Catalogue 88-003-XIE

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

Innovation Analysis Bulletin
Vol. 4, No. 3 (November 2002)

Catalogue Number 88-003-XIE
Aussi disponible en français, N° 88-003-XIF au catalogue

In this issue

A theoretical link between innovation and economic growth has been contemplated since at least the late 1700's. Read the work of Professor Ajay Agrawal wherein he discusses the significance of knowledge spillovers, the relation to innovation and growth, and the closely related concept of absorptive capacity. Clearly, the immense complexity of the issue of innovation and economic growth has increased scholarly interest in the topic.

One can argue that every organization that provides goods and services is interested in innovation to maximize its competitiveness. The question is whether the organizational structure – the bureaucracy – as the means to organizational ends is conducive to innovations. Read insights of Dr. Soma Hewa in his discussion of some of Max Weber's thoughts to understanding the role of innovation in organizations.

After several difficult years, radio is making a comeback! Total revenues in the radio industry reached over $1 billion. This increase is partly explained by the launch of new stations, but mainly due to FM broadcasting, with 71% of the industry revenues coming from the FM sector.

The commercial arrival of the Internet in conjunction with the convergence of information and communications technologies (ICTs) has generated the need for examining several issues including understanding the Digital Divide – the gaps between ICT "haves" and have-nots". Read an excerpt from the Statistics Canada study, "Unveiling the Digital Divide", which provides perspective on this connectivity issue and shows that the divide may be narrowing but it is still present.

Rapid progress in skill-biased technologies has increased the demand for skilled workers in all countries. The importance of skills for innovation and productivity in Canada is examined in this Industry Canada study.

Despite the increased availability of high speed Internet by cable, lack of access for smaller communities in Canada continues to be significant. More than 70% of cable homes (homes with access to cable) in small communities did not have access to high-speed Internet by cable in 2001.

Canada's telecommunications service providers and their network infrastructure have kept Canadians connected for over a century. The industry has undergone significant growth and transformation. Statistics Canada data is examined to measure the impacts and outcomes of the regulatory decisions that have helped shape the state of telecommunications services in Canada.

The increased penetration of direct-to-home satellite services and digital cable has had a profound impact on revenues, profits and employment in the Canadian television industry. Specialty television services reported revenues of $1.2 billion in 2001, a striking increase of almost 14% from 2000.

Innovation analysis bulletin

ISSN 1488-433X

Please address all enquiries to the Editor, Innovation Analysis Bulletin

E-mail: *sieidinfo@statcan.ca*
Telephone: *(613) 951-8585*
Fax: *(613) 951-9920*
Post: *SIEID*
Statistics Canada
7th Floor R.H. Coats Building
Tunney's Pasture
Ottawa, Ontario
Canada K1A 0T6

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

The ***Innovation Analysis Bulletin*** is produced under the direction of Fred Gault and edited by Michael Bordt. Special thanks to the contributors and Rad Joseph (editing and coordination).

Published by authority of the Minister responsible for Statistics Canada

Note of appreciation

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

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

Downloadable publications

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

- start at the main Statistics Canada page: http://www.statcan.ca
- for papers, select *Our Products and Services*

  Our papers are in three areas:

  1. *Publications for sale ($)*

     Documents are under the categories: *Science and Technology* and *Communications*

  2. *Free publications*

     Documents are under the category: *Science and Technology* and *Communications*

  3. *Research papers (free)*

     Our documents are in the category *Science, Innovation and Electronic Information Division*. This page contains a list of all free research papers, and working papers.

- Sample questionnaires are in the section
  - *Statistical Methods* in the area
    - *Questionnaires* under
      - *Science Innovation and Electronic Information*.

Subscription request

If you would like to receive a printed version, or if you would like e-mail notifications of new issues, please contact the editor by e-mail.

Get connected with us

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

As of October 2002, there were:

- 11 publications for sale
- 4 free publications
- 12 research papers,
- 86 working papers, and
- 27 questionnaires.

Innovation, growth theory, and the role of knowledge spillovers

The relationship between innovation and economic growth has been well studied. However, that is not to say that it is well understood. Renowned scholars continue to work with incredibly simplified models of an incredibly complex economy. Consequently, empirical results are usually carefully annotated with caveats noting the limitations of all findings and the great uncertainties that remain concerning fundamental assumptions in the field.

The author of this article, Professor Ajay Agrawal at Queen's University's School of Business, can be reached at aagrawal@business.queensu.ca. *This paper represents the views of the author and does not necessarily reflect the opinions of Statistics Canada.*

Clearly though, the immense complexity of this subject has not quelled scholarly interest in this topic, but rather has increased it. This topic has generated numerous studies, which have been synthesized into many books (Griliches 1998; Nelson, 1996; Mowery and Rosenberg, 1989; Helpman, 1998; Malecki, 1997; Scherer, 1999).

A theoretical link between innovation and economic growth has been contemplated since at least as early as Adam Smith (1776). Not only did he articulate the productivity gains from specialization through the division of labour as well as from technological improvements to capital equipment and processes, he even recognized an early version of technology transfer from suppliers to users and the role of a distinct R&D function operating in the economy:

"All the improvements in machinery, however, have by no means been the inventions of those who had occasion to use the machines. Many improvements have been made by the ingenuity of the makers of the machines, when to make them became the business of a peculiar trade; and some by that of those who are called philosophers or men of speculation, whose trade it is not to do anything, but to observe everything; and who, upon that account, are often capable of combining together the powers of the most distant and dissimilar objects. In the progress of society, philosophy or speculation becomes, like every other employment, the principal or sole trade and occupation of a particular class of citizens… and the quantity of science is considerably increased by it."[1]

Although the relationship between innovation and growth had been articulated at an intuitive level for some time, innovation was not introduced into formal economic growth models until 1957 (Solow, 1957). Robert Solow, a professor at MIT, was awarded a 1987 Nobel Prize in Economics for this and related work. Like scholars before him, he defined growth as the increase in GDP per hour of labour per unit time. He carefully measured the fraction of this growth that was actually attributable to increases in capital, such as investments in machinery and related equipment, since the theory of the day was that capital accumulation was the primary determinant of growth. However, capital accumulation accounted for less than a quarter of the measured growth. Solow's insight was in attributing the remainder of the growth, the majority share, to "technical change." The magnitude of the residual calculated in this empirical study placed the role of innovation in economic growth squarely on centre stage, where it has remained for the past half century.

Since Solow's contributions, the relationship between innovation and growth has been modeled in increasingly sophisticated ways. Perhaps the most notable recent advances came from Lucas (1988) and Romer (1986, 1990), who emphasized the concepts of human capital and knowledge spillovers, respectively. Following the recent idea of distinguishing human capital, which is developed by investments in education and training, from physical capital, Lucas modeled human capital with constant rather than diminishing returns, thus offering useful insights into the critical role of a highly skilled workforce for long-term growth. Romer endogenized innovation in the growth model by introducing knowledge spillovers, which resulted in deep implications for how scholars think about growth.

The following is a gross simplification of how the Romer model works. Firms engage in R&D because they expect it will be profitable. In other words, firms allocate funds to R&D as long as the expected payoff (return on investment, or "ROI") from R&D at the margin is higher than for any other allocation of those resources. This investment in R&D results in the creation of two types of knowledge, that which is appropriable and that which is not. Appropriable knowledge refers to knowledge the firm can utilize itself, exclude others from using, and generate profits from. Knowledge that is not appropriable has the properties of a public good; it is non-rivalrous (use by one firm does not preclude use by another) and non-excludable (it is difficult to prevent others from using). The more knowledge there is, the more productive R&D efforts using human capital are. So, when firms conduct R&D, they apply human capital to the stock of knowledge for profit-maximizing purposes. In the process, however, the firm unintentionally contributes back to the increasing stock of knowledge. This unintentional contribution is referred to as a knowledge spillover.

The implications of this model are increasing returns to growth from investments in human capital and R&D due to knowledge

[1] While this quote is from the text of Adam Smith, Scherer (1999) is acknowledged for noting the relevance of this passage to the topic considered here.

spillovers. This is because the more human capital that exists in an economy, the more value that economy can derive from the stock of public knowledge through R&D efforts, which further raises the value of conducting R&D. As a result, the economy engages in more R&D, which in turn makes further contributions to the stock of knowledge spillovers; this argument continues in a virtuous circle. This model is based on the assumption that profit-seeking firms will engage in R&D for selfish reasons, since they can appropriate some of the value from the knowledge they create. Most economists argue that a role also exists for the public funding of some types of R&D, particularly basic research that is often very hard for any single firm to appropriate, since the resulting knowledge spillovers are valuable to the overall economy and would otherwise suffer from under-investment.

This explains why the concept of knowledge spillovers is central to our thinking about innovation and growth. So, in the next section, highlights from recent work on knowledge spillovers are reviewed.

Knowledge spillovers and the appropriability problem

From the above discussion, it may not be clear why investments in human capital or local R&D have any relevance to the economic growth of any particular country, such as Canada. If knowledge spillovers are a public good, why does it matter which country produces them? In fact, might it not be optimal for a particular country to "free ride" on the efforts of other nations? At the same time, the concept of knowledge spillovers as a public good may seem inconsistent with the evidence, given the variety of growth rates across open economies. Why haven't all countries converged towards equal prosperity if knowledge spillovers are freely available?

There may be many path dependency reasons for this (i.e., differences in initial conditions), but, for the purposes of this paper, the focus is on human capital and tacit knowledge. Human capital refers to the level of education and training in an economy. Tacit knowledge refers to knowledge that is difficult to codify.

For example, consider the knowledge spillovers generated by a firm that conducts research in Toronto. Some fraction of the cities around the world will possess local human capital that has the capacity to benefit from this research by examining the firm's new product or by reading the firm's patents or journal publications. However, part of the knowledge that was generated from the research may not be easily inferred from examining the product or simply communicated through written documents, even if the firm is not intentionally keeping it secret. This is the tacit knowledge that is passed from one engineer to another only through direct interaction. As a result, it may be the case that other firms in Toronto or whose engineers visit Toronto benefit more from the spillovers generated by the firm in this city than those at a distance. Many scholars argue that tacit knowledge is "sticky" and remains geographically localized. This has significant implications for innovation and its impact on regional economic growth, since this public good, a key ingredient to growth, is obtainable at a much lower cost by local firms.

Following are brief surveys of two literature streams related to knowledge spillovers. The first examines the degree to which spillovers are geographically localized and explanations for why this might be so. The second examines the characteristics of firms that enable them to utilize knowledge spillovers. The ability of a firm to exploit knowledge spillovers is referred to as its "absorptive capacity."

Localized knowledge spillovers

Most papers in this stream of research measure the variance in levels of knowledge inputs and associated outputs and examine this relationship across geographic space. The inputs and outputs considered vary from study to study, as does the geographic unit of analysis. Jaffe (1989) relates the input "federal research funding" to the output "new patents issued" and examines the variance in this relationship across geographic space at the state level. Jaffe *et al* (1993) relate the input "original patents" to the output "patents that cite the original patents" and examine the variance in this relationship across geographic space at the city level. Audretsch and Feldman (1996) relate the input "local university research funding" to the output "local industry value-added" and examine the variance in this relationship across geographic space at the state level.

Zucker *et al* (1998) relate the input "number of local research stars" to the output "number of new local biotech firms" and examine the variance in this relationship across geographic space at the economic region level. Branstetter (2000) relates the input "scientific publications from the University of California" to the output "patents that cite those papers" and examines the variance in this relationship across geographic space at the state level. Agrawal (2000) relates the input "hours of interaction with the MIT professor associated with a particular patented invention" to the output "likelihood or degree of success in commercializing the invention" and examines the variance in this relationship across geographic space in terms of distance measured in miles. Key findings reported in these papers are described briefly.

Results from Jaffe's 1989 study indicate that patents occur in those states where public and private knowledge-generating inputs are the greatest. Even after controlling for industrial R&D, the results indicate that the knowledge generated at universities spill over for higher realized innovative output. The author also reports results suggesting that university research appears to increase industry R&D, which in turn increases the production of patents.

Jaffe *et al* investigate the degree to which knowledge spillovers are geographically localized. They conduct this experiment by examining patent citations of patents. Specifically, they compare probabilities of patents citing prior patents that are associated with inventors from the same city with a randomly drawn control sample of cited patents. The authors report results suggesting that the citations are significantly more localized than the controls after adjusting for organizational types, such as universities. These results hold when the data is aggregated for analysis at higher geographic levels.

Audretsch and Feldman report results that indicate the relative economic importance of new knowledge to the location and concentration of industrial production. Even after controlling for the geographic concentration of production, the results suggest a greater propensity for innovative activity to cluster spatially in industries in which industry R&D, university research, and skilled labour are important inputs.

Zucker *et al* report results indicating that the number of local stars and their collaborators is a strong predictor of the geographic distribution of biotech firms in 1990. Importantly, these results persist when controls are added for the number of top-quality universities in the region and the number of faculty with federal support in the region.

Branstetter's results suggest that distance does matter, or at least regions matter. While being in the same state has a statistically significant impact on the probability of a citation, linear distance measured in miles does not. The results also suggest that the temporal link between academic science and patented innovation is short. The modal lag in the raw data is only two years, indicating that it is recent science that is a driving force behind patenting.

Agrawal examines the importance of geographic distance and direct interaction between university inventors and company scientists to the successful transfer and commercialization of patented university inventions. This study supports the hypothesis that geographic distance, measured in miles between MIT and the licensee, has a negative effect on the commercial success of the licensed invention. This effect becomes statistically insignificant when a control for direct scientific interaction, measured in numbers of hours, is introduced. The interaction explanatory variable does have a positive effect on both the likelihood and degree of commercial success.

The concepts of localized knowledge spillovers and absorptive capacity are closely related. Whereas the spillover literature is focused on the variance of the production function over distance from the R&D source, the absorptive capacity literature is focused on the variance of the production function across firms that vary in their organizational design. A brief summary of a few of the most important papers on absorptive capacity follows.

Absorptive capacity

There is a small but growing literature concerning the organizational design of firms that influence their ability to utilize knowledge spillovers. This branch of research originates from a pair of papers by Cohen and Levinthal (1989, 1990) that introduce the concept of "absorptive capacity"[2] and argue that a firm's ability to utilize knowledge spillovers for its own commercial gain is a function of its investment in R&D. Cockburn and Henderson (1998) build on this notion, but add that the degree to which firms are "connected" is also important for utilizing knowledge spillovers. Lim (2000) restructures the above two concepts and argues that the absorptive capacity of firms is primarily a function of its connectedness, of which its investment in R&D is just one of several components. Finally, Zucker *et al* (2000) investigate the importance of connectedness to firms by examining their location decisions relative to star university scientists. These papers are now described.

Cohen and Levinthal introduce and develop the concept of absorptive capacity and argue that this characteristic of the firm is strongly related to its prior related knowledge generated by in-house R&D.

The authors report results that support their two predictions. First, in the case of technological opportunity, the estimated coefficients for the impact of the applied sciences on R&D intensity are generally lower than those for the basic sciences, since the basic sciences are more relevant (of higher quality) and this knowledge has a more positive effect on R&D intensity. Second, the effect of increasing appropriability on R&D intensity is shown to be significantly greater in those industries in which the applied sciences are more relevant to innovation than the basic sciences. The authors conclude that these results support their hypothesis that R&D investments create a capacity to assimilate and exploit new knowledge.

Cockburn and Henderson argue that while investments in in-house R&D are necessary for firms to develop their absorptive capacity to utilize knowledge spillovers, this alone is not enough. Firms must be connected to the open science community by being actively involved in sharing research results (publishing) as well as engaged in research collaboration. The authors interview research scientists and managers from both the public and private sectors that both confirm the importance of absorptive capacity in the classical sense and identify three additional factors perceived as being important for conducting leading-edge research within the firm. These include: 1) recruiting the best people, 2) rewarding researchers on the basis of their standing in the public rank hierarchy, and 3) encouraging them to be actively engaged with their public-sector counterparts.

The authors address two related questions with their quantitative analyses concerning the concepts of connectedness, the organization of internal research, and research productivity. Their results indicate a positive relationship between connectedness and research productivity, which is arguably the most interesting finding reported in this paper.

Lim picks up from Cockburn and Henderson and argues that not only is connectedness important but it is in fact the main ingredient for creating absorptive capacity. Internal R&D is but one mechanism to foster connectedness, and it in turn generates absorptive capacity. The author identifies three additional mechanisms for fostering connectedness, including: 1) cultivating university relationships by way of sponsoring research, collaborating with faculty, and recruiting graduate students, 2) participating in research consortia, and 3) partnering with other companies that do related scientific research. The key contribution of this study is the finding that firms are able to acquire and exploit externally generated scientific knowledge without conducting in-house R&D, but instead by being connected to the scientific community in other ways.

[2] The concept of absorptive capacity is prevalent throughout the knowledge transfer literature. This refers to a firm's ability to recognize, assimilate, and apply new scientific information for its innovation and new product development.

Zucker, Darby, and Armstrong investigate the effect on the performance of the firm of star university scientists who either left tenured positions to found firms or who remained in the university but established tight working relationships with their colleagues in private industry. The primary result of this research is that the number of star scientists who are tied to the firm, either linked or affiliated, have a positive and significant effect on the productivity of the firm in all three major stages of research and product development.

Given the importance of knowledge spillovers and absorptive capacity to the issue of innovation and growth, these papers offer a useful point of departure for further investigation.

References

Agrawal, A. (2000) "Importing Scientific Inventions: Direct Interaction, Geography, and Economic Performance," mimeo, MIT.

Audretsch, D. B. and M. P. Feldman (1996) "R&D Spillovers and the Geography of Innovation and Production," American Economic Review, Vol. 86 (3), pp. 630-640.

Branstetter, L. (2000) "Measuring the Link Between Academic Science and Industrial Innovation: The Case of California's Research Universities," mimeo, University of California, Davis.

Cockburn, I., and R. Henderson (1998) "Absorptive Capacity, Coauthoring Behavior, and the Organization of Research in Drug Discovery," The Journal of Industrial Economics, Vol. XLVI, No. 2, pp. 157-182.

Cohen W. M. and Levinthal D. A. (1989) "Innovation and Learning: The Two Faces of R&D," The Economic Journal, Vol. 99, pp. 569-596.

Cohen W. M. and Levinthal D. A. (1990) "Absorptive Capacity: A New Perspective on Learning and Innovation," Administrative Science Quarterly, Vol. 35, pp 128-152.

Griliches, Z. (1979) "Issues in Assessing the Contribution of R&D to Productivity Growth," Bell Journal of Economics, Vol. 10, pp. 92-116.

Griliches, Z. (1998) *R&D and Productivity: The Econometric Evidence*, University of Chicago Press, Chicago, IL.

Helpman, E. (ed.) (1998) *General Purpose Technologies and Economic Growth*, MIT Press, Cambridge, MA.

Jaffe, A. (1989) "The Real Effects of Academic Research," American Economic Review, Vol. 79, pp. 957-970.

Jaffe, A. R. Henderson, and M. Trajtenberg (1993) "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations," Quarterly Journal of Economics, August, pp. 577-598.

Lim, K. (2000) "The Many Faces of Absorptive Capacity: Spillovers of Copper Interconnect Technology for Semiconductor Chips," mimeo, MIT.

Lucas, R. E. Jr. (1988) "On the Mechanics of Economic Development," Journal of Monetary Economics, Vol. 22, pp. 3-42.

Malecki, E. J. (1997) *Technology and Economic Development*, Addison Wesley Longman, Essex, UK.

Mowery, D. and N. Rosenberg (1989) *Technology and the Pursuit of Economic Growth*, Cambridge University Press, Cambridge, UK

Nelson, R. (1996) The *Sources of Economic Growth*, Harvard University Press, Cambridge, MA.

Nelson, R. and N. Rosenberg (1993) "Technical Innovation and National Systems," in *National Innovation Systems*, ed. by R. Nelson, Oxford University Press, Oxford, UK.

Romer, P. M. (1986) "Increasing Returns and Long-Run Growth," Journal of Political Economy, Vol. 94, pp. 1001-37.

Romer, P. M. (1990) "Endogenous Technological Change," Journal of Political Economy, Vol. 98, supplement to No. 5, pp. s71-102.

Scherer, F. M (1999) *New Perspectives on Economic Growth and Technological Innovation*, Brookings Institution Press, Washington, D.C.

Smith, A. (1776) *An Inquiry into the Nature and Causes of the Wealth of Nations*, Modern Library edition, NY, NY, 1937.

Solow, R. M. (1957), "Technical Change and the Aggregate Production Function," Review of Economics and Statistics, Vol. 39, pp. 312-20.

Zucker, L., M. Darby, and M. Brewer (1998) "Intellectual Capital and the Birth of U. S. Biotechnology Enterprises," American Economic Review, Vol. 88, pp. 290-306.

Zucker, L., M. Darby, and J. Armstrong (2000) "University Science, Venture Capital, and the Performance of U. S. Biotechnology Firms," mimeo, University of California, Los Angeles.

This article is an excerpt of Professor Agrawal's working paper Innovation and Growth: Implications for Canada, *available free of charge on the Queen's University Web site at* http://qsilver.queensu.ca/~agrawala/. *The author gratefully acknowledges the Queen's Centre for Enterprise Development (QCED Inc.) for financial support.*

Innovation in organizational settings

To innovate or not to innovate is a business decision that varies with many factors including the nature of business, type of organization and economic climate. Statistics Canada's efforts to date have focussed on understanding innovation with respect to the nature of the business. This article outlines some of Max Weber's (1864-1920) contributions to understanding the role of innovation in the organization.

The author, Dr. Soma Hewa is the Principal Investigator of a research program on Philanthropy and Social Development in Montreal. His research interests focus on sociological theory, social history of medicine, and civil society. His recent publications include ***Colonialism, Tropical Disease and Imperial Medicine: Rockefeller Philanthropy in Sri Lanka*** *(University Press of America, 1995). Currently, he is organizing an international conference* ***Globalization, Civil Society and Philanthropy: Toward a New Political Culture in the 21st Century****, to be held June, 2003 at the Rockefeller Archive Center in New York. This paper represents the views of the authors and does not necessarily reflect the opinions of Statistics Canada.*

In a recent study on bureaucracy, an organizational sociologist asked "What do the Vatican and General Motors, NASA and the British Health Services have in common?" Taking the cue from Max Weber, the foremost authority of modern organizations, he replied "They are all bureaucracies." (Beetham, 1996: 9). Although at a quick glance, it may seem correct to suggest that all these formal structures constitute complex bureaucracies, a systematic analysis will reveal that all organizations do not generate the same administrative dynamics in their day-to-day operations. Albeit Weber's optimistic proposition that the future of modern industrial society belongs to bureaucracy that epitomizes the process of rationalization, he acknowledged the general malaise of bureaucratization in such familiar terms as "iron cage," "bureaucratic petrification" and "specialist without spirit." How do we understand these inherently contradictory internal dynamics of organizational structure of bureaucracy? Do bureaucracies undermine or facilitate innovations? How did Weber and other organizational sociologists address these issues?

Weber defines modern organizations in terms of a formal structure of bureaucracy, the characteristics of which includes:

1. Hierarchy of authority in the divisions of labor (centralization),
2. Tasks specialization by individual members (complexity),
3. Members are evaluated in terms of performance criteria and rewarded on the basis of rank, which motivates them to achieve (stratification),
4. Tasks are performed according to a set of written rules (formalization).

For Weber, these structural conditions of an organization lead to, among other things, efficiency in the process of production, effective management, and goal orientation. He stated "The fully developed bureaucratic apparatus compares with other organizations exactly as does the machine with the non-mechanical modes of production" (Weber, [1956] 1978: 973).

Thus, the formal structure of bureaucracy in modern organizations is clearly the means to organizational ends (Parsons, Bales and Shils, 1958; Aiken and Hage, 1971). Every organization has a particular objective. For example, a department store wants to maximize sales, a pharmaceutical company to discover new drugs, and a hospital to provide better patient care. "Innovation" is defined as the development of new products or services to acquire a competitive advantage in the market place among similar organizations. In essence, one can argue that every organization that provides goods and services is interested in innovation to maximize their competitiveness. The question is whether the organizational structure – the bureaucracy – as the means to organizational ends is conducive to innovations. Drawing from the theoretical interpretations of Weber and Hage, in a recent study by Hetherington and Hewa (2000), found both negative and positive impact of organizational structure on innovativeness in a multi-hospital system in the United Sates.

Although Weber expected increased efficiency with the hierarchy of authority in the division of labor (centralization), it also leads to a lack of participation in the process of decision making by the members of various departments. Hetherington and Hewa found that the hierarchy of authority can have a positive impact on innovativeness, provided the organization increases the level of participation in the process of decision making. Thus, the hierarchy of authority itself is not an obstacle to innovativeness as it helps to coordinate the tasks of different departments.

For Weber, task specialization is one of the most important aspects of the modern industrial economy, which has lead to professionalism. He believed that bureaucratization would produce professional experts, who would dominate modern society. As Weber might have expected, evidence shows that increased specialization leading to professionalism in modern organizations increases innovativeness. However, this positive relationship exists only insofar as the professional experts are not subjected to a centralized authority. Professional experts prefer to exercise their professional judgment in an environment uninhibited by the authority structure.

Although for Weber stratified structure is an incentive to move upward in the occupational ladder, most studies have found a negative correlation between stratification and innovativeness. In their study, Hetherington and Hewa confirmed this general trend that in a stratified environment, poor quality communication, a sense of powerlessness and dependency mentality undermine individual initiative, thus obstructing innovativeness.

Weber suggested that in formal organizations where complex tasks are carried out by specialized professionals, task definitions, clarifications and specifications would contribute to clarity and technical competence. Such a working environment permits professional experts to attain greater knowledge and depth within a specified domain leading to higher rate of innovations, compared to those who have a general knowledge in an extensive field. Thus, as confirmed by Hetherington and Hewa, there is a positive correlation between formalization and innovativeness in modern complex organizations.

In conclusion, it should be noted that the bureaucratic structure of modern organizations, as the means to specific ends, does not always guarantee a positive correlation. Nor did Weber himself suggest such a relationship in all organizational systems. On the basis of specific objectives of an organization, that is, the nature of production and services provided by the organization, the formal structure of the bureaucracy must be designed to achieve its goals.

References

Aiken, Michael and Jerald Hage, 1971, *The Organic Organization and Innovation*, Sociology 5: 63-82.

Beetham, David 1996, *Bureaucracy*, University of Minnesota Press, Minneapolis.

Hetherington, Robert W. and Soma Hewa, 2000, *The Structural Correlates of Climate for Change in a Multihospital System*, International Journal of Contemporary Sociology 37: 26-50.

Parsons, Talcott, Robert Bales and Edward Shils, 1958, *The Working Papers in the Theory of Action*, The Free Press, Glencoe, Illinois.

Weber, Max [1956] 1978, *Economy and Society: An Outline of Interpretative Sociology*, edited by Guenther Roth and Claus Wittich, University of California Press, Berkeley.

Private radio broadcasting, 2001

Radio, the oldest electronic medium, is making a comeback after several difficult years in the late 1980s and most of the 1990s, thanks mainly to FM broadcasting. The industry's profits (before interest and taxes) represented 16.3% of revenues in 2001, up from 13.6% in 1998, according to the latest data.

The FM segment is one of the most profitable in broadcasting. The profit margin of FM stations (before interest and taxes) has surpassed 25% for the past three years, while AM stations have incurred losses, the latest amounting to 3% of revenues in 2001. However, the magnitude of AM losses has declined in the last two years.

In 2001, 64% of FM stations realized a profit, compared with only 41% of AM stations. (Statistics are for the fiscal years ending August 31.)

Radio broadcasters have in fact outperformed television broadcasters for three straight years in terms of revenue growth and profitability.

Total revenues in the radio industry reached almost $1.1 billion in 2001, up 14.0% from 1998. FM revenues accounted for 71% of total revenues in 2001, compared with 64% three years earlier. The share of AM stations fell to 28% from 34% in 1998.

Total air time sales reached just under $1.1 billion in 2001, with FM radio again accounting for 71% of the total. FM air time sales have grown at a pace of more than 7.5% in each of the last three years.

Radio stations operating outside census metropolitan areas had the strongest growth in airtime sales (+5.1%) after lagging behind larger market stations in 2000. Their 12.6% profit margin was still lower than the profit margin achieved by stations operating in larger markets, but the gap is closing.

The improved financial fortune of private radio broadcasters was not achieved at the expense of the industry's labour force. The average weekly number of employees climbed to 9,311 in 2001 from 8,810 in 2000.

This increase is partly explained by the launch of new stations. In addition, wages, salaries and benefits paid by the industry rose 4.3%. Labour costs represented 43.4% of the industry's revenues in 2001, unchanged from 2000.

Available on CANSIM: table 357-0001.

More detailed information is available in the June 2002 issue of *Broadcasting and telecommunications*, Vol. 32, no. 2 (56-001-XIE, $10/$32).

Daniel April, SIEID, Statistics Canada.

The digital divide in Canada

The commercial arrival of the Internet in conjunction with the convergence of information and communications technologies (ICTs) has generated the need for understanding several issues. Prominent among these is understanding the Digital Divide –commonly understood as the gap between ICT "haves" and "have-nots". Governments, business, international and non-governmental organizations are in the midst of numerous initiatives to address ICT-related inequities and reap 'digital dividends'.

Defining digital divide and the impact of timing

The concept "digital divide" serves as an umbrella term for many issues, including infrastructure and access to ICTs, use and impediments to use, and the crucial role of ICT literacy and skills to function in an information society. In reality, many divides exist. They can be identified for any permutation of i) individual ICTs and the timing of their introduction, and; ii) variable of interest. Findings show that household penetration of several ICTs increases by income (Chart 1) and that the effect of income is more pronounced on new technologies rather than older and established ones. However, the income divide is also present in the case of vehicles (an example of a non-ICT commodity) showing that the effect of income on penetration is not simply an ICT phenomenon. Chart 1 also displays divides by education, the presence of children and urban areas - within each level of income - and age.

The timing of the introduction of individual ICTs is important in placing digital divides in perspective. For example, a "telephone divide" today must be seen under the light that the technology, in its basic form, has been around for over a century. This differs from the divide associated with the Internet, which has been around for less than a decade in its commercial incarnation. Historically, the introductions of new commodities have been gradual. Chart 2 presents a collection of recorded penetration histories over an almost 50 year period. Despite perceptions about the meteoric rise of the Internet, fast as though it may have been, the penetration of television in people's lives was faster. The penetration of the VCR was also very fast, particularly during its first decade. While the speed of adoption among commodities differs, their penetration is generally characterized by accelerating growth in the initial periods, which eventually gives way to decelerating growth.

Chart 1. Household penetration, by income, 2000

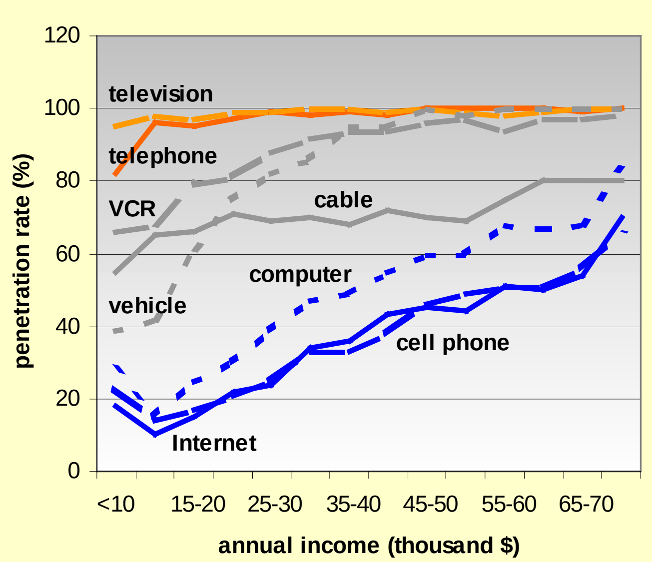


Table 1. Differences in penetration rates, top vs. bottom income deciles

	1982	1986	1990	1996	2000
	percentage points				
Telephone	7.4	7.5	4.6	5.2	11.9
Television	3.9	2.9	2.2	1.5	3.8
Cable	-	-	-	24.6	23.2
VCR	-	47.1	54.3	36.4	33.4
Computer	-	18.8	31.8	48.2	65.2
Internet	-	-	-	18.2	62.5
Cell phone	-	-	-	24.8	55.9
Vehicle	56.5	56.4	51.3	47.1	58.8

The digital divide is defined as a relative concept whose measurement involves comparisons between the 'haves', between 'have-more' and 'have-less' groups. Its size can be approximated with the difference in the penetration rates between high and low-income groups. Such differences, computed for households in the top and bottom income deciles for selected years, are contained in Table 1. The findings indicate that the divide in newer technologies (Internet, computers, cell phones) is sizeable and drops for older and saturated technologies (television, telephone). The fact that the telephone divide widened sharply in the last year of data serves as an example that closing divides should not be taken for granted, but they can regress.

Size of the divide - a shrinking or growing phenomenon?

Notwithstanding the size of the digital divide, a more pertinent question is whether it is growing or closing. While inequalities of this type are difficult to prove conclusively with any single measure, in an overall sense the digital divide is slowly closing. As seen in Chart 3, with the exception of 1996, the estimated Lorenz curves[1] for each successive year are cleanly enveloped by

[1] The Lorenz Curve is a method commonly used to study the inequality of the distribution of income. Making appropriate modifications to the standard application, this analytical tool is adapted to fit the context of the digital divide. Rather than plotting penetration against each income percentile, the cumulative distribution of penetration is plotted against the cumulative income percentiles, from lowest to highest.

Chart 2. Penetration rates over time

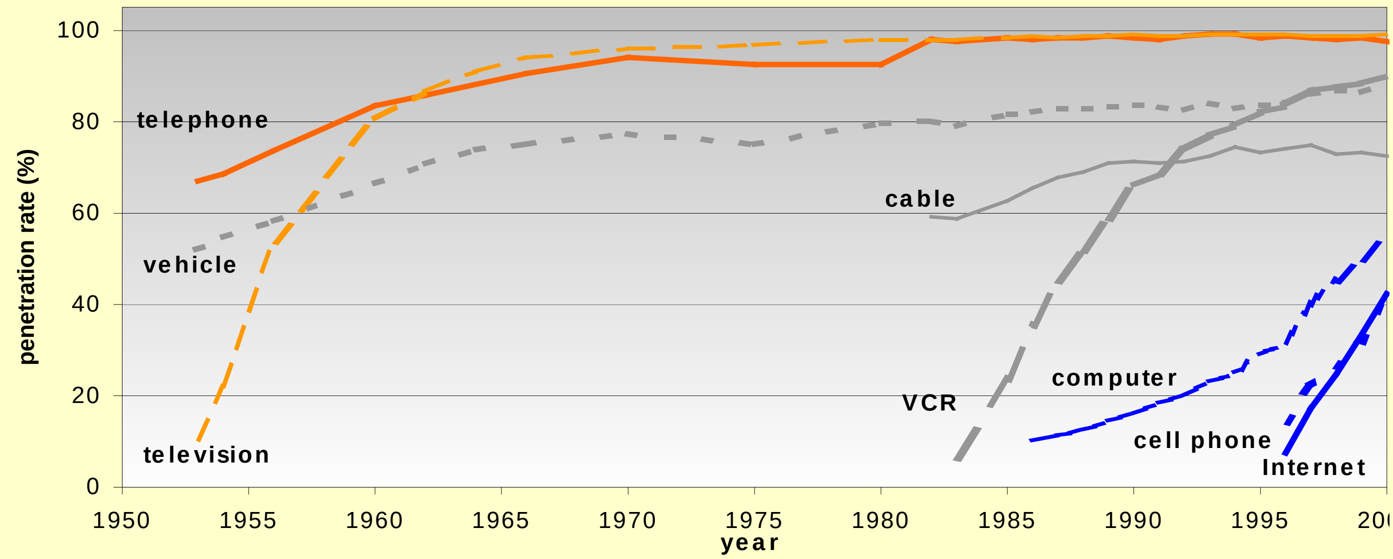


Chart 3. Evolution of the relative Internet divide, home use

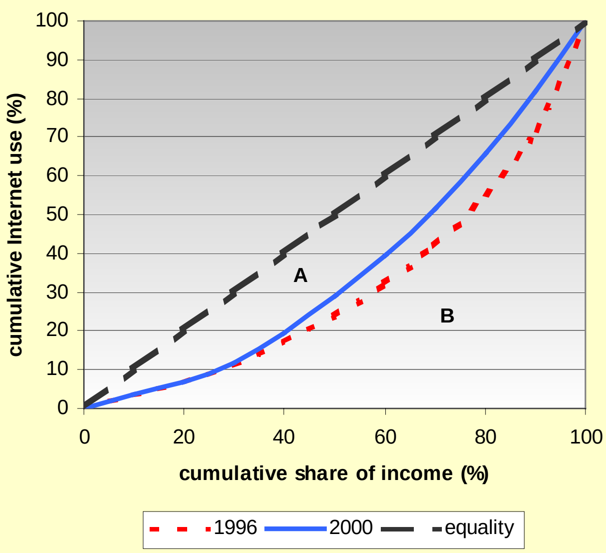


Table 2. Evolution of differences in Internet penetration rates (income adjusted percentage points)

Deciles	1997-1996	1998-1997	1999-1998	2000-1999	2000-1996	2000-1997
top-bottom	21.0	4.3	6.9	1.1	32.5	12.3
9th - 2nd	17.1	5.0	11.9	3.7	36.1	20.7
8th - 3rd	11.1	9.6	3.8	3.4	26.9	16.9
7th - 4th	8.9	3.6	7.0	-4.7	14.6	6.0
6th - 5th	1.1	6.6	-3.4	1.8	6.0	5.1
top - 9th	4.4	1.1	-6.2	-1.6	-1.5	-6.7
top - 8th	9.4	-5.2	1.9	-5.0	1.7	-8.3
9th - 8th	4.9	-6.3	7.8	-3.1	3.4	-1.5
8th - 7th	0.8	4.6	-4.7	4.9	5.0	4.7
6th - 4th	4.4	6.1	-0.2	-0.1	9.9	5.7
5th - 4th	3.4	-0.4	3.1	-2.1	3.9	0.6
4th - 3rd	1.5	1.3	1.8	3.1	7.2	6.2
top 5 - bottom 5	12.8	6.8	6.0	2.8	28.5	15.6

those of the previous year and the Gini coefficients[2] are declining. However, this analysis camouflages important movements at more detailed levels. Thus, further analysis was performed.

Computing the distribution of Internet users by income decile for the 1996-2000 period reveals that there has been a sizeable decline in the relative share of the highest income decile (down to 18.2% from 28.4% of all users) and a much smaller decline of the importance of the 9th decile. While the relative loss of the importance of the two highest income deciles was matched by gains in the middle incomes, it did not translate to relative gains for the lowest two deciles. In addition, a detailed examination of the income deciles from which new Internet users came confirms that while the relative contribution of the higher-income groups declined and that of the others increased, the gains were once again more pronounced among the middle incomes rather than the lowest deciles.

A more explicit look at the divide involves the computation of the differences in Internet penetration among many pairs of income deciles for every year of available data. Then, as a measure of the evolution of the divide, the changes in these differences were computed, annually and for longer periods (and an adjustment was made for the growing income gap between high and low incomes). In this specification, a positive number indicates a

[2] Gini coefficients are calculated to provide an overall measure. These are effectively measured by the ratio of area A over A+B. Gini coefficients can assume values from 0 (perfect equality) to 1 (extreme inequality). The larger the area between the 45°line and the Lorenz curve, the further away from perfect equality, and the higher the value of the Gini coefficient.

growing divide and a negative number indicates a closing divide. The results are provided in Table 2. Generally, the divide is smaller, the smaller the income difference between the groups examined. As well, the pattern of its evolution is mixed. The key finding - although a closing divide appears between certain income groups, there is still a persistent divide between pairs of very high and very low incomes (e.g. top vs. bottom, 9th vs. 2nd and 8th vs. 3rd deciles), indicative of growing disparities. To demonstrate the degree such comparisons depend on the exact cut-off selected, the exercise was repeated with only two broad income groupings - the top half and the bottom half. In this case, considering the situation of the bottom three deciles, the digital divide is clearly growing.

Collectively the findings conclude the digital divide is sizeable. It is however, generally closing, the result of the progress made by middle-income groups (particularly upper-middle) when compared to the highest income group. The lowest income groups (the three bottom deciles) continue to lose ground vis-à-vis the very high-income groups. Clearly, despite changes, there is a long way to go before the divide between these groups is eliminated.

The entire article, "Unveiling the Digital Divide" can be found in Statistics Canada's Connectedness Series, Catalogue No. 56F0004MIE, No. 7, July 2002.

George Sciadas, SIEID, Statistics Canada.

Importance of skills for innovation and productivity

Skills have become increasingly important to economic growth in all countries due to the rapid progress in skill-biased technologies (those that require special skills). The importance of skills for innovation and productivity in Canada is examined in this Industry Canada study. The results suggest that companies that hire experienced employees and new graduates from universities outperform, in terms of product and process innovation, the firms that do not. The evidence also indicates that inter-industry differences in labour productivity among Canadian manufacturing industries are positively related to differences in skills intensity, after controlling for capital intensity, R&D intensity and the influence of industry characteristics.

This note, authored by Jianmin Tang, Senior Research Economist with Industry Canada, summarizes the study by Rao, Tang, and Wang (2002). This paper represents the views of the authors and does not necessarily reflect the opinions of Statistics Canada.

Introduction

Rapid progress in skill-biased technologies has increased the demand for skilled workers in all countries. The importance of human capital and skills, especially problem solving, communication and inter-personal skills has increased in all economies. For instance, on a net basis, all jobs created in Canada during the 1990s required at least a high school diploma. Growth was much faster for jobs requiring a post-secondary diploma or a university degree than jobs with lower qualifications (Chart 1). Indeed, jobs requiring less than high school diploma declined. Similar trends are also observed in other OECD countries.

Skills are one of key drivers of innovation and improvements in productivity. Recently, many studies have identified Canada's relative weak innovation performance as one of the main reasons for Canada's productivity problem – Canada's labour productivity level is well below the United States (U.S.) and the gap widened considerably in the second half of the 1990s.

The main objective of this article is to examine the linkage between skills, innovation and productivity in Canada. Using Statistics Canada's Survey of Innovation 1999, the article analyses the impact of different types of skills for product or process innovation. The article also uses panel industry data to study the role of skills in accounting for the inter-industry differences in labour productivity levels among Canadian manufacturing industries.

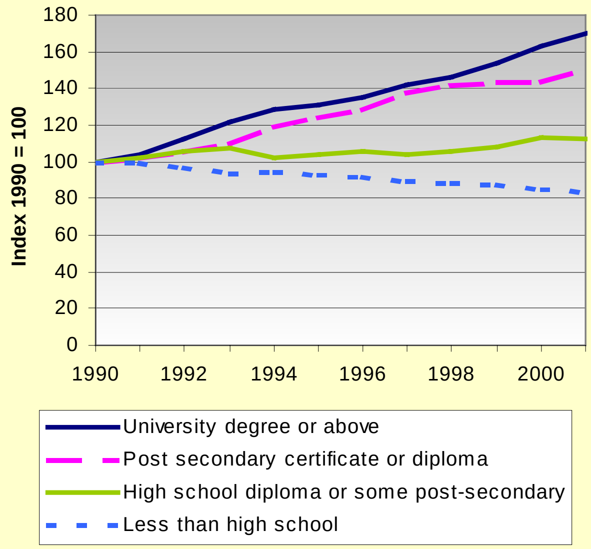
The dynamics of innovation in Canada: a firm-level analysis

Using firm-level data from the Survey of Innovation 1999, this article examines the importance of skills for innovation in Canadian manufacturing industries. Two types of innovation outcomes are analysed: product innovation (introduction of new or significantly improved products); and process innovation (introduction of new or significantly improved processes).

The sample consists of 5,451 manufacturing firms. All 20 three-digit[1] manufacturing industries are represented. Of the total sample, 68 per cent of firms reported undertaking product innovation (Chart 2). Almost 65 per cent of all firms report some type of process innovation. About 80 per cent of all firms in the sample undertake either product or process innovation. Only slightly more than half (54 per cent) of all firms report the two types of innovation.

[1] The Survey of Innovation 1999 employed the North American Industrial Classification System (NAICS).

Chart 1. Employment growth by educational attainment, Canada



Source: Statistics Canada, Labour Force Survey Estimates.

The firms in the sample are organized into four separate groups:

- firms that report either product or process innovation are compared with non-innovators;
- firms that do both types of innovation are compared with non-innovators;
- firms that report only product innovation are compared with non-innovators; and
- firms that report only process innovation are compared with non-innovators.

The innovation behaviour of the four sets of firms is examined separately by using a logit model. The empirical results suggest that (a) hiring experienced employees and new university graduates, (b) co-operation with other firms, (c) product market competition and government support for R&D, and (d) training and technical support and assistance programs are the important drivers of product and process innovation.

Importance of skills for innovation and labour productivity in the Canadian manufacturing sector

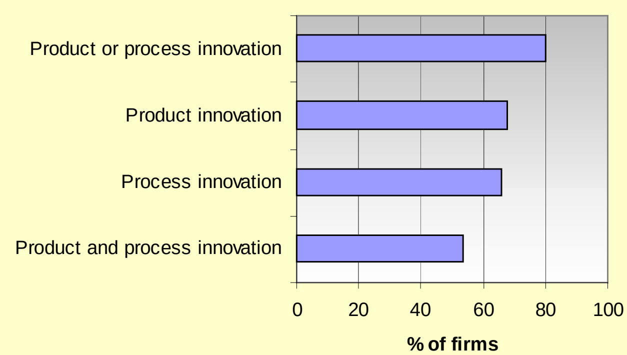
Labour productivity varies a great deal across Canadian manufacturing industries. For instance, in 1996, output per person employed varied from a high of $116,760 in refined petroleum and coal industry to a low of $33,090 in clothing industry. Similarly, there are substantial differences in capital intensity, R&D intensity and education attainment of employees across manufacturing industries.

In addition, the Canada-U.S. manufacturing labour productivity level gap increased from 21 percent in 1990 to 34 percent in 2000, and the gap is pervasive across many manufacturing industries, especially large ones in machinery and electrical and electronic equipment industries. This happened despite a substantial increase in Canada's trade and investment linkages with the U.S. and other countries. Canada, however, generally lags the U.S. in capital intensity and R&D intensity. It also trails behind the U.S. in university education.

Canada leads the U.S. in terms of the proportion of employees with some (one to three years) post-secondary education, but it lags significantly behind the U.S. in terms of the proportion of the employees with a university education. For instance, in 2000, the share of the population aged 25-64 with a university degree in the labour force was 20 per cent in Canada compared to 30 per cent in the U.S. (Chart 3). This gap is greater in the manufacturing sector than at the economy-wide level as Canada in 1998 had only 60 per cent of the U.S. proportion of workers with a university degree in the manufacturing sector, compared to 68 per cent for all industries.

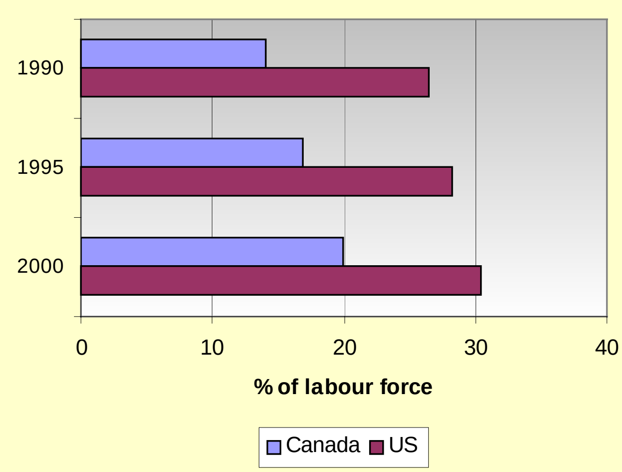
In this section, using the panel data on Canadian manufacturing industries, the article examines the role of differences in skills and other variables in the differences in productivity levels among Canadian manufacturing industries. Skills are proxied by two education variables: the proportion of workers with some post-secondary education; and the percentage with a university degree. In a knowledge-based economy, it is expected that a uni-

Chart 2. Manufacturing firms engaging in innovation, 1997-99



Source: Statistics Canada, Survey of Innovation, 1999.

Chart 3. Percentage of labour force with university degree or above



Source: Statistics Canada and US Bureau of Labour Statistics.

versity education will have a greater positive impact on innovation than a non-university post-secondary education. This is especially true for fundamental innovation and productivity because a university education provides skills that are essential to succeed in a fiercely competitive and fast changing global knowledge-based economy. In addition to the two skills variables, the article also includes capital intensity (capital stock per worker), R&D intensity (R&D per worker) and industry characteristics as the drivers of productivity levels. Skills are hypothesised to influence productivity directly as well as indirectly by stimulating fundamental innovation via increased R&D spending.

After controlling for the influence of industry characteristics, all other explanatory variables have a positive impact on labour productivity. As expected, differences in "university education" have a much larger impact on inter-industry differences in productivity levels than differences in "some post-secondary education". The two skill variables have a positive impact on R&D spending, the key driver of fundamental innovation. Not surprisingly, once again, "university education" has a bigger impact on R&D spending than "some post-secondary education".

Conclusions

All economies are becoming increasingly knowledge-based. In addition, all industrialised countries are currently facing a shortage of highly qualified people and these pressures are expected to increase in the future because of low birth rates and the ageing of population. Consequently, competition for skilled people among countries is going to intensify. Given that human capital is a strong complement to R&D and physical capital, especially M&E, improving the economic climate for attracting and retaining skilled people is critical for stimulating innovation and increasing the trend productivity growth in Canada. In addition, Canada needs to close the capital intensity gap and the gap in university education vis-à-vis the U.S., our largest trading partner as well as a major competitor. This would set in motion a virtuous circle of narrowing of the capital deficit and the innovation, productivity and real income gaps vis-à-vis the U.S.

References

Rao, Someshwar, Jianmin Tang, and Weimin Wang, 2002, *The Importance of Skills for Innovation and Productivity*, International Productivity Monitor, No 4.

Further information: Jianmin Tang, Senior Research Economist, Micro-Economic Policy Analysis Branch, Industry Canada, (613) 946-1621, tang.jianmin@ic.gc.ca.

High-speed Internet by cable, 2001

Access to high-speed Internet by cable increased substantially in 2001, but smaller communities in Canada were still far behind their larger counterparts. Despite the improvement in the availability of this technology in small communities, the gap between them and medium-sized and large communities is still significant. More than 70% of cable homes (homes with access to cable) in small communities did not have access to high-speed Internet by cable.

As of August 31, 2001, just over 9.4 million homes, or about 85% of cable homes, had access to broadband service, up from about 70% a year ago.

Deployment occurred fastest in small communities, where the number of homes with access to high-speed service more than doubled to almost 363,400. This represented only about 27% of homes with access to cable, up from 11% in 2000. In medium-sized communities, 78% had access, compared with 47% in 2000.

Network upgrades necessary to offer this service were almost completed in the largest communities, where 96% of cable homes had access to this broadband technology, up from 86%.

The rate of adoption of cable Internet also progressed rapidly in communities of all sizes. Overall, almost 15% of homes with access to cable Internet had adopted it as of August 31, 2001.

The rate of adoption was highest in large communities (16%) and lowest in small communities (10%).

In total, there were just under 1.4 million subscribers to Internet by cable as of August 31, 2001, up 77% from 2000. This strong growth continued in the latter part of 2001 and the number of subscribers surpassed 1.7 million at the end of the year, according to the Household Internet Use Survey.

There are signs that the gap between large and small communities will continue to close. Investments in cable systems serving small communities amounted to $88.5 million in 2001, up from $74.8 million in 2000.

The top four cable operators, who have aggressively upgraded their networks in large and medium-sized communities in the last years, invested $34.7 million in small communities in 2001. This could signal a wish to offer a suite of broadband services similar to those available in larger communities. If this strategy were adopted, availability of high speed Internet by cable in small communities would progress significantly, since 40% of cable homes in these communities are served by those enterprises.

Smaller cable operators, who often find it difficult to raise the necessary sums to upgrade their networks, serve the majority of households in smaller communities. Despite this difficulty, smaller cable operators invested $53.8 million in their systems in 2001.

Note: For the purposes of this report, large communities represent census metropolitan areas, medium-sized communities represent census agglomerations and small communities represent census divisions outside those areas.

Service bulletin, broadcasting and telecommunications, Vol. 32, no. 3 (56-001-XIE, $10/$32) will be available soon.

Daniel April, SIEID, Statistics Canada.

Internet by cable - Deployment, penetration and investment indicators by community size1

	2000	2001	% increase
Deployment			
Homes with access to Internet by cable	000		
Large-size communities[2]	6,567.7	7,529.6	14.6
Medium-size communities[3]	898.9	1,512.1	68.2
Small-size communities[4]	143.1	363.4	154.0
Total	**7,609.7**	**9,405.1**	**23.6**
Homes with access to Internet by cable / homes with access to cable	%		
Large-size communities	85.7	96.1	12.2
Medium-size communities	47.3	78.3	65.6
Small-size communities	10.8	27.0	150.6
Total	**69.8**	**84.7**	**21.2**
Penetration (Adoption)	000		
Subscribers to Internet by cable			
Large-size communities	696.2	1,174.7	68.7
Medium-size communities	80.1	178.3	122.5
Small-size communities	10.1	37.4	271.8
Total	**786.4**	**1,390.4**	**76.8**
Subscribers to Internet by cable / homes with access to Internet by cable	%		
Large-size communities	10.6	15.6	47.2
Medium-size communities	8.9	11.8	32.6
Small-size communities	7.0	10.3	47.1
Total	**10.3**	**14.8**	**43.7**
Subscribers to Internet by cable / homes with access to cable	%		
Large-size communities	9.1	15.0	65.1
Medium-size communities	4.2	9.2	119.0
Small-size communities	0.8	2.8	266.8
Total	**7.2**	**12.5**	**73.4**
Investments	000$		
Additions to the cable network			
Large-size communities	1,214,537.8	1,796,135.2	32.4
Medium-size communities	234,618.9	243,208.9	3.5
Small-size communities	74,789.6	88,467.2	15.5
All communities with access to cable services	**1,523,946.3**	**2,127,811.3**	**28.4**
Additions per home passed by cable	$		
Large-size communities	158.41	229.28	44.7
Medium-size communities	123.36	125.89	2.0
Small-size communities	56.40	65.83	16.7
All communities with access to cable services	**139.88**	**191.53**	**36.9**

1 The coverage of cable systems sometimes crosses the boundaries between communities of different sizes. In those cases, the cable system was assigned to the community that served the largest number of homes. This limitation of the data does not significantly affect its analytical value.
2 A large community is here defined as a census metropolitan area (CMA). A CMA is a very large urban area, together with adjacent urban and rural areas that have a high degree of economic and social integration with that urban area.
3 A medium-sized community is here defined as a census agglomeration (CA). A CA is a large urban area, together with adjacent urban and rural areas that have a high degree of economic and social integration with that urban area.
4 A small-size community is here defined as a census division located outside a CMA or CA.

The state of telecommunications services in Canada

Canada has developed a telephone system recognized to be among the best in the world. Data from Statistics Canada's *Annual and Quarterly Surveys of Telecommunications* are examined as to how the telecommunications services industry is performing in the context of a changing regulatory environment. Findings are presented based on indicators of concentration, which have been developed and analyzed for selected market segments.

Telecommunications connects Canadians

Canada's telecommunications service providers and their network infrastructure have kept Canadians connected for over a century. From plain old telephone services to the latest mobile devices, Canada has been among the pioneers of products and sophisticated networks that make them operable. With the introduction of technological advances and market liberalization, the Canadian telecommunications services industry has undergone remarkable growth and transformation, particularly in the adoption and use of telecommunications services by consumers and businesses. Service providers have adapted to these fast changing market conditions and opportunities with an unprecedented wave of mergers, acquisitions and corporate transactions. The structural changes stemming from the increasingly competitive environment make the tasks of measuring and assessing telecommunications services even more critical.

The telecommunications services industry is comprised of network operators and resellers of telecommunications services, traditionally classified to one of the five telecommunications industries under the North American Industry Classification System (NAICS 5133) – wireline (51331), wireless (51332), resellers (51333), satellite (51334), and other (51339) (Statistics Canada 1998).

Canada has taken an incremental approach to introducing competition, gradually opening up monopoly-based telecommunications markets over the last twenty years. This began with private lines in 1979, followed by the liberalization of the terminal equipment market (1980-82), the resale of long distance services (1987), privatization (international long distance carrier Teleglobe, 1987; satellite telecommunications provider Telesat, 1992), facilities-based long distance (1992) and, more recently, local telephony (1997), payphones and overseas telephony (1998), and fixed satellite services (2000).

Telecommunication service and products

While telecommunications service providers offer a wide range of products to Canadian businesses, households and government, this discussion is limited to the telecommunications industry's most important products: local telephony, long distance telephony, data, and private line (or dedicated) services. These products are delivered over both fixed and wireless networks. To the extent that that there are strong substitution effects between wireline and wireless services, the products would define a single market, as is the case for data and private line (where it is likely that customers are less concerned with the technology employed than with the cost of the service). There are, however, several historical, technological and regulatory reasons why market segmentation between fixed and mobile telephone services is appropriate. Thus, the provision of local or long distance services by wireline and wireless technologies will be considered here as different products, leading to the existence of different markets. Local mobile services are considered as a proxy for mobile telephony in general, since long distance mobile services are not yet provided as stand alone services.

Hirfindahl-Hirschman Index Analysis

Considering the diversity of products and markets, assessing the status of competition is a complex task. Indicators in the form of the Hirfindahl-Hirschman Index (HHI) were analyzed for each product, by province in order to get a sense of market power[1]. A relative assessment among the various telecommunications services can be made by ordinally ranking (first, second, third, etc.) the HHIs for each province, and then summing and averaging the cardinal values of the ordinals[2]. The lower the average ordinal value, the less market power is deemed to be present (less concentrated market). The results of this methodology are presented in Table 1.

Markets were found to be less concentrated in mobile services, followed by long distance wireline, private line and data services, and lastly, local wireline services. This is what might be expected given the deregulation time frames for the various products, as well as their specific characteristics. Mobile services, for example, lend themselves best to a geographic overlap of networks, therefore setting the stage for genuine competition. In addition, a competitive market structure was adopted when mobile services

---

[1] The HHI is the sum of the squares of the market shares for a given product in a given province or territory. It runs between 1 (monopoly), declining with each added company and approaching 0 (where there is perfect competition). HHIs have been calculated for provincial markets for the product groups described above.

[2] For example, if local mobile services had the lowest HHI in every province, its ordinal ranking would be 1 for each province and the average of these would be 1. The territories have been omitted, since each reported HHIs of 1 (monopoly) for all products.

Table 1. Index of market power, telecommunications services in Canada, 1999.

Rank	Telecommunications service	Provincial ordinal average	
1	Local Mobile	1.5	Less concentrated
2	LD Wireline	2.4	
3	Private Line	2.7	
4	Data	2.9	
5	Local Wireline	4.3	More concentrated

were first introduced – with the creation of regional duopolies (two service providers in one market area).

The relatively similar ordinal ranking of the non-local wireline services (voice, data and private) is interesting. The fact that data and dedicated services have been unregulated for a considerably longer period than long distance voice services, one might expect a more developed competitive market structure for the former. Voice services, on the other hand, have been provided to a large extent by non facilities-based resellers, an area characterized by ease of market entry. Do these characteristics imply co-incidental HHI results? The data suggest that the number of resellers were in rapid decline over the period – there were 54% fewer in 1999 than in 1997, whereas the number of facilities-based carriers of LD services declined only 7%. With the decline in resellers, the competitive profile of the markets for these services seems to be converging – the same companies are increasingly responsible for providing a growing share of all three of these services. The local wireline market is ranked the least competitive.

A generalized market structure index by province for 1999 is achieved by taking an average of the HHIs for each of the services by province (Chart 1). Overall, Quebec comes out on top, followed closely by Ontario and British Columbia. These are also Canada's three largest telecommunications markets, and their sheer size is undoubtedly a key factor explaining the extent of

Chart 1. Average HHI for telecommunications services, by province, 1999.

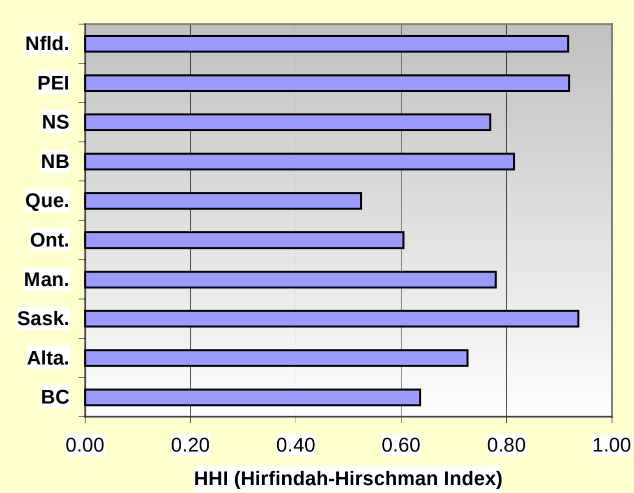
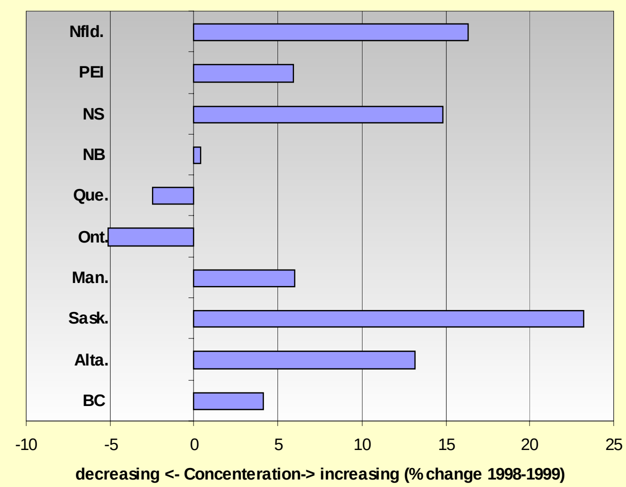


Chart 2. Average change in HHI, by province, 1998-1999.



competition found in those markets. Smaller markets may simply not be able to generate the level of activity that would justify market entry given the significant capital investments required.

Not only did Quebec and Ontario report the lowest HHIs in the country, but the average HHI for the telecommunications services listed in Table 1 declined over the 1998-1999 period for these provinces – indicative of falling market concentrations and increased competitiveness. HHIs for four of the five telecommunications services declined in Quebec and Ontario, yielding an average drop of 5.1% in Quebec, and an average drop of 2.5% in Ontario (Chart 2). Despite British Columbia's lower concentration compared with most of the other provinces, only two of the five services marketed there showed lower HHIs – overall they increased by an average of 4.1% from 1998 to 1999.

In the middle range, with HHIs between 0.700 and just over 0.800, are Alberta, Nova Scotia, Manitoba and New Brunswick, Canada's fourth, seventh, fifth and eighth largest telecommunications markets respectively. New Brunswick recorded the lowest average increase in HHI for the telecommunications services reported for that province, at only 0.4%. Between 1998 and 1999, two of its three telecommunications services showed a lower HHI, whereas two of five services in Nova Scotia and Manitoba, and one of four services in Alberta showed lower HHIs. Manitoba had the next smallest increase in average HHI of the middle group (6.0%), followed by Alberta (13.2%) and Nova Scotia (14.8%).

The provinces displaying the highest HHIs are Newfoundland, PEI, and Saskatchewan. In Newfoundland, each of the three products for which HHIs were calculated showed markets with increased concentration, as did four of the five in Saskatchewan. PEI's average HHI only increased by 5.9%, however, meaning that it fared better than five other provinces. Newfoundland and Saskatchewan posted the greatest increases in concentration between 1998 and 1999, with their average HHIs rising by 16.3% and 23.2%, respectively. PEI. and Newfoundland are the two smallest markets in Canada, and this has probably contributed to their higher levels of concentration. As for Saskatchewan, despite constituting the sixth largest market (considerably larger than PEI or Newfoundland), its competitive profile has lagged behind all other jurisdictions. This may be attributed to the delayed introduction of competition in that province compared to other jurisdictions. Saskatchewan was granted a five-year exemption from CRTC regulation at the time the new pro-competitive Telecommunications Act was enacted in 1993. Facilities-based long distance competition introduced in other provinces in 1992 did not come into force in Saskatchewan until November 1996. Likewise, local and pay phone competition was delayed until the year after regulatory approval for deregulating these services in other parts of the country.

Need for increased measurement of regulatory impact

Clearly, more analytical work needs to be done in this area, in an effort to measure the impacts and outcomes of the regulatory decisions that have helped shape the state of telecommunications services in Canada. Competition in the industry depends on many complex and interrelated factors, including the regulatory framework, the viability of alternatives, innovative technology, consolidation of the sector, and convergence. However, we must not forget the consumer, without whom there would be no reason to compete at all. The telephone has come a long way since Alexander Graham Bell made the first long distance call from Brantford to Paris, Ontario in 1876. In the past 125 years, Canada has developed a telephone system recognized to be among the best in the world. The decisions and choices made now will shape the kind and quality of services we can expect in the future.

Heidi Ertl and Haig McCarrell, SIEID, Statistics Canada.

Television broadcasting, 2001

The rapid growth of specialty television services and pay-TV is having a profound impact on revenues, profits and employment in the Canadian television industry, according to the latest figures. In 2001, specialty television reported revenues of $1.2 billion, up 13.9% from 2000. This level represented 26.6% of total television industry revenues of $4.5 billion, compared with only 19.0% in 1998.

Similarly, pay-TV revenues reached $286.0 million in 2001, a 33.8% gain from 2000. This level represented 6.3% of total revenues, double the proportion of 3.3% in 1998. (Statistics in this release are for the fiscal years ending August 31.)

From 1998 to 2001, the share of total revenues represented by private conventional TV and public and non-commercial TV combined has declined from 77.7% to 67.1%.

The profit margin of the pay-TV segment increased from 18.1% in 1998 to 21.7% in 2001, while that of specialty television rose from 14.5% to 17.4%.

Pay-TV's profitability depends on its ability to attract new subscribers rather than advertising revenues. The increased penetration of direct-to-home satellite services and digital cable has had a positive impact on the financial performance of these operators.

Television broadcasters sold airtime worth more than $2.5 billion last year, up 4.3% from 2000, the biggest increase in the last three years. Airtime sales accounted for 56.6% of total industry revenues.

The strongest growth in airtime sales occurred in the specialty segment, where sales jumped 15.1% to $438.0 million. This represented 17% of the industry total, up significantly from 10% in 1998.

Private conventional broadcasters still accounted for the lion's share, with almost $1.8 billion in airtime sales last year, up 1.5% from 2000.

About 58% of conventional stations reported profits in 2001, down from 67% in 2001, while the percentage of specialty services that realized a profit remained essentially unchanged at about 75%.

Average weekly employment in the television industry fell from 20,094 in 2000 to 19,507 in 2001 after two years of marginal gains. This downturn is attributable to the public and non-commercial segment, where the workforce fell more than 11.0%. Employment among private broadcasters rose 3.7%.

Television broadcasters spent 59% of their revenues on programming and production in 2001, compared with 57% in 2000. This upward trend was observed in all segments of the industry, except pay-TV.

Available on CANSIM: table 357-0001. More detailed information will soon be available in the *Broadcasting and telecommunications bulletin*, Vol. 32, no. 1 (56-001-XIE, $10/$32).

Daniel April, SIEID, Statistics Canada.

Financial indicators by type of television broadcasters

	1998	1999	2000	2001	2000 to 2001
	$ thousands				% change
Revenues					
Total	3,777,232.1	3,981,330.4	4,290,152.1	4,526,440.2	5.5
Private conventional television	1,821,868.3	1,873,901.6	1,887,221.3	1,910,852.5	1.3
Public and non-commercial conventional television	1,113,282.2	1,070,136.4	1,132,753.4	1,126,074.1	-0.6
Specialty television[1]	717,197.7	880,610.5	1,056,508.2	1,203,519.8	13.9
Pay television[1]	124,883.8	156,681.9	213,669.2	285,993.8	33.8
	$ thousands				% change
Sale of airtime					
Total	2,328,816.0	2,386,622.2	2,456,089.7	2,560,490.4	4.3
Private conventional television	1,723,095.1	1,758,751.3	1,763,473.8	1,789,704.1	1.5
Public and non-commercial conventional television	365,216.3	323,494.9	311,914.8	332,762.6	6.7
Specialty television[1]	240,504.6	304,376.0	380,701.1	438,023.7	15.1
Pay television[1]	0	0	0	0	...
	%				
Profit margin (PBIT) (private)					
Total	12.3	14.7	15.3	15.1	...
Private conventional television	11.0	14.9	13.8	12.6	...
Specialty television[1]	14.5	13.4	18.5	17.4	...
Pay television[1]	18.1	20.2	12.3	21.7	...

[1] Statistics collected and published by the Canadian Radio-television and Telecommunications Commission (CRTC), Industry Statistics and Analysis, Broadcast Analysis Branch.

… Figures not appropriate or not applicable.

What's new?

Recent and upcoming events in connectedness and innovation analysis.

Connectedness

The Connectedness Series, Volume 7 and Volume 8 were released in October. Volume seven featured *Unveiling the digital divide*. Volume 8 featured *The state of telecommunications services.*

A pocket-size guide to the information and communications technology sector, Internet use and more, *Canada's information society* will be released in November.

Telecommunications

Annual survey of telecommunications service providers

The publication *Telecommunications in Canada, 1999*, No. 56-203, was released in August 2002.

Quarterly survey of telecommunications service providers

The service bulletin, *Telecommunications statistics, 1st quarter, 2002*, No. 56-002-XIE was released in September 2002.

Broadcasting

Two issues of the service bulletin *Broadcasting and telecommunications* were published in June 2002, one presenting the 2001 statistics for *Television broadcasting* (56-001, volume 32, no. 1) and the other the 2001 statistics for *Private radio broadcasting* (56-001, volume 32, no.2).

Two articles appeared in the *Daily* in September 2002. The first provided information on the deployment and use of Internet by cable by community size (September 3, 2002). The second article presented information on the impact of competition between cable and wireless operators by community size (September 12).

A Broadcasting and Telecommunications service bulletin providing cable industry statistics for 2001 is forthcoming.

Household Internet use

The redesigned electronic commerce component of the *2001 Household Internet Use Survey* was released in September. The electronic commerce component was redesigned to be able to capture Internet shopping from households that regularly used the Internet from various locations, solely for household purposes. In previous years, household electronic commerce data were collected only if the Internet shopping was conducted from home. This survey improvement constitutes a break in the data series, preventing a direct comparison of results of 2001 with those of previous years. The final year of collection of the HJIUS will be conducted in January 2003 for reference year 2002. Presently a feasibility study is being developed to determine the utility, feasibility and potential of continuing this data series.

Results from the *2001 Household Internet use survey* were released in July.

Business e-commerce

Survey of electronic commerce and technology

The report *Embracing e-business: Does size matter?* part of the Connectedness Series, was released in June 2002. It is available on Statistics Canada's Web site (*www.statcan.ca*). From the *Our products and services* page, choose *Research papers (free)*, then *Communications*.

Science and innovation

S&T activities

Research and development in Canada

Estimates of Canadian research and development expenditures (GERD), Canada, 1991 to 2002, and by province 1991 to 2000 will be released in November 2002.

Federal and provincial S&T

Federal science expenditures

A working paper, *Federal government expenditures and personnel in the natural and social sciences, 1992-93 to 2001-2002 (preliminary)* was released in June 2002.

Industrial R&D

Research and development in Canadian industry (RDCI)

Volume 26, No. 4, *Industrial research and development, 1998 to 2002 (preliminary)* was released in July 2002.

Research and development in the health field

A working paper, *Estimates of total expenditures on research and development in the health field in Canada, 1988 to 2001* was released in May 2002.

Human resources and intellectual property

Federal intellectual property management

Federal science expenditures and personnel 2001-2002, intellectual property management, fiscal year 2000/2001

The 2001 survey is in the field. Results are expected to be available in the fall of 2002.

The higher education sector

Intellectual property commercialization in the higher education sector

The 2001 survey is in the field. Results are expected to be available in the fall of 2002.

Advanced technologies

Innovation and advanced technologies

A working paper entitled *Survey of innovation 1999: Methodological framework—decisions taken and lessons learned* by Susan Schaan and Brian Nemes was released in June 2002.

A working paper entitled *An overview of organisational and technological change in the private sector, 1998-2000* by Louise Earl, based on the organisational and technological change question in the 2000 *Survey of electronic commerce and technology (SECT)*, was released in June 2002.

Innovation

Innovation in manufacturing

Data from the *1999 Survey of innovation* are available for special tabulations. We are developing the methodology for sub-provincial aggregates of survey data.

Innovation in services

A new survey of innovation in selected service sector industries is being prepared. Questionnaire design has begun.

A presentation on *Knowledge in business service industries: How much do the innovation surveys miss?* was made at the conference on "Services and Innovation" held in Manchester, England on September 26th and 27th, 2002. The conference was hosted by the Centre for Research on Innovation and Competition, University of Manchester

Innovation in services seminar series

Statistics Canada in partnership with the University of Ottawa (PRIME) is holding a series of fortnightly seminars in preparation for the launch of the next survey of innovation in service industries. The series is scheduled to begin in October 2002 and will continue until spring 2003.

The process of innovation in services is less well understood than the manufacturing sector. Services innovation is neither identical to that of manufacturing firms nor something completely new or unfamiliar. This topic has drawn a great deal of attention in recent years. These seminars will make a retrospective evaluation of what we have learned from our experience with measuring innovation in the service sector and what improvements can be made.

The speakers at the seminars will look at innovation from different perspectives. They will include people who have experience in measuring innovation in services, academics who theorize about the innovative behaviour of the firm, researchers who have tested hypotheses using data from the innovation surveys as well as decision makers who use survey findings for policy formulation.

Biotechnology

The Biotechnology use and development survey 2001 is in the field. Results are expected in the fall of 2002

Knowledge management practices

Work has commenced on creating a linked database for the *Knowledge management practices survey.*

National and international

The book *Networks, alliances and partnerships in the innovation process* (Kluwer Academic Publishing) was released in September 2002. This publication is a result of the fifth in a series of joint research projects organized by the Program of Research on Innovation, Management and the Economy (PRIME) and Statistics Canada. The research projects examined key aspects of the innovation process. The most recent workshop focused on alliances, networks and partnerships in the innovation process from which this volume was produced. Given that alliances, networks and partnerships transcend geography and subsume technologies and practices, understanding their role in the process of innovation is important.

The approach taken in the book includes discussion of frameworks, measurement, practice and impacts. Each of the chapters in this intriguing reading has referenced how firms use alliances, networks and partnerships to achieve their innovation strategies. The speed with which innovation is exercised by firms will determine their competitive capability. Accordingly, firms are partnering with other firms; organizations and institutions in an effort to prosper with the key gain being improved timeliness. A recurring theme in the text is alliances, networks, and partnerships are important to the innovation process because they represent innovative strategic arrangements that enhance the process and foster mechanisms to internalize knowledge spillovers. As a consequence, this new technology-based competitive order is changing the boundaries of the firm. As these boundaries change, the role of the public sector will become more important. If technology policy is to be effective in assisting domestic industries to compete successfully in global markets, government's ability to successfully facilitate alliances and networks and to partner with private-sector firms in a timely manner will be critical.

Among the merits of the book are the authors' abilities to set forth a policy and a research agenda for others to expand upon. The reader is left with the message that this collection of work can serve as a catalyst for improved "analytic radars and to open up new avenues of analysis and action". Clearly, future work in the area will determine the impact and effectiveness of the policy and research agenda provided by the authors.