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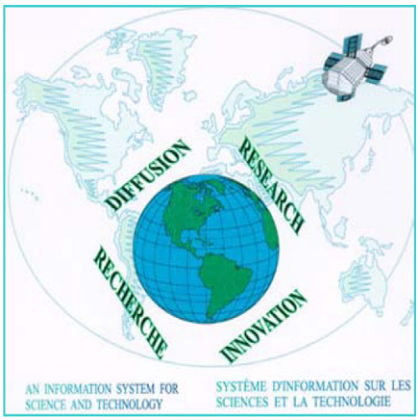
Innovative firms: A look at small firms



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Innovative firms: A look at small firms

Survey of Electronic Commerce and Technology, 2002

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Symbols

The following standard symbols are used in Statistics Canada publications:

.	not available for any reference period
..	not available for a specific reference period
…	not applicable
0	true zero or a value rounded to zero
0^s	value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{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

NOTE: Due to rounding, components may not add to totals

The science and innovation information program

The purpose of this program is to develop **useful indicators of science and technology activity** in Canada based on a framework that ties them together into a coherent picture. To achieve the purpose, statistical indicators are being developed in five key entities:

- **Actors**: are persons and institutions engaged in S&T activities. Measures include distinguishing R&D performers, identifying universities that license their technologies, and determining the field of study of graduates.
- **Activities**: include the creation, transmission or use of S&T knowledge including research and development, innovation, and use of technologies.
- **Linkages**: are the means by which S&T knowledge is transferred among actors. Measures include the flow of graduates to industries, the licensing of a university's technology to a company, co-authorship of scientific papers, the source of ideas for innovation in industry.
- **Outcomes**: are the medium-term consequences of activities. An outcome of an innovation in a firm may be more highly skilled jobs. An outcome of a firm adopting a new technology may be a greater market share for that firm.
- **Impacts**: are the longer-term consequences of activities, linkages and outcomes. Wireless telephony is the result of many activities, linkages and outcomes. It has wide-ranging economic and social impacts such as increased connectedness.

The development of these indicators and their further elaboration is being done at Statistics Canada, in collaboration with other government departments and agencies, and a network of contractors.

Prior to the start of this work, the ongoing measurements of S&T activities were limited to the investment of money and human resources in research and development (R&D). For governments, there were also measures of related scientific activity (RSA) such as surveys and routine testing. These measures presented a limited picture of science and technology in Canada. More measures were needed to improve the picture.

Innovation makes firms competitive and we are continuing with our efforts to understand the characteristics of innovative and non-innovative firms, especially in the service sector that dominates the Canadian Economy. The capacity to innovate resides in people and measures are being developed of the characteristics of people in those industries that lead science and technology activity. In these same industries, measures are being made of the creation and the loss of jobs as part of understanding the impact of technological change.

The federal government is a principal player in science and technology in which it invests over five billion dollars each year. In the past, it has been possible to say only *how much* the federal government spends and *where* it spends it. Our report **Federal Scientific Activities, 1998 (Cat. No. 88-204)** first published socio-economic objectives indicators to show *what* the S&T money is spent on. As well as offering a basis for a public debate on the priorities of government spending, all of this information has been used to provide a context for performance reports of individual departments and agencies.

As of April 1999, the Program has been established as a part of Statistics Canada's Science, Innovation and Electronic Information Division.

The final version of the framework that guides the future elaboration of indicators was published in December, 1998 (**Science and Technology Activities and Impacts: A Framework for a Statistical Information System,** Cat. No. 88-522). The framework has given rise to **A Five-Year Strategic Plan for the Development of an Information System for Science and Technology** (Cat. No. 88-523).

It is now possible to report on the Canadian system on science and technology and show the role of the federal government in that system.

Our working papers and research papers are available at no cost on the Statistics Canada Internet site at http://www.statcan.ca/cgi-bin/downpub/research.cgi?subject=193.

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Acknowledgements

This report provides new Statistics Canada estimates on innovation in small firms. The results are based on information from the Survey of Electronic Commerce and Technology, 2002. 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 co-operation and goodwill.

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Preface

Innovation and the adoption and dissemination of technologies and practices are vital to economic growth and development. It is through innovation that new products are introduced to the market, new production processes are developed and introduced, and organisational changes are made. Through adoption of newer, more advanced, technologies and practices, industries can increase their production capabilities, improve their productivity, and expand their lines of new products and services. They can also innovate.

In 1993, the first Statistics Canada survey of innovation and the adoption of advanced technologies in the Canadian manufacturing sector was carried out. It was followed in 1996 by a survey of innovation in the communications, financial services and technical business services industries. The Survey of Innovation 1999 surveyed manufacturing and was the first innovation survey of selected natural resource industries. The 1999 Survey of Innovation, Advanced Technologies and Practices in the Construction and Related Industries is the first survey of this type in the construction sector. The recently conducted Survey of Innovation 2003 surveyed selected services industries.

Biotechnology surveys carried out in 1996, 1997, 1999 and 2003 have examined both the development of new biotechnology products and processes and the use and planned use of biotechnologies. A number of surveys have focused on the use and planned use of advanced technologies and practices: surveys of advanced manufacturing technologies were carried out in 1987, 1989, 1993 and 1998; and surveys of the use and planned use of information and communication technologies have been conducted annually since 1999.

In 2001, Science, Innovation and Electronic Information Division (SIEID) piloted the Knowledge Management Practices Survey that gathered information on the use and planned use of a series of business management practices as well as the reasons for implementing these practices and their perceived results. Interest in business practices continued with the addition of a question on how private sector enterprises and public sector organisations use electronic networks to share business information within their organisations and with other organisations to the 2001 Survey of Electronic Commerce and Technology (SECT).

This study is one in a series of studies that SIEID has undertaken that have examined technological and organisational change in the Canadian economy. The SECT, 2000, contained two questions on organisational and technological improvements. These two questions provided the first cross-economy data on this issue, covering firms in the private sector and organisations in the public sector. In 2002, SECT asked two questions related to innovation. The first was on technological acquisition and second related to sales of new or significantly improved products, the combined results of these questions are explored in this paper.

Highlights

An innovative firm either implements new or significantly improved processes for the production or delivery of products, or it introduces new or significantly improved products to the market, or both. This paper analyses data from the Survey of Electronic Commerce and Technology 2002 which looks at the acquisition of significantly improved technologies and the introduction of new or significantly improved products to the market.

According to the definition used in the paper, half of Canadian firms are technological innovators and the other half are non-innovators. The propensity to be innovative rises with firm size with seven out of ten firms of at least twenty full-time employees falling into the technological innovators category.

Technological innovators overall were much stronger users of information communication technologies (ICT) than non-innovators. Non-innovators generally showed little interest in using some of the more recent and complex ICTs such as wireless communications and electronic data interchanges and Extranets. Also, the non-innovators had lower rates of employee access to personal computers, the Internet and e-mail and were far less likely to have Web-sites or to be involved in Internet Commerce.

Smaller firms are keeping pace with larger firms in their rates of technological innovation, but the types of ICTs used, Web presence and the preferred methods of technological acquisition show divergence. It appears that larger firms are better able to invest in new and complex ICTs and to use more resource intensive technology acquisition methods.

Innovative firms: A look at small firms

Introduction

An innovative firm either implements new or significantly improved processes for the production or delivery of products, or it introduces new or significantly improved products to the market, or both (OECD/Eurostat 1997). This paper analyses data from the Survey of Electronic Commerce and Technology 2002 which looks at the acquisition of significantly improved technologies and the introduction of new or significantly improved products to the market. Acquisition of technologies does not necessarily make the firm innovative, but the assumption made is that if the technologies are indeed new or improved, then their implementation will be part of innovation in the firm. There will be cases where this is not true and, as a result, estimates for the propensity to innovate in this paper should be seen as an upper bound.

A principal finding, which is not new, is that size is a factor in the acquisition of new technologies, training related to technological acquisition (Earl 2002a&b, 2004; Betcherman, Leckie & McMullen 2000; Leckie, Léonard, Turcotte & Wallace 2001; Sussman 2002; and Turcotte, Léonard & Montmarquette 2003) and in product innovation (Hanel 2003; Cozzarin 2003; Therrien and Chang 2003).

The fact that firm size is a distinguishing feature suggests that most firms may be acquiring generic technologies, such as information communication technologies (ICTs), rather than industry specific technologies. In 2002 a total of 42% of firms acquired significantly improved technologies, of these firms 41% only acquired new technologies and did not make sales of new products, the remaining 59% both acquired new technologies and sold new products. Product innovators comprised one-quarter of firms with 30% of these firms not acquiring new technologies[1].

The paper begins by introducing the groups under study and their distribution across firms of different employment size groups. It then looks at technological innovators by their use of information communication technologies with specific reference to small firms - one to nineteen full-time employees. This is followed by the Web presence of technological innovators as well as barriers to using ICTs. Methods of introducing technological change are described next. The paper ends with an overview of the sub-categories of technological innovators by employment size groups with statistical information found in the profiles in Appendix 3.

[1] The finding for firms engaged in product innovation is only somewhat comparable to information available from other Statistics Canada sources (Schaan and Anderson 2001; and Schaan and Nemes 2003) with some important differences. The Survey of Innovation 1999 found that two-thirds of manufacturing firms were product innovators (Le & Tang 2003: 239). These manufacturing firms had at least 20 employees and annual revenues of $250,000 or more. The Survey of Electronic Commerce and Technology 2002 had no minimum employment size group. To reduce response burden on small firms, the survey universe was partitioned into two groups based on income limits by industry. The income limits are calculated in such a way that a maximum of 5% of the total revenue in the industrial sector becomes out-of-scope to a maximum exclusion threshold of $250,000. These differences in survey collection methodology must be considered in comparisons between the two surveys. More specifically, an estimate that 70.1% of firms with 20 or more full-time employees are technological innovators in Table 1, compared with an estimate of 80% from the Survey of Innovation 1999 can be explained in part, by the presence of firms with a revenue less than $250,000 and the presence of non-manufacturing firms with a lower propensity to innovate. Working in the opposite direction is the implicit assumption that the acquisition of significantly improved technologies gives rise to an innovation that is first to the firm.

Defining technological innovators and non-innovators

The target groups are technological innovators (firms that acquired new technologies and/or sold new products); and non-innovators (firms that neither acquired new technologies nor sold new products). Technological innovators are composed of technological acquirers and product innovators (firms that acquired new technologies and sold new products); new technological acquirers only (firms that only acquired new technologies); and new product sales only (firms that sold new products only). This paper presents a series of profiles of ICT use as well as barriers to its use for technological innovators and non-innovators. Information on how the groups were derived can be found in Appendix 1.

The profiles are by firm size and for the total private sector. The analysis concentrates on highlighting the differences shown between small firms - 1-19 full-time employees and firms with 20 or more full-time employees. Tables for technological innovators and non-innovators for other size groups are provided in Appendix 2.

The underlying hypothesis is that "technological innovators", as defined for this paper, would show higher rates of usage of ICTs than non-innovators and that these rates would converge with increasing firm size. The findings are consistent with this hypothesis. Also, the proportion of innovators increased with firm size indicating the importance of technological change to large firms as it is known that the propensity to acquire, and train in support of, new or modified technologies increases with firm size (Earl 2002a&b, 2004). It is impossible to determine if the high usage rates of ICTs by technological acquirers, the largest component of the technological innovators, was driven in part by their rate of purchasing off-the-shelf technologies which could include software and telecommunications systems and devices, all of which are ICTs.

Information communication technologies are often considered as general purpose technologies. General purpose technologies such as the telegraph and steam engine have significantly transformed how the economy and firms operate. Examples include decentralisation of enterprises enabled by telegraph technology and transformation in the layout of factories due to electric motors (David 1990). Also, the steam engine is often considered the catalyst of the industrial revolution (Brynjolfsson & Hitt 2000: 23-24). Technology diffusion is much studied (see Fagerberg 2001 for an overview). Firms which perceive a strong advantage, or need, or have the investment capability are most likely to become early adopters. Larger firms are predominant in the early adoption of new technology and management practices (Earl 2003).

The Canadian private sector is not evenly distributed across firm sizes. In fact, as Table 1 highlights, in 2002 three-quarters of firms in the survey universe had between one and nineteen full-time employees. Of interest, is the fact that a similar proportion of technological innovators were firms in this employment size group. Two-thirds of technological innovators with no full-time employees only acquired new technologies whereas for firms of at least one full-time employee this proportion fell to about one-half. It is important to note that across the employment size groups, the rates for technological acquisition always exceeded those for the other two groups which clearly show the emphasis on technological acquisition in the technological innovators under study.

Table 1
Distribution of technological innovators showing sub-categories and non-innovators by employment size group, 2002

	Total Private Sector	0 Full-time Employees	1-19 Full-time Employees	20 or more Full-time Employees
Total	100%*	12.8%B	74.1%A	13.1%A
	100%*	**100%***	**100%***	**100%***
Technological Innovators	100%*	5.1%B	76.2%A	18.7%A
	49.1% B	**19.8%C**	**50.5%**	**70.1%**
Technological Acquirers and New Product Sales	*17.3%B*	*3.9%C*	*17.5%B*	*29.5%B*
Technological Acquirers only	*24.5%B*	*12.5%C*	*24.9%B*	*34.3%B*
New Products Sales only	*7.3%B*	*3.3%C*	*8.2%B*	*6.3%B*
Non-innovators	**50.9%B**	**80.2%C**	**49.5%B**	**29.9%B**
	100%*	20.2%C	72.2%B	7.7%B

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002.
Notes: * May not add due to rounding.

Table 2
Distribution of sub-categories of technological innovators within employment size group, 2002

	Total Private Sector	0 Full-time Employees	1-19 Full-time Employees	20 or more Full-time Employees
Technological Innovators	100%*	100%*	100%*	100%*
Technological Acquirers and New Product Sales	35.2%B	19.8%C	34.6%B	42.0%B
Technological Acquirers only	49.9%B	63.4%C	49.2%B	48.9%B
New Products Sales only	14.9%B	16.8%C	16.2%B	9.0%B

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002.
Notes: * May not add due to rounding.

The propensity to innovate for firms with 20 or more employees is, at 70.1%, lower than the estimate for manufacturing in the Survey of Innovation 1999 of 80.2% (Anderson and Schaan 2002: 145). This difference can be explained by the presence of industries other than manufacturing which may have a lower propensity to innovate. According to the definition used for this paper, in 2002, 72.6 % of manufacturers with at least 20 full-time employees were technological innovators. The two estimates are reasonably close given the differences between the two surveys as well as the time periods.

As has been noted elsewhere (Landry and Amara 2003:71-73), these high figures for innovation that appear here, and in the Survey of Innovation 1999 results, may not be that helpful for analysing the characteristics of innovative firms. To understand the innovative firm better, studies conducted using the Survey of Innovation 1999 have broken down innovation into three

categories: first to the firm; a Canada first; or a world first. The results here are for first to the firm innovation. The concept of firm-first is sufficient to provide insight into the variation of the propensity to innovate according to the size of the firm, as illustrated in Tables 1 and 2. It also allows a new look at technological innovation in small firms.

Technological innovators and the use of information communication technologies

Technological innovators overall were much more likely to be users of information communication technologies (ICTs) than non-innovators see Table 3. Non-innovators generally showed little interest in implementing some of the more recent and complex ICTs such as wireless communications and electronic data interchanges and Extranets. Also, the non-innovators had lower rates of employee access to personal computers, the Internet and e-mail.

The propensity to use ICTs by small firms with one to nineteen full-time employees that were technological innovators mirrored those of the firms with twenty or more employees with true differences showing only in the much lower propensity of using Intranets, Extranets and electronic data interchanges for the smaller firms (Tables 4 & 5). These lower usage rates could reflect a lack of need to create and support systems such as Intranets when the firm has less than twenty employees. Intranets are often used as means to provide employees with ready access to company information such as human resources policies, job postings, knowledge bases, central files and project templates. These systems may not have perceived costs-benefits for small firms.

Electronic data interchanges either on the Internet or over proprietary networks have allowed firms to change their relationships with suppliers through the elimination of the paper trail on orders and a lessening of the potential of transcription error in a manual system. Automated stocking assists retailers and other services such as hospitals in keeping supplies current without overstocking of perishable items. It also assists suppliers in calculating their production and warehousing needs. (Brynjolfsson & Hitt 2000: 27-8.) Non-innovators and smaller technological innovators may not be making use of this type of technological advance due to costs, need for skilled human resources or lack of perceived benefits.

Of interest is the high level of implementation of network / information security technology by technological innovators of all sizes. Technological innovators with no full-time employees show a similar level of implementation as those with twenty or more full-time employees. However, the very large technological innovators with at least 500 full-time employees showed the highest implementation rates for all the ICTs (see Appendix 2 for Profiles of no full-time employees and at least 500 full-time employees).

Of interest is the fact that employees of small firms, with one to nineteen employees, were more likely to have access to personal computers, workstations or terminals, the Internet and e-mail than were employees of larger firms with at least 20 full-time employees. This could be due to the nature of the work conducted by the small firms as well as larger firms having production facilities which may not require employees to use these ICTs.

Table 3
Information communication technology use by technological innovators and non-innovators - total private sector

	Technological Innovators		Non-innovators	
Information Communication Technology Use	**%**	**Confidence Interval**	**%**	**Confidence Interval**
Personal computers, workstations or terminals	97.9%	0.6%	73.5%	1.8%
Internet	93.0%	1.0%	58.9%	2.0%
E-mail (electronic mail)	90.0%	1.2%	53.0%	2.0%
Network/Information Security Technology (e.g. firewall, anti-virus software, access control)	76.5%	1.6%	35.2%	1.8%
Wireless communications	71.2%	1.7%	44.8%	1.9%
Intranet	23.5%	1.5%	6.5%	0.9%
Electronic Data Interchange (EDI) on the Internet	19.8%	1.5%	6.1%	0.9%
Electronic Data Interchange (EDI) not on the Internet	16.5%	1.3%	5.0%	0.8%
Extranet	9.0%	1.0%	1.7%	0.5%
Percentage of employees with direct access to:				
Personal computers, workstations or terminals	77.1%	1.2%	53.6%	1.8%
Internet	65.6%	1.4%	39.4%	1.7%
E-mail (electronic mail)	62.8%	1.4%	36.4%	1.7%

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002

Table 4
Information communication technology use by technological innovators and non-innovators - private sector with one to nineteen full-time employees

	Technological Innovators		Non-innovators	
Information Communication Technology Use	**%**	**Confidence Interval**	**%**	**Confidence Interval**
Personal computers, workstations or terminals	97.7%	0.7%	77.3%	2.0%
Internet	92.0%	1.3%	61.5%	2.3%
E-mail (electronic mail)	88.4%	1.5%	55.0%	2.3%
Network/Information Security Technology (e.g. firewall, anti-virus software, access control)	73.7%	2.0%	36.8%	2.2%
Wireless communications	69.6%	2.1%	47.0%	2.3%
Intranet	18.9%	1.7%	6.1%	1.1%
Electronic Data Interchange (EDI) on the Internet	17.2%	1.7%	5.9%	1.1%
Electronic Data Interchange (EDI) not on the Internet	13.9%	1.5%	5.1%	1.0%
Extranet	6.5%	1.1%	1.6%	0.5%
Percentage of employees with direct access to:				
Personal computers, workstations or terminals	79.9%	1.4%	55.4%	2.1%
Internet	68.0%	1.7%	40.4%	2.0%
E-mail (electronic mail)	64.7%	1.7%	37.3%	2.0%

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002

Table 5
Information communication technology use by technological innovators and non-innovators - private sector with twenty or more full-time employees

	Technological Innovators		Non-innovators	
Information Communication Technology Use	**%**	**Confidence Interval**	**%**	**Confidence Interval**
Personal computers, workstations or terminals	99.6%	0.5%	92.0%	3.7%
Internet	97.9%	1.0%	80.3%	5.3%
E-mail (electronic mail)	97.8%	1.0%	76.6%	5.5%
Network/Information Security Technology (e.g. firewall, anti-virus software, access control)	90.1%	2.1%	60.7%	5.9%
Wireless communications	79.6%	2.6%	60.5%	5.8%
Intranet	45.6%	3.2%	22.4%	4.4%
Electronic Data Interchange (EDI) on the Internet	31.2%	3.0%	14.9%	3.7%
Electronic Data Interchange (EDI) not on the Internet	30.2%	3.0%	11.7%	2.8%
Extranet	20.1%	2.4%	6.1%	2.3%
Percentage of employees with direct access to:				
Personal computers, workstations or terminals	60.9%	2.6%	41.2%	4.5%
Internet	48.7%	2.5%	28.8%	4.0%
E-mail (electronic mail)	48.7%	2.5%	28.9%	4.0%

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002

Technological innovators and Web presence

Larger firms were more likely to have a Web presence than smaller firms, whether or not they were technological innovators. However, smaller technological innovators did have stronger tendencies towards having Web sites than the non-innovators. They also showed a slightly higher proclivity towards engaging in Internet Commerce through selling goods and services on-line with or without on-line payment. While just one-in-ten technological innovators overall engaged in Internet Commerce in 2002, this rate rose to one-in-four for the largest with at least 500 full-time employees (Table 6).

Table 6
Web presence of technological innovators and non-innovators by employment size groups

	Technological Innovators		Non-innovators	
Web presence	**%**	**Confidence Interval**	**%**	**Confidence Interval**
Total private sector				
Internet Web site	46.8%	1.8%	16.7%	1.4%
Internet Commerce	12.7%	1.2%	2.5%	0.6%
With 0 full-time employees*				
Internet Web site	29.2%	8.4%	4.5%	1.9%
Internet Commerce	6.1%	4.6%	1.5%	1.1%
With one to nineteen full-time employees				
Internet Web site	41.8%	2.2%	17.1%	1.7%
Internet Commerce	12.1%	1.4%	2.5%	0.7%
With twenty or more full-time employees				
Internet Web site	71.9%	3.1%	44.5%	5.6%
Internet Commerce	16.7%	2.6%	5.5%	2.7%
With at least 500 full-time employees				
Internet Web site	87.8%	12.2%	79.1%	16.7%
Internet Commerce	24.1%	11.1%	14.0%	4.2%

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002.

Notes: *The category 0 full-time employees includes firms that only hire part-time workers; firms that contract hiring of employees to another firm which in turn pays the employees; firms in joint ventures whose partner(s) hire employees and some self-employed individuals.

Barriers to Internet commerce for technological innovators

The four most important barriers to Internet commerce - selling or buying goods over the Internet - were similar for technological innovators and non-innovators. The primary reason declared by firms of all sizes was that the goods or services produced or purchased did not lend themselves to Internet transactions. A preference "to maintain current business model (e.g. face-to-face interaction)" was the second most important barrier for about one third of technological innovators and non-innovators alike. Coming third, but slightly more strongly for technological innovators were security concerns. The fourth most important barrier to Internet commerce were the high costs of development and maintenance, again technological innovators were slightly more concerned about this barrier than non-innovators (Table 7).

Table 7
Selected barriers to Internet commerce for technological innovators and non-innovators by employment size group

	Technological Innovators		Non-innovators	
	%	Confidence Interval	%	Confidence Interval
Total private sector				
Goods or services produced or purchased did not lend themselves to conducting Internet transactions	45.4%	1.9%	45.1%	2.0%
Preferred to maintain current business model (e.g. face-to-face interaction)	35.5%	1.8%	34.1%	1.9%
Security concerns	20.0%	1.5%	13.7%	1.4%
Cost of development and maintenance was too high	16.2%	1.4%	10.6%	1.2%
With one to nineteen full-time employees				
Goods or services produced or purchased did not lend themselves to conducting Internet transactions	45.5%	2.2%	47.7%	2.4%
Preferred to maintain current business model (e.g. face-to-face interaction)	37.2%	2.2%	36.7%	2.3%
Security concerns	20.7%	1.8%	14.8%	1.7%
Cost of development and maintenance was too high	17.0%	1.7%	11.2%	1.5%
With twenty or more full-time employees				
Goods or services produced or purchased did not lend themselves to conducting Internet transactions	46.1%	3.3%	47.4%	5.8%
Preferred to maintain current business model (e.g. face-to-face interaction)	29.4%	3.0%	31.1%	5.4%
Security concerns	18.0%	2.4%	18.4%	4.5%
Cost of development and maintenance was too high	13.3%	2.1%	14.0%	3.9%

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002

Technological innovators, new product sales and type of technological change

The majority of technological innovators implemented technological change between 2000 and 2002 and half also sold new products in 2002. For the technological innovators, purchasing off-the-shelf technologies was the most frequent method of acquiring new technologies with seven out of ten technological innovators using this method. Customising or significantly modifying existing technologies placed second at three out of ten technological innovators overall. The least popular method of introducing new technologies with technological innovators in general was putting in place an improved production facility. This technology implementation method was perhaps the most complex and expensive listed as it could encompass all of the other implementation methods. Examples would include building a new pulp and paper mill (see Earl 2004 for a discussion).

The order of using the technological implementation methods remained relatively stable across the firm sizes with variations seen in the level of usage. The larger technological innovators showed higher inclinations towards using more complex technology acquisition methods such as customising or significantly modifying existing technologies which requires a degree of in-house or contracted expertise to implement; licensing new technologies; and developing new technologies (either alone or with others) all of which have associated costs of time, revenues and human resources. Smaller technological innovators may be inhibited from employing the more complex methods of technology acquisition by their associated costs.

Table 8
Rates for methods of acquiring new technologies for technological innovators by selected firm sizes

	Technological Innovators			
	Total Private Sector	**0 Full-time Employees***	**1-19 Full-time Employees**	**20 or more Full-time Employees**
Sales of New or Significantly Improved Products	50.1% B	36.6% D	50.8% B	51.1% B
Acquired New or Significantly Improved Existing Technology	85.1% A	83.2% C	83.8% A	91.0% A
Purchasing Off-the-Shelf Technologies	68.7% A	74.8% C	68.1% A	69.5% A
Licensing New Technologies	15.6% A	9.7% C	12.8% A	28.9% A
Customising or Significantly Modifying Existing Technologies	30.6% A	17.3% C	27.5% A	46.6% A
Leasing New Technologies	13.3% A	7.1% B	12.6% A	17.7% A
Developing New Technologies (either alone or with others)	13.5% A	6.5% B	10.9% A	26.0% A
Putting in Place an Improved Production Facility	11.5% A	…	9.9% A	19.9% A
Training in Support of Acquiring New or Significantly Improved Technology	47.4% B	21.3% C	43.7% B	69.8% B

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002
Note. *The category 0 full-time employees includes firms that only hire part-time workers; firms that contract hiring of employees to another firm which in turn pays the employees; firms in joint ventures whose partner(s) hire employees and some self-employed individuals.

New product sellers and information communication technology use

Firms that only sold new products and did not acquire new technology between 2000 and 2002 showed a somewhat lower propensity to use information communication technology than did firms which undertook technology acquisition. For instance, almost every firm that acquired technology and made new product sales or only acquired technology between 2000 and 2002 used personal computers; workstations; or terminals; only nine out of ten new product sales only firms used this type of information communication technology. In fact firms that only sold new products had lower usage rates for all of the ICTs listed while firms that sold new products and acquired technology led in the usage of these ICTs (see Appendix 3).

Firms selling new products only also were less likely to have employees with direct access to the Internet or e-mail. These firms were also less likely than firms that both sold new products and acquired technology to have an Internet Web site or to be engaged in Internet Commerce. Firms that both acquired new technology and sold new products led in the propensity towards having Web presence at six out of ten firms. There was very little difference shown in ranking the barriers to Internet Commerce by the type of firm.

Firm size played a role in the propensity of firms selling new products only using ICTs. Very few differences are seen across the ICTs used by firms with at least 20 employees whether or not they only acquired technology, only sold new products or both acquired technology and sold new products. Having new products to sell and acquiring new technology did appear to affect positively Web presence of firms, especially the firms with one to nineteen full-time employees.

Summary

It appears that firm size can be effectively employed in classifying and studying the propensity towards technological innovation as defined in this paper. This suggests that firms may have a greater propensity towards acquiring generic or general purpose technologies such as information communication technologies than industry or firm specific technologies, particularly if they are smaller firms. Smaller firms are less likely to have generated sales from new products than larger firms however this could be a classification issue. If the small firm was a newly started firm then all sales would come from new products to the firm making it a challenge for new small firms to determine if their sales were from new products.

Small firms that were technological innovators were about as likely to use more generally available information communication technologies such as personal computers as were their larger counterparts. However, smaller technological innovators were noticeably less likely to use the more complex, newer and at times more resource-dependent ICTs such as Intranets and Extranets. These ICTs would need support for administration and update that would require in-house expertise and / or readily accessible contract labour at what might be considered an added cost with few perceived benefits.

Small firms were less likely to have a Web presence than larger firms in general. However, small technological innovators with 1-19 full-time employees were almost twice as likely to have an Internet site and three times more likely to engage in Internet Commerce than were their non-innovator counterparts. Small firms that engaged both in technology acquisition and new products sales were more likely to have a Web presence than their counterparts who made new products sales only or just acquired technology.

The most readily accessible method of acquiring new technologies - purchasing off-the-shelf technologies - was also the most highly used method by firms of all sizes. Small firms veered away from the more complex and it is posited more expensive methods of acquiring new technologies which may not be as cost-effective for smaller firms.

Smaller firms are keeping pace with larger firms in their rates of technological innovation, but the types of ICTs used and the preferred methods of technological acquisition show divergence. It appears that larger firms are better able to invest in new and complex ICTs and to use more resource intensive technology acquisition methods. This is part of the challenge of trying to understand technology diffusion and its lag in adoption through the economy.

Appendix 1 - Definitions and Quality Indicators

Technological innovators comprise firms that made new product sales and / or acquired new or significantly improved existing technologies. This category is composed of technology acquirers only, new product sales only and technology acquirers who also made new product sales.

Technology acquirers only comprise firms that only acquired new or significantly improved existing technologies between 2000 and 2002 and did not make sales of new products.

New product sales only comprises firms that only made sales from new products in 2002 and did not acquire new or significantly improved technology between 2000 and 2002.

New technology acquirers and new product sales comprise firms that both acquired new or significantly improved existing technologies between 2000 and 2002, and made sales of new products in 2002.

Non-innovators are firms that neither acquired new or significantly improved existing technologies between 2000 and 2002 nor made sales from new products in 2002.

The **private sector** includes firms in most industrial sectors in the following North American Industrial Classification System, 1997 (Statistics Canada 1998). Some sectors are excluded such as:

Sector 11 Sub-sector 111, 112, 114, 1151 and 1152 (Crop and Animal Production Industries, Fishing, Hunting and Trapping industries, Support Activities for Crop and Animal Production industries),
Sector 23 Sub-sector 238 (Construction –Specialist contractors),
Sector 55 Sub-sector 551114 (Head office),
Sector 81 Sub-sector 814 (Private households).

Quality indicator interpretation

	Imputation rate			
CV	0.00 - 0.10	0.10 - 0.33	0.33 - 0.60	0.60 - +++
0.00 - 0.05	A	B	C	F
0.05 - 0.10	B	C	D	F
0.10 - 0.15	C	D	E	F
0.15 - 0.25	D	E	F	F
0.25 - 0.50	E	F	F	F
0.50 - +++	F	F	F	F

A: Excellent B: Very good C: Good
D: Acceptable E: Use with caution F: Unpublishable

For more information on the methodology used in the Survey of Electronic Commerce and Technology please refer to Statistics Canada's website at www.statcan.ca.

Appendix 2 - Profiles of technological innovators and non-innovators

Table A2.1 - Profile of information communication technology use by technological innovators and non-innovators - private sector with 0 full-time employees*

	Technological Innovators		Non-innovators	
Information Communication Technology Use	**%**	**Confidence Interval**	**%**	**Confidence Interval**
Personal computers, workstations or terminals	95.4%	3.9%	52.9%	4.6%
Internet	90.6%	5.3%	41.4%	4.6%
E-mail (electronic mail)	85.8%	6.5%	37.0%	4.5%
Network/Information Security Technology (e.g. firewall, anti-virus software, access control)	68.7%	8.6%	19.7%	3.7%
Wireless communications	64.4%	8.8%	31.3%	4.3%
Intranet	12.0%	6.0%	1.7%	1.2%
Electronic Data Interchange (EDI) on the Internet	15.5%	6.8%	3.4%	1.7%
Electronic Data Interchange (EDI) not on the Internet	5.9%	4.4%	2.4%	1.5%
Extranet	6.0%	4.6%	…	…
Percentage of employees with direct access to:				
Personal computers, workstations or terminals	94.2%	4.2%	51.9%	4.6%
Internet	90.2%	5.3%	39.8%	4.5%
E-mail (electronic mail)	85.4%	6.5%	36.3%	4.4%
Selected Barriers to Internet Commerce				
Goods or services produced or purchased did not lend themselves to conducting Internet transactions	41.2%	9.1%	34.9%	4.4%
Preferred to maintain current business model (e.g. face-to-face interaction)	33.2%	8.7%	25.9%	4.1%
Security concerns	17.0%	7.0%	8.2%	2.5%
Cost of development and maintenance was too high	15.0%	6.6%	7.4%	2.5%

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002

Notes:* The category 0 full-time employees includes firms that only hire part-time workers; firms that contract hiring of employees to another firm which in turn pays the employees; firms in joint ventures whose partner(s) hire employees and some self-employed individuals.

… number of respondents with these characteristics is too small to be expressed.

Table A2.2 - Profile of information communication technology use by technological innovators and non-innovators - private sector with 500 or more full-time employees

	Technological Innovators		Non-innovators	
Information Communication Technology Use	**%**	**Confidence Interval**	**%**	**Confidence Interval**
Personal computers, workstations or terminals	100.0%	0%	99.3%	0.8%
Internet	100.0%	0%	99.3%	0.8%
E-mail (electronic mail)	99.9%	0%	99.3%	0.8%
Network/Information Security Technology (e.g. firewall, anti-virus software, access control)	97.2%	4.2%	92.2%	6.8%
Wireless communications	89.8%	4.9%	74.6%	16.7%
Intranet	76.8%	14.7%	77.3%	8.0%
Electronic Data Interchange (EDI) on the Internet	46.4%	13.6%	29.0%	7.5%
Electronic Data Interchange (EDI) not on the Internet	45.5%	12.5%	49.0%	11.9%
Extranet	44.6%	13.1%	37.9%	9.5%
Percentage of employees with direct access to:				
Personal computers, workstations or terminals	60.5%	12.1%	61.4%	12.1%
Internet	49.1%	10.3%	47.4%	9.7%
E-mail (electronic mail)	51.7%	9.8%	52.9%	9.9%
Selected Barriers to Internet Commerce				
Goods or services produced or purchased did not lend themselves to conducting Internet transactions	40.6%	13.5%	53.9%	11.3%
Preferred to maintain current business model (e.g. face-to-face interaction)	11.5%	3.6%	15.6%	7.3%
Security concerns	12.7%	5.9%	13.2%	4.1%
Cost of development and maintenance was too high	9.9%	5.6%	5.8%	2.3%

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002

Appendix 3 - Profiles of the three sub-categories of technological innovators

Table A3.1 - Profile of information communication technology use for the three sub-categories of technological innovators - total private sector

	Technology acquirers only		New product sales only		Technology acquirers and new product sales	
Information Communication Technology Use	**%**	**Confidence Interval**	**%**	**Confidence Interval**	**%**	**Confidence Interval**
Personal computers, workstations or terminals	98.9	0.6	91.2	3.1	99.4	0.5
Internet	93.6	1.4	83.9	3.9	96.1	1.3
E-mail (electronic mail)	90.0	1.7	79.1	4.3	94.7	1.6
Network/Information Security Technology (e.g. firewall, anti-virus software, access control)	76.6	2.4	57.9	5.0	84.2	2.4
Wireless communications	70.9	2.5	62.6	4.9	75.2	2.7
Intranet	21.6	2.1	12.2	3.0	31.1	2.7
Electronic Data Interchange (EDI) on the Internet	20.4	2.2	10.1	2.8	22.9	2.5
Electronic Data Interchange (EDI) not on the Internet	15.6	1.9	9.2	2.7	21.0	2.4
Extranet	7.8	1.3	4.2	1.8	12.7	1.9
Percentage of employees with direct access to:						
Personal computers, workstations or terminals	80.0	1.7	63.3	4.0	78.9	1.9
Internet	68.7	2.1	48.8	4.2	68.2	2.3
E-mail (electronic mail)	65.8	2.1	46.6	4.2	65.3	2.4
Web presence						
Internet Web site	40.7	2.6	36.5	4.7	59.6	3.1
Internet Commerce	8.0	1.4	10.2	3.0	20.3	2.5
Selected Barriers to Internet Commerce						
Goods or services produced or purchased did not lend themselves to conducting Internet transactions	49.4	2.7	42.1	5.0	41.1	3.1
Preferred to maintain current business model (e.g. face-to-face interaction)	33.4	2.6	46.0	5.0	34.1	3.0
Security concerns	20.1	2.2	19.2	3.9	20.2	2.5
Cost of development and maintenance was too high	13.6	1.9	21.3	4.1	17.7	2.4

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002

Table A3.2 - Profile of information communication technology use for the three sub-categories of technological innovators - 0 full-time employees*

	Technology acquirers only		New product sales only		Technology acquirers and new product sales	
Information Communication Technology Use	**%**	**Confidence Interval**	**%**	**Confidence Interval**	**%**	**Confidence Interval**
Personal computers, workstations or terminals	99.8	0.4	76.6	19.7	97.0	5.8
Internet	95.5	4.8	65.8	21.3	96.4	5.9
E-mail (electronic mail)	89.8	7.1	69.9	20.8	86.1	14.3
Network/Information Security Technology (e.g. firewall, anti-virus software, access control)	70.7	10.7	52.7	22.2	75.9	18.1
Wireless communications	66.9	10.9	57.9	21.9	62.0	20.5
Percentage of employees with direct access to:						
Personal computers, workstations or terminals	99.7	0.5	70.6	20.5	97.0	5.8
Internet	95.1	4.8	…	…	96.4	5.9
E-mail (electronic mail)	89.6	7.1	68.6	20.8	86.1	14.3
Selected Barriers to Internet Commerce						
Goods or services produced or purchased did not lend themselves to conducting Internet transactions	43.3	11.6	…	…	39.7	20.5
Preferred to maintain current business model (e.g. face-to-face interaction)	30.4	10.8	44.0	22.0	32.9	19.8
Security concerns	21.7	9.7	…	…	…	…
Cost of development and maintenance was too high	16.5	8.7	…	…	…	…

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002

Notes: *The category 0 full-time employees includes firms that only hire part-time workers; firms that contract hiring of employees to another firm which in turn pays the employees; firms in joint ventures whose partner(s) hire employees and some self-employed individuals.

… number of respondents with these characteristics is too small to be expressed.

Table A3.3 - Profile of information communication technology use for the three sub-categories of technological innovators - one to nineteen full-time employees

	Technology acquirers only		New product sales only		Technology acquirers and new product sales	
Information Communication Technology Use	**%**	**Confidence Interval**	**%**	**Confidence Interval**	**%**	**Confidence Interval**
Personal computers, workstations or terminals	98.8	0.8	91.1	3.5	99.3	0.7
Internet	92.7	1.8	83.6	4.3	95.0	1.7
E-mail (electronic mail)	88.2	2.2	77.8	4.8	93.5	2.0
Network/Information Security Technology (e.g. firewall, anti-virus software, access control)	73.9	2.9	55.3	5.6	82.0	2.9
Wireless communications	70.0	3.0	61.0	5.6	73.0	3.4
Intranet	17.5	2.4	9.9	3.3	25.0	3.2
Electronic Data Interchange (EDI) on the Internet	18.3	2.5	9.0	3.2	19.5	3.0
Electronic Data Interchange (EDI) not on the Internet	13.2	2.2	7.6	2.9	18.0	2.9
Extranet	5.6	1.5	3.3	2.0	9.2	2.1
Percentage of employees with direct access to:						
Personal computers, workstations or terminals	83.5	1.9	64.5	4.5	82.0	2.2
Internet	71.7	2.5	50.1	4.7	71.3	2.8
E-mail (electronic mail)	68.2	2.6	47.0	4.7	68.1	2.9
Web presence						
Internet Web site	36.0	3.1	33.4	5.2	53.9	3.8
Internet Commerce	7.4	1.7	9.8	3.3	19.9	3.0
Selected Barriers to Internet Commerce						
Goods or services produced or purchased did not lend themselves to conducting Internet transactions	50.2	3.3	42.4	5.6	40.4	3.7
Preferred to maintain current business model (e.g. face-to-face interaction)	35.0	3.1	47.3	5.7	35.5	3.6
Security concerns	20.3	2.6	20.1	4.5	21.6	3.1
Cost of development and maintenance was too high	13.9	2.2	22.5	4.7	18.8	3.0

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002

Table A3.4 - Profile of information communication technology use for the three sub-categories of technological innovators - twenty or more full-time employees

	Technology acquirers only		New product sales only		Technology acquirers and new product sales	
Information Communication Technology Use	**%**	**Confidence Interval**	**%**	**Confidence Interval**	**%**	**Confidence Interval**
Personal computers, workstations or terminals	99.3	1.0	99.5	1.0	100	0
Internet	96.8	1.7	95.2	5.4	99.8	0.3
E-mail (electronic mail)	97.1	1.6	92.9	6.0	99.6	0.8
Network/Information Security Technology (e.g. firewall, anti-virus software, access control)	89.8	3.0	79.4	9.5	92.8	3.1
Wireless communications	76.0	4.2	77.0	9.1	84.5	3.1
Intranet	42.5	4.8	31.1	9.1	52.4	4.9
Electronic Data Interchange (EDI) on the Internet	30.1	4.5	18.7	6.6	35.2	4.6
Electronic Data Interchange (EDI) not on the Internet	29.6	4.5	25.6	9.7	31.9	4.4
Extranet	18.0	3.5	9.5	4.2	24.9	3.9
Percentage of employees with direct access to:						
Personal computers, workstations or terminals	58.3	3.9	50.3	8.6	66.2	3.7
Internet	47.2	3.8	31.2	6.0	54.4	3.8
E-mail (electronic mail)	47.7	3.8	32.9	7.1	53.2	3.8
Web presence						
Internet Web site	65.9	4.8	67.7	10.4	79.8	4.3
Internet Commerce	11.5	3.1	17.9	9.2	22.4	4.4
Selected Barriers to Internet Commerce						
Goods or services produced or purchased did not lend themselves to conducting Internet transactions	48.6	4.9	43.3	11.0	43.9	4.8
Preferred to maintain current business model (e.g. face-to-face interaction)	27.8	4.4	37.3	10.4	29.4	4.4
Security concerns	18.9	3.6	15.5	6.9	17.5	3.6
Cost of development and maintenance was too high	11.5	3.0	17.9	7.4	14.4	3.2

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002

Table A3.5 - Profile of information communication technology use for the three sub-categories of technological innovators - 500 or more full-time employees

	Technology acquirers only		New product sales only		Technology acquirers and new product sales	
Information Communication Technology Use	**%**	**Confidence Interval**	**%**	**Confidence Interval**	**%**	**Confidence Interval**
Personal computers, workstations or terminals	100	0	100	0	100	0
Internet	100	0	100	0	100	0
E-mail (electronic mail)	100	0	100	0	99.9	0.1
Network/Information Security Technology (e.g. firewall, anti-virus software, access control)	99.3	0.4	100	0	94.9	8.7
Wireless communications	92.0	4.3	87.9	4.3	87.6	9.1
Intranet	77.9	21.8	83.3	4.5	75.1	20.9
Electronic Data Interchange (EDI) on the Internet	53.0	20.6	43.3	6.4	39.7	15.3
Electronic Data Interchange (EDI) not on the Internet	43.4	19.0	67.5	6.4	46.2	16.9
Extranet	47.7	21.2	43.7	6.5	41.5	15.7
Percentage of employees with direct access to:						
Personal computers, workstations or terminals	46.4	16.3	60.3	4.4	75.2	8.3
Internet	35.7	12.9	45.0	4.8	63.4	7.1
E-mail (electronic mail)	41.7	14.6	54.7	4.7	62.0	8.3
Web presence						
Internet Web site	83.3	22.3	85.6	4.7	92.6	8.7
Internet Commerce	20.9	15.3	23.4	4.7	27.6	16.7
Selected Barriers to Internet Commerce						
Goods or services produced or purchased did not lend themselves to conducting Internet transactions	39.2	20.8	46.8	6.6	41.6	18.5
Preferred to maintain current business model (e.g. face-to-face interaction)	8.8	3.8	20.2	5.6	13.7	6.2
Security concerns	13.5	10.6	…	…	11.9	5.7
Cost of development and maintenance was too high	10.4	10.2	…	…	9.5	4.9

Source: Statistics Canada, Survey of Electronic Commerce and Technology 2002
Note: …number of respondents with these characteristics is too small to be expressed.

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