69.2	72.6	86.2	87.9	92.7
Use the Internet to purchase goods or services	% of enterprises	..	44.2	49.1	54.5	65.2	68.2
Use the Internet to sell goods or services	% of enterprises	..	14.5	8.6	12.8	14.2	15.9
Value of sales over the Internet	$ millions current	..	244.6	111.5	354.8	327.2	511.4
Teledensity indicators							
Wired access (Voice Grade Equivalent - VGE)	per 100 inhabitants	63.8	64.3	66.1	66.9	65.1	62.9
Wireless access (VGE)	per 100 inhabitants	18.5	23.7	28.3	34.2	37.8	41.7
Total public switched telephone network (PSTN) (VGE)	per 100 inhabitants	82.3	88.0	94.4	101.1	102.9	104.6
Homes with access to cable	thousands	10,564.6	10,725.2	10,903.8	11,082.5	11,402.7	11,729.4
Homes with access to Internet by cable	thousands	..	..	7,609.7	9,343.4	10,091.0	10,670.0
Access indicators							
Total wired access lines (VGE)	thousands	19,293.7	19,806.3	20,347.0	20,805.1	20,300.8	19,950.9
Residential access lines (VGE)	thousands	12,601.5	12,743.9	12,871.7	12,854.2	12,752.1	12,650.4
Business access lines (VGE)	thousands	6,692.2	7,062.4	7,475.3	7,950.9	7,548.7	7,300.5
Analogue mobile subscribers	thousands	3,939.0	4,318.3	4,282.6	3,138.9	2,691.2	2,085.9
Digital mobile subscribers	thousands	1,406.4	2,592.0	4,444.0	7,509.9	9,180.8	11,135.9
Digital cable television subscribers	thousands	..	..	387.2	806.5	1,150.8	1,392.6
Satellite and MDS subscribers	thousands	..	..	967.1	1,609.2	2,018.6	2,204.4
High speed Internet by cable subscribers	thousands	..	..	786.3	1,387.8	1,874.7	2,363.5
Investment indicators							
Investments by the telecommunications services industries (NAICS 517)	$ millions (current)	7,737.1	8,679.2	9,517.8	10,720.5	7,4425.8	6,347.9
Investments by the telecommunications services industries (NAICS 517)	$ millions (constant)	7,772.7	8,847.6	9,864.2	11,240.7	7,693.2	7,037.7
Characteristics of biotechnology innovative firms[5]							
Number of firms	number	..	358	..	375	..	496
Total biotechnology employees	number	..	7,748	..	11,897	..	11,931
Total biotechnology revenues	$ millions	..	1,948	..	3,569	..	3,820
Expenditures on biotechnology R&D	$ millions	..	827	..	1,337	..	1,487
Export biotechnology revenues	$ millions	..	718	..	763	..	..
Import biotechnology expenses	$ millions	..	234	..	433	..	..
Amount of capital raised	$ millions	..	2,147	..	980	..	..
Number of firms that were successful in raising capital	number	..	138	..	134	..	..
Number of existing patents	number	..	3,705	..	4,661	..	..
Number of pending patents	number	..	4,259	..	5,921	..	..
Number of products on the market	number	..	6,597	..	9,661	..	..
Number of products/processes in pre-market stages	number	..	10,989	..	8,359	..	..
Intellectual property commercialization[6]							
Federal government							
New patents received	number	130	89	..	109[r]	133[p]	142[r]
Royalties on licenses	$ thousands	6,950	11,994	..	16,467	16,284[r]	15,509[r]
Universities							
New patents received	number	143	349	..	381	..	337[p]
Royalties on licenses	$ thousands	15,600	21,100	..	47,584	..	51,000[p]

5. Source: Statistics Canada, 2003, *Features of Canadian biotech innovative firms: Results from the Biotechnology Use and Development Survey – 2001*, Science, Innovation and Electronic Information Division Working Paper Series, Cat. No. 88F0006XIE2003005, Ottawa, Canada.
6. Sources: Statistics Canada, Federal Science Expenditures and Personnel Survey, and Survey of Intellectual Property Commercialization in the Higher Education Sector (various years).