Consortium canadien sur les indicateurs de science et d'innovation
Canadian Science and Innovation Indicators Consortium

Indicators for Benchmarking Innovation in Atlantic Canada

Prepared for
Industry Canada and Atlantic Canada Opportunities Agency

By
Wade Locke, Charles Davis, Ron Freedman,
Benoît Godin and Adam Holbrook

March 30, 2004

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1. Introduction

This report presents a set of forty indicators of innovation in Atlantic Canada for purposes of benchmarking. In the context of this paper, innovation refers to the complex set of social and economic processes that produce knowledge and convert it into wealth and other forms of social value. Benchmarking, on the other hand, pertains to the monitoring of the behavior within an innovation system and is designed to assess performance and affect the allocation of resources within that system to permit strategies to be translated into actions that will optimize the flow of innovation activities from that system.

Innovation is the key to realize our social and economic aspirations. The more "knowledge-based" a society is, the better its innovation capabilities must be. Innovation is about learning to do things in new or different or better ways. Although every human society has had some innovative capability, constant innovation based on science and technology is relatively new in human experience. In the first place, the rate of global knowledge production is so rapid that knowledge obsolesces quickly. Most scientific knowledge has a half life of less than five years. Most technological knowledge in areas of rapid technological change has a half life of less than three years. Detailed market knowledge that is enabled by IT-based interactivity has a half life of days or hours.

In the second place, since it is impossible to be self-sufficient in knowledge, it is extremely important to possess absorptive capacity, which is enabled and sustained by knowledge flows and networks. Educational institutions and other specialized transfer institutions are critically important elements of an incoming knowledge transfer infrastructure.

In the third place, the regional context is of utmost importance. World-class innovative capabilities in particular industries or technologies tend to cluster in certain places. This is because these places have developed specialized pools of human capital, knowledge, or natural resources that allow them to perform complex tasks more efficiently than other places that perform analogous tasks. Regions that are catching up, like Atlantic Canada, are seeking to develop differentiating areas of specialization that generate economic rents more efficiently than competitors. Regional specialization is based on firm-level learning. Nokia was once a forest products company, IBM made mechanical calculators, Detroit bicycle shops became automobile manufacturers, and the Georgia carpet and towel industry began when the teenaged Miss Evans began making tufted bedspreads as gifts. Ongoing Schumpeterian creative destruction in the world economy will open up opportunities for Atlantic Canada as long as entrepreneurial capabilities, market awareness and access, specialized knowledge, investment, and support services, and knowledge spillovers are available in the region.

In the knowledge-based economy, capabilities to innovate are located in a broad group of public and private institutions, many of them with specialized knowledge production or transfer functions, which must work together as an "innovation system." The advent of the knowledge economy poses very significant management and policy challenges

because many of the linkages, flows, and processes that are the lifeblood of innovation are difficult or expensive to observe. Innovation surveys provide indicators of some activities, but they may not permit accurate prediction of outcomes that policymakers seek. Causal ambiguity in innovation systems makes it difficult to accurately model system behavior. However, comparison of innovation indicators between one region and another can provide useful insights into factors that are inhibiting performance.

This report provides a first cut at benchmarking innovation in Atlantic Canada. As discussed in Section Four, the art of *regional innovation benchmarking* is evolving out of practices of policymaking based on *national S&T indicators*. Regional innovation benchmarking practices therefore must deepen their own capabilities in three directions. First, S&T indicators measure knowledge inputs. Regional innovation benchmarking must develop indicators for innovation across the set of knowledge producing, knowledge transferring, and knowledge using institutions, and link these behaviors to overall system performance in a simulation model. This is a major conceptual undertaking but we are confident that regional innovation benchmarking will evolve in this direction. Second, regional innovation benchmarking must regionalize many indicators that are available only on the national level and develop a framework to understand how regional innovation performance is affected by national innovation system behavior. For example, it is clear that peer-adjudicated research resource allocation and "building on strengths" are processes that channel investments to regions that already have significant innovation capability. Third, regional innovation benchmarking must maintain enough standard or conventional indicators to permit comparison with other regions, and enough specialized or customized indicators to allow understanding of the internal workings and performance of the regional system. This is analogous to the ways that firms maintain standard performance indicators based on generally accepted accounting principles for external purposes, and management accounting frameworks for purposes of internal control.

The indicators presented here are ones that are readily available from sources that produce them from surveys. These are the least costly indicators to obtain for benchmarking purposes. As is typical in early stages of regional innovation benchmarking, most of the indicators have to do with knowledge inputs. Of the forty indicators presented here, twenty-nine have to do with the creation and diffusion of knowledge (to use the categories of innovation presented in the 2003 OECD STI scoreboard). Four have to do with the information economy, seven have to do with economic structure and productivity, and none covers global integration of economic activity, as follows:

Creation and diffusion of knowledge

- Human capital formation
    - Indicator 1: Resources Devoted to Education Relative to the Size of the Economy
    - Indicator 2: Performance on Standardized Tests of 15-Year Students Relative to that Observed Nationally
    - Indicator 3: Enrollment at Universities by City
    - Indicator 4: Percentage of Population Participating in Adult Education and Training
    - Indicator 5: Time Spent on Adult Education and Training Per Capita

- Indicator 6: University Graduation Rates for Bachelors and First Professional Degrees
- Indicator 7: University Graduation Rates by Master's Degree
- Indicator 8: University Graduation Rates by Doctorate Degree
- Indicator 9: University Graduates by Field of Study Per 100,000 Population
- Indicator 10: Composition of University Graduates by Field of Study

- Knowledge production
  - Indicator 11: Granting Agency Funding by City
  - Indicator 12: Research Dollars from Granting Agency per HQP by City
  - Indicator 13: Indicator: Educational Attainment
  - Indicator 14: Research and Development Intensity Within Each Jurisdiction
  - Indicator 15: Sectoral Breakdown of R&D Performed Within Each Jurisdiction
  - Indicator 16: R&D Intensity Performed by the Business Sector
  - Indicator 17: Provincial Shares of BERD in Atlantic Canada
  - Indicator 18: Concentration of R&D Establishments
  - Indicator 19: Number of R&D Performing Establishments by Industry
  - Indicator 20: Industrial R&D Personal by Type
  - Indicator 21: Average Sponsored Research Income by Fiscal Year and Region
  - Indicator 22: Research Intensity ($ per Full-time Faculty) by Fiscal Year and Region
  - Indicator 23: Research Intensity ($ per Full-time Graduate Student) by Fiscal Year and Region
  - Indicator 24: Research Intensity ($ per Capita) by Fiscal Year and Region
  - Indicator 25: Cumulative Research Papers Published by City (Modified by Impact Factor)
  - Indicator 26: Canadian Patents per 100,000 Population
  - Indicator 27: US Patents per 100,000 Population
  - Indicator 28: Number of Inventions per 100,000 Population
  - Indicator 29: National Share of Canadian Patents

Information economy

- Indicator 30: Percentage of Households Connected to the Internet by Location
- Indicator 31: Change in the Percentage of Households Connected to the Internet at Home and Relative to that Experienced Canada-wide
- Indicator 32: Change in the Percentage of Households Connected to the Internet at Work and Relative to that Experienced Canada-wide
- Indicator 33: Change in the Percentage of Households Connected to the Internet at School and Relative to that Experienced Canada-wide

Economic structure and productivity

- Indicator 34: Technology Use by Functional Group
- Indicator 35: Proportion of Firms that are Innovators
- Indicator 36: Percentage of Manufacturing Firms Engaged in Activities Linked to Innovation
- Indicator 37: Implementation of New Technologies
- Indicator 38: Percent of Firms involved in Collaborative and Cooperative Arrangements
- Indicator 39: Percent of Firms involved in Collaborative and Cooperative Arrangements by Type of Firm
- Indicator 40: Percent of Firms involved in Collaborative and Cooperative Arrangements by Reason for Agreement

Global integration of economic activity

- No indicators are presented in this report.

Our twenty-nine indicators of knowledge creation and diffusion can be divided into two groups: indicators of human capital formation, and indicators of knowledge production. Most indicators of human capital formation measure relative or absolute levels of investment in education and training, and certain immediate outcomes of these investments such as graduation rates and performance on standardized tests. Indicators of knowledge production measure investments in knowledge production by institutional sector and publication and patenting rates. Taken together, these two sets of indicators show investments in education in Atlantic Canada that are higher than the Canadian average, performance on standardized tests that are lower than the Canadian average, and relative regional decline in regional scientific production capability, which is concentrated in the higher education sector. Business expenditures on R&D (BERD), a key indicator of firms' willingness to spend money on innovation, are lagging severely in Atlantic Canada.

Our four indicators of the information economy measure penetration of connectivity into households. This is a proxy measure of households' ability to consume information and new services. Indicators show levels of connectivity that are comparable to but somewhat lower than those observed elsewhere in Canada.

Our seven indicators of economic structure and productivity measure technology use and innovation among firms (mostly manufacturing firms) could be expanded considerably to measure levels of production efficiency, include non-manufacturing firms, describe the regional economic structure in greater detail, and discuss patterns of firm formation and growth. Indicators included in this report show that, using self-reported rates of innovation, a regional innovation gap of around ten or fifteen percent exists. However other indicators show comparable rates of technology adoption and involvement in collaborative activities, although patterns of collaboration in Atlantic Canada differ from those in Canada as a whole. Levels of sponsored research are relatively low in Atlantic Canada.

We have not included any indicators of global economic activity in this report. In future regional innovation benchmarking exercises it would be useful to include indicators of regional technological specialization and trade. Such indicators are not currently available – they would have to be constructed.

The overall portrait of innovation in Atlantic Canada shows that the region is failing to keep up with central Canada in key areas of R&D investment. These investment shortfalls will have consequences on knowledge spillovers in the region and on the region's capacity to attract and retain highly qualified talent.

2. Summary of Innovation Performance in the Atlantic Provinces

Atlantic Region

- While the Atlantic Provinces invest between 8.2 and 8.5% of their GDP in education, which was approximately 25% more than was invested on average Canada-wide, their students' performance on standard tests was below that reported nationally. However, Atlantic Canadian student performed above the average for OECD countries. Interestingly, Atlantic Canadian students did relatively better on standardized tests that evaluated science skills and reading skills, but performed relatively more poorly on tests that assessed mathematics skills.

- On a city basis, one observes that the overall student enrollment in Atlantic Canada was low relative to that observed in other Canadian cities. This is explained in part by the fact that cities in Atlantic Canada are smaller than those which exist in other regions of Canada. In addition, although graduation rates in Atlantic Canada at the undergraduate and the Masters levels were similar to that observed nation-wide, earned doctorates in each of the Atlantic Provinces fell below the national average.

- While Nova Scotia had a higher share of its population participating in adult education and training in 1997, the other three Atlantic Provinces fell below the levels observed nationally. However, when number of hours spent in training was normalized by population, Nova Scotia fell below that observed nationally whereas Newfoundlanders and Labradorians spent similar amounts of time engaged in adult education and training as was observed nationally.

- When normalized by population, Atlantic Canada has a higher level of university graduates physical sciences than the national average in all provinces but Prince Edward Island. With the exception of Nova Scotia, Atlantic Canada had less humanities, social science business and health care graduates than observed Canada-wide per 100,000 population. The proportion of degrees in the physical science was above the national average while the proportion in humanities and social sciences was slightly below the national average. The proportion of its graduates with either business or health care was similar to that recorded Canada-wide. Finally, in terms of overall educational attainment, Atlantic Canada is comparable to the nation.

- The thirteen (13) universities in Atlantic Canada comprised 19% of all Canadian universities (2002). Yet, Atlantic universities account for only 4% of the research income of Canadian universities. Moreover, the average research income of Atlantic universities ($13.0 million in 2002) was less than one-fifth of the average research income of universities in the Rest of Canada, and less than one-quarter of the income of all Canadian universities. Furthermore, this represented an increase of 44.9% from 1999. Even so, this was considerably less than the growth in the

Rest of Canada (72.5%) and the total Canadian average (71.1%). As well, Atlantic Canadian universities did not do as well as other Canadian universities in terms of receiving granting agency funding. This perspective is improved when the number of highly qualified personnel is used to normalize the result.

- Research intensity – research income per full-time faculty position – grew by 41.3% in Atlantic Canada from 1999-2002, which was far slower than the 60.1% rate of growth in the Rest of Canada. In 2002, Atlantic universities averaged $40,700 whereas the Rest of Canada universities averaged $114,600. Furthermore, research intensity at Atlantic universities ($40,700) was only 36% of the intensity in the Rest of Canada, and 38% of the Canadian total.

- Atlantic universities performed somewhat better when measured on graduate student research intensity – research income per full-time graduate student. In 2002, Atlantic universities attracted $33,100 per full-time graduate student versus $46,500 in the Rest of Canada and the Canadian average of $45,700. Graduate student research intensity grew by 44.5% in Atlantic Canada between 1999-2002, compared with 63.2% in the Rest of Canada and 62.1% in the country as a whole. Finally, when measured in terms of research income per-capita (provincial population), Atlantic universities in 2002 attracted $72 per provincial resident compared with $126 per resident in the Rest of Canada and $122 per resident for the country as a whole.

- While the level of overall research and development performed in Atlantic Canada relative to the size of its economy is low (1.1% of GDP), it is skewed toward the education sector and away from the business sector as is the case Canada-wide. In Atlantic Canada, nearly 60% of the research and development activities are performed by the education sector with 20% accounted for by the business sector. The corresponding estimates nationally are 30% and 60%, respectively. Since the incentive for commercialization is higher for research and development undertaken by the business sector, having research and development skewed toward the education sector has direct implications for innovation activity within Atlantic Canada. When the size of the economy is controlled for, one observes that research and development performed by the business sector in Atlantic Canada is less than one quarter that observed nationally.

- The industrial research and development is becoming more concentrated in Atlantic Canada than that observed nation-wide. There are fewer and fewer firms performing industrial research and development and each firm is performing more industrial research and development than in the past. Most of the research and development activity in Atlantic Canada is in the services and manufacturing sector. As well, the pool of research and development labour is growing in Atlantic Canada, but not rapidly and much slower than that record Canada-wide.

- Research papers published in Atlantic Canadian cities falls well short of that observed in major Canadian cities.

- Both US and Canadian patents held by residents of the Atlantic Provinces is well below that observed nationally. As well, the situation improves when normalized the number of inventions by population, the region still falls well below the national average.

- Household Internet usage in Atlantic Canada falls short of that observed nationally. While household Internet usage grew in Atlantic Canada from 1997 to 2002, the growth rate was similar to that experienced nationally. The one exception to this was Prince Edward Island, which experienced growth rates in household Internet usage that exceeded those observed nationally. In addition, Household Internet usage through the school system was important in each or the Atlantic Provinces than reported nationally. Also, household Internet usage at work in Atlantic Canada was lower than national levels.

- Atlantic Canadian manufacturers' technological capabilities show strengths in the areas of integration and control, processing-fabrication-assembly, network communications and design and fabrication but are relatively weak in inspection and automated materials handling.

- The rate of innovation in Atlantic Canadian manufacturers is comparable to the national average in the area of process innovation, and is only slightly lower than the national average in the area of product innovation.

- Manufacturing firms in Atlantic Canada do not seem to differ systematically from the Canadian average in activities related to product or process innovation.

- Innovative firms in Atlantic Canada and Canada are involved in cooperative or collaborative arrangements at a similar rate.

- Innovative Atlantic Canadian firms seem to conform to the pattern of innovative Canadian firms with respect to external collaborative linkages. However, Atlantic Canadian firms appear to collaborate with consulting forms more frequently than that observed nationally.

- The reasons for collaborating are similar in Atlantic Canada and Canada.

Newfoundland and Labrador

- Newfoundland and Labrador invested approximately 8.5% of its GPD in 1999-2000 in education. This was slightly larger than was invested in the other Atlantic Provinces and was significantly larger than what was invested nationally. On the other hand, the share of GDP that Newfoundland and Labrador invested in education had fallen from 12 to 8.5% from 1997-98 to 1999-2000. In addition, Newfoundland and Labrador students performed below the national average on standardized tests in science, mathematics and reading but their performance was above that observed on average for OECD countries. Newfoundland and Labrador students' performance on standardized tests for science was 97.5% of

the national average. The corresponding performance on reading and mathematics were 97.6% and 95.5%, respectively. Newfoundland and Labrador led the other Atlantic Provinces in terms of their reading performance and was tied with Nova Scotia for best performance on science with Atlantic Canada. Its performance on mathematics was the second lowest of the Atlantic Provinces, exceeding only New Brunswick.

- St. John's fell below Halifax and other Canadian cities in terms of student enrollment, but exceeds that observed in the other Atlantic Canadian cities. While graduation rates at the undergraduate level in Newfoundland and Labrador was similar to that observed within the region and nationally, Newfoundland and Labrador showed the most improvement in this indicator from 1991 to 1998. A similar pattern was observed with students graduating with a Masters degree but Newfoundland and Labrador had one of the lowest graduation rates for doctorate degrees.

- Newfoundland and Labrador, with 25% of its population engaged in adult education and training, is below that observed nationally and in the other Atlantic Provinces in 1997. However, in per capita terms, Newfoundlander and Labradorians spent 57 hours annually in training, which just fell short of the 58 hour observed nationally but exceeded that observed in the other Atlantic Provinces.

- When normalized by population, Newfoundland and Labrador (at 126 per 100,000 people) had a higher level of university graduates in the physical sciences than the national average (116 graduates per 100,000 people). It was, however, below the national average in humanities, social science, business and health care graduates. As well, it ranked third in Atlantic Canada in all categories except for health care graduates. The proportion of degrees in the physical science was above the national average but below the regional average while the proportion in humanities and social sciences was slightly below the national average but above the regional average. The proportion of its graduates specializing in either business or health care was similar to that recorded Canada-wide. Finally, in terms of overall educational attainment, Newfoundland and Labrador had a higher proportion of its population with less than a high school education.

- Memorial University of Newfoundland recorded $34.9 million of sponsored research income in 2002, which was nearly three times the Atlantic university average ($13.0 million). However, it is important to recognize that universities with medical schools, such as Memorial, consistently record higher research income than universities that do not have medical schools. Furthermore, although total research income was high at Memorial University, income grew more slowly between 1999-2002 (25.3%) than in Nova Scotia (72.4%), Prince Edward Island (73.9%) or the Atlantic region as a whole (44.9%).

- Research intensity at Memorial – as reflected in research income per full-time faculty position – was $40,700 in 2002, the same as the Atlantic average, but

somewhat less than the average in Nova Scotia universities ($49,200). In addition, research income per full-time graduate student was $26,400, the lowest in the Atlantic region and less than the Atlantic university average of $33,100 per student. Graduate student research intensity also grew more slowly between 1999-2002 (30.0%) in Newfoundland and Labrador than the Atlantic average (44.5%). Finally, in 2002, research income per-capita was $67 in Newfoundland and Labrador versus the Atlantic Canada average of $72.

- Research and development intensity was low in Newfoundland and Labrador. Specifically, total research and development as a per cent of GDP was approximately 1% in Newfoundland and Labrador in recent years. The corresponding estimate for Atlantic Canada was 1.1% and for Canada it was 1.8%. As well, research and development Newfoundland and Labrador was skewed toward the education sector and away from the business sector, which was opposite to that observed nationally. In fact, the education sector accounted for a higher proportion of research and development performed in Newfoundland and Labrador than in any other Atlantic Province or Canada-wide. Specifically, 63% of the research and development in Newfoundland and Labrador was undertaken by the education sector and only 14% was performed by the business sector. The corresponding estimates for Canada were approximately 30% and 60%, respectively. Research and development performed by the business sector in Newfoundland and Labrador as a percent of GDP was only 0.14%, which was significantly less than the 1.15% observed nationally. Newfoundland and Labrador also recorded one of the lowest levels of business research and development intensity within Atlantic Canada.

- With 152 research and development personnel and 110 support personnel, Newfoundland and Labrador's research and development labour force was one of the lowest in the country and exceeded only Prince Edward Island within the region. Further, while this labour force grew slightly from 1997 to 2001, the increase was below that observed nationally. In addition, the number of industrial research and development establishments has declined from 116 in 1996 to 58 in 2001.

- Published research papers attributed to researchers living in St. John's fell well short of that observed in major Canadian cities and was less than accounted for by Halifax, but was above that reported for other Atlantic Canadian cities.

- Newfoundland and Labrador, with 1.5 patents per 100,000 population, had the lowest level of patent activity in Atlantic Canada and was well below the 7.3 patents per 100,000 people observed nationally. The same pattern held for inventions – Newfoundland and Labrador had 2.1 inventions per 100,000 people in 2001 while the national average was 12.8 inventions per 100,000 people.

- Seventy-one percent of manufacturing firms in Newfoundland and Labrador were considered to be innovators for the period 1997-1999. This was lower than the Canadian average of 80%. Further, a higher proportion of Newfoundland and

Labrador manufacturing firms considered themselves to be process innovators (65.2%) than were product innovators (59%). The opposite was the case nationally, where 68% of firms considered themselves to be product innovators and 65.8% thought of themselves as process innovators.

- Approximately 16% of innovative firms in Newfoundland and Labrador were involved in cooperative or collaborative arrangements. This is less than half of the Canadian average of 33%.

- Household Internet usage in Newfoundland and Labrador fell short of that observed nationally and exceeded only New Brunswick within Atlantic Canada. While household Internet usage grew, the growth rate was similar to that observed nationally. Having access to the Internet at schools in Newfoundland and Labrador was relatively more important than in other jurisdictions. For example, 25% of Newfoundland and Labrador households connected to the Internet at work and at school in 2002. This compared to 34% and 23%, respectively, Canada-wide.

Nova Scotia

- Nova Scotia invested 8.3% of its GDP on education in 1999-2000, which was down from the 8.7% invested in the previous year but it was on par with the level of investment (8.2%) that it undertook in 1997-1998. This level of investment is comparable to that which was undertaken in the other Atlantic Provinces in 1999-2000, but was significantly above the investment recorded nationally. However, Nova Scotia students performed below the national average on standardized tests in science, mathematics and reading, which was above that observed on average for OECD countries. Nova Scotia students' performance on standardized tests for science was 97.5% of the national average. The corresponding performance on reading and mathematics were 96.8% and 96.2%, respectively. This put Nova Scotia at or tied for the top in Atlantic Canada for science and mathematics.

- Halifax dominated Atlantic Canadian cities in terms of graduate and undergraduate students enrolled in university but fell behind other Canadian cities.

- Nova Scotia had 32% of its population engaged in adult education and training in 1997. This led the other Atlantic Provinces and exceeded that observed nationally. While Nova Scotia had the highest percentage of its population engaged in adult education and training, they were spending fewer hours than that observed nationally or in Newfoundland and Labrador.

- When normalized by population, Nova Scotia had the highest number of university graduates in all categories in Atlantic Canada and it exceeded the national average as well. The proportion of degrees in the physical science was above the national average but below the regional average, while the proportion in humanities and social sciences was slightly below the national average but above

the regional average. The proportion of its graduates with either business or health care was similar to that recorded Canada-wide. Finally, in terms of overall educational attainment, Nova Scotia had the highest proportion of its population with more than a high school education.

- With 8 universities in the province in 2002, Nova Scotia accounted for 62% of the total number of Atlantic universities. Nova Scotia institutions received a corresponding portion of Atlantic university research income (57%). Between 1999 and 2002, research income at Nova Scotia universities grew by 72.4%, which was faster than the Atlantic region university research income growth of 44.9%. Average research income per university in Nova Scotia was only about $12.0 million in 2002. This was less than the Atlantic average of $13.0 million per university. As well, Nova Scotia universities recorded the highest research intensity – as reflected in the research income per full-time faculty. In 2002, research intensity averaged $49,200 per faculty position in Nova Scotia.

- Research intensity grew by 65.7% between 1999-2002 in Nova Scotia, which was highest in growth compared to both the Atlantic region (41.3%) and the Rest of Canada (60.1%). In terms of research intensity per full-time graduate student, Nova Scotia institutions recorded $36,500 per student, compared with the Atlantic average of $33,100 in 2002. Graduate student research intensity grew by 74.6% between 1999-2002, which was the highest in the region and exceeded the Rest of Canada total (63.2%). On a per-capita basis in 2002, Nova Scotia universities received an average of $103, compared with the Atlantic average of $72 and the Rest of Canada average of $126.

- Overall research and development intensity was low in Nova Scotia relative to that observed nationally, but Nova Scotia led the region in this indicator. Specifically, total research and development as a per cent of GDP was approximately 1.5% in Nova Scotia in recent years. The corresponding estimate for Atlantic Canada was 1.1% and for Canada it was 1.8%. As well, research and development Nova Scotia was skewed toward the education sector (57%) and away from the business sector (21%), which was opposite to that observed nationally but was an improvement on the shares observed in Newfoundland and Labrador. Research and development performed by the business sector in Nova Scotia as a percent of GDP was 0.3%, which was significantly less than the 1.15% observed nationally. However, Nova Scotia exceeded the levels recorded in the other Atlantic Provinces for business research and development measured relative to its GDP and Nova Scotia accounted for nearly 60% of regional business expenditures on research and development.

- Industrial research establishments in Nova Scotia fell from 210 in 1997 to 168 in 2001. Nova Scotia led all other Atlantic Provinces with establishments engaged in industrial research and development. As well, its labor force engaged in research and development also exceeded all other provinces.

- Research papers published by residents of Halifax fell short of that observed in major Canadian cities, but exceeded the numbers reported in other Atlantic Canadian cities.

- In 2001, while Nova Scotia led the region with 2.9 Canadian patents per 100,000 population, it was significantly below the 7.3 patents per 100,000 population recorded Canada-wide. Prior to 2001, New Brunswick was the regional leader in this indicator. When US patents are considered, Nova Scotia (1.9 patents per 100,000 people) is below New Brunswick's 3.1 patents per 100,000 people and 11 patents per 100,000 people reported for Canada. When the number of inventions per 100,000 people is considered, Nova Scotia, with 2, is the lowest of the Atlantic Provinces and well below the 12.8 observed nationally.

- Seventy-seven percent of manufacturing firms in Nova Scotia were considered to be innovators for the period 1997-1999. This was lower than the Canadian average of 80%. A higher proportion of Nova Scotia manufacturing firms considered themselves to be product innovators (63.9%) than were process innovators (62.7%).

- Approximately 39% of innovative firms in Nova Scotia were involved in cooperative or collaborative arrangements. This exceeded the Canadian average of 33%.

- Nova Scotia firms report a higher than average rate of collaboration with firms from within a corporate group. As well, prototype development is an important motivation for engaging in collaboration for Nova Scotia firms.

- Household Internet usage in Nova Scotia fell short of that observed nationally but was the highest in Atlantic Canada. While household Internet usage grew, the growth rate was similar to that observed nationally. Having access to the Internet at work in Nova Scotia was relatively more important than in Newfoundland and Labrador or Prince Edward Island but was comparable to that observed in New Brunswick. For example, 31% of Nova Scotia households connected to the Internet at work in 2002. This compared to 34% nationally.

Prince Edward Island

- Prince Edward Island invested 8.2% of its GDP on education in 1999-2000, which was down from the 9.1% invested in 1997-98. This level of investment is comparable to that which was undertaken in the other Atlantic Provinces in 1999-2000, but was significantly above the investment recorded nationally. Prince Edward Island students performed below the national average on standardized tests in science, mathematics and reading but their performance was above that observed on average for OECD countries. Nova Scotia students' performance on standardized tests for science was 96.0% of the national average. The corresponding performance on reading and mathematics were 96.8% and 96.1%, respectively.

- Charlottetown has one of the lowest levels of graduate and undergraduate students enrolled in universities of all Canadian cities.

- 27% of the Prince Edward Island's population was engaged in adult education and training in 1997. This was below the national average but was the second highest in Atlantic Canada. However, with only 43 hours annually per capita, the residents of Prince Edward Island were spending the lowest amount of time in this activity.

- When normalized by population, Prince Edward Island had a lowest level of university graduates per 100,000 population for all categories. The proportion of degrees in each category was similar to that observed for the other Atlantic Provinces. Finally, in terms of overall educational attainment, Prince Edward Island had 29% of its population with less than a high school education, which was similar to that which existed in the region in 2001.

- University of Prince Edward Island (UPEI) recorded only $5.2 million of sponsored research income in 2002. Since 1999 the university's research income has jumped by 73.9%, but growth has been volatile. Research income at UPEI was considerably less than the Atlantic average of $13.0 million per institution in 2002.

- In 2002, research intensity was also lowest at UPEI. Full-time professors attracted an average of $27,000 each, which was considerably less than the Atlantic university average of $40,700 and far behind the Rest of Canada ($114,600). Research intensity (per full-time faculty) grew by 62.7% at UPEI between 1999-2002, which was faster than the Atlantic average (41.3%) and the Rest of Canada average (60.1%). However, actual intensity was unstable with significant changes from year to year. When measured by graduate student research intensity, UPEI out-performed all others in 2002. The university attracted $62,400 per full-time graduate student, compared with $33,100 in the Atlantic region as a whole and $46,500 in the Rest of Canada. However, graduate student intensity was also volatile with a -39.3% decline between 1999-2002. On a per-capita basis UPEI attracted only $38 per resident, compared with $72 in the region as a whole and $126 in the Rest of Canada in 2002.

- Overall research and development intensity was low in Prince Edward Island relative to that observed nationally. Specifically, total research and development as a per cent of GDP was approximately 1.06% in Prince Edward Island in recent years. The corresponding estimate for Atlantic Canada was 1.12% and for Canada it was 1.8%. As well, research and development in Prince Edward Island was skewed toward the federal sector (44%) and the education sector (42%). Research and development performed by the business sector in Prince Edward Island as a percent of GDP was 0.12%, which was significantly less than the 1.15% observed nationally.

- Prince Edward Island has the lowest number of establishments undertaking industrial research and development in Atlantic Canada. The number of establishment has declined from 23 in 1997 to 17 in 2001. It also has the lowest number of research and development personnel in Atlantic Canada.

- Research papers published by researchers residing in Charlottetown is one of the lowest in the country.

- In 2001, while Prince Edward Island was second in the region with 2.2 Canadian patents per 100,000 population, it was significantly below the 7.3 patents per 100,000 population recorded Canada-wide. When US patents are considered, Prince Edward Island (1.5 patents per 100,000 people) exceeded only Newfoundland and Labrador. When the number of inventions per 100,000 people is considered, Prince Edward Island, with 2.2, is the second highest of the Atlantic Provinces but well below the 12.8 observed nationally.

- Nearly 80% of manufacturing firms in Prince Edward Island were considered to be innovators for the period 1997-1999. This was on par with the Canadian average. An equal proportion of firms reported being product and process innovators.

- Approximately 35.5% of innovative firms in Prince Edward Island were involved in cooperative or collaborative arrangements. This exceeded the Canadian average of 33%.

- Prince Edward Island firms report a higher than average rate of collaboration with universities. As well, prototype development is an important motivation for engaging in collaboration for Prince Edward Island firms.

- Household Internet usage in Prince Edward Island fell short of that observed nationally. Household Internet usage grew faster in Prince Edward Island than that observed nationally and within the region. Having access to the Internet at work and schools in Prince Edward Island was about the same relative importance.

<u>New Brunswick</u>

- New Brunswick invested 8.3% of its GDP on education in 1999-2000, which was down from the 8.6% invested in 1997-1998. This level of investment was comparable to that which was undertaken in the other Atlantic Provinces in 1999-2000, but was significantly above the investment recorded nationally. New Brunswick students performed below the national average and the regional average on standardized tests in science, mathematics and reading but, with the exception of science, it was above that observed on average for OECD countries. New Brunswick students' performance on standardized tests for science is 94.0% of the national average. The corresponding performance on reading and mathematics were 93.8% and 94.9%, respectively. The relatively stronger

performance of New Brunswick students was in mathematics, which was opposite that observed in the other Atlantic Provinces.

- While undergraduate and graduate student enrollment in New Brunswick cities exceeds that observed in Prince Edward Island, it fell below that observed in other Atlantic Provinces and in other Canadian cities.

- Like Prince Edward Island, New Brunswick had 27% of its population engaged in Adult Education and Training in 1997. This was below the national average but was the second highest in Atlantic Canada. With 52 hours per capita spent in this activity, the residents of New Brunswick were the second lowest of all the Atlantic Provinces and were below that observed nationally.

- When normalized by population, New Brunswick (138 per 100,000 people) had a higher level of university graduates in the physical sciences than the national average (116 per 100,000 people). It was below the national average in humanities, social science, and health care graduates but above the average for business graduates. The proportion of degrees in each category followed a pattern similar to that observed in the region. Finally, in terms of overall educational attainment, New Brunswick had 29% of its population with less than a high school education.

- New Brunswick's 3 universities accounted for about one-quarter (23%) of the Atlantic total of 13 institutions in 2002. Sponsored research income at New Brunswick universities was $33.1 million in 2002, which was 20% of the Atlantic total. In 2002, New Brunswick universities attracted an average of $11.0 million each of research income, compared with the Atlantic average of $13.0 million. Research income grew by only 9.6% between 1999 and 2002, which was the lowest growth rate among the Atlantic Provinces (44.9%) and far below the Rest of Canada (72.5%).

- New Brunswick universities attracted $28,600 per full-time faculty position in 2002, which was considerably less than the Atlantic average of $40,700, and far behind the Rest of Canada total of $114,600 per faculty. Growth in research intensity was 8.3% between 1999 and 2002 – far below all other regions. In terms of research intensity per full-time graduate student in 2002, New Brunswick universities attracted an average of $31,300 per student, which was close to the Atlantic average ($33,100) but less than the Rest of Canada ($46,500). Graduate student research intensity in New Brunswick rose by 44.5% between 1999 and 2002. On a per-capita basis New Brunswick institutions attracted $44 each, compared with $72 for the Atlantic region as a whole and $126 for the Rest of Canada. Per-capita growth was only 10.3% between 1999 and 2002 – the lowest of all Atlantic Provinces.

- Overall research and development intensity was low in New Brunswick relative to that observed nationally and regionally. Specifically, total research and development as a per cent of GDP was approximately 0.76% in New Brunswick

in recent years. The corresponding estimate for Atlantic Canada was 1.12% and for Canada it was 1.8%. As well, research and development in New Brunswick was skewed toward the education sector (57%). Research and development performed by the business sector in New Brunswick as a percent of GDP was 0.16%, which was significantly less than the 1.15% observed nationally. As well, research and development in the business sector relative to GDP in New Brunswick declined in recent years.

- New Brunswick had the second highest number of establishments undertaking industrial research and development in Atlantic Canada. The number of establishment has declined from 170 in 1997 to 130 in 2001. It also has the second highest number of research and development personnel in Atlantic Canada and this remained relatively constant in recent years.

- Research papers published by researchers residing in New Brunswick cities was low relative to the region and the country.

- In 2001, while New Brunswick was second lowest in the region with 1.8 Canadian patents per 100,000 population, it was significantly below the 7.3 patents per 100,000 population recorded Canada-wide. When US patents are considered, New Brunswick (3.1 patents per 100,000 people) exceeded all other Atlantic Provinces. When the number of inventions per 100,000 people is considered, New Brunswick, with 9.6, was the highest of the Atlantic Provinces and relatively close to the 12.8 observed nationally.

- Nearly 74% of manufacturing firms in New Brunswick were considered to be innovators for the period 1997-1999. This was below the Canadian average. A higher proportion of firms consider themselves to be process innovators (58.4%) than thought of themselves as product innovators (61.3%).

- Approximately 32.6% of innovative firms in New Brunswick were involved in cooperative or collaborative arrangements. This was on par with the Canadian average of 33%.

- Cost sharing and accessing new markets were important motivations for engaging in collaboration for New Brunswick firms.

- Household Internet usage in New Brunswick fell short of that observed nationally and within Atlantic Canada. While household Internet usage grew, the growth rate was similar to that observed nationally. Having access to the Internet at work and schools in New Brunswick was relatively more important than in other jurisdictions.

3. Review of Innovation Indicators

Indicator 1: Resources Devoted to Education Relative to the Size of the Economy

Figure 1: Combined Public and Private Expenditures on Education as a Percent of GDP, Select Years

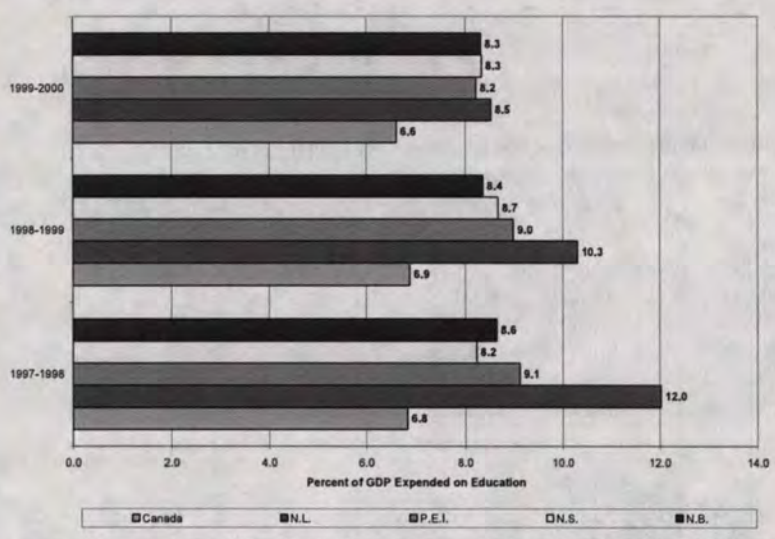
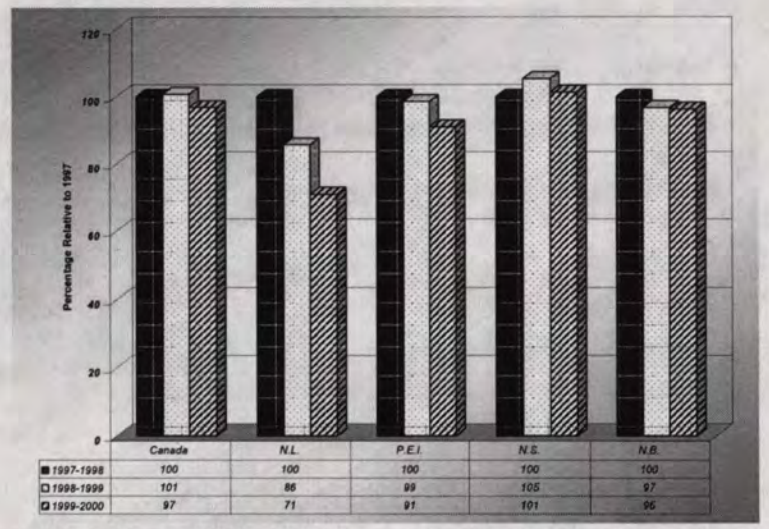


Figure 2: Combined Public and Private Expenditures on Education as a Percent of GDP Relative to 1997-98



- Figures 1 and 2 illustrate the resources that each of the Atlantic Provinces and Canada invests in education, normalized for the size of their respective economies. Education is an important input in the innovation process. The more resources devoted to education, the greater is the potential for future innovation. Moreover, to the extent that these relative differences in investment in education between jurisdictions are protracted, the stronger will this statistic be as an indicator of differences in innovation currently observed between these jurisdictions.
- In 1999-2000, the latest year for which data was available for this study, the four Atlantic Provinces invested similar amounts in education – between 8.2 and 8.5% of their GDP. This was approximately 25% higher than that invested nationally (6.6%).
- Newfoundland and Labrador's investment in education dropped relative to the size of its economy, from 12 to 8.5%. This is a significant drop over three years. There was also a slight drop, approximately one percentage point, in Prince Edward Island's investment in education, while investment levels in Nova Scotia, New Brunswick and Canada remained essentially unchanged.

Indicator 2: Performance on Standardized Tests of 15-Year Students Relative to that Observed Nationally

Figure 3: Mean Performance of 15-Year-Old Students on Standardized Tests (PISA 2000) Relative to that Achieved Canada-wide by Subject Tested for the Atlantic Provinces and the OECD

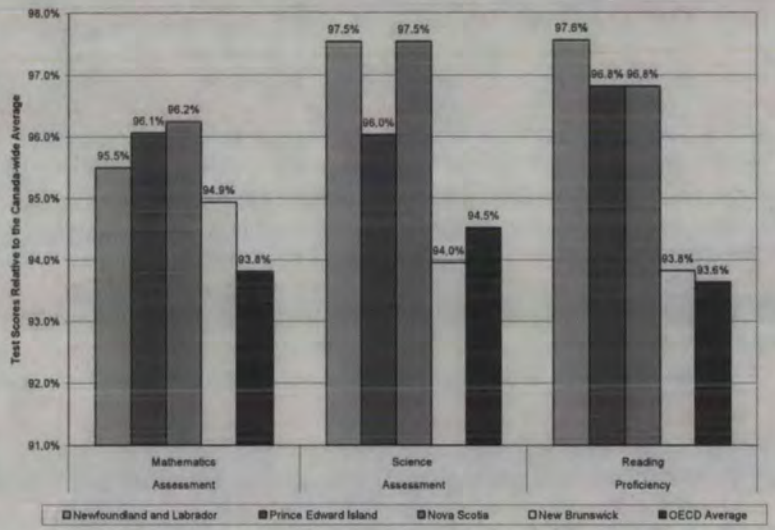
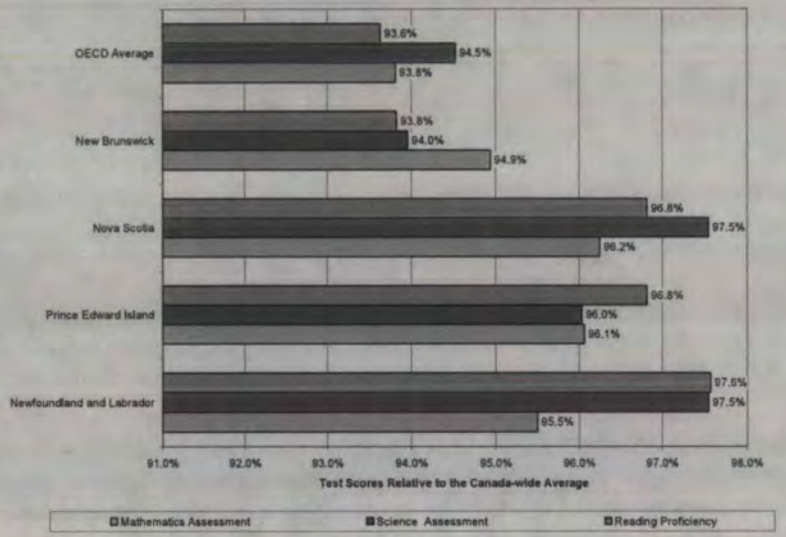


Figure 4: Mean Performance of 15-Year-Old Students on Standardized Test (PISA 2000) Relative to that Achieved Canada-wide by Jurisdiction and Subject Area



- The quality of education at the high school and elementary levels is also a potentially important determinant of innovation capacity. One measure of the quality of education in a given jurisdiction is how students perform on standardized tests relative to some reference group. Figures 3 and 4 highlight the performance of 15-year-old students in each of the Atlantic Provinces and the OECD relative to that which exists nationally.
- In the areas of Mathematics, Science and Reading, students in all four Atlantic Provinces are below performance levels observed nationally and above that observed on the average for OECD countries. The exception to this is New Brunswick's performance on Science, which was below that observed in the OECD.
- Newfoundland and Labrador students' performance is similar to that observed nationally for Science and Reading (within three percentage points), but they are more deficient in terms of their Mathematics performance (95.5% of the national average).
- Prince Edward Island falls within three to four percentage points of the national performance on all three tasks.
- Nova Scotia students, while below the national average on all three tasks, performed closest to the national average in Science.
- New Brunswick falls below the other Atlantic Provinces in all three areas. However, the area its students perform best in is mathematics, which, surprisingly, turns out to be the worse for the other provinces.

Indicator 3: Enrollment at Universities by City

Figure 5: Full- and Part-Time Undergraduate Enrollment, 2002

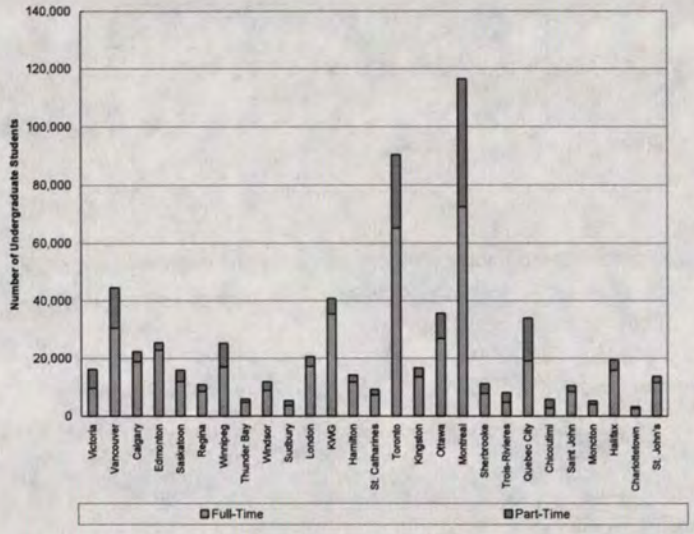
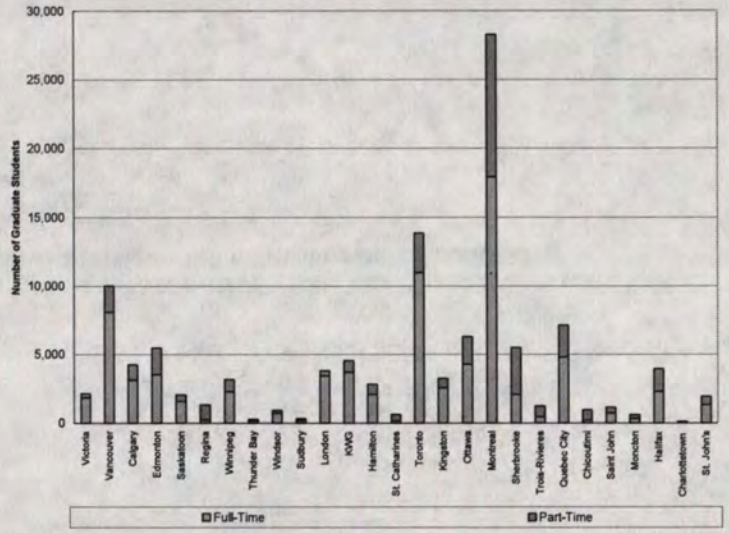


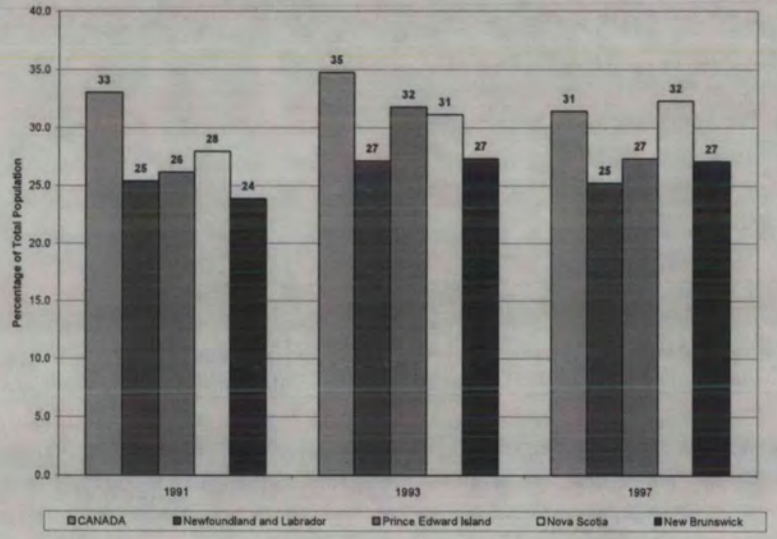
Figure 6: Full- and Part-Time Graduate Enrollment, 2002



- Within Atlantic Canada, Halifax dominates the other Atlantic Canadian cities in terms of both undergraduate and graduate enrollment and St. John's is next.
- The overall student enrollment in Atlantic Canada is low relative to that observed in other cities, Canada-wide, but that is explained in part by smaller cities in Atlantic Canada.
- The number of students, both undergraduate and graduate reflect the demand for and supply of HQP (highly qualified personnel) in a given jurisdiction, which, in turn, provide an indication of the knowledge base and potential for innovation in the area. As well, graduate students, both full- and part-time, are good indicators of intellectual output and intellectual attractiveness of an area.
- Current enrollment is an indicator of future innovation potential as these students become an input in knowledge-based workforce when they graduate.

Indicator 4: Percentage of Population Participating in Adult Education and Training

Figure 7: Percentage of Total Population Participating in Adult Education and Training – Select Years



- There has been a slight decrease in the percentage of the population in Canada participating in Adult Education and Training from 1991 to 1997.
- Both Newfoundland and Labrador and Prince Edward Island were essentially unchanged over this period, but Nova Scotia and New Brunswick registered an increase the percentage of people engaged in adult education and training. In fact, in 1997 Nova Scotia, with 32% of its population engaged in adult education and training, exceeded the level observed nationally.
- Newfoundland and Labrador (25%), Prince Edward Island (27%) and New Brunswick (27%) are below that observed nationally (31%).

Indicator 5: Time Spent on Adult Education and Training Per Capita

Figure 8: Mean Annual Number of Hours Spent on Adult Education and Training Per Capita

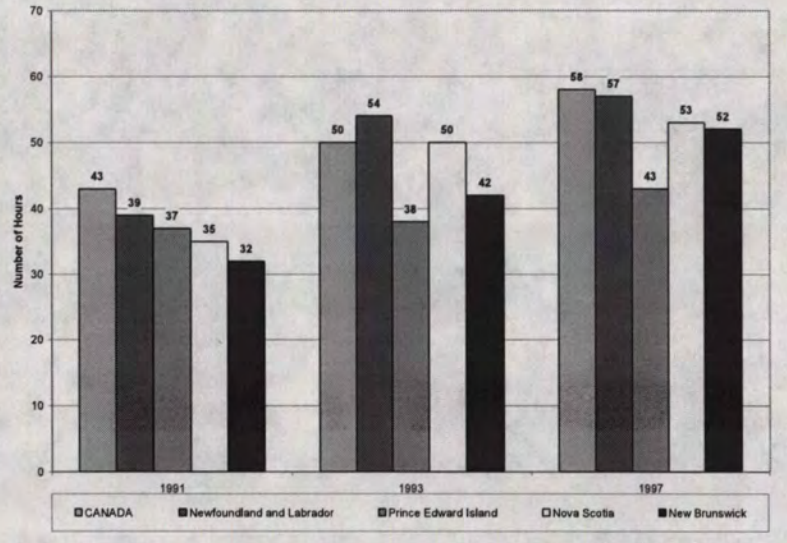
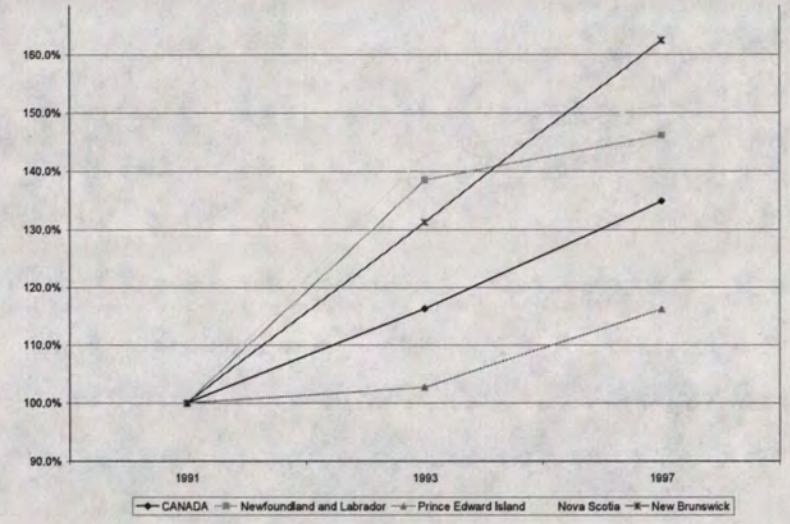


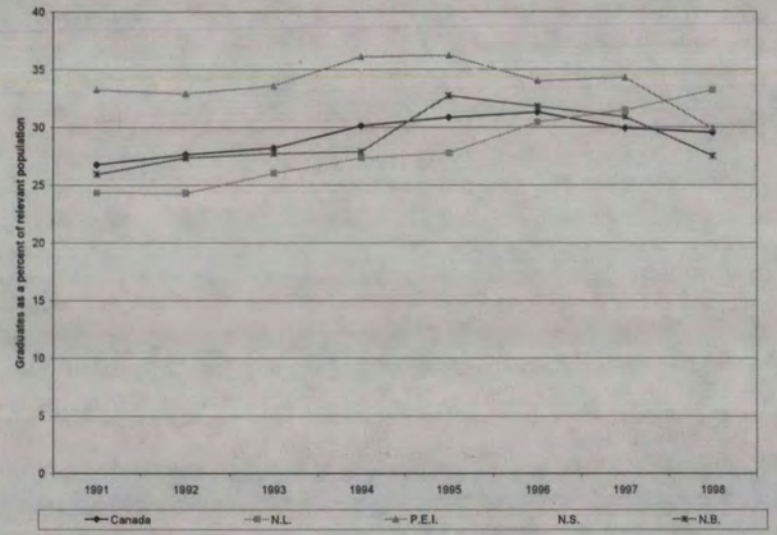
Figure 9: Index of Mean Annual Number of Hours Spent on Adult Education and Training Per Capita



- On a per capita basis, Newfoundlanders and Labradorians are currently undertaking similar levels of adult education (57 hours) as that observed nationally (58 hours).
- The biggest increase (in excess of 60%) was observed in New Brunswick.
- Prince Edward Island (43 hours) was significantly below the other Atlantic Provinces and the nation in terms of the number of hours per capita of adult education and training undertaken.

Indicator 6: University Graduation Rates for Bachelors and First Professional Degrees

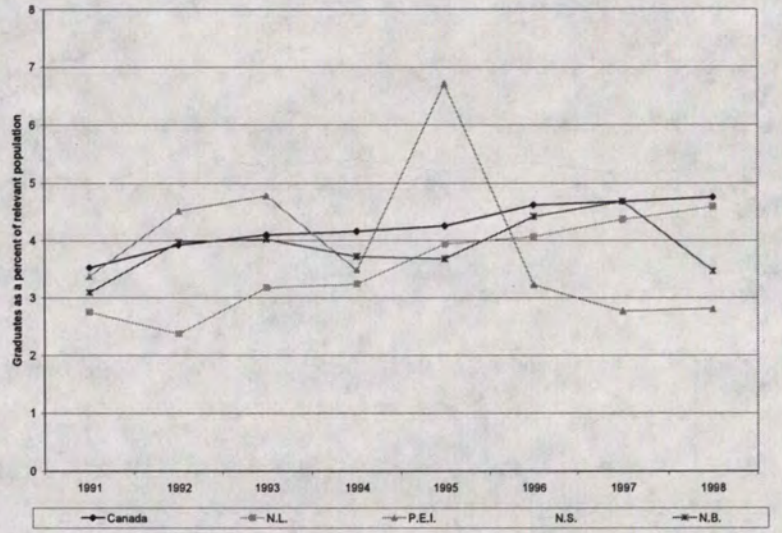
Figure 10: University Graduation Rates for Bachelor's and First Professional Degrees by Jurisdiction of Residence



- While graduation rates at the undergraduate level are similar in each of the Atlantic Provinces and Canada, Nova Scotia has a distinct edge in this category with a graduation rate in excess of 35%.
- Prince Edward Island was leading the other province in this indicator until recently, when it dropped back to the national average.
- Newfoundland and Labrador showed the most improvement in this indicator from 1991 to 1998; increasing from less than 25% to nearly 35%.
- New Brunswick showed a slight improvement in the graduation rate for undergraduates.

Indicator 7: University Graduation Rates by Master's Degree

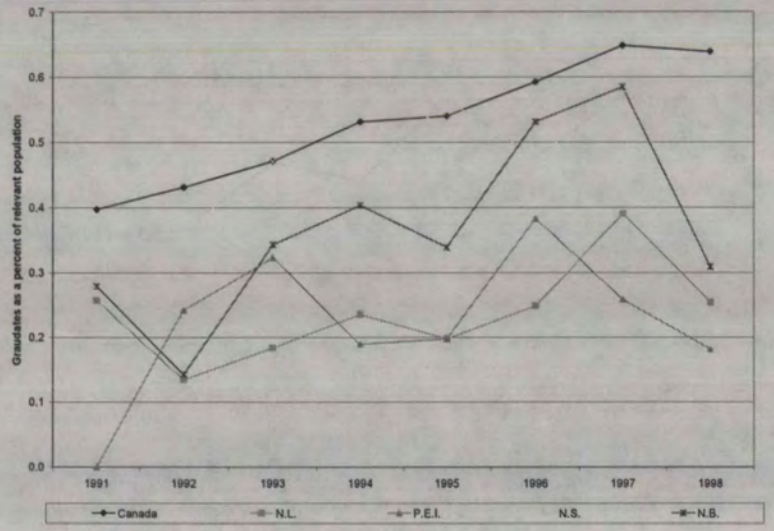
Figure 11: University Graduation Rates of Master's Degrees by Jurisdiction of Residence



- All provinces were similar in the graduation rates exhibited at the master's level, although there was more variability in the annual graduation rates observed for the undergraduate degrees.
- Newfoundland and Labrador showed the largest improvement over the time period considered; increasing from less than 3% to nearly 5%.

Indicator 8: University Graduation Rates by Doctorate Degree

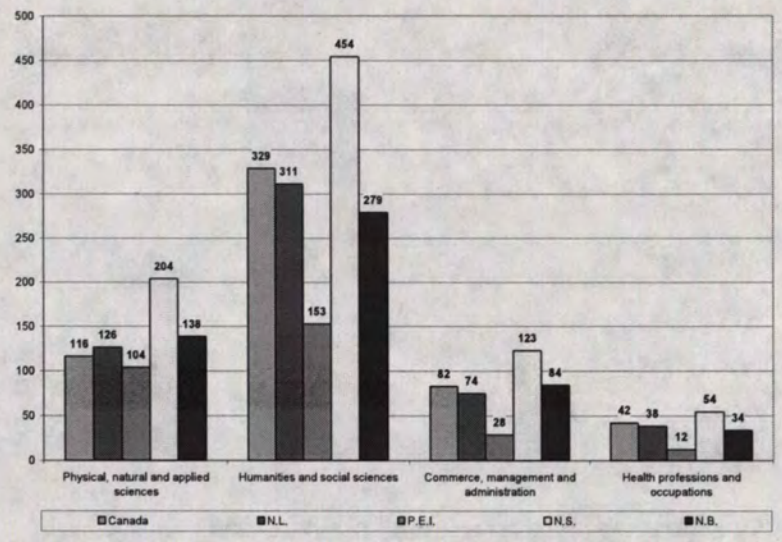
Figure 12: University Graduation Rates of Doctorate Degrees by Jurisdiction of Residence



- The Atlantic Provinces did not fare as well as the nation as a whole for the graduation rate exhibited by the earned doctorate.
- Again, there was quite a bit of variability for this level of degree.

Indicator 9: University Graduates by Field of Study Per 100,000 Population

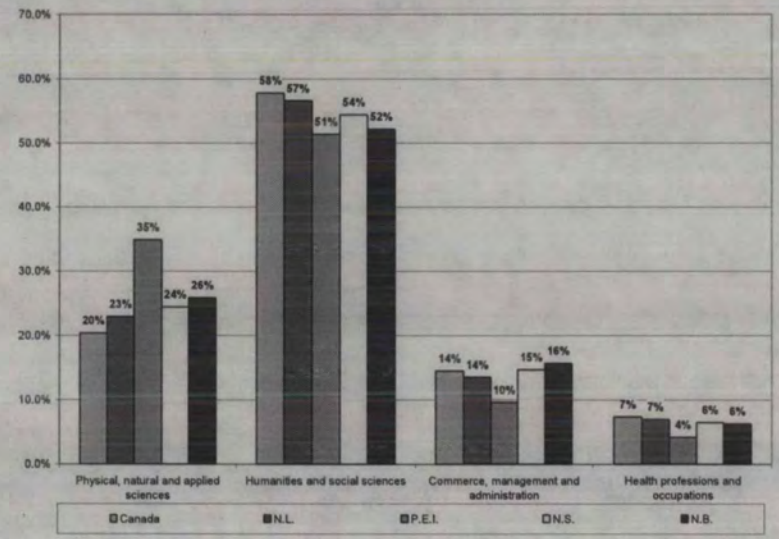
Figure 13: Number of University Graduates per 100,000 People by Field of Study



- Nova Scotia is leading the Atlantic Provinces and is above the Canada-wide average in terms of the number of graduates per 100,000 population for all fields of study. It is well above the Canadian average in each field of study.
- Newfoundland and Labrador and Prince Edward Island are above the Canadian average in humanities and social science graduates and Helath professions and occupations per 100,000 population but are below in the physical, natural and applied sciences.
- New Brunswick falls short of the other Atlantic Provinces and the national average in all fields of study.

Indicator 10: Composition of University Graduates by Field of Study

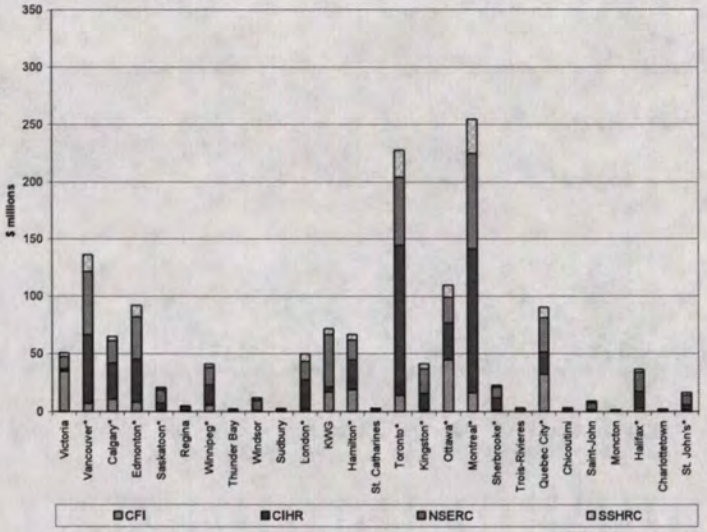
Figure 14: Composition of University Graduates by Field of Study



- The share of graduates in each field by jurisdiction is similar across jurisdictions, with the humanities and social sciences representing more than half of the degrees, followed by the hard science, business and health sciences.
- Prince Edward Island has relatively more graduates in the physical sciences.

Indicator 11: Granting Agency Funding by City

Figure 15: Granting Agency Funding, Fiscal year 2002/03

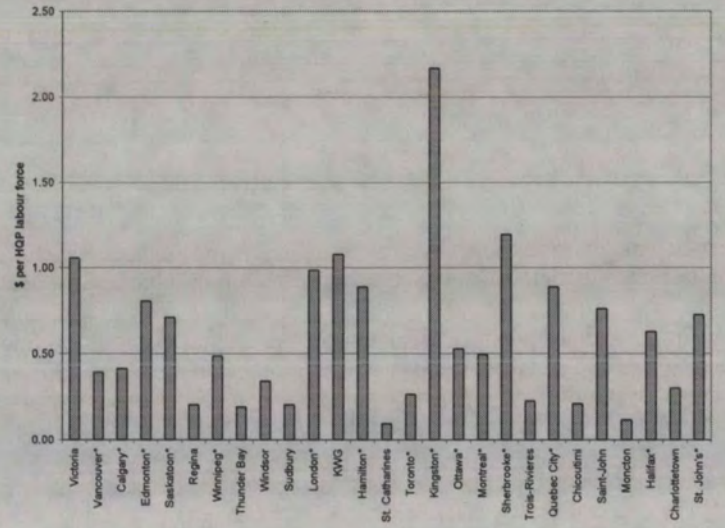


- Research by the Innovation Systems Research Network (ISRN) on industrial clusters in Canada and their role in the national system of innovation has confirmed that the presence of a large, publicly-funded, research institution (usually a university) at the centre of the cluster is important for innovation and the economic activity that flows from it.[1] The granting agencies have the collective ability to support the creation and development of clusters, by concentrating funds in institutions that have the capacity to develop new technologies. An aggregation of research and development expenditures in a city/region allocated by informed, but arm's length, stakeholders reflects an independent evaluation of the ability of a region to generate knowledge.
- This graph shows that peer-adjudicated research funding tends to concentrate in a small number of highly successful centers according to a process of accumulation of advantage. Peripheral or smaller areas will find it increasingly difficult to maintain a relative share of investment in peer-adjudicated research.

[1] See Wolfe, D.A. and M.S. Gertler, "*Clusters Old and New: Lessons from the ISRN Study of Cluster Development,*" in "*Clusters Old and New,*" edited by D.A. Wolfe, McGill-Queens University Press, Montreal and Kingston, 2003.

Indicator 12: Research Dollars from Granting Agency per HQP by City

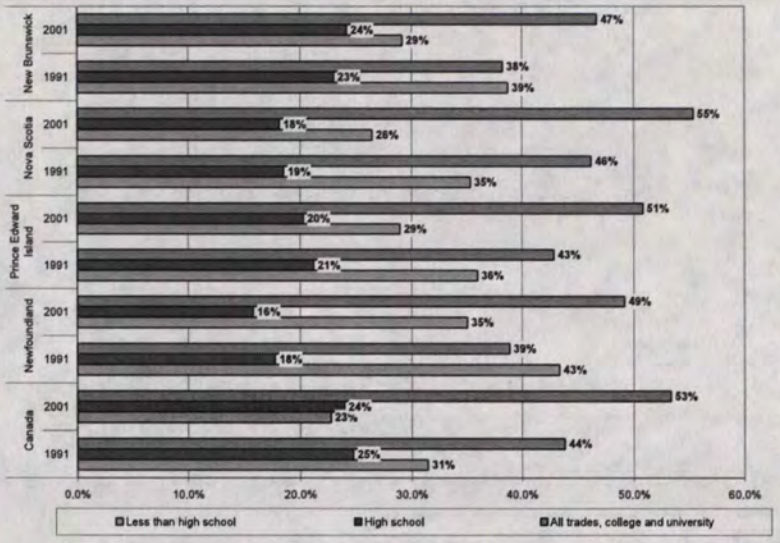
Figure 16: Research Dollars from Granting Council by HQP Labour Force by City for Fiscal Year 2002/03



- Indicators show investment in R&D per capita by highly qualified person and by city or census metropolitan area. Cities in which universities are the primary knowledge-producing institution in the urban economy have higher scores than large, diversified cities.

Indicator 13: Indicator: Educational Attainment

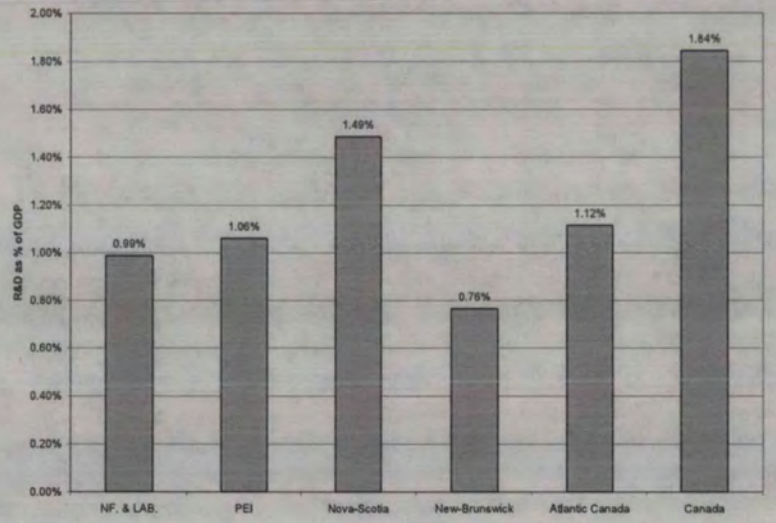
Figure 17: Proportion of Population between 25 to 64 by Educational Attainment



- For Canada and the four Atlantic Provinces, there has been drop in the proportion of the population with less than high school education by approximately 9 percentage points and for the most part this has been made up by people receiving an education above a high school level.
- Newfoundland and Labrador had the highest proportion of its population with less than a high school population in 2001and the proportion of its population with above high school education (49%) was still below that observed nation-wide (53%).
- With more than 51% of its population being educated beyond high school, Prince Edward Island is close to the national average.
- Nova Scotia, with 55% of its population educated beyond high school, is doing better than the national average.
- New Brunswick is below the other Atlantic Provinces and the national average with 47% of its population with more than a high school education.

Indicator 14: Research and Development Intensity Within Each Jurisdiction

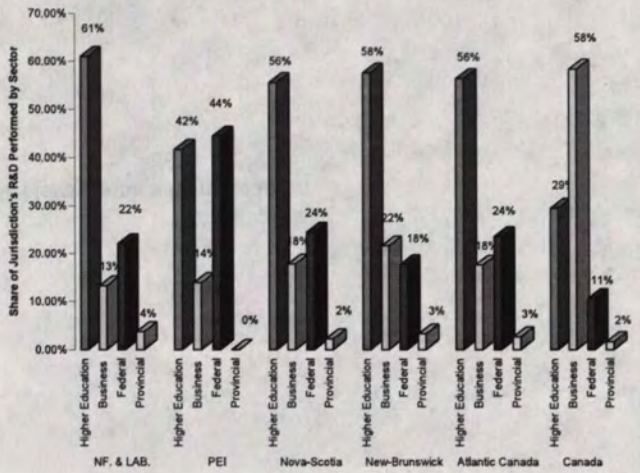
Figure 19: R&D Performed as a percent of GDP by Jurisdiction, 2000



- Controlling for the differences in the amount of economic activity, Atlantic Canada (1.12% of GDP) invests less in research and development than occurs on average in Canada (1.84%);
- Nova Scotia (1.49%) has the highest research intensity in Atlantic Canada, followed by Prince Edward Island (1.06%), Newfoundland and Labrador (0.99%) and New Brunswick (0.76%);
- Research and development is an input to the innovation process. The low level of investment in Atlantic Canada does not bode well for innovation in the region.

Indicator 15: Sectoral Breakdown of R&D Performed Within Each Jurisdiction

Figure 19: Sectoral Composition of R&D Performed by Jurisdiction, 2000



- The majority of the research and development performed in Atlantic Canada comes from the education sector (between 56 and 61%), while more than 58% if the research and development performed Canada-wide in 2000 resulted from the business sector. Since the business sector has a stronger incentive to commercialize research and development, the lower shares of research and development from this sector indicates that innovation within the region may not grow as fast as that observed elsewhere in Canada.
- The share of research and development undertaken by the education sector in 2000 was
    - 61% for Newfoundland and Labrador;
    - 42% for Prince Edward Island;
    - 56% for Nova Scotia;
    - 58% for New Brunswick; and
    - 52% for Atlantic Canada.

Indicator 16: R&D Intensity Performed by the Business Sector

Figure 20: R&D Intensity Performed by the Business Sector, 1997-2001

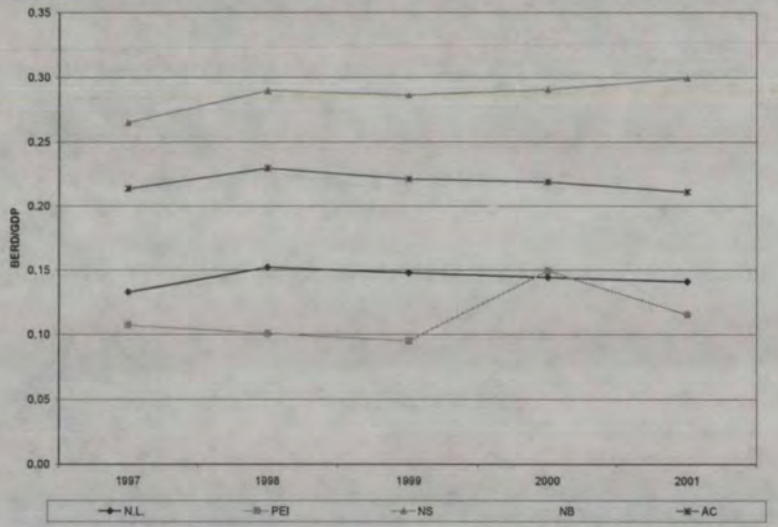
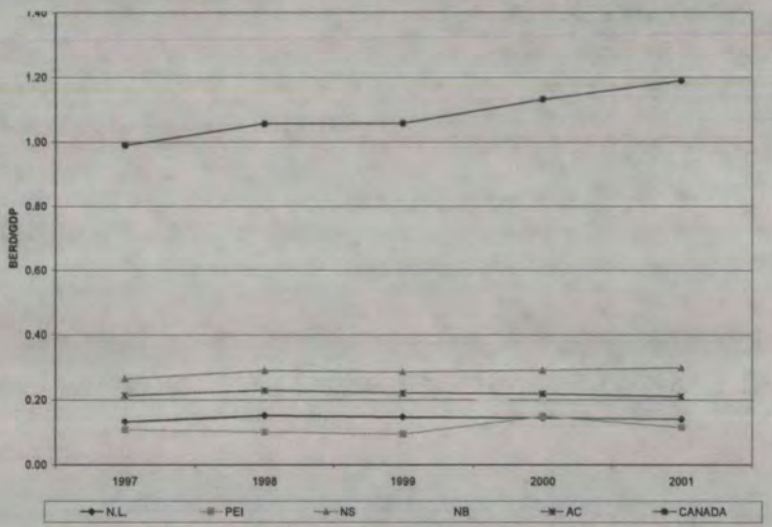


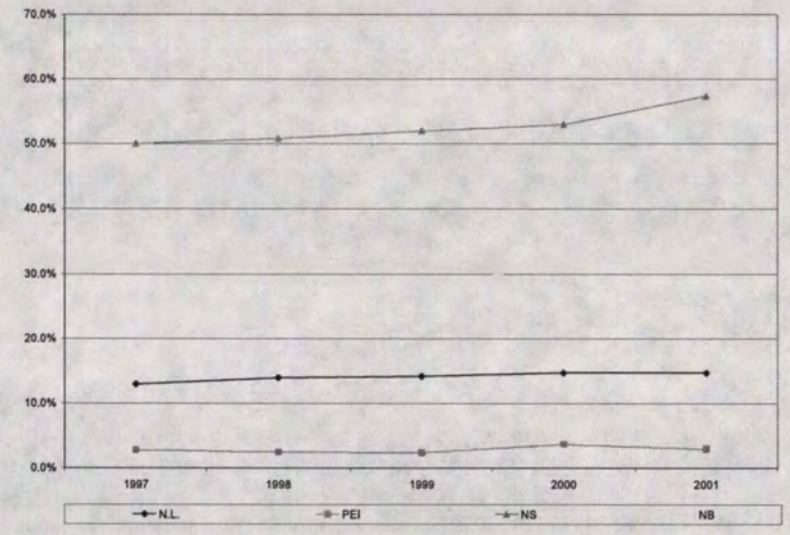
Figure 21: R&D Intensity Performed by the Business Sector, Including Canada, 1997-2001



- BERD/GDP ratio (Business Expenditures on R&D) is a measure of the extent to which the business sector invests in invention. Atlantic Canada's business sector is approximately one-sixth as R&D intensive as Canada's as a whole.
- Low R&D intensity indicates that Atlantic Canadian businesses are not creating their own technologies or even their own products. When they innovate, they do so by purchasing capital equipment.
- Canada's BERD/GDP ratio increased from .99 in 1997 to 1.19 in 2001, while Atlantic Canada's remained stationary. Canada's business sector increased its R&D spending from $8.7B to $13.2B, while Atlantic Canada's business sector increased its R&D spending from $108M to $136M.
- Within Atlantic Canada, Newfoundland and Labrador's BERD/GDP ratio increased slightly from .13 to .14, and Prince Edward Island's increased slightly from .11 to .12. New Brunswick's declined from .22 to .16, and Nova Scotia's increased from .27 to .30.
- Atlantic Canada is falling far behind the Canadian average in terms of its ability or willingness to invest in innovation. Only Nova Scotia is improving its position steadily.

Indicator 17: Provincial Shares of BERD in Atlantic Canada

Figure 22: Provincial Shares of BERD in Atlantic Canada



Nova Scotia is quickly increasing its role as the region's business R&D center. More than half the region's business R&D is performed in Nova Scotia.

- Total BERD in Atlantic Canada in 2001 was $136M.
- Nova Scotia's share of regional BERD increased from 50% in 1997 to 57.3% in 2001.
- Newfoundland and Labrador increased from 12.9% to 14.7%.
- New Brunswick's share declined from 34.2% to 25% in the same period.
- Prince Edward Island stayed about the same at 2.7% or 2.8% of the regional BERD.

Indicator 18: Concentration of R&D Establishments

Figure 23: Concentration of industrial R&D in fewer establishments in Canada and Atlantic Canada, 1997-2001

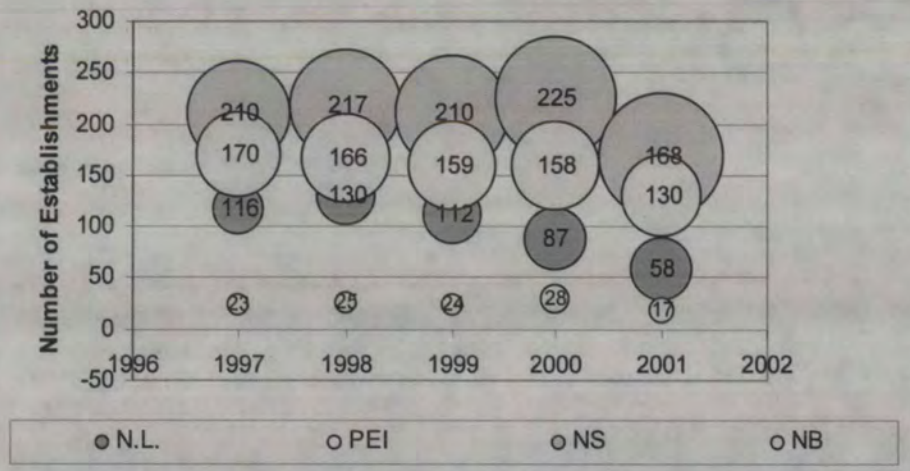
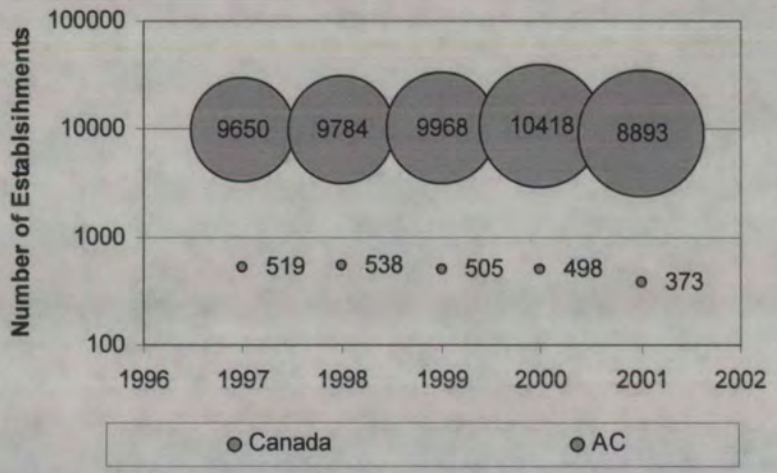


Figure 24: Concentration of industrial R&D establishments, Canada and Atlantic Canada, 1997-2001



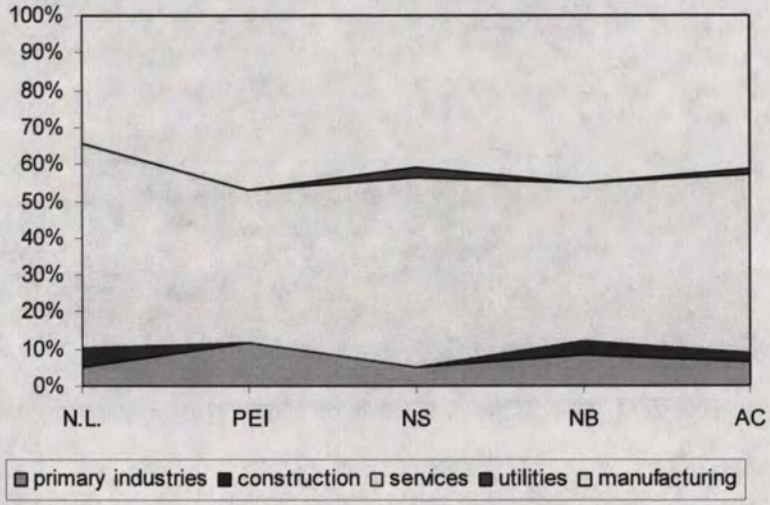
Vertical axis and number in the bubble show number of industrial R&D establishments. Size of bubble represents provincial BERD per year.

Industrial R&D establishments are firms or parts of firms (such as subsidiaries) that conduct R&D. The number of industrial R&D establishments declined in Canada from 9650 to 8693 between 1997 and 2001, a reduction of about 7.9 percent. At the same time, BERD/establishment increased from %.91M to %1.48M – an increase of 63.6%.

A similar but more highly accelerated process is underway in Atlantic Canada, as shown below. The number of industrial R&D establishments decreased by 28.2% between 1997 and 2001, and the BERD/establishment increased by 75.2%. In other words, industrial R&D is being performed by fewer firms, but at a higher scale.

Indicator 19: Number of R&D Performing Establishments by Industry

Figure 25: Numbers of R&D-performing establishments (firms) in principal industries in Atlantic Canada, 1999



Total number of R&D-performing establishments (firms) per province: Newfoundland and Labrador (58), Prince Edward Island (17), Nova Scotia (167), New Brunswick (129), and Atlantic Canada (371).

Most of the R&D activity in Atlantic Canada is in the services and manufacturing sectors. 89.7% of all firms in Atlantic Canada that perform R&D are manufacturing or service firms.

Notes: Primary Industries: agriculture, forestry, fishing and hunting, and mining and oil and gas extraction. Manufacturing: food, beverage and tobacco, wood products, pharmaceuticals, medicine, other chemicals, fabricated metal products, machinery, navigational, measuring, medical and control instruments; electrical equipment, appliances and components, and other manufacturing. Services: wholesale trade; retail trade; information and cultural industries; architectural, engineering and related services; computer system design and related services; management, scientific, and technical consulting services; scientific research and development services; other services.

Indicator 20: Industrial R&D Personal by Type

Figure 26: Industrial R&D professional personnel in Atlantic Canada, 1997-2001

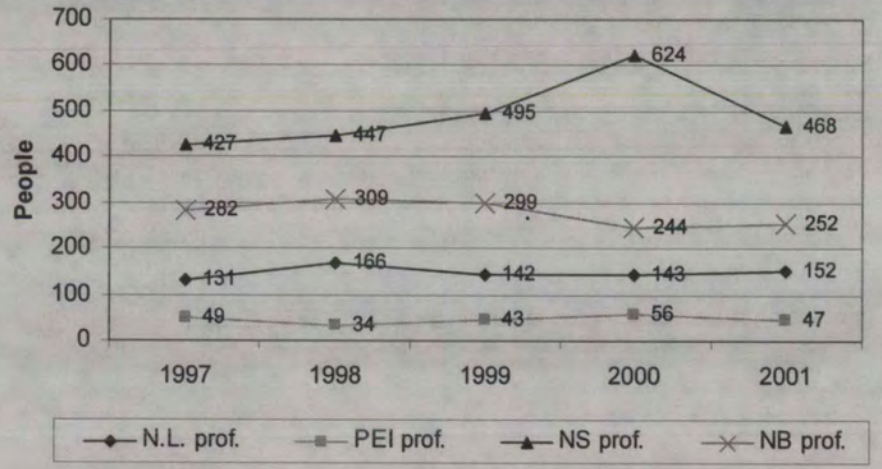
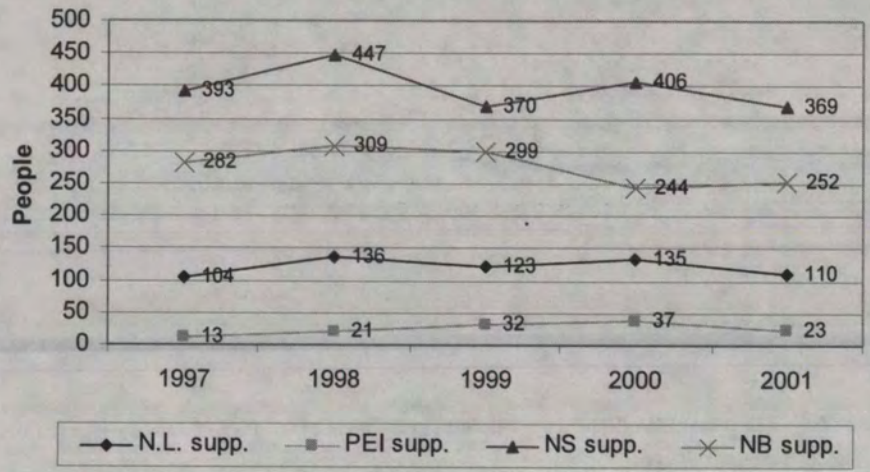
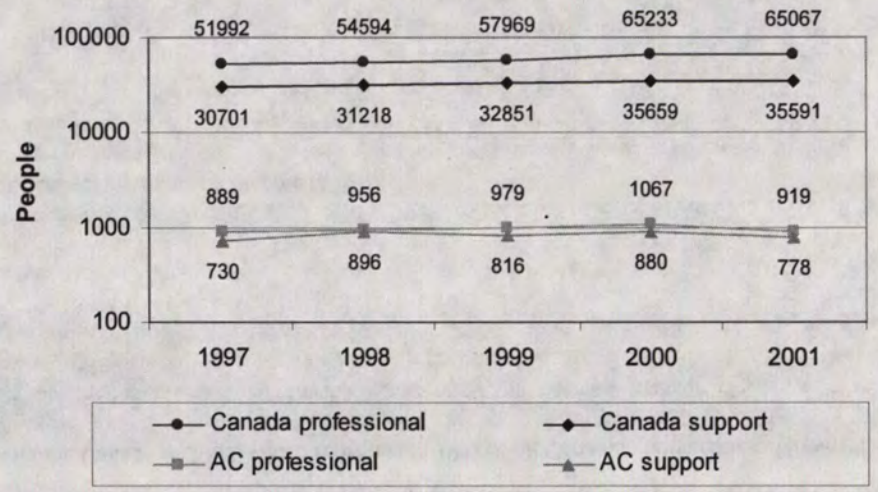


Figure 27: Industrial R&D support personnel in Atlantic Canada, 1997-2001



Indicator 20: Industrial R&D Personal by Type (continued)

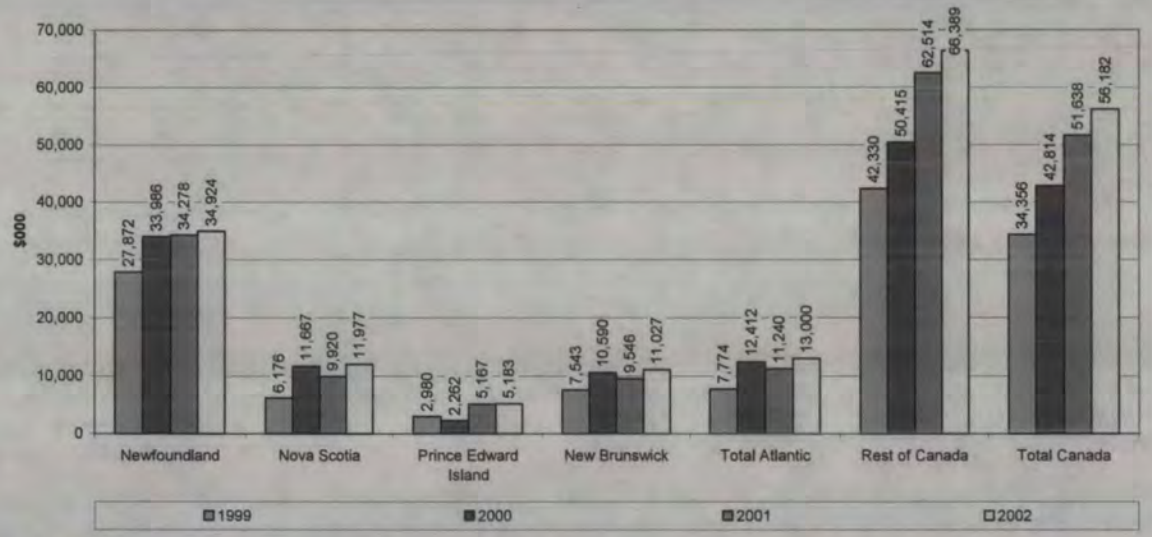
Figure 28: Industrial R&D professional and support personnel in Atlantic Canada and Canada, 1997-2001



The pool of industrial R&D labor is growing in Atlantic Canada, but not rapidly. In Canada, the number of industrial R&D professionals increased by 25.1%, from 51992 to 65067, between 1997 and 2001. The number of industrial R&D support staff increased by 15.9%, from 30701 to 35591. In Atlantic Canada, the number of industrial R&D professionals increased by 3.4%, from 889 to 919, between 1997 and 2001. In the same period, the number of industrial R&D support staff increased by 6.6%, from 730 to 778.

Indicator 21: Average Sponsored Research Income by Fiscal Year and Region

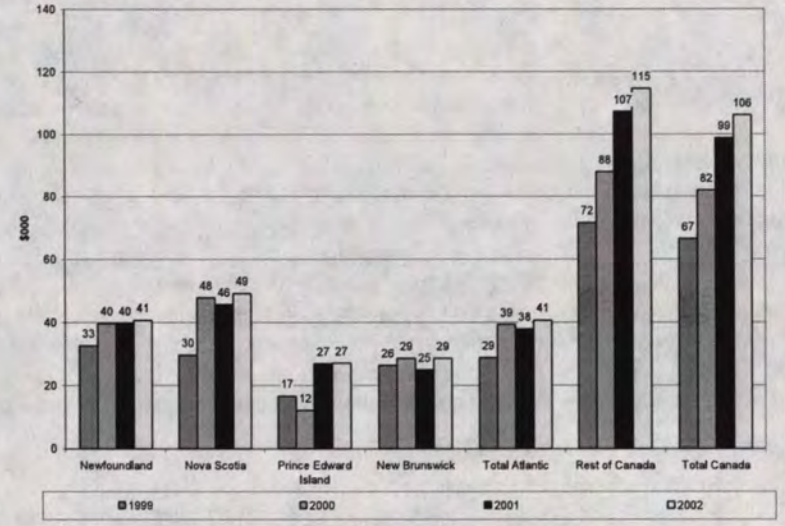
Figure 29: Average Sponsored Research Income by Fiscal Year and Region



- There were 13 universities in Atlantic Canada in 2002, which represented 19% of all Canadian universities. However, as a group these universities only accounted for 4% of research income of Canadian universities.
- The average income of Atlantic Canada universities in 2002 was $13 million, which was one-fifth the average income in the rest of Canada.
- University research income grew by 45% in Atlantic Canada between 1999-2002, but this was less that the 73% growth experienced in the rest of Canada.
- Memorial University recorded $35 million of sponsored research income in 2002, which was nearly three time the Atlantic University average of $13 million. This is explained, in part, by the fact that Memorial University has a medical school.
- Although total research income was high at Memorial, income grew more slowly between 1999-2002 (25.3%) than in Nova Scotia (72.4%), Prince Edward Island (73.9%) or the Atlantic region as a whole (44.9%).
- With 8 universities in the province in 2002, Nova Scotia accounted for 62% of the total number of Atlantic universities. Nova Scotia institutions accounted for a corresponding portion of Atlantic university research income (57%).
- Research income at Nova Scotia universities grew by 72.4% between 1999-2002, which was faster than the Atlantic region university research income growth of 44.9%.
- Average research income per university in Nova Scotia was only about $12.0 million in 2002, which was less than the Atlantic average of $13.0 million per university.
- University of Prince Edward Island (UPEI) recorded only $5.2 million of sponsored research income in 2002. Since 1999 the university's research income has jumped by 73.9%, but growth has been volatile.
- Research income at UPEI was considerably less than the Atlantic average of $13.0 million per institution in 2002.
- New Brunswick's 3 universities accounted for about one-quarter (23%) of the Atlantic total of 13 institutions in 2002.
- Sponsored research income at New Brunswick universities was $33.1 million in 2002, which was 20% of the Atlantic total.
- In 2002, New Brunswick universities attracted an average of $11.0 million each of research income, compared with the Atlantic average of $13.0 million.
- Research income grew by only 9.6% between 1999-2002, which was the lowest growth rate among the Atlantic provinces (44.9%) and far below the Rest of Canada (72.5%).

Indicator 22: Research Intensity ($ per Full-time Faculty) by Fiscal Year and Region

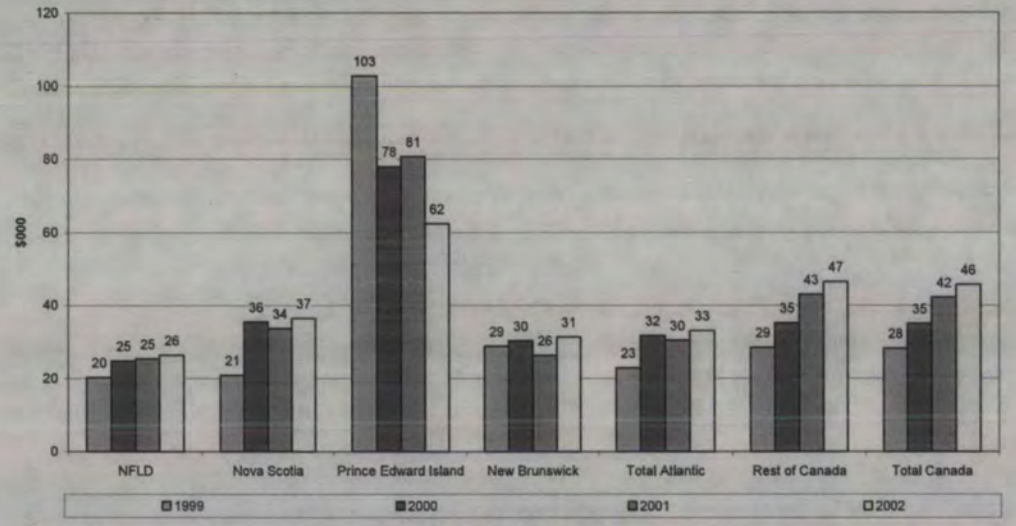
Figure 30: Research Intensity ($ per Full-time Faculty) by Fiscal Year and Region



- Research intensity – research income per full-time faculty position – grew by 41.3% in Atlantic Canada from 1999-2002. However, this was far slower than the 60.1% rate of growth in the Rest of Canada. In 2002, Atlantic universities averaged $40,700 whereas the Rest of Canada universities averaged $114,600.
- Research intensity at Atlantic universities ($40,700) was only 36% of the intensity in the Rest of Canada, and 38% of the Canadian total.
- Research intensity at Memorial – research income per full-time faculty position – was $40,700 in 2002, the same as the Atlantic average, but somewhat less than the average in Nova Scotia universities ($49,200).
- Nova Scotia universities recorded the highest research intensity – research income per full-time faculty. In 2002, research intensity averaged $49,200 per faculty position in Nova Scotia.
- Research intensity grew by 65.7% between 1999-2002 in Nova Scotia, which was highest in growth compared to both the Atlantic region (41.3%) and the Rest of Canada (60.1%).
- In 2002, research intensity was also lowest at UPEI. Full-time professors attracted an average of $27,000 each, which was considerably less than the Atlantic university average of $40,700 and far behind the Rest of Canada ($114,600).
- Research intensity (per full-time faculty) grew by 62.7% at UPEI between 1999-2002, which was faster than the Atlantic average (41.3%) and the Rest of Canada average (60.1%). However, actual intensity was unstable with significant changes from year to year.
- New Brunswick universities attracted $28,600 per full-time faculty position in 2002, which was considerably less than the Atlantic average of $40,700, and far behind the Rest of Canada total of $114,600 per faculty. Growth in research intensity was 8.3% between 1999-2002 – far below all other regions.

Indicator 23: Research Intensity ($ per Full-time Graduate Student) by Fiscal Year and Region

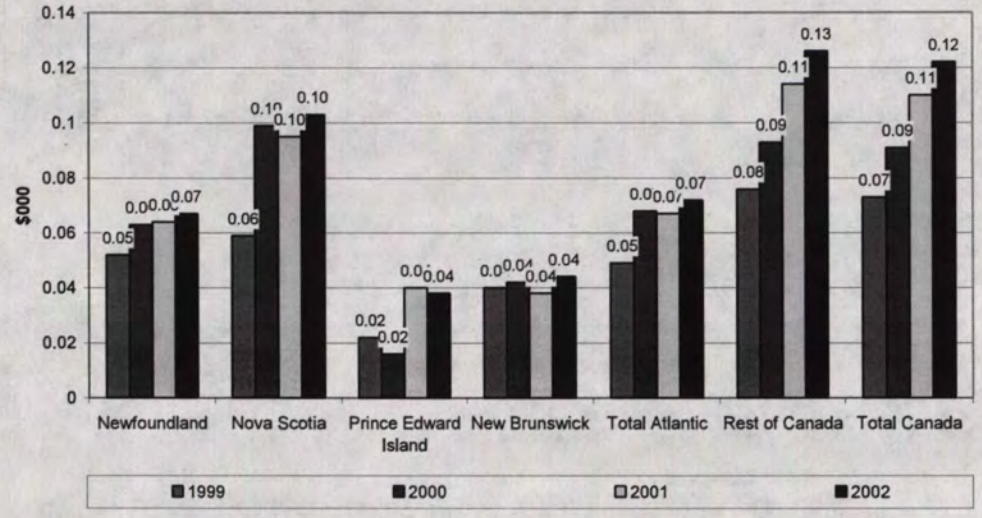
Figure 31: Research Intensity ($ per Full-time Graduate Student) by Fiscal Year and Region



- Atlantic universities performed somewhat better when measured on graduate student research intensity – research income per full-time graduate student. In 2002, Atlantic universities attracted $33,100 per full-time graduate student versus $46,500 in the Rest of Canada and the Canadian average of $45,700.
- Graduate student research intensity grew by 44.5% in Atlantic Canada between 1999-2002, compared with 63.2% in the Rest of Canada and 62.1% in the country as a whole.
- Research income per full-time graduate student was $26,400, the lowest in the Atlantic region and less than the Atlantic university average of $33,100 per student. Graduate student research intensity also grew more slowly in Newfoundland between 1999 and 2002 (30.0%) than the Atlantic average (44.5%).
- In terms of research intensity per full-time graduate student, Nova Scotia institutions recorded $36,500 per student, compared with the Atlantic average of $33,100 in 2002. Graduate student research intensity grew by 74.6% between 1999-2002, which was the highest in the region and exceeded the Rest of Canada total (63.2%).
- When measured by graduate student research intensity, UPEI out-performed all others in 2002. The university attracted $62,400 per full-time graduate student, compared with $33,100 in the Atlantic region as a whole and $46,500 in the Rest of Canada. However, graduate student intensity was also volatile with a -39.3% decline between 1999 and 2002.
- In terms of research intensity per full-time graduate student in 2002, New Brunswick universities attracted an average of $31,300 per student, which was close to the Atlantic average ($33,100) but less than the Rest of Canada ($46,500). Graduate student research intensity in New Brunswick rose by 44.5% between 1999 and 2002.

Indicator 24: Research Intensity ($ per Capita) by Fiscal Year and Region

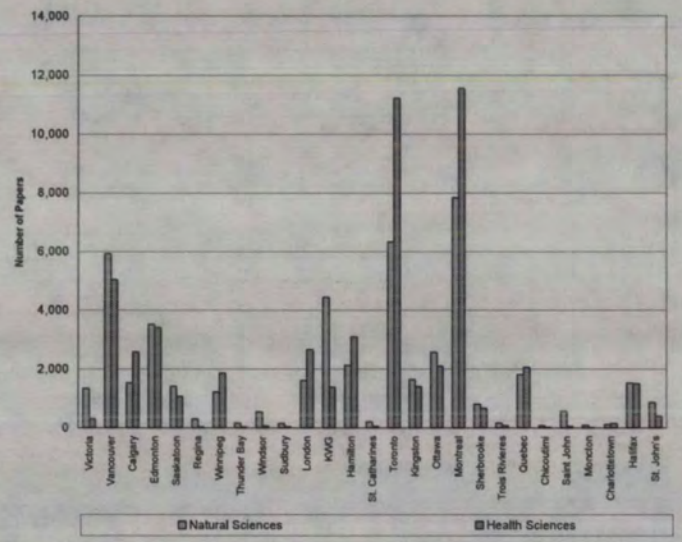
Figure 32: Research Intensity ($ Per Capita) by Fiscal Year and Region



- When measured in terms of research income per-capita (provincial population), Atlantic universities in 2002 attracted $72 per provincial resident compared with $126 per resident in the Rest of Canada and $122 per resident for the country as a whole.
- In 2002, research income per-capita was $67 in Newfoundland versus the Atlantic Canada average of $72.
- On a per-capita basis in 2002, Nova Scotia universities received an average of $103, compared with the Atlantic average of $72 and the Rest of Canada average of $126.
- On a per-capita basis UPEI attracted only $38 per resident, compared with $72 in the region as a whole and $126 in the Rest of Canada in 2002.
- On a per-capita basis New Brunswick institutions attracted $44 each, compared with $72 for the Atlantic region as a whole and $126 for the Rest of Canada. Per-capita growth was only 10.3% between 1999 and 2002 – the lowest of all Atlantic Provinces.

Indicator 25: Cumulative Research Papers Published by City (Modified by Impact Factor)

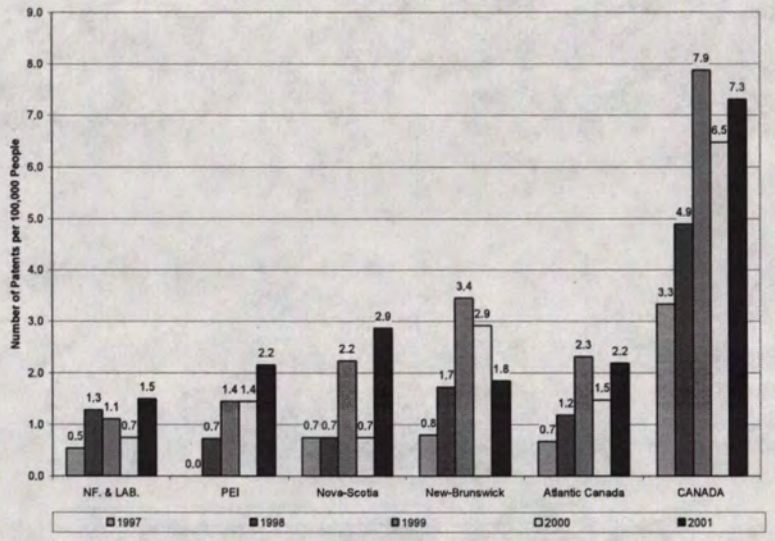
Figure 33: Cumulative Research Papers Published 1997-2000 (modified by Impact factor)



- Research publications represent one measure of intellectual output. They contribute to the knowledge base of an area and facilitate innovation as their ideas are utilized by industry to develop new products and new processes.
- This indicator shows that scientific production is concentrated in certain Canadian cities. Montreal, Toronto, and Vancouver account for well over half the production of scientific papers in Canada.

Indicator 26: Canadian Patents per 100,000 Population

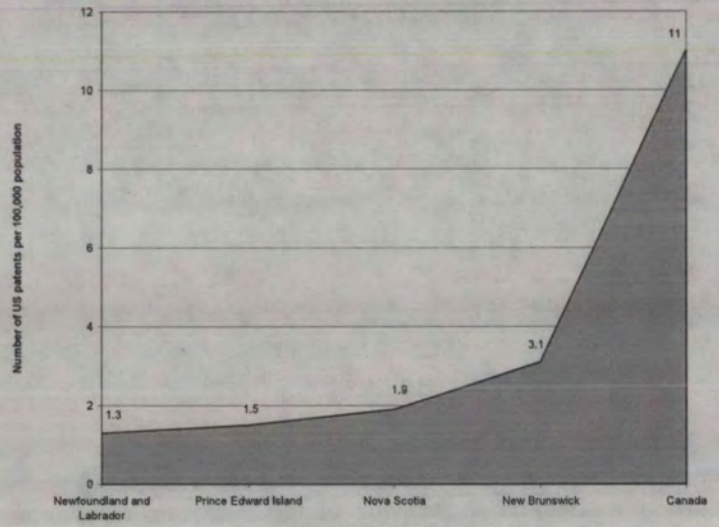
Figure 34: Canadian Patents per 100,000 Population



- The number of Canadian patents per 100,000 population in Atlantic Canada is 30% of that observed Canada-wide.
- In 2001, Newfoundland and Labrador fell behind the other Atlantic Provinces in this regard.
- While New Brunswick had the dominant Atlantic Canadian role for this indicator, it dropped to third place in 2001, being surpassed by both Nova Scotia and Prince Edward Island.

Indicator 27: US Patents per 100,000 Population

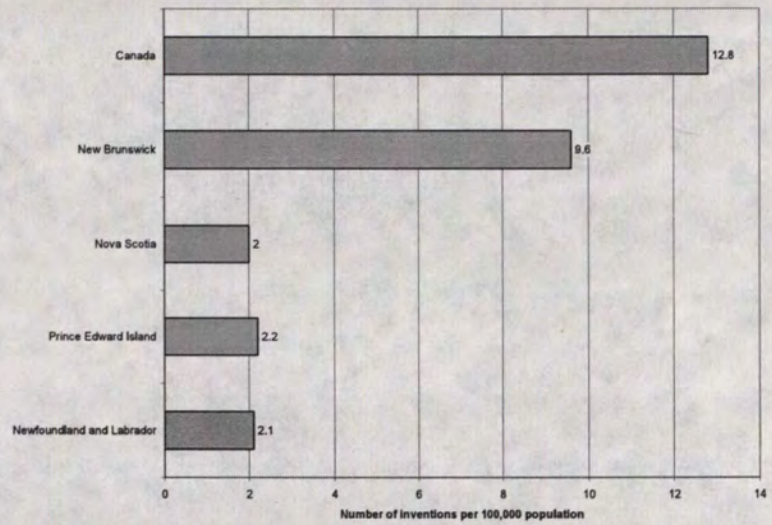
Figure 35: US Patent Ownership per 100,000 Population by Jurisdiction, 2001



- The same basic pattern was observed for US patent ownership in 2001, except that New Brunswick was the dominant Atlantic Province. It was still only one third of that observed nationally.

Indicator 28: Number of Inventions per 100,000 Population

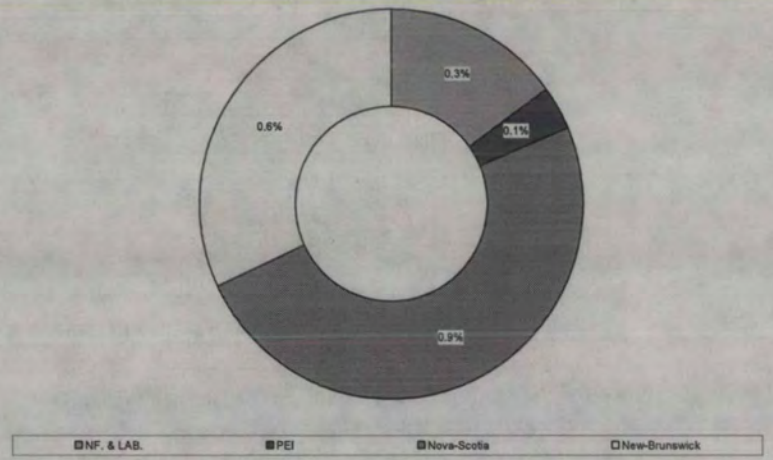
Figure 36: Number of Inventions Per 100,000 Population, 2001



- The number of inventions per 100,000 shows that New Brunswick exceeded the other Atlantic Provinces by more than fourfold.
- However, it was still only about 75% of that observed nationally.
- The other Atlantic Provinces were at about 15% of the levels observed Canada-wide.

Indicator 29: National Share of Canadian Patents

Figure 37: National Share of Canadian Patents, 1980-2001



- No Atlantic Province achieves even its per capita share of patents in Canada, although Nova Scotia comes closest.

Indicator 30: Percentage of Households Connected to the Internet by Location

Figure 38: Percentage of Households Connected to the Internet in Canada by Location

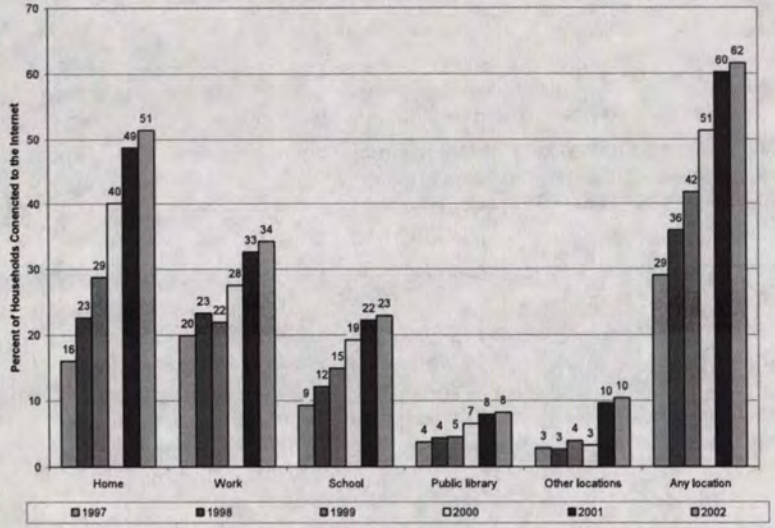


Figure 39: Percentage of Households to the Internet in Newfoundland and Labrador by Location

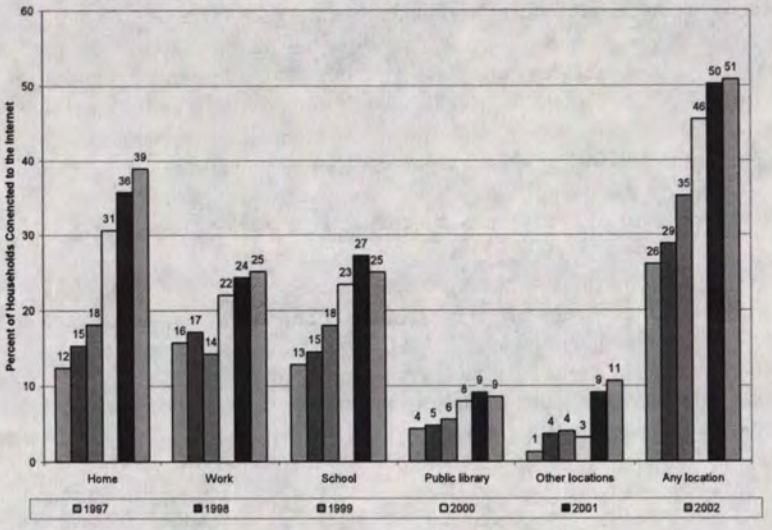


Figure 40: Percentage of Households Connected to the Internet in Prince Edward Island by Location

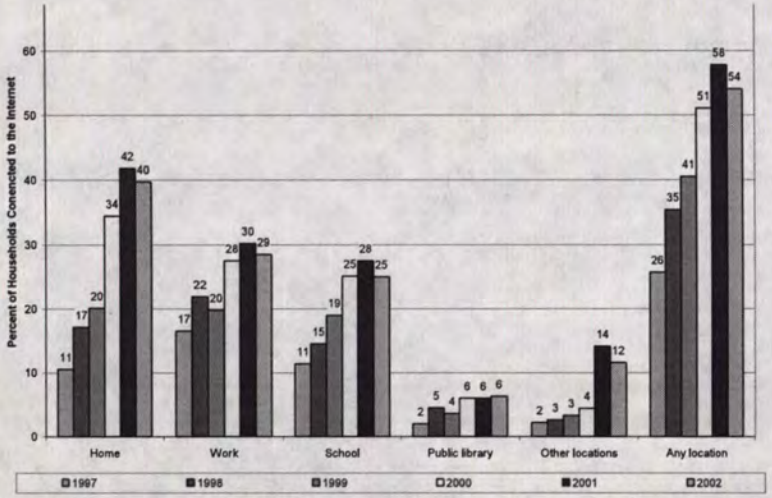


Figure 41: Percentage of Households Connected to the Internet in Nova Scotia by Location

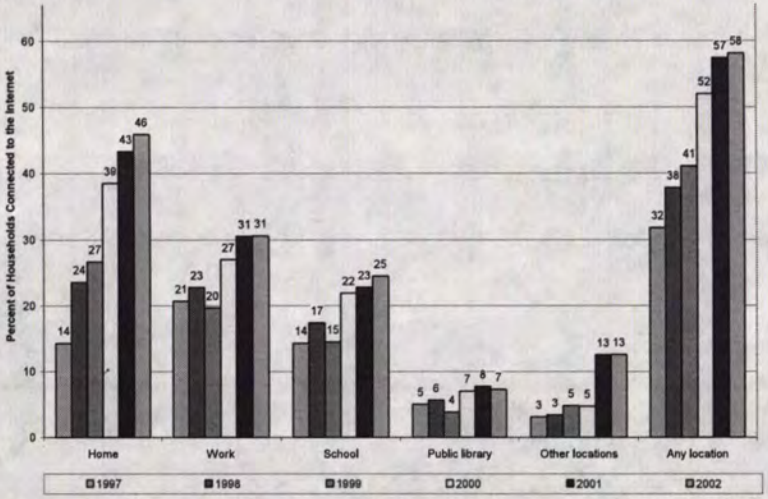
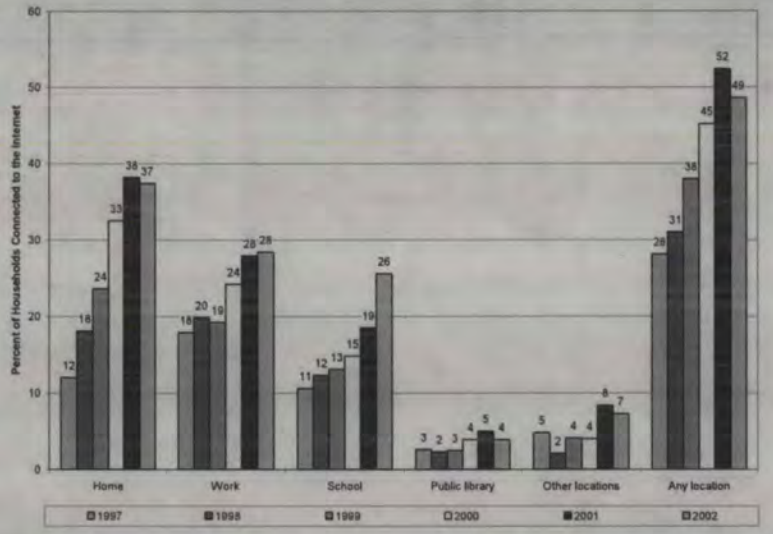


Figure 42: Percentage of Households Connected to the Internet in New Brunswick by Location



- Much of the innovation experienced in Canada and elsewhere can be tied to the adoption of ICT and the Internet in different ways – this would include e-commerce, research and education to name a few. Figures 38 - 44 display the percentage of households connected to the Internet for Canada and the Atlantic Provinces by location of connection from 1997 to 2002. Overall Internet usage has more than double in Canada from 29 to 62% over the period 1997- 2002. The predominant part of this growth came from home Internet usage – growing from 16 to 51%. Internet usage at work has increased by 14 percentage points, from 20% to 34%. Similarly, household Internet usage through schools has increased from 9 to 23%. While Internet usage through the public library system and other locations are small relative to home, work and school, usage of these sites have doubled as well. In terms of relative importance, home Internet usage is the largest source of Internet usage within Canada. This is followed by work and then school.
- The profile of Internet usage in Newfoundland and Labrador similar to that experienced nation-wide. However, both the level of overall Internet usage and its growth is below that observed for Canada as a whole. Internet usage at school is relatively more important in Newfoundland and Labrador than it is for the country as a whole. In addition, in 2002 only 39% of households were connected to the Internet at home compared to 51% for Canada and only 25% of households indicated that they were connected to the Internet at work. This is significantly lower than the 34% observed nation-wide.
- The growth in overall household Internet usage observed in Prince Edward Island is similar to that observed for Canada, but overall usage (54%) is still below that observed within Canada. The level of household Internet usage in Prince Edward Island is similar for home, work and school, although home usage is still the more dominant source for connecting to the Internet. While household Internet usage through work is higher than that observed in Newfoundland and Labrador, it is slightly below that observed nationally. Household Internet usage in Prince Edward Island through the schools is more prominent than that observed Canada-wide.
- Although Nova Scotia had the highest overall household Internet usage (58%) in Atlantic Canada in 2002, it was still below that observed nation-wide. The increase usage of Internet through the home was dramatic, increasing by more than threefold. Also, Internet usage at work in Nova Scotia (31%) was higher than that observed in the other Atlantic Provinces, but it was still below the national level (34%).
- New Brunswick's overall Internet usage was the lowest of the four Atlantic Province. It also experienced a lower growth rate from 1997 to 2002 than was observed nationally or within the region. While work and school Internet usage were similar to that observed in the other Atlantic Provinces, was below that observed nationally.

Indicator 31: Change in the Percentage of Households Connected to the Internet at Home and Relative to that Experienced Canada-wide

Figure 43: Index of Households Connected to the Internet at Home, 1997-2002 (1997=100)

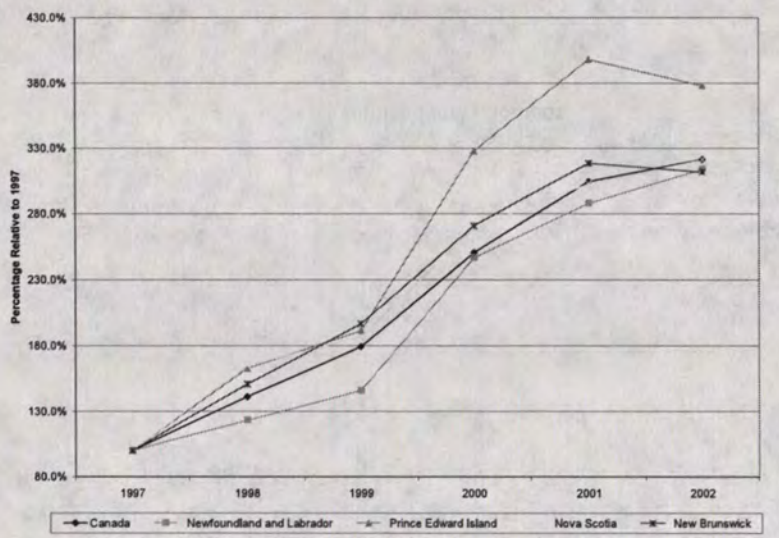
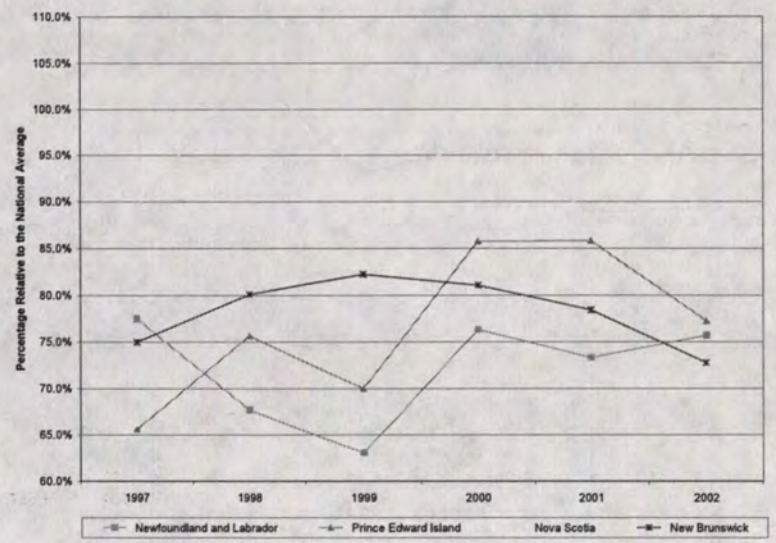


Figure 44: Proportion of Households Connected to the Internet at Home Relative to the National Average



- Figures 43 and 44 illustrate how household Internet usage at home has changed over time and relative to that which is experienced nationally.
- The fastest growth in household Internet usage at home was observed in Prince Edward Island. Prior to 2000, Prince Edward Island's growth rate was comparable to that observed nationally and within the region. The growth rate experienced in the other three Atlantic Provinces was similar to that observed nationally.
- Relative to the national average, Nova Scotia household Internet usage at home exceeded that observed in the other Atlantic province and it exceeded the national average in 1998. Nova Scotia's average is currently at 90% of that observed nationally, while the other three Atlantic Provinces come in at approximately 75% of the national average.

Indicator 32: Change in the Percentage of Households Connected to the Internet at Work and Relative to that Experienced Canada-wide

Figure 45: Index of Households Connected to the Internet at Work, 1997-2002 (1997=100)

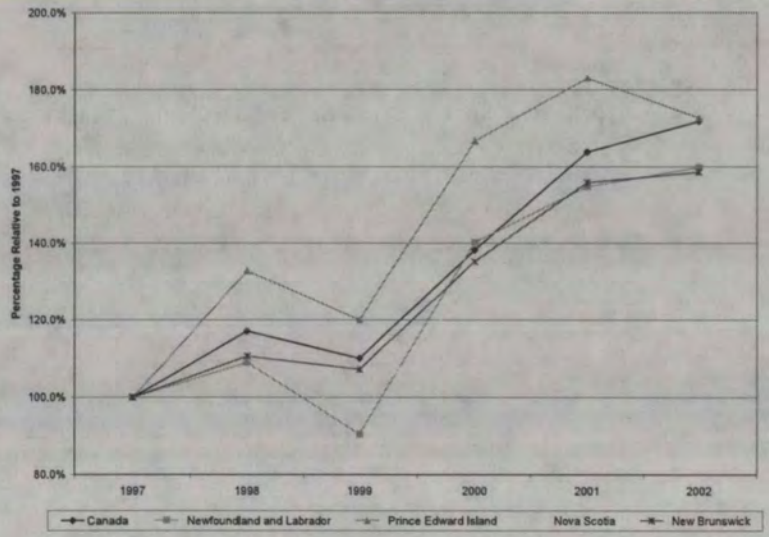
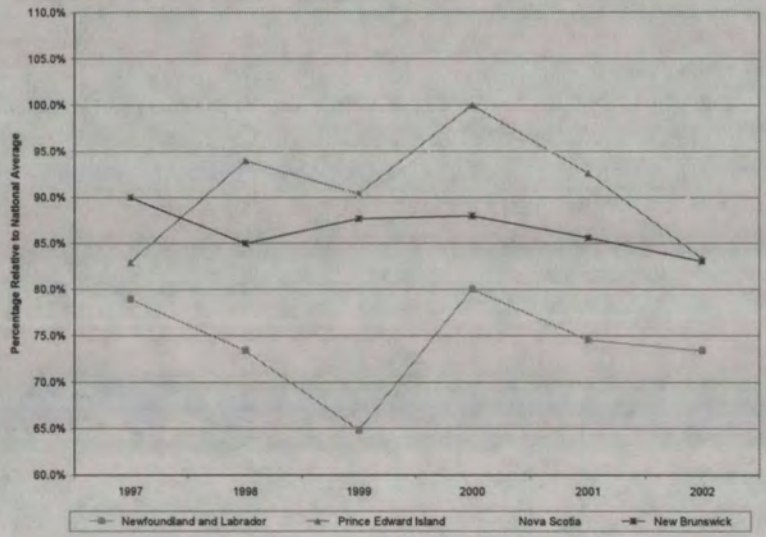


Figure 46: Proportion of Households Connected to the Internet at Work Relative to the National Average



- As shown in Figures 45 and 46, household Internet usage at work has followed a similar pattern in the Atlantic Provinces and the nation. However, Prince Edward Island did grow faster than the other jurisdictions.
- Relative to the national average, Newfoundland and Labrador falls short of the national average and below that experienced in the other Atlantic Provinces. Household Internet usage at work in Nova Scotia is about 90% of that observed nationally. It is about 85% of the national level in both Prince Edward Island and New Brunswick and less than 75% in Newfoundland and Labrador.

Indicator 33: Change in the Percentage of Households Connected to the Internet at School and Relative to that Experienced Canada-wide

Figure 47: Index of Households Connected to the Internet at School, 1997-2002 (1997=100)

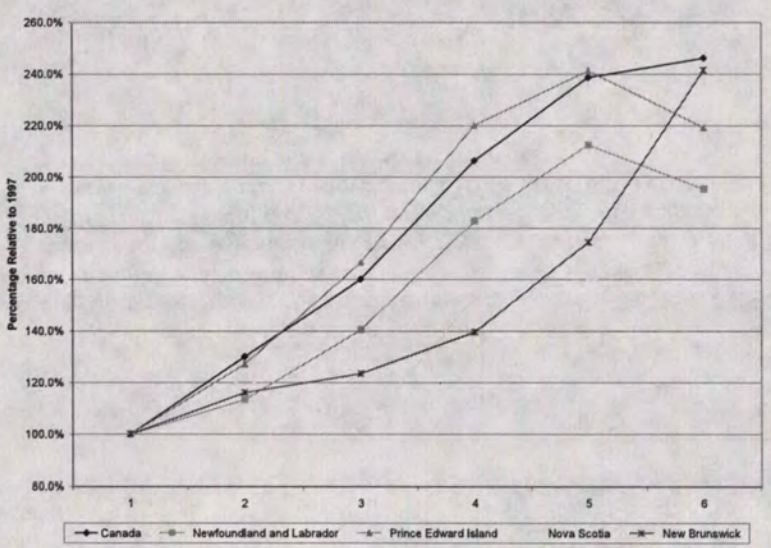
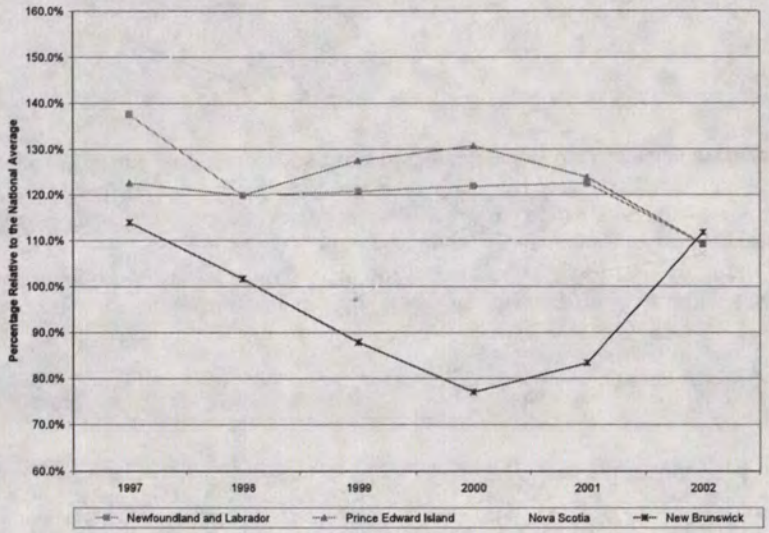


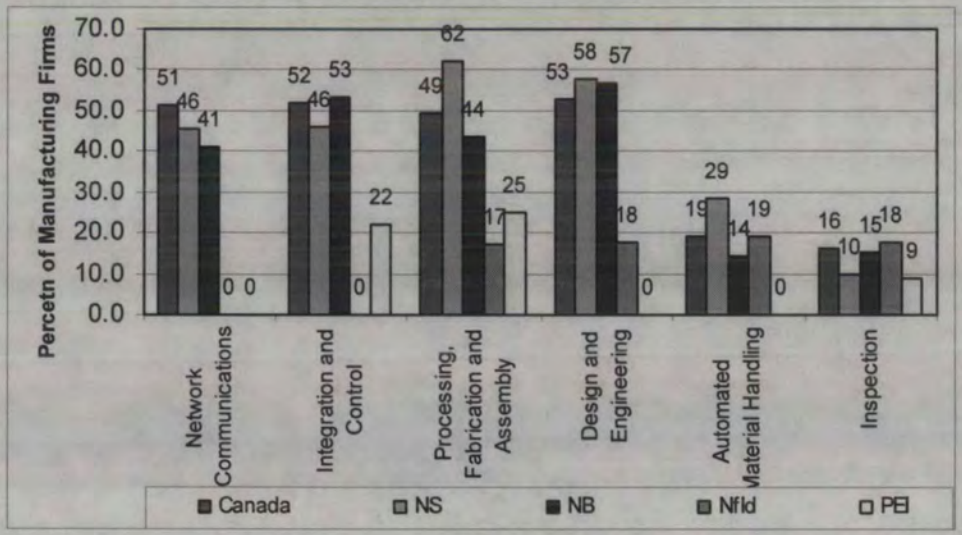
Figure 48: Proportion of Households Connected to the Internet at School Relative to the National Average



- Household Internet usage at schools, as shown in Figures 47 and 48, have grown in the Atlantic Provinces comparably to that observed nationally, except that the growth in Nova Scotia was less pronounced.
- Household Internet usage through the schools in Atlantic Canada exceeds that observed nationally by about 10%.

Indicator 34: Technology Use by Functional Group

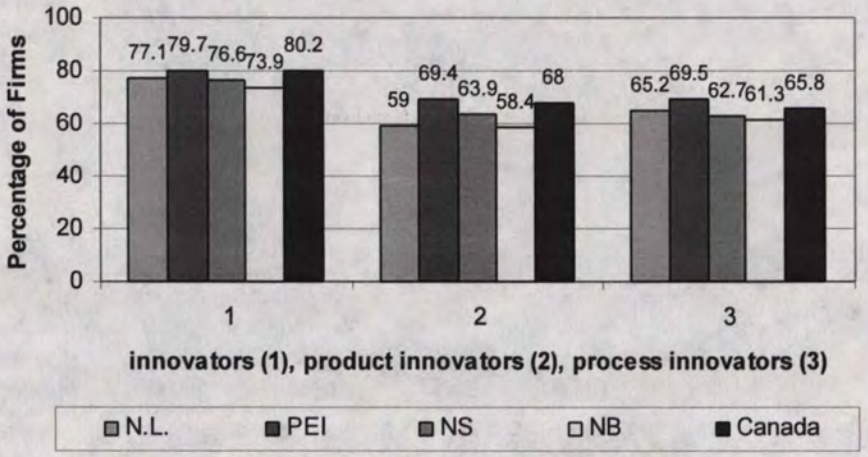
Figure 49: Technology use by functional group, 1998



This chart shows use of advanced manufacturing technologies by functional group of technologies and by province in 1998. From this diagram, one notes that 22% of manufacturing firms in PEI use integration and control technologies; 25% use processing, fabrication, and assembly technologies; and fewer than 10% inspection technologies and no firms appear to use design and engineering technologies, network communications, automated material handling technologies. Manufacturing firms in Labrador do not utilize either network communications or integration and control technologies while between 15 and 20% of firms employ the remaining technologies. With the exception of processing, fabrication and assembly technologies, Nova Scotia and New Brunswick firms employ technologies in similar percentage to those observed Canada-wide. However, Nova Scotia firms (62%) exceed the Canadian average (49%) and New Brunswick firms (44%) fall below the Canadian average for processing, fabrication and assembly technologies.

Indicator 35: Proportion of Firms that are Innovators

Figure 50: Innovators – product and process, 1997-1999



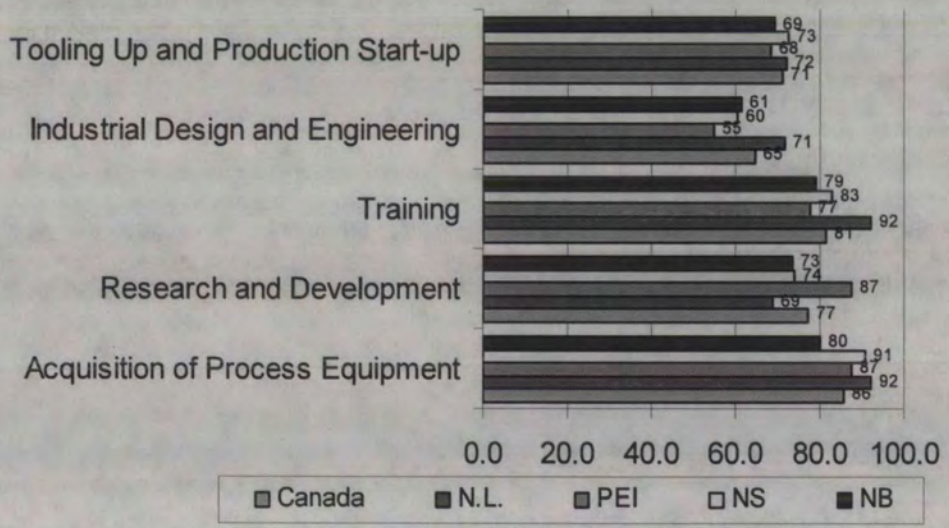
Rate of firm-level innovation is an important indicator because it sheds light on the relative degree to which firms are attempting to compete on the basis of differentiation (via the introduction of new products) and on the basis of improved efficiency or new production methods (via the introduction of process innovations). This indicator provides information on self-reported rates of product or process innovation among manufacturers. It shows that the rate of innovation in Atlantic Canadian manufacturers is comparable to the national average in the area of process innovation, and is only slightly lower than the national average in the area of product innovation.

This indicator requires interpretation with the following caveats. First, it includes innovations of widely varying importance - firm-first, Canada-first, and world-first. Firm-first innovations are usually incremental changes to internal processes.

Second, the rate of product innovation is only a proxy indicator for the rate of commercially successful new products. It is known that in some industries (for example, software) the rate of product innovation is higher in regional economies than in central metropolitan regions. However, the rate of commercially successful product innovation is lower. This is because market networks that are required for successful commercialization may not be as dense in regional economies as in central metropolitan economies.

Indicator 36: Percentage of Manufacturing Firms Engaged in Activities Linked to Innovation

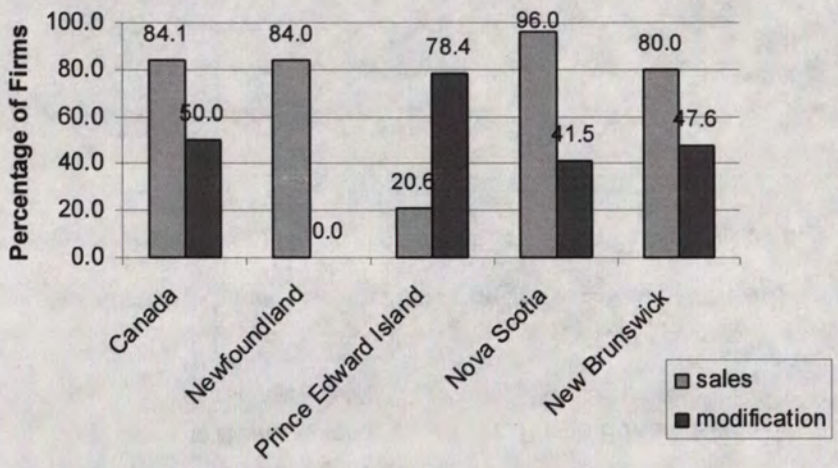
Figure 51: Percentage of Manufacturers Engaged In Activities Linked To Product or Process Innovation During the Period 1997 – 1999



Manufacturing firms in Atlantic Canada don't seem to differ systematically from the Canadian average in respect of engagement in activities related to product or process innovation: tooling up, production startup, industrial design and engineering, training, R&D, and acquisition of process equipment.

Indicator 37: Implementation of New Technologies

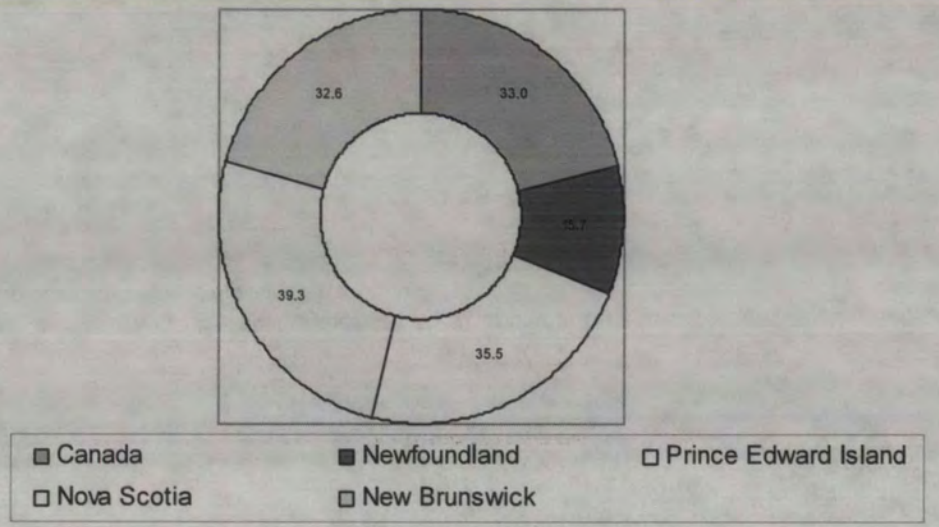
Figure 52: Implementation of new technologies – two main



This indicator may to the make-or-buy decision. Since it is hard to understand how 80% of Prince Edward Island firms and no Newfoundland and Labrador firms can produce their own technology, we should interpret this indicator with caution.

Indicator 38: Percent of Firms involved in Collaborative and Cooperative Arrangements

Figure 53: Percent of firms involved in cooperative and collaborative arrangements, 1997-1999

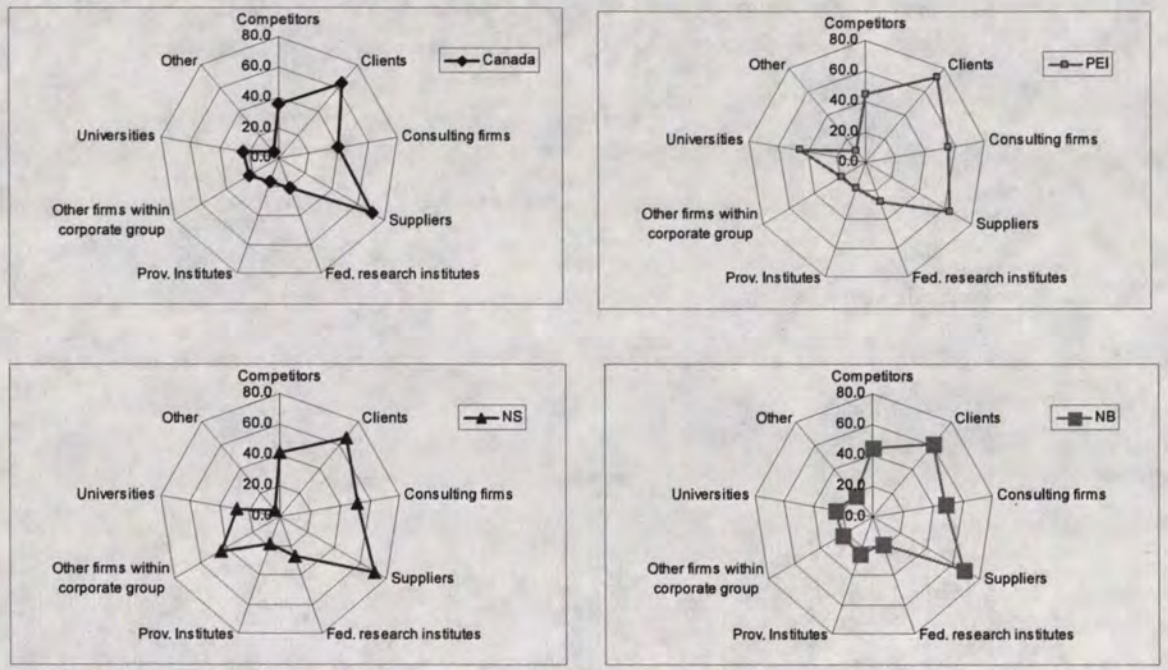


Innovative firms are ones that have introduced one or more firm-first, Canada-first, or world-first product or process innovations.

This indicator shows that with the exception of Prince Edward Island, innovative manufacturing firms in Atlantic Canada and Canada are involved in cooperative or collaborative arrangements at a similar rate.

Indicator 39: Percent of Firms involved in Collaborative and Cooperative Arrangements by Type of Firm

Figure 54: Percentage of Innovative Firms with Cooperative and Collaborative Arrangements with the Following Types of Firms and Organizations during the Period 1997-1999



Note: data for N.L. are not available

These charts show the percentage of innovative firms with cooperative or collaborative arrangements with various kinds of firms and organizations: competitors, clients, consulting firms, competitors, suppliers, federal R&D institutes, provincial institutes, other firms in a corporate group, universities, and others.

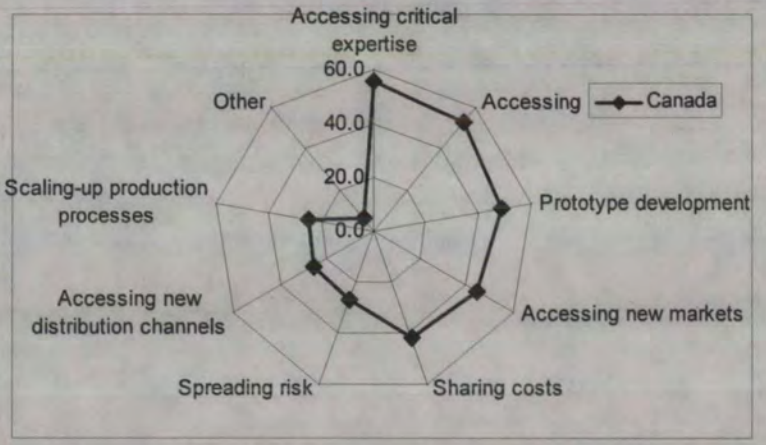
Innovative firms routinely engage in cooperation or collaboration with clients and suppliers. Between 60 and 80 percent of innovative firms have such relationships. Cooperative or collaborative relations with other actors are less frequent.

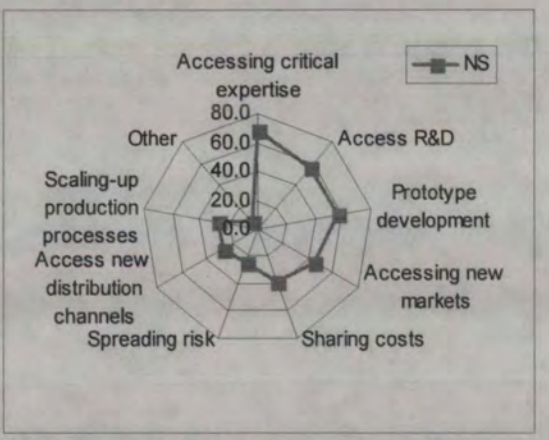
With few exceptions, innovative Atlantic Canadian firms seem to conform to the pattern of innovative Canada firms with respect to external collaborative linkages. The exceptions seem to be:

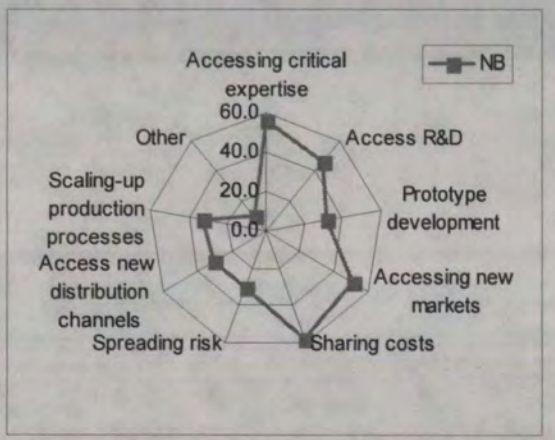
- Atlantic Canadian innovators seem to engage in collaboration with consulting firms more frequently than Canadian firms do.
- Prince Edward Island innovators report a higher than average rate of collaboration with Universities.
- Nova Scotia firms report a higher than average rate of collaboration with firms from within a corporate group.

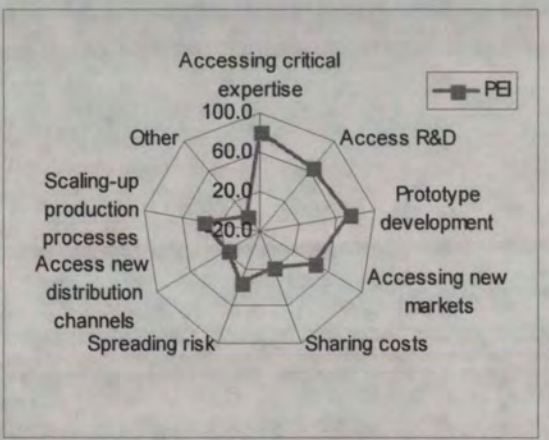
Indicator 40: Percent of Firms involved in Collaborative and Cooperative Arrangements by Reason for Agreement

Figure 55: Percentage of Innovative Firms with Cooperative and Collaborative Arrangements with the Following Reasons for Having these Arrangements during the Period 1997-1999









Motivations for establishing collaborative relationships with other firms or institutions vary widely, but the two most important motivations in Canada and in Atlantic Canada are to have access to critical expertise and to have access to R&D. In New Brunswick, cost sharing and accessing new markets are important motivators to collaborate. In Prince Edward Island and Nova Scotia, prototype development is an important motivation.

4. Conceptual Issues Associated With Provincial Benchmarking of Innovation Indicators and Suggestions for Further Development

The Philosophy of Benchmarking

Benchmarking in science and technology is an art that has existed for several decades, but gained popularity in the 1990s. Four elements generally guide or should guide a benchmarking exercise.

1. The Model

Benchmarking exercises and scoreboards usually rest on a theoretical or conceptual model. Conceptual models help in collecting relevant data and in interpreting results. Actually, the two most frequently used models are National System of Innovation (NSI) and Knowledge-Based Economy (KBE). A third one is the chain-value model, a variant of the linear model.

A NSI is a set of institutions whose interactions determine the innovative performance of national firms. It is constituted by elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge. The elements or institutions of the system are firms, public laboratories and universities, but also financial institutions, the educational system, government regulatory bodies and others that interact with the former. The emphasis of benchmarking exercises based on a NSI model is on measuring the performances of the actors of the system, but also the flows between them: flows of knowledge, flows of personnel, etc.

The knowledge-based model puts emphasis on three dimensions of knowledge in a national system: production, diffusion and use. It suggests collecting indicators that go beyond the traditional ones, like tacit knowledge or related scientific activities. However, very few indicators are actually available to measure these dimensions of knowledge.

2. The Indicators

There are two logics as regards the number of indicators to be included in scoreboards. One can collect a large numbers of indicators (like the OECD's *Science, Technology and Industry Scoreboard*) [2] or draw up a shorter list (like the European Commission's *Innovation Scoreboard*) [3]. Generally, the latter option depends on a long consultation process designed to get consensus among experts and/or users on the indicators to be included in the scoreboard.

3. The Dimensions

Science and technology is a multidimensional phenomenon. Ideally, then, one try or should try to measure the following four dimensions of science and technology:

- Inputs;
- Activities;
- Outputs; and

[2] http://www.oecd.org/document/21/0,2340,en_2649_33703_16683413_1_1_1_1,00.html.
[3] http://trendchart.cordis.lu/scoreboard2003/html/scoreboard_papers.html.

- Impacts.

Generally, inputs like monetary investments in R&D (and its associate indicators: GERD and GERD/GDP) and human resources devoted to R&D activities are the main indicators used in innovation scoreboards. This is not surprising since official time series for these statistics go back to the 1960s. Outputs, on the other hand, are much more difficult to obtain. In fact, frequently there is confusion between output and impacts. Outputs are what come out directly from R&D activities, like knowledge (measured with papers) or innovation (measured with numbers of products, processes, or patents). Impacts are indirect and long-term outcomes, like economic growth, productivity and social welfare.

4. The Criteria

Selecting indicators depend on a number of criteria. At least five criteria should be considered when collecting data for a scoreboard:

- Theoretical (or conceptual) validity;
- Empirical reliability;
- Comparability;
- Relevance; and
- Availability and costs.

The first criterion – theoretical validity – refers to the capacity of the indicator to really and correctly reflect the model and measure the concepts one is attempting to measure. The second criterion – empirical reliability – asks for measures that are coherent as regard the instrument used. The third criterion – comparability – suggests choosing indicators for which one has comparable data in time (time series) or in space (between provinces, for example). This is in fact the essence of benchmarking: measuring by comparing. The fourth criterion – relevance – suggests having (some) indicators that are policy-relevant. Finally, the last criterion – availability and costs – often explains the limitations of the chosen indicators: either the indicators selected were the only ones for which data were available, or data are too expensive to be used in the scoreboard. This criterion is often the most important one when the author of the scoreboard is not itself a producer of statistics, but has to get them from a third source. Moreover, it is an important limitation for provincial scoreboard since several indicators exist at the national level only.

Benchmarking at the International Level

Benchmarking in science and technology goes back to the early 1970s when the National Science Foundation (NSF) started compiling and publishing its biennial series *Science and Engineering Indicators*. At present, the two most important benchmarking exercises are conducted at the OECD and the European Commission.

Since 1999, the OECD has published a *Scoreboard on Science, Technology and Industry* every two years. The last edition (2003) contains 66 indicators grouped under four dimensions (see Appendix 1):

- Creation and diffusion of knowledge (27 indicators);
- Information economy (14 indicators);
- Global integration of economic activity (13 indicators); and
- Economic structure and productivity (12 indicators).

The European Commission started publishing an Innovation Scoreboard in 2001. The last edition (2003) contains 17 indicators selected for their relevance in measuring the objectives of the Lisbon strategy (see Appendix 2).

The Canadian Experience

Canada began benchmarking science and technology quite recently. The first national exercise was conducted for Industry Canada by the Conference Board of Canada in collaboration with the Canadian Consortium on Science and Innovation Indicators (CSIIC) in Fall 2003. While the final report has yet to be published, it contains 16 indicators:

- Knowledge performance
  - GERD/GDP;
  - BERD/GDP;
  - Papers;
  - Triadic patent families;
  - University-Industry Collaboration; and
  - Technology balance of payments.
- Skill Performance
  - Educational attainment in the labor force; and
  - Adult participation in continuing education.
- Innovation Environment
  - Economy-wide regulatory environment;
  - Total corporate tax as a percentage of GDP;
  - R&D tax treatment;
  - Investment in venture capital;
  - World competitiveness ranking;
  - Relocation of R&D facilities; and
  - FDI confidence Index.
- Community-Based Innovation
  - Broadband subscribers per 100 population.

This national benchmarking was preceded by provincial scoreboards. Three provincial scoreboards of S&T indicators are presently available: British Columbia, [4] Ontario [5] and Quebec [6]. Alberta is currently conducting its own, as well as ACOA for eastern provinces. Furthermore, the Quebec government is also preparing a benchmarking exercise for its 16 regions.

The Indicators

Appendix 3 lists the indicators available in current national and provincial scoreboards. In total, there are over 100 different indicators used to assess science and technology in the country and the provinces. Each scoreboard contains indicators on investments and human resources devoted to R&D – examined from several dimensions, for example, by economic sectors (industry, government and university). But several other indicators are covered. The main ones are:

- R&D
  - Monetary investments;

[4] http://www.scbc.org/pdf/British_Columbia_Innovation_Benchmarks.pdf.
[5] http://www.ontariocanada.com/ontcan/en/downloads/reports/report_dec_2002_innovation_index.pdf.
[6] http://www.mrst.gouv.qc.ca/_fr/publications/siq.htm.

    - Intensity (R&D/GDP); and
    - Human resources (researchers).

- Education
    - Investments;
    - Enrollments;
    - Graduates;
    - Performance scores; and
    - Lifelong learning.
- Scientific and technological culture
    - Literacy;
    - Awareness and interest in S&T affairs; and
    - Coverage of S&T in the press.
- Knowledge
    - Scientific papers.
- Technologies
    - Innovation (number of firms who innovate);
    - High technology trade;
    - Patents;
    - Use of advanced technologies;
    - Information and communication technologies (internet, electronic commerce); and
    - Capital investments (machinery and equipment).
- Commercialization (of university research)
    - Spin-off;
    - Licenses; and
    - Patents.
- Clusters
- Economic environment
    - Venture capital; and
    - Taxes.

The Ranking

None of the benchmarking exercises in Canada has engaged in ranking performances using composite indicators. This is not necessarily a bad thing, considering the methodological challenges of such an exercise.

Suggestions for Further Development

Inputs are generally the indicators that are the most measured in current scoreboards. In fact, forty years of R&D data are available in the case of provinces, for example. Outputs are less well served for several reasons that have to do with ideology, policy and methodology. Finally, impacts are almost non-existent. When there are, they are concerned mainly economic outcomes (like productivity). Social, organizational, and cultural outcomes are totally absent from current measurements. Be it as it may, there is always a methodological challenge here that no one has seriously addressed: the imputation problem, or linking inputs to outputs.

Among the missing indicators, the next series is worth mentioning for further improvements of scoreboards. First, indicators on knowledge flows are almost totally absent. [7] Despite the efforts of many, this type of indicator remains difficult to construct (for OECD's suggestions, see Appendix 4). Second, indicators on innovation are very few. R&D, as a proxy, remains the most cherished indicator of innovation. When there are indicators on innovation, they concern technological innovation only. They rarely cover organizational or social innovations. Third, no indicators on impacts are available although one finds, for example, data on productivity, but without any model to link these data to science. Finally, very few indicators concern industrial sectors (R&D broken down by industrial sectors) or specific technologies. Also, foreign R&D and international mobility are not well covered.

What about indicators specifically dedicated to provinces or regions? No scoreboard conducted at the provincial level contains indicators really different from those found in international or national scoreboards. Provincial benchmarking exercises rather satisfy themselves with "provincializing" standardized indicators. We suggest adding indicators that would help assess the provinces' specificity. For example, R&D could be broken down by industries or technologies in order to distinguish provinces' industrial specialization. Similarly, indicators could be produced on the uniqueness of provincial government support to R&D: government R&D broken down by socioeconomic objectives (health, energy, environment, etc.). Briefly stated, any of the standard indicators would have to be more disaggregated than they actually are.

Finally, even though some of the indicators do not currently exist at the provincial or regional level, the following indicators might be considered for inclusion in future regional scoreboards:

- Creation and Diffusion of Knowledge
  - Mobility of qualified personnel;
  - Scientific literacy;
  - R&D by socioeconomic objectives;
  - R&D intensity by industry and sector;
  - Resources devoted to post secondary education;
  - Number of companies in an industry engaged in R&D;
  - Patents by industry and sector;
  - Papers by fields of science (specialization index);
  - Papers by technologies (ICT, biotechnology); and
  - Papers written in collaboration between sectors (government, industry and government).
- Information Economy
  - ICT investments; and
  - Share of ICT sector.
- Economic Structure and Productivity
  - Investment ($) in innovation;
  - Social capital
  - Spin-off companies; and
  - Licenses.
- Global Integration
  - Papers written in collaboration;
  - International mobility of personnel (and students);
  - Coinvention (patents); and
  - HT trade.

[7] Those present are business funding of university R&D, collaborative agreements between firms, and co-signatures in scientific papers.

Appendix 1.

OECD STI Scoreboard, 2003

A. Creation and Diffusion of Knowledge

Investments in knowledge
Domestic R&D expenditure
R&D financing and performance
Business R&D
Business R&D by industry
R&D in selected ICT industries and ICT patents
Business R&D by size classes of firms
R&D performed by the higher education and government sectors
Biotechnology R&D, venture capital and patents
Health-related R&D
Basic research
Defence R&D in government budgets
Space R&D and innovation
Tax treatment of R&D
Venture capital
Human resources
Flows of university graduates
Employment of tertiary-level graduates
Human resources in science and technology
Researchers
International mobility of human capital
International mobility of PhD students
Patent applications to the European Patent Office (EPO)
Patent families
R&D in non-OECD economies
Human resources in non-OECD economies
Scientific publications

B. Information Economy

Investment in ICT equipment and software
Occupations and skills in the information economy
Telecommunication networks
Internet infrastructure
Internet subscribers and number of secure servers
ICT access by households
Use of internet by individuals
Internet access and use by enterprise size and industry
Internet and electronic commerce by size of enterprise
Internet and electronic commerce by activity of enterprise
Price of Internet access and use
Size and growth of the ICT sector
Contribution of the ICT sector to employment
Contribution of the ICT sector to international trade

C. Global Integration of Economic Activity

International trade and investment flows
Exposure to international trade competition by industry
Intra-firm trade in total trade
Import content of exports
Foreign direct investment flows
Cross-border mergers and acquisitions
Activity of affiliates under foreign control in manufacturing
Activity of affiliates under foreign control in services
Contribution of multinationals to value added and labour productivity
Internationalization of manufacturing R&D
Cross-border ownership of inventions
International co-operation in science and technology
Technology balance of payments

D. Economic Structure and Productivity

Differences in income and productivity
Income and productivity
Labour productivity growth
Growth accounting
Labour productivity growth by industry
Technology and knowledge-intensive industries
Structure of OECD economies
Services sector value added embodied in manufactured goods
International trade by technology intensity
Trade in high and medium-high-technology industries
Revealed comparative advantage by technology intensity
Entry, exit and survival of firms

Appendix 2.

European Innovation Scoreboard (2003)

S&E Graduates
Population with tertiary education
Participation in life-long learning
Employed in med/high-tech manufacturing
Employed in high-tech services
Public R&D/GDP
Business R&D/GDP
High-tech patents/population
SMEs innovating in-house
SMEs innovation co-operation
Innovation expenditures/total sales
High-tech venture capital/GDP
New capital raised/GDP
New capital raised/GDP
Sales of new-to-market products
Home internet access
ICT markets/GDP
High-tech value added in manufacturing

Appendix 3.

Canadian Scoreboards : Indicators

	Alberta	British-Columbia	Ontario	Québec	Canada
R&D					
Gross Domestic Expenditure on R&D as a per cent of GDP					X
Gross Expenditures on Research and Development		x			
BC Gross Expenditures on R&D		x			
Gross Expenditures on R&D as a Percentage of GDP, 1990 & 1999		x			
Government spending on R&D [Federal & Provincial].	x				
R&D [GERD, BERD, HERD]	x				
R&D Expenditures			x		
Gross Expenditures on R&D per Capita, Selected Provinces, 1999 - $			x		
Ontario R&D Expenditures by Performing Sector, 1989-1999 - $ Millions			x		
R&D Expenditures as a Percentage of Gross Domestic Product for Jurisdictions, 1999			x		
Sectoral R & D Performance		x			
BC Sectoral R&D Performance as % of GDP		x			
Sectoral R&D Performance as Percentage of GDP, 1998		x			
Percentage of Government R&D (GOVERD) Financed by Industry				x	
Government R&D (GOVERD) Financed by Industry, Quebec and some OECD countries, 2000 (%)				x	
Government R&D (GOVERD) Financed by Industry, Quebec, Ontario and other provinces, 1990-2000 (%)				x	
Percentage of the Higher Education Research (HERD) Financed by the Industry)				x	
Higher Education Research (HERD) Financed by Industry, Quebec and some OECD countries, 2000 (%)				x	
Higher Education Research (HERD) Financed by Industry, Quebec, Ontario & other provinces, 1990-00 (%)				x	
R&D Expenditures in the Higher Education Sector (HERD) as a Percentage of GDP				x	
HERD by Scientific Field, Quebec, 1991-2000 (millions dollars)				x	
HERD as a Percentage of GDP, Quebec, Ontario and some OECD countries, 1996-2000				x	
Research subsidized and financed per capita, 2000 (dollars)				x	
R&D Expenditure in the Government Sector (GOVERD) as a Percentage of GDP				x	
GOVERD, Various Indicators, Quebec, Ontario and other provinces, 1990-2000				x	
R&D Expenditures in the Government Sector (GOVERD) as a Percentage of GDP, Quebec and some OECD countries, 1990, 1995 et 2000				x	
Business Enterprise Expenditure on R&D as a per cent of GDP					X
R&D Expenditure in the Business Sector (BERD) as a Percentage of GDP				x	
BERD Growth Between 1997and 2000 - (millions dollars)				x	
BERD as a Percentage of GDP				x	
BERD as a Percentage of GDP, Quebec and Americans States close to Quebec, 1999				x	
University-Industry Collaboration in R&D					X
University-Industry Collaboration		x			
BC Higher Education R&D Expenditures Funded by Business		x			
Business Funding as Percentage of Total R&D Expenditures in the Higher Education Sector, 1991 & 1999		x			
Industry investment in university research.	x				
Knowledge Jobs			x		
Researchers per 1,000 Persons in the Labour Force, Selected Jurisdictions, 1998			x		
Number of Business Enterprises Active in R&D				x	
Industrial R&D Laboratories, Canada				x	
Number of Companies Active in R&D (main industries),Quebec, 1999				x	
Number of researchers per 10 000 active workers				x	
Number of researchers per 10 000 active Workers, employment sectors, 1998				x	
Number of researchers per 10 000 active Workers, Canada, 1998				x	
Number of researchers per 10 000 active Workers, OECD countries, 1998				x	
R&D Personnel in Business Enterprise Sector per 1000 Active workers				x	
Growth of Industrial R&D Personnel between 1997 and 2000, Quebec (FTE)				x	
Industrial R&D Personnel by category, Quebec (FTE)				x	
Industrial R&D Personnel, some OECD countries, 2000 (per 1000 active workers)				x	
Research Personnel		x			
BC Research Workforce		x			
Research Workforce per 100,000 Population, 1998		x			

Canadian Scoreboards : Indicators

	Alberta	British-Columbia	Ontario	Québec	Canada
Education					
Spending on education (Public and private)	x				
Spending on Education as a percentage of GDP				x	
Spending on Education as a Percentage of GDP				x	
Spending on Education as a Percentage of GDP, some OECD countries				x	
Spending on Education as a Percentage of GDP, by Education level, Quebec				x	
Bachelor Degrees in Science and Engineering		x			
Bachelor Degrees in the Sciences & Engineering per 100,000 Population, 1997		x			
BC Bachelor Degrees in the Sciences & Engineering		x			
University Graduation Rates in Natural Science and Engineering (Bachelor's, Master's & PhD)				x	
University Graduation Rates in Natural Sciences and Engineering by degrees, Canada, 1998				x	
University Graduation Rates in Natural Sciences and Engineering by degrees, Québec				x	
University Graduation Rates in Natural Sciences and Engineering by degrees, G7 countries, 2000				x	
Enrolment (Autumn semester) in Natural Sciences and Engineering by degrees, Quebec (# and %)				x	
University Graduation Rates (Bachelor's degree, Master's and PhD)				x	
University Graduation Rates by sex, Quebec (%)				x	
University Graduation Rates, Quebec, 1976-2001 (%)				x	
University Graduation Rates Quebec, Ontario and various countries, 2000 (%)				x	
Total graduates	x				
Enrolment in Secondary School Science Courses			x		
Enrolment in Science Courses in Grade 11 and Above by Field of Study as a Percentage of Total Science Course Enrolments, 1999-2000			x		
Total Enrolment in Science Courses, Grade 11 and Above, by Field of Study, 1996-1997 to 1999-2000 - Enrolment Level			x		
Total Publicly Funded Secondary School Enrolments in Science Courses in Grade 11 and Over, 1996-1997 to 1999-2000 - Enrolment Level			x		
Graduates in Science, Engineering and Business			x		
Bachelor's and First Professional Degrees Awarded for Selected Fields of Study, 1998 - Percentage of Total Degrees			x		
Bachelor's and First Professional Degrees Awarded in Ontario, 1994-1998			x		
Ontario Graduates in the Natural Sciences and Engineering, 1998			x		
Post-secondary Credentials		x			
BC Percentage of the Population 15 Years and Older with Post-secondary Credentials		x			
Percentage of the Population 15 Years and Older with Post-secondary Credentials, 1990 & 2000		x			
Grade School Math and Science Assessments		x			
Average Marks in BC Provincial Science & Math Exams		x			
Grade 8 Test Results in Math & Science from TIMSS		x			
Scores in reading, mathematics and sciences				x	
Mean Score in reading, mathematics and sciences, OECD countries, 2000				x	
Mean Score in reading, mathematics and sciences, Canadian provinces, 2000				x	
Ontario Student Performance in Science - Level of achievement of Ontario Grade 8 students on the Third International Mathematics and Science Study (TIMSS) in 1999			x		
Grade 8 Science Scores for Selected Jurisdictions, 1999 - Mean Score			x		
Students' Attitudes Toward Science - Per Cent in Agreement			x		
Students' educational performance	x				
Percentage of Teachers with Backgrounds in Science and Technology - Field of specialization for secondary school teachers			x		
Field of Specialization for Highest Degree, Secondary School Teachers, 1996 - Per Cent			x		
Retirements of Subject-Qualified Secondary School Teachers by 2010			x		
Percentage of the population 25 years of age & over with a post secondary qualification.	x				
Education al Attainment in the Labour Force					x
Educational Attainment of the Workforce			x		
Educational Attainment Highest Degree, Diploma or Certificate—1996 Census Percentage of population age 15 and Over			x		
Educational Attainment in Ontario—1996 Census			x		
Percentage of the Labour Force with University Backgrounds in Science, Engineering or Business, 1996 - Number in thousands			x		
Percentage of population with a University diploma (bachelor degree or higher)				x	
Percentage of Canadian population (25 to 54 years old) with a University diploma				x	
Percentage of population (25 to 64 years old) with a University diploma, OECD				x	
Student completion rates (secondary / tertiary)	x				
Percentage of adult population involved in Life-long learning				x	
Differences Between Canadian Average and Provinces Rates in Life-long learning 1991, 1993 and 1997				x	
Percentage of adult population participating in Life-long learning, by Education level, Quebec				x	
Percentage of adult population participating in Life-long learning, 1997				x	
Percentage of adult population (25 too 64 years old) participating in Life-long learning, 1997				x	
Adult Participation in Continuing Education					x
Education Level of immigrants		x			
Percentage of BC Immigrants Aged 25 Years & Older with 16 or More Years of Education		x			
Percentage of Immigrants 25 Years & Older with 16 or More Years of Education, 1990 & 2000		x			

Canadian Scoreboards : Indicators

	Alberta	British-Columbia	Ontario	Québec	Canada
Scientific and technological culture					
Government investment in science awareness.	x				
Albertans perception of the value of spending on science	x				
Coverage of Science and Technology in the Press			x		
Appearance of Science-Related Key Words in Ontario Regional Newspapers, 1998-2000 - Average Number of Citations			x		
Appearance of the Key Word "Technology" in Major and Regional Ontario Newspapers, 1998-2000 - Average Number of Citations			x		
Awareness of Science-Related Key Words in Major Ontario Newspapers, 1997-2000 - Average Number of Citations			x		
Coverage of science and Technology in the press.	x				
Percentage of population interested in Science and Technology				x	
People frequently using various media to get information about the scientific and technological affairs, Quebec 2002, 1990 et 1985 (%)				x	
Frequentation of an institution in scientific matter according to the type, Quebec, 2002 (%)				x	
Proportion of the scientific leisure's amateurs according to the age and the sex, Quebec 2002				x	
Knowledge					
Alberta university research output	x				
Bibliometrics			x		
Distribution of Scientific Publications by Sector, Ontario, 1995			x		
Scientific Publications per Capita, 1995 - Number of Publications Per Million Population			x		
Specialization Index*, Ontario, 1995			x		
Ontario University Research Performance			x		
Percentage of Papers Involving International Collaboration in the Natural, Biomedical and Engineering Fields, 1998			x		
Publications per Professor in the Natural, Biomedical and Engineering Fields, 1998			x		
Relative Weighted Impact Factor (RWIF) in the Natural, Biomedical and Engineering Fields, 1998*			x		
Number of Scientific papers per 100 000 capita				x	
Specialization index (NSEB), Quebec, 2000				x	
Scientific Papers (NSEB), per 100 000 capita, Quebec and Ontario, 1990-2000				x	
Scientific Papers per 100,000 capita, Natural Sciences and Engineering (including biomedical Research), 2000				x	
Percentage of Industry papers written in intersectoral collaboration				x	
Industry papers written in intersectoral collaboration by sector, Quebec, (average 1995-2000)				x	
Industry papers written in intersectoral collaboration, Canada, 1993-1998				x	
Industry papers written in intersectoral collaboration, Canada, 1998				x	
Percentage of Papers Written in International Collaboration				x	
Percentage of Papers (NSEB) written in International Collaboration, Canada, 1990-2000				x	
Percentage of Papers (NSEB) in written International Collaboration, Canada, 2000				x	
Papers written in International Collaboration by country, Quebec, 1998 (%)				x	
Publication of Scientific Papers					x
Scientific Publications		x			
Number of Scientific Publications in BC		x			
Scientific Publications Per 10,000 Population, 1999		x			
Technologies					
# of businesses establishments in Alberta's knowledge intensive industries.	x				
# of new processes adopted [Proxy – business spending on M&E]	x				
Clusters of Technology–based Companies		x			
BC High Tech Sector Establishments by Region, 2000		x			
Industries with Most Number of High Tech Sector Establishments, 2000		x			
High Technology Sector GDP		x			
BC High Tech Sector GDP (Constant 1992 $)		x			
High Tech Sector Growth Rate, 2000		x			
Innovative Manufacturing Firms		x			
Percent of Innovative Manufacturing Firms, 1997-1999		x			
Fixed Business Investment		x			
BC Gross Fixed Business Investment Percent of GDP (in 1997 $)		x			
Gross Fixed Business Investment as Percent of GDP (in 1997 $), 1991 & 2000		x			
Industry Investments in Machinery and Equipment as a Percentage of GDP				x	
Industry Investments in Machinery and Equipment (thousand dollars)				x	
Industry Investment in Machinery and Equipment as a Percentage of GDP				x	
Investment in physical capital [Public & private]	x				
Investments in Machinery and Equipment			x		
Investment in Machinery and Equipment, Selected Industries, as a Percentage of Total Investments in Machinery and Equipment, 2000			x		
Total Investments in Machinery and Equipment, Selected Industries, for Ontario 1999-2000 - $ Millions			x		
Total Investments in Machinery and Equipment as a Percentage of Provincial Gross Domestic Product, 1991-1999			x		

	Alberta	British-Columbia	Ontario	Québec	Canada
Knowledge Jobs			x		
Employment in Selected Knowledge-Intensive Sectors, 1998 - Percentage of National Total			x		
Experienced Labour Force in Management, Business, Sciences and Engineering, 1996 - Percentage of Workforce			x		
Patents Granted per Million capita				x	
Patents Granted per Million capita, USPTO (1999)				x	
Patents Granted (USPTO) per Million capita, 1980-2000				x	
Triadic Patent Families					X
Patents			x		
Individual and Institutional inventions, Selected Provinces, (1980-1999) - Number (in Thousands)			x		
Individual Inventions by Province per Million Population (1980-1999)			x		
Patents Awarded		x			
BC Patents Awarded		x			
Patents Awarded Per 10,000 Population, 1999		x			
Patents granted to Alberta residents [Canada & US]	x				
Patterns of Innovative and Collaborative Behaviour Among Manufacturing Firms			x		
Percentage of Innovative Manufacturing Firms with Co-operative and Collaborative Arrangements During the Period 1997-1999			x		
Percentage of Manufacturing Firms Introducing an Innovation During the Period 1997-1999			x		
Technology Adoption Rates - Adoption rates of advanced technologies in the manufacturing sector, 1998			x		
Approach to the Introduction of Advanced Technologies, 1998 - Per Cent			x		
Percentage of Manufacturing Firms Using at Least One Advanced Technology, 1998			x		
Percentage of Manufacturing Firms Using at Least One Advanced Technology				x	
Distribution of Manufacturing Firms by the number of Advanced Technologies used, by region, 1998 (weighted by the number of firms)				x	
Introduction of Advanced Technologies, two main ways (%)				x	
Use of Technologies, by functional group by region, 1998 (in %, weighted by the number of firms)				x	
Technology Balance of Payments					X
Value added exports	x				
High-Technology Exports			x		
High-Technology Exports, 2000 - Billions			x		
Leading Destinations of Ontario High-technology Exports, 2000 - Can $ Billions			x		
Positioning of Ontario's High-Technology Exports Average Growth in High-Tech Exports, 1996-2000, (%)			x		
High Technology exports				x	
Quebec Export of Manufactured products by technological level				x	
Structure of Export of Manufactured products by technological level, Quebec and some OECD countries, 2000 (%)				x	
Structure of Export of Manufactured products by technological level, Quebec, 1991-2000 (%)				x	
Share of Manufactured product by technological level, Quebec, 1991-2001 (%)				x	
Percentage of Firms Using the Internet and the E-Commerce				x	
Enterprises Using Internet and Web Presence by the number of employee, Quebec, 2001 (%)				x	
Enterprises Using Internet for various business processes by the number of employees, Quebec, 2001 (%)				x	
Rates of use of Internet and E-commerce, Firms with 10 employees or more, 2001				x	
Percentage of Innovative Manufacturing Firms with Co-operative and Collaborative Agreements, 1997-1999				x	
Collaborators of Innovative Manufacturing Firms with Agreements, 1997-1999				x	
Percentage of Innovative Manufacturing Firms with Agreements, 1997-1999				x	
Reasons for which Innovative Manufacturing Firms have Concluded arrangements, 1997 à 1999				x	
Percentage of Innovative Manufacturing Firms who participate in activities related to Innovation				x	
Percentage of Innovative Manufacturing Firms during the period 1997 to 1999				x	
Percentage of activities related to Innovation by the Firms type				x	
Percentage of Innovative Manufacturing Firms who participate in activities related to Innovation, 1997-1999				x	
Broadband Subscribers per 100 Population					X
Household Internet use.	x				
Household Internet Use			x		
Internet Access Rates from Any Location, by Province, 1997-2001 - Per Cent			x		
Subscribers to High-Speed Internet by Cable, 1999-2000 - Thousands of Subscribers			x		
Use of the Internet from the Home, Selected Jurisdictions, 1998-2001 - Per Cent			x		
Internet Connectivity		x			
BC Digital Divide-Gap Analysis, 2002		x			
Percentage of Households Using the Internet, 1997 & 2000		x			
Household Internet Use				x	
Household Internet Use, 1997-2001				x	
Household Internet Use, 1998-2001				x	
Household Internet Use by various activities (%)				x	
Employment Growth in High-Technology Fields			x		
Employment Growth in High-Technology Sectors, 1991-2000 - Per Cent			x		
Percentage Increase in Total Employment for Selected R&D Intensive Industries in Ontario, 1995-2000			x		
Total Employment in High-Technology Industries, 1990-2000			x		
Workforce in Natural and Applied Science Related Occupations		x			
Percentage of Workforce in Natural & Applied Science Related Occupations, 1991 & 2000		x			
Percentage of BC Workforce in Natural & Applied Science Related Occupations		x			

Canadian Scoreboards : Indicators

	Alberta	British-Columbia	Ontario	Québec	Canada
Commercialization (of university research)					
# of university spin off companies.	x				
Share of Quebec in the commercialization of Canadian universities				x	
Commercialization activities in Canadian universities, 1998-1888 (%)				x	
Number of Universities commercializing Intellectual Property, Canada 1998-2000 (%)				x	
University Idea Generation and Commercialization			x		
Spin-off Companies: Canadian Universities, 1999			x		
University Patents and Inventions, Selected Jurisdictions, 1998-1999			x		
University Technology Licenses, 1999			x		
University license revenues.	x				
University Technology Licensing		x			
Gross Income Per Technology License, 1991 & 1999 (in US$)		x			
UBC Gross Income Per Technology License and Number of Licenses		x			
Economic Environment					
Economy-Wide Regulatory Environment					X
Relocation of R&D Facilities as a Threat to the Economy's Future					X
Total Corporate Tax as a per cent of GDP					X
R&D Tax Treatment					X
FDI Confidence Index					X
Cost of R&D		x			
After-Tax Cost of $1 R&D Expenditures in BC		x			
After-Tax Cost of $1 R&D Expenditures, 1999		x			
General Corporate Income Tax Rate		x			
BC General Corporate Tax Rate		x			
General Corporate Tax Rate, 1990 & 2002		x			
World Competitiveness Rankings					X
Competitiveness Index of the tax system for R&D				x	
Break-even point for 1$ Expenditure in R&D, 1999				x	
Break-even point for 1$ Expenditure in R&D, Québec et Ontario, 2002				x	
Individual Tax Rate		x			
BC Index of All Taxes Paid by Unattached Individuals Earning $80,000 Per Year		x			
Index of All Taxes Paid by Unattached Individuals Earning $80,000 per Year, 1992 & 2000		x			
Relative Attractiveness of R&D Tax Incentives - Measuring the relative attractiveness of the R&D tax regime in selected jurisdictions, 1998			x		
B-Index Score (Canada-Large Firms Only; U.S. states, Sweden-All Firms), 1998			x		
B-Index Score (Small Manufacturing Firms), 1998			x		
Tax Rates			x		
Comparison of Ontario and U.S. Personal Income Tax Rates, 2001 - Marginal Tax Rate (Per Cent)			x		
Marginal Individual Capital Gains Tax Rates, Selected Jurisdictions, 2001-2002 - Marginal Tax Rate (Per Cent)			x		
Comparison of Corporate Income Tax Rates, Selected Jurisdictions, 2002 - General CIT rate (Per Cent)			x		
Investment in Venture Capital					X
Venture Capital Investment per Capita				x	
Venture Capital Investment— Average Investment by round of financing (million Canadian dollars)				x	
Venture Capital Investment per Capita (Canadian dollars)				x	
Venture Capital Investment, Quebec, Ontario and other Provinces				x	
Venture Capital Investment		x			
Venture Capital Investment in BC		x			
Venture Capital Investment per Capita, 1991 & 2000		x			
Venture Capital Investments			x		
Distribution of Venture Capital Investments by Sector and Province, 2001 - Sector Investments as a Per Cent of Total VC Investments			x		
Venture Capital Investments Per Capita, Selected Jurisdictions, 2001			x		
Venture capital investments made.	x				

	Alberta	British-Columbia	Ontario	Québec	Canada
Others					
% Albertans who are foreign born.	x				
Air Quality			x		
10-Year Range of Composite Annual Mean for PM10 Concentrations in Selected Cities Around the World -1999			x		
10-Year Range of Maximum One-Hour Ozone Levels in Selected Cities Around the World (1990-1999)			x		
Ranking of Metropolitan Areas in the Great Lakes Basin Area According to Criteria Pollutant Levels (1990-1999)			x		
Albertans in artistic occupations.	x				
Average Pay per Worker			x		
Average Ontario Pay, Selected R&D-intensive Industries - R&D expenditures as a percentage of revenues			x		
Average Weekly Earnings - (For All Industries, Seasonally Adjusted)			x		
Average Weekly Earnings of All Employees, Selected Industries, April 2001			x		
Crime Rates			x		
Property and Violent Crime Rates, Ontario, 1990-2000 - Rate per 100,000 Population			x		
Youths Charged with Selected Criminal Code Incidents for Canada and Selected Provinces, 2000 - Rate per 100,000 of the Youth Population			x		
Selected Criminal Code Incidents for Canada and Selected Provinces, 2000 - Rate per 100,000 of the Youth Population			x		
Cultural Diversity			x		
Foreign-Born* Population as a Share of the Total Population, Selected North American Cities			x		
Immigrant Population as a Share of Total Population for Canada and Selected Provinces, 1996			x		
GDP per Capita			x		
GDP per Capita, Ontario and Selected North American Jurisdictions, 2000 - $US Thousands			x		
GDP per Capita, Percentage change			x		
Percentage Distribution of Ontario GDP by Selected Industries, 1999			x		
Health of Ontarians			x		
Health Index - Index score			x		
Leisure Time Physical Activity in Ontario, 1998-1999			x		
Smokers and Quitters - Percentage of the Population that Smokes			x		
Inclusive workforce	x				
Initial Public Offerings			x		
IPO Activity in Ontario - Average Value ($ Millions)			x		
IPO Activity in Ontario - Number of IPOs			x		
Number of IPOs, 2000			x		
Value of IPOs - $ Billions			x		
Innovative Manufacturing Firms		x			
Impact on Sales in 1999 of New Products		x			
Inter-Provincial Migration		x			
Net Inter-Provincial Migration per 1,000 Population, 1991 & 2000		x			
Net Inter-Provincial Migration to BC		x			
Number of gazelle companies in Technology Fast 50				x	
Number of gazelle companies in Technology Fast 50, by province				x	
Technology Fast 50 2002: Quebec champion's				x	
Number of gazelle companies	x				
New Business Starts			x		
New Business Starts Number of New Businesses, in Thousands			x		
New Businesses by Sector, 1998			x		
New Businesses per Capita - New Businesses per 1,000 People			x		
Size distribution of firms	x				
Business Start Cost				x	
Tax Competitiveness Index of R&D, Average of 12 sectors (United-States = 100)				x	
Business Start Cost Index, Average of 12 sectors (United-States = 100)				x	
Labour Productivity Performance			x		
Average Gross Domestic Product per Job, by Province, 1996-1997 - GDP per Job ($ Thousands)			x		
Sectoral Productivity in Ontario, 1996-1997 - GDP per Job ($ Thousands)			x		
Sectoral Productivity in the Innovative Sectors, 1996-1997 - GDP per Job ($ Thousands)			x		
Number of people employed in Value added sector.	x				
Productivity in the Value added sector.	x				
Qualified immigrants to Alberta	x				
Value added sectors share of GDP.	x				

Appendix 4.

Indicators on Knowledge Flows

(National Innovation Systems, OECD, 1997)

Type of knowledge flows	Main [source of] indicator
Industry alliances	
Inter-firm research co-operation	Firm surveys
	Literature-based counting
Industry/university interactions	
Co-operative industry/university R&D	university annual reports
Industry/University co-patents	patent record analysis
Industry/University co-publications	publications analysis
Industry use of university patents	citation analysis
Industry/University information-sharing	firm surveys
Industry/University institute interactions	
Co-operative industry/institute R&D	government reports
Industry/institute co-patents	patent record analysis
Industry/institute co-publications	publications analysis
Industry use of research institute patents	citation analysis
Industry/institute information-sharing	firm surveys
Technology diffusion	
Technology use by industry	firm surveys
Embodied technology diffusion	input-output analysis
Personnel mobility	
Movement of technical personnel among	labor market statistics
industry, university and research	university/institute reports

Appendix 5: Data Tables

Table 1: Combined Public and Private Expenditures on Education as a Percentage of GDP, Select Years

	Percentage				
	Canada	N.L.	P.E.I.	N.S.	N.B.
1997-1998	6.8%	12.0%	9.1%	8.2%	8.6%
1998-1999	6.9%	10.3%	9.0%	8.7%	8.4%
1999-2000	6.6%	8.5%	8.2%	8.3%	8.3%
Source: Statistics Canada					

Table 2: Index of Change of Combined Public and Private Expenditures on Education as a Percentage of GDP (1997-98=100)

	Percentage				
	Canada	N.L.	P.E.I.	N.S.	N.B.
1997-1998	100%	100%	100%	100%	100%
1998-1999	101%	86%	99%	105%	97%
1999-2000	97%	71%	91%	101%	96%
Source: Statistics Canada					

Table 3: Mean Scores of 15-Year-Olds in the PISA 2000 in Reading, Math and Science

	Mean Score in Mathematics Assessment	Mean Score in Science Assessment	Mean Score in Reading Proficiency
Canada	533	529	534
Newfoundland and Labrador	509	516	521
Prince Edward Island	512	508	517
Nova Scotia	513	516	517
New Brunswick	506	497	501
OECD Average	500	500	500
Source: Statistics Canada			

Table 4: Mean Scores of 15-Year-Olds in the PISA 2000 in Reading, Math and Science Relative to the Canada-wide Average

	Mean Score in Mathematics Assessment	Mean Score in Science Assessment	Mean Score in Reading Proficiency
Newfoundland and Labrador	95.5%	97.5%	97.6%
Prince Edward Island	96.1%	96.0%	96.8%
Nova Scotia	96.2%	97.5%	96.8%
New Brunswick	94.9%	94.0%	93.8%
OECD Average	93.8%	94.5%	93.6%
Source: Statistics Canada			

Table 5: Percentage of Households Connected to the Internet by Location, for Canada and the Atlantic Provinces

		1997	1998	1999	2000	2001	2002
Canada	Home	16%	22.6%	28.7%	40.1%	48.7%	51.4%
	Work	19.9%	23.3%	21.9%	27.5%	32.6%	34.2%
	School	9.3%	12.1%	14.9%	19.2%	22.2%	22.9%
	Public library	3.7%	4.3%	4.5%	6.5%	7.9%	8.2%
	Other locations	2.8%	2.6%	3.9%	3.2%	9.6%	10.4%
	Any location	29%	35.9%	41.8%	51.3%	60.2%	61.6%
Newfoundland and Labrador	Home	12.4%	15.3%	18.1%	30.6%	35.7%	38.9%
	Work	15.7%	17.1%	14.2%	22%	24.3%	25.1%
	School	12.8%	14.5%	18%	23.4%	27.2%	25%
	Public library	4.3%	4.7%	5.5%	7.9%	9.1%	8.5%
	Other locations	1.3%	3.6%	4%	3.1%	9.1%	10.6%
	Any location	26.1%	28.8%	35.2%	45.5%	50.2%	50.8%
Prince Edward Island	Home	10.5%	17.1%	20.1%	34.4%	41.8%	39.7%
	Work	16.5%	21.9%	19.8%	27.5%	30.2%	28.5%
	School	11.4%	14.5%	19%	25.1%	27.5%	25%
	Public library	2%	4.5%	3.6%	6%	6%	6.3%
	Other locations	2.2%	2.6%	3.3%	4.4%	14.1%	11.6%
	Any location	25.7%	35.4%	40.5%	51.1%	57.8%	54.1%
Nova Scotia	Home	14.3%	23.6%	26.7%	38.5%	43.3%	45.9%
	Work	20.7%	22.8%	19.7%	27%	30.5%	30.6%
	School	14.3%	17.4%	14.5%	21.9%	22.8%	24.5%
	Public library	5%	5.6%	3.8%	7%	7.7%	7.3%

	Other locations	3.1%	3.4%	4.8%	4.7%	12.5%	12.6%
	Any location	31.8%	37.8%	41.1%	52%	57.4%	58.1%
New Brunswick	Home	12%	18.1%	23.6%	32.5%	38.2%	37.4%
	Work	17.9%	19.8%	19.2%	24.2%	27.9%	28.4%
	School	10.6%	12.3%	13.1%	14.8%	18.5%	25.6%
	Public library	2.6%	2.3%	2.5%	3.9%	5%	3.9%
	Other locations	4.8%	2.1%	4.1%	4%	8.4%	7.3%
	Any location	28.1%	31%	38%	45.2%	52.4%	48.6%
Source: Statistics Canada							

Table 6: Percentage of Households Connected to the Internet for Canada and the Atlantic Provinces Relative to 1997

		1997	1998	1999	2000	2001	2002
Home	Canada	100.0%	141.3%	179.4%	250.6%	304.4%	321.3%
	Newfoundland and Labrador	100.0%	123.4%	146.0%	246.8%	287.9%	313.7%
	Prince Edward Island	100.0%	162.9%	191.4%	327.6%	398.1%	378.1%
	Nova Scotia	100.0%	165.0%	186.7%	269.2%	302.8%	321.0%
	New Brunswick	100.0%	150.8%	196.7%	270.8%	318.3%	311.7%
Work	Canada	100.0%	117.1%	110.1%	138.2%	163.8%	171.9%
	Newfoundland and Labrador	100.0%	108.9%	90.4%	140.1%	154.8%	159.9%
	Prince Edward Island	100.0%	132.7%	120.0%	166.7%	183.0%	172.7%
	Nova Scotia	100.0%	110.1%	95.2%	130.4%	147.3%	147.8%
	New Brunswick	100.0%	110.6%	107.3%	135.2%	155.9%	158.7%
School	Canada	100.0%	130.1%	160.2%	206.5%	238.7%	246.2%
	Newfoundland and Labrador	100.0%	113.3%	140.6%	182.8%	212.5%	195.3%
	Prince Edward Island	100.0%	127.2%	166.7%	220.2%	241.2%	219.3%
	Nova Scotia	100.0%	121.7%	101.4%	153.1%	159.4%	171.3%
	New Brunswick	100.0%	116.0%	123.6%	139.6%	174.5%	241.5%
Source: Statistics Canada							

Table 7: Percentage of Households Connected to the Internet in the Atlantic Provinces Relative to that Observed Canada-wide, by Location

		1997	1998	1999	2000	2001	2002
Home	Canada	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	Newfoundland and Labrador	77.5%	67.7%	63.1%	76.3%	73.3%	75.7%
	Prince Edward Island	65.6%	75.7%	70.0%	85.8%	85.8%	77.2%
	Nova Scotia	89.4%	104.4%	93.0%	96.0%	88.9%	89.3%
	New Brunswick	75.0%	80.1%	82.2%	81.0%	78.4%	72.8%

Work	Canada	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	Newfoundland and Labrador	78.9%	73.4%	64.8%	80.0%	74.5%	73.4%
	Prince Edward Island	82.9%	94.0%	90.4%	100.0%	92.6%	83.3%
	Nova Scotia	104.0%	97.9%	90.0%	98.2%	93.6%	89.5%
	New Brunswick	89.9%	85.0%	87.7%	88.0%	85.6%	83.0%
School	Canada	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	Newfoundland and Labrador	137.6%	119.8%	120.8%	121.9%	122.5%	109.2%
	Prince Edward Island	122.6%	119.8%	127.5%	130.7%	123.9%	109.2%
	Nova Scotia	153.8%	143.8%	97.3%	114.1%	102.7%	107.0%
	New Brunswick	114.0%	101.7%	87.9%	77.1%	83.3%	111.8%
Source: Statistics Canada							

Table 8: University Enrollment in 2002 by City

City Name	Full time Undergraduate Enrollment	Part time Undergraduate Enrollment	Full time Graduate Enrollment	Part time Graduate Enrollment	HQP	Full time Undergraduate Enrollment Per HQP	Part time Undergraduate Enrollment
Victoria	9,730	6,445	1,845	305	48,000	0.20	0.13
Vancouver	30,465	14,080	8,070	1,945	348,215	0.09	0.04
Calgary	18,775	3,565	3,140	1,115	156,960	0.12	0.02
Edmonton	22,810	2,620	3,530	1,930	114,295	0.20	0.02
Saskatoon	11,985	3,880	1,580	470	29,225	0.41	0.13
Regina	8,555	2,350	235	1,080	24,335	0.35	0.10
Winnipeg	16,995	8,210	2,270	915	84,650	0.20	0.10
Thunder Bay	4,770	1,145	185	95	12,300	0.39	0.09
Windsor	8,940	2,985	710	215	35,375	0.25	0.08
Sudbury	3,610	1,750	185	145	12,695	0.28	0.14
London	17,150	3,390	3,420	380	50,450	0.34	0.07
KWG	35,425	5,225	3,700	840	66,490	0.53	0.08
Hamilton	11,785	2,410	2,080	740	75,010	0.16	0.03
St. Catharines	7,410	1,845	180	455	31,350	0.24	0.06
Toronto	65,215	25,300	10,970	2,880	866,840	0.08	0.03
Kingston	13,510	3,130	2,550	675	18,975	0.71	0.16
Ottawa	26,850	8,785	4,275	2,010	207,815	0.13	0.04
Montreal	72,465	44,080	17,925	10,365	514,560	0.14	0.09
Sherbrooke	7,955	3,235	2,065	3,420	19,035	0.42	0.17
Trois-Rivieres	4,740	3,370	435	800	15,225	0.31	0.22
Quebec City	19,135	14,755	4,795	2,335	101,675	0.19	0.15
Chicoutimi	2,785	2,965	200	755	15,190	0.18	0.20

Saint John	8,495	1,980	730	395	11,845	0.72	0.17
Moncton	4,100	1,125	325	270	12,825	0.32	0.09
Halifax	15,810	3,525	2,290	1,655	57,810	0.27	0.06
Charlottetown	2,660	535	85	35	7,355	0.36	0.07
St. John's	11,575	2,150	1,320	610	22,860	0.51	0.09

Table 9: Cumulative Research Papers Published, 1997-2000 in Natural and Health Sciences (Modified by Impact Factor)

	NSE	*Health*
St. John's	864	*389*
Halifax	1,519	1,498
Charlottetown	117	152
Moncton	86	7
Saint John	559	53
Chicoutimi	71	22
Quebec	1,802	2,053
Trois Rivieres	161	77
Sherbrooke	803	662
Montreal	7,832	11,549
Ottawa	2,563	2,098
Kingston	1,636	1,402
Toronto	6,316	11,208
St. Catharines	207	52
Hamilton	2,120	3,086
KWG	4,435	1,380
London	1,606	2,651
Sudbury	144	38
Windsor	545	63
Thunder Bay	160	26
Winnipeg	1,221	1,857
Regina	296	32
Saskatoon	1,409	1,066
Edmonton	3,513	3,404
Calgary	1,519	2,571
Vancouver	5,918	5,041
Victoria	1,332	313

Table 10: Granting Agency Funding ($ Millions) for Fiscal Year 2002/03 by City

	CFI	CIHR	NSERC	SSHRC	Total	HQP	Pop.	HQP/Pop	$/HQP
Victoria	34.7	2.3	10.2	3.5	50.8	48,000	0.31	0.15	1.06
Vancouver*	7.1	59.3	55.1	14.8	136.3	348,215	2.13	0.16	0.39
Calgary*	10.8	30.8	19.7	3.5	64.8	156,960	0.95	0.17	0.41
Edmonton*	8.1	36.8	37.1	10.0	91.9	114,295	0.94	0.12	0.80
Saskatoon*	1.0	6.3	11.5	1.9	20.7	29,225	0.23	0.13	0.71
Regina	0.5	1.0	2.6	0.8	5.0	24,335	0.19	0.13	0.20
Winnipeg*	5.7	17.5	15.0	2.9	41.0	84,650	0.67	0.13	0.48
Thunder Bay	0.1	0.1	1.6	0.5	2.3	12,300	0.12	0.10	0.19
Windsor	0.9	0.2	8.9	2.0	12.0	35,375	0.31	0.11	0.34
Sudbury	0.2	0.3	1.9	0.1	2.6	12,695	0.16	0.08	0.20
London*	2.4	24.8	16.3	6.2	49.7	50,450	0.43	0.12	0.98
KWG	17.1	4.2	45.2	5.1	71.6	66,490	0.54	0.12	1.08
Hamilton*	19.1	25.4	17.4	4.7	66.5	75,010	0.66	0.11	0.89
St. Catharines	0.2	0.0	2.1	0.6	2.9	31,350	0.38	0.08	0.09
Toronto*	14.2	130.4	59.5	23.6	227.7	866,840	5.13	0.17	0.26
Kingston*	1.8	13.9	21.3	4.2	41.1	18,975	0.15	0.13	2.17
Ottawa*	44.8	31.7	22.5	10.4	109.4	207,815	1.06	0.20	0.53
Montreal*	16.4	124.6	83.8	29.7	254.5	514,560	3.43	0.15	0.49
Sherbrooke*	1.3	10.6	9.4	1.4	22.7	19,035	0.15	0.12	1.19
Trois-Rivieres	0.1	0.0	2.3	0.9	3.4	15,225	0.14	0.11	0.23
Quebec City*	32.2	19.1	29.9	9.1	90.2	101,675	0.68	0.15	0.89
Chicoutimi	0.5	0.3	1.9	0.5	3.2	15,190	0.16	0.10	0.21
Saint-John	1.7	0.2	5.8	1.3	9.0	11,845	0.12	0.10	0.76
Moncton	0.2	0.1	0.9	0.4	1.5	12,825	0.12	0.11	0.11
Halifax*	3.0	14.5	16.3	2.5	36.3	57,810	0.36	0.16	0.63
Charlottetown	0.2	0.5	1.2	0.3	2.2	7,355	0.06	0.13	0.30
St. John's*	1.7	4.0	8.4	2.4	16.6	22,860	0.17	0.13	0.72
Total	225.8	559.0	507.6	143.4	1,435.9	2,961,360	19.74	0.15	0.48

Table 11: Proportion of Population between aged 25 and 64 by level of educational attainment

	Canada		Newfoundland		Prince Edward Island		Nova Scotia		New Brunswick	
	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001
Less than high school	31.5%	22.7%	43.4%	35.0%	36.0%	28.9%	35.3%	26.4%	38.8%	29.2%
High school	24.7%	23.9%	17.8%	15.8%	21.2%	20.3%	18.5%	18.2%	23.0%	24.2%
Trades	13.2%	12.9%	18.8%	21.5%	15.5%	15.6%	17.7%	17.4%	13.4%	13.8%
College	13.8%	17.9%	9.3%	13.8%	14.1%	18.3%	13.0%	17.8%	12.3%	16.7%
University	16.8%	22.6%	10.7%	13.9%	13.3%	16.9%	15.5%	20.2%	12.6%	16.2%
All trades, college and university	43.8%	53.4%	38.9%	49.1%	42.9%	50.8%	46.2%	55.4%	38.3%	46.7%
Source: Statistics Canada										

Table 12: Percentage of Adult Population Participating in Adult Education and Training – Select Years

	1991	**1993**	**1997**
CANADA	29	30	28
Newfoundland and Labrador	19	22	19
Prince Edward Island	22	27	22
Nova Scotia	23	28	29
New Brunswick	20	23	23
Source: Statistics Canada			

Table13: Mean Annual Number of Hours Spent on Adult Education and Training Per Capita

	1991	**1993**	**1997**
Canada	43	50	58
Newfoundland and Labrador	39	54	57
Prince Edward Island	37	38	43
Nova Scotia	35	50	53
New Brunswick	32	42	52
Source: Statistics Canada			

Table 14: Index of Mean Annual Number of Hours Spent on Adult Education and Training Per Capita (1991=100)

	1991	1993	1997
Canada	100.0%	116.3%	134.9%
Newfoundland and Labrador	100.0%	138.5%	146.2%
Prince Edward Island	100.0%	102.7%	116.2%
Nova Scotia	100.0%	142.9%	151.4%
New Brunswick	100.0%	131.3%	162.5%
Source: Statistics Canada			

Table 15: University Graduation Rates for Bachelor's and First Professional Degrees

	Canada	N.L.	P.E.I.	N.S.	N.B.	
1991	27	24	33	30	26	22
1992	28	24	33	31	27	22
1993	28	26	34	32	28	22
1994	30	27	36	35	28	22
1995	31	28	36	34	33	22
1996	31	30	34	37	32	22
1997	30	31	34	37	31	22
1998	30	33	30	37	28	22
Source: Statistics Canada						

Table 16: University Graduation Rates for Master's degrees:

	Canada	N.L.	P.E.I.	N.S.	N.B.	
1991	4	3	3	5	3	24
1992	4	2	5	6	4	24
1993	4	3	5	5	4	24
1994	4	3	3	5	4	24
1995	4	4	7	5	4	24
1996	5	4	3	5	4	24
1997	5	4	3	5	5	24
1998	5	5	3	5	3	24
Source: Statistics Canada						

Table 17: University Graduation Rates for Earned doctorates:

	Canada	N.L.	P.E.I.	N.S.	N.B.	
1991	0.4	0.3	0.0	0.4	0.3	27
1992	0.4	0.1	0.2	0.4	0.1	27
1993	0.5	0.2	0.3	0.5	0.3	27
1994	0.5	0.2	0.2	0.4	0.4	27
1995	0.5	0.2	0.2	0.6	0.3	27
1996	0.6	0.2	0.4	0.5	0.5	27
1997	0.6	0.4	0.3	0.6	0.6	27
1998	0.6	0.3	0.2	0.5	0.3	27
Source: Statistics Canada						

Table 18: Number of Graduates Per 100,000 Population

	Canada	N.L.	P.E.I.	N.S.	N.B.
Physical, natural and applied sciences	116	126	104	204	138
Humanities and social sciences	329	311	153	454	279
Commerce, management and administration	82	74	28	123	84
Health professions and occupations	42	38	12	54	34
Total	569	550	297	835	535
Source: Authors' calculation from Statistics Canada data					

Table 19: Composition of Graduates

	Canada	N.L.	P.E.I.	N.S.	N.B.
Physical, natural and applied sciences	20.4%	22.9%	34.9%	24.4%	25.8%
Humanities and social sciences	57.8%	56.6%	51.4%	54.4%	52.2%
Commerce, management and administration	14.5%	13.5%	9.6%	14.7%	15.7%
Health professions and occupations	7.4%	7.0%	4.2%	6.5%	6.3%
Source: Authors' calculation from Statistics Canada data					

Table 20: Number of Patents Issued In Canada

	1997	1998	1999	2000	2001	Total
NF. & LAB.	3	7	6	4	8	108
PEI	0	1	2	2	3	25
Nova-Scotia	7	7	21	7	27	357
New-Brunswick	6	13	26	22	14	230
CANADA	998	1479	2401	1992	2272	39,308
Atlantic Canada	16	28	55	35	52	720
Source: Canada Intellectual Property Office (CIPO), Industry Canada						

Table 21: National Share of Canadian Patents

	1997	1998	1999	2000	2001	1980-2001
NF. & LAB.	0.3%	0.5%	0.2%	0.2%	0.4%	0.3%
PEI	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%
Nova-Scotia	0.7%	0.5%	0.9%	0.4%	1.2%	0.9%
New-Brunswick	0.6%	0.9%	1.1%	1.1%	0.6%	0.6%
Atlantic Canada	1.6%	1.9%	2.3%	1.8%	2.3%	1.8%
Source: Authors' calculation from CIPO data						

Table 22: Canadian Patents per 100,000 Population

	1997	1998	1999	2000	2001
NF. & LAB.	0.5	1.3	1.1	0.7	1.5
PEI	0.0	0.7	1.4	1.4	2.2
Nova-Scotia	0.7	0.7	2.2	0.7	2.9
New-Brunswick	0.8	1.7	3.4	2.9	1.8
Atlantic Canada	0.7	1.2	2.3	1.5	2.2
Canada	3.3	4.9	7.9	6.5	7.3
Source: Authors' calculation from CIPO and Statistics Canada data					

Table 23: Total R&D Expenditure Performed By All Sectors as a Percent of Nominal GDP By Province

	1997	1998	1999	2000
NF. & LAB.	0.98%	1.06%	1.04%	0.99%
PEI	0.57%	0.77%	0.85%	1.06%
Nova-Scotia	1.26%	1.46%	1.50%	1.49%
New-Brunswick	0.76%	0.89%	0.87%	0.76%
Canada	1.66%	1.76%	1.78%	1.84%
Atlantic Canada	1.00%	1.15%	1.16%	1.12%
Source: Authors' calculation from Statistics Canada data				

Table 24: Relative Provincial Share of R&D Performed by Sector by Province

	1997	1998	1999	2000
NF. & LAB.				
Higher Education	*60.19%*	*60.50%*	*62.20%*	*61.03%*
Business	*13.59%*	*14.29%*	*14.17%*	*13.24%*
Federal	*22.33%*	*21.85%*	*19.69%*	*22.06%*
Provincial	*3.88%*	*3.36%*	*3.94%*	*3.68%*
PEI				
Higher Education	*31.25%*	*47.83%*	*40.74%*	*41.67%*
Business	*12.50%*	*8.70%*	*14.81%*	*13.89%*
Federal	*56.25%*	*43.48%*	*44.44%*	*44.44%*
Provincial	*0.00%*	*0.00%*	*0.00%*	*0.00%*
Nova-Scotia				
Higher Education	*48.64%*	*52.56%*	*61.05%*	*55.56%*
Business	*21.01%*	*20.19%*	*18.60%*	*17.78%*
Federal	*27.24%*	*24.68%*	*20.93%*	*24.44%*
Provincial	*3.11%*	*2.56%*	*2.33%*	*2.22%*
New Brunswick				
Higher Education	*45.31%*	*50.96%*	*53.61%*	*57.52%*
Business	*28.91%*	*26.11%*	*24.10%*	*21.57%*
Federal	*21.88%*	*19.75%*	*19.28%*	*17.65%*
Provincial	*3.91%*	*3.18%*	*3.01%*	*3.27%*

Canada				
Higher Education	*26.50%*	*27.17%*	*29.10%*	*29.47%*
Business	*59.73%*	*60.17%*	*58.56%*	*58.31%*
Federal	*11.75%*	*10.84%*	*10.64%*	*10.59%*
Provincial	*2.02%*	*1.82%*	*1.69%*	*1.62%*
Atlantic Canada				
Higher Education	*49.60%*	*53.52%*	*58.58%*	*56.35%*
Business	*21.23%*	*20.13%*	*18.98%*	*17.52%*
Federal	*25.79%*	*23.57%*	*21.23%*	*23.50%*
Provincial	*3.37%*	*2.78%*	*2.71%*	*2.63%*
Source: Authors' calculation from Statistics Canada data				

Table 25: US Patent Ownership Per 100,000 Population, 2001

Jurisdiction	**Patents Per 100,000 Population**
Newfoundland and Labrador	1.3
Prince Edward Island	1.5
Nova Scotia	1.9
New Brunswick	3.1
Canada	11
Source: USPTO (CSIIC Compilation), population from Stats Canada	

Table 26: Number of Inventions Per 100,000 Population, 2001

Jurisdiction	**Inventions Per 100,000 Population**
Newfoundland and Labrador	2.1
Prince Edward Island	2.2
Nova Scotia	2
New Brunswick	9.6
Canada	12.8
Source: USPTO (CSIIC Compilation), population from Stats Canada	

Table 27: Number of Universities by Fiscal Year and Region

Region	Fiscal Year											
	1999			2000			2001			2002		
	#	% of Total Atlantic	% of Total Canada	#	% of Total Atlantic	% of Total Canada	#	% of Total Atlantic	% of Total Canada	#	% of Total Atlantic	% of Total Canada
Newfoundland	1	7	2	1	8	2	1	7	2	1	8	1
Nova Scotia	9	60	14	8	62	12	9	64	14	8	62	12
Prince Edward Island	1	7	2	1	8	2	1	7	2	1	8	1
New Brunswick	4	27	6	3	23	5	3	21	5	3	23	4
Total Atlantic	**15**	**100**	**23**	**13**	**100**	**20**	**14**	**100**	**21**	**13**	**100**	**19**
Rest of Canada	50		77	52		80	52		79	55		81
Total Canada	**65**		**100**	**65**		**100**	**66**		**100**	**68**		**100**

Source: RE$EARCH Infosource Inc.

Table 28: Total Sponsored Research Income by Fiscal Year and Region

Region	Fiscal Year												% Change 1999-2002
	1999			2000			2001			2002			
	Total $000	% of Total Atlantic	% of Total Canada	Total $000	% of Total Atlantic	% of Total Canada	Total $000	% of Total Atlantic	% of Total Canada	Total $000	% of Total Atlantic	% of Total Canada	
Newfoundland	27,872	24	1	33,986	21	1	34,278	22	1	34,924	21	1	25.3
Nova Scotia	55,585	48	2	93,338	58	3	89,281	57	3	95,812	57	3	72.4
Prince Edward Island	2,980	3	**	2,262	1	**	5,167	3	**	5,183	3	**	73.9
New Brunswick	30,172	26	1	31,770	20	1	28,638	18	1	33,081	20	1	9.6
Total Atlantic	**116,609**	**100**	**5**	**161,356**	**100**	**6**	**157,364**	**100**	**5**	**169,000**	**100**	**4**	**44.9**
Rest of Canada	2,116,507		95	2,621,556		94	3,250,723		95	3,651,407		96	72.5
Total Canada	**2,233,116**		**100**	**2,782,912**		**100**	**3,408,087**		**100**	**3,820,407**		**100**	**71.1**

Source: RE$EARCH Infosource Inc.

Table 29: Average Sponsored Research Income by Fiscal Year and Region

Region	Fiscal Year Average $000			
	1999	2000	2001	2002
Newfoundland	27,872	33,986	34,278	34,924
Nova Scotia	6,176	11,667	9,920	11,977
Prince Edward Island	2,980	2,262	5,167	5,183
New Brunswick	7,543	10,590	9,546	11,027
Total Atlantic	**7,774**	**12,412**	**11,240**	**13,000**
Rest of Canada	42,330	50,415	62,514	66,389
Total Canada	**34,356**	**42,814**	**51,638**	**56,182**
Source: RE$EARCH Infosource Inc.				

Table 30: Research Intensity ($ per Full-time Faculty), by Fiscal Year and Region

Region	Fiscal Year												Research Intensity* % Change 1999-2002
	1999			2000			2001			2002			
	Research Income $000	Full-time Faculty	Research Intensity* $000	Research Income $000	Full-time Faculty	Research Intensity* $000	Research Income $000	Full-time Faculty	Research Intensity* $000	Research Income $000	Full-time Faculty	Research Intensity* $000	
Newfoundland	27,872	854	32.6	33,986	857	39.7	34,278	861	39.8	34,924	859	40.7	24.8
Nova Scotia	55,585	1,872	29.7	93,338	1,954	47.8	89,281	1,953	45.7	95,812	1,946	49.2	65.7
Prince Edward Island	2,980	179	16.6	2,262	189	12.0	5,167	192	26.9	5,183	192	27.0	62.7
New Brunswick	30,172	1,145	26.4	31,770	1,109	28.6	28,638	1,150	24.9	33,081	1,157	28.6	8.3
Total Atlantic	**116,609**	**4,050**	**28.8**	**161,356**	**4,109**	**39.3**	**157,364**	**4,156**	**37.9**	**169,000**	**4,154**	**40.7**	**41.3**
Rest of Canada	2,116,507	29,542	71.6	2,621,556	29,823	87.9	3,250,723	30,327	107.2	3,651,407	31,870	114.6	60.1
Total Canada	**2,233,116**	**33,592**	**66.5**	**2,782,912**	**33,932**	**82.0**	**3,408,087**	**34,483**	**98.8**	**3,820,407**	**36,024**	**106.1**	**59.5**
Source: RE$EARCH Infosource Inc.													

*Research dollars per full-time faculty
Note: may not add due to rounding

Table 31: Research Intensity ($ per Full-time Graduate Student), by Fiscal Year and Region

Region	Fiscal Year												Research Intensity* % Change 1999-2002
	1999			2000			2001			2002			
	Research Income $000	Full-time Grad. Student	Research Intensity* $000	Research Income $000	Full-time Grad. Student**	Research Intensity* $000	Research Income $000	Full-time Grad. Student+	Research Intensity* $000	Research Income $000	Full-time Grad. Student++	Research Intensity* $000	
NFLD	27,872	1,373	20.3	33,986	1,373	24.8	34,278	1,352	25.4	34,924	1,321	26.4	30.0
Nova Scotia	52,886	2,529	20.9	89,750	2,529	35.5	83,987	2,492	33.7	90,996	2,496	36.5	74.6
P.E.I.	2,980	29	102.8	2,262	29	78.0	5,167	64	80.7	5,183	83	62.4	-39.3
New Brunswick	30,172	1,048	28.8	31,770	1,048	30.3	28,638	1,088	26.3	33,081	1,057	31.3	8.7
Total Atlantic	**113,910**	**4,979**	**22.9**	**157,768**	**4,979**	**31.7**	**152,070**	**4,996**	**30.4**	**164,184**	**4,957**	**33.1**	**44.5**
Rest of Canada	2,109,744	73,932	28.5	2,612,822	74,305	35.2	3,239,521	75,332	43.0	3,646,601	78,383	46.5	63.2
Total Canada	**2,223,654**	**78,911**	**28.2**	**2,770,590**	**79,284**	**35.0**	**3,391,591**	**80,328**	**42.2**	**3,810,785**	**83,340**	**45.7**	**62.1**

Source: RESEARCH Infosource Inc.

*Research dollars per full-time graduate student. Universities with no graduate students have been removed

**FY1999 full-time graduate student enrollment used

+FY2000 full-time graduate student enrollment used

++FY2001 full-time graduate student enrollment used

Table 32: Research Intensity ($ per Capita), by Fiscal Year and Region

Region	Fiscal Year												Res. Intensity* % Change 1999-2002
	1999			2000			2001			2002			
	Research Income $000	Pop.+	Research Intensity* $000	Research Income $000	Pop.+	Research Intensity* $000	Research Income $000	Pop.+	Research Intensity* $000	Research Income $000	Pop.+	Research Intensity* $000	
NFLD	27,872	541,000	0.052	33,986	538,823	0.063	34,278	533,761	0.064	34,924	519,300	0.067	30.5
Nova Scotia	55,585	939,791	0.059	93,338	940,996	0.099	89,281	942,691	0.095	95,812	934,400	0.103	73.4
P.E.I.	2,980	137,980	0.022	2,262	138,928	0.016	5,167	128,514	0.040	5,183	137,000	0.038	75.2
New Brunswick	30,172	754,969	0.040	31,770	756,598	0.042	28,638	757,077	0.038	33,081	750,200	0.044	10.3
Total Atlantic	**116,609**	**2,373,740**	**0.049**	**161,356**	**2,375,345**	**0.068**	**157,364**	**2,362,043**	**0.067**	**169,000**	**2,340,900**	**0.072**	**47.0**
Rest of Canada	2,116,507	28,018,276	0.076	2,621,556	28,274,304	0.093	3,250,723	28,610,940	0.114	3,651,407	28,920,500	0.126	67.1
Total Canada	**2,233,116**	**30,392,016**	**0.073**	**2,782,912**	**30,649,649**	**0.091**	**3,408,087**	**30,972,983**	**0.110**	**3,820,407**	**31,261,400**	**0.122**	**66.3**

Source: RE$EARCH Infosource Inc.

*Research dollars per capita
+Population data from Statistics Canada
Note: may not add due to rounding

Table 33: Comparison of Research Intensity Measures, by Fiscal Year and Region

Region	Fiscal Year $000											
	1999			2000			2001			2002		
	$ per Full-time Faculty	$ per Full-time Graduate Student	$ per Capita	$ per Full-time Faculty	$ per Full-time Graduate Student	$ per Capita	$ per Full-time Faculty	$ per Full-time Graduate Student	$ per Capita	$ per Full-time Faculty	$ per Full-time Graduate Student	$ per Capita
Newfoundland	32.6	20.3	0.052	39.7	24.8	0.063	39.8	25.4	0.064	40.7	26.4	0.067
Nova Scotia	29.7	20.9	0.059	47.8	35.5	0.099	45.7	33.7	0.095	49.2	36.5	0.103
Prince Edward Island	16.6	102.8	0.022	12.0	78.0	0.016	26.9	80.7	0.040	27.0	62.4	0.038
New Brunswick	26.4	28.8	0.040	28.6	30.3	0.042	24.9	26.3	0.038	28.6	31.3	0.044
Total Atlantic	**28.8**	**22.9**	**0.049**	**39.3**	**31.7**	**0.068**	**37.9**	**30.4**	**0.067**	**40.7**	**33.1**	**0.072**
Rest of Canada	71.6	28.5	0.076	87.9	35.2	0.093	107.2	43.0	0.114	114.6	46.5	0.126
Total Canada	**66.5**	**28.2**	**0.073**	**82.0**	**35.0**	**0.091**	**98.8**	**42.2**	**0.110**	**106.1**	**45.7**	**0.122**

Source: RE$EARCH Infosource Inc.

Table 34: Concentration of Industrial R&D in Establishments in Canada and Atlantic Canada, 1997-2001

Region	% change in number of industrial R&D establishments between 1997 and 2001	BERD/establishment, 2001	% change in BERD/establishment, 1997-2001
Canada	-7.9%	$1.481M	+63.6%
Atlantic Canada	-28.2%	$.365M	+75.2%
Newfoundland/Labrador	-50.0%	$.345M	+185.7%
Prince Edward Island	-26.1%	$.235M	+80.4%
Nova Scotia	-20.0%	$.464M	+80.6%
New Brunswick	-23.6%	$.261M	+20.2%
Source: Statistics Canada			