BRITISH COLUMBIA

BC STATS

Ministry of Finance and Corporate Relations

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Business Indicators ◆ June 2000

High Technology Input Indicators, the 1990s

HIGHLIGHTS:

- **Relative to other provinces, BC displays a better than average contribution to the high technology system from the educational sector**
- **BC returns average or below average ratings for all of the business stimulus indicators**
- **Within the government sector, BC's tax regime is lower relative to most other provinces, however, the province is weaker when it comes to other factors, such as research and development contributions**

INTRODUCTION

Since 1994, BC STATS, in conjunction with the Information, Science & Technology Agency (ISTA), has annually produced the *Profile of the British Columbia High Technology Sector*.[1] The Profile gives measures of GDP, employment, wages and salaries, revenues, establishments, and exports and imports—what might be called the outputs of the high technology sector. By maintaining a consistent methodology from year to year, the *Profile* gives an excellent indication of the growth of the BC high technology industries.

While there is obvious value in monitoring the "output" of the high technology sector, a full understanding requires information about the processes that give rise to that output. In fact, the high technology sector and the infrastructure network that surrounds it is a complex system with many players and interactions. Understanding this system, as with any system, is a matter of identifying the various parts, and collecting information that shows how these behave and interact over time. A companion to the Profile has been developed, to address the need for this type of information. The *British Columbia High Technology Input Indicators Report* is now available at BC STATS' web site.[2] It presents forty-two indicators related to the development of the high technology sector during the 1990s.

THE MODEL

To identify the parts of the high technology system that should be tracked, BC STATS has modified a traditional model of economic production that focuses on land, labour and capital. These are the "factors of production" or inputs into the production process. These factors are transformed by firms, other organizations, or individuals into valued goods and services. GDP is the main measure of that value and is the most common statistic used to describe the production of economic sectors. This traditional model can be thought of as an input/output view of the economy. The inputs are obtained from a variety of sources and enter a production process, resulting in outputs.

[1] http://www.bcstats.gov.bc.ca/DATA/BUS_STAT/hi_tech/HighTechProfile.pdf

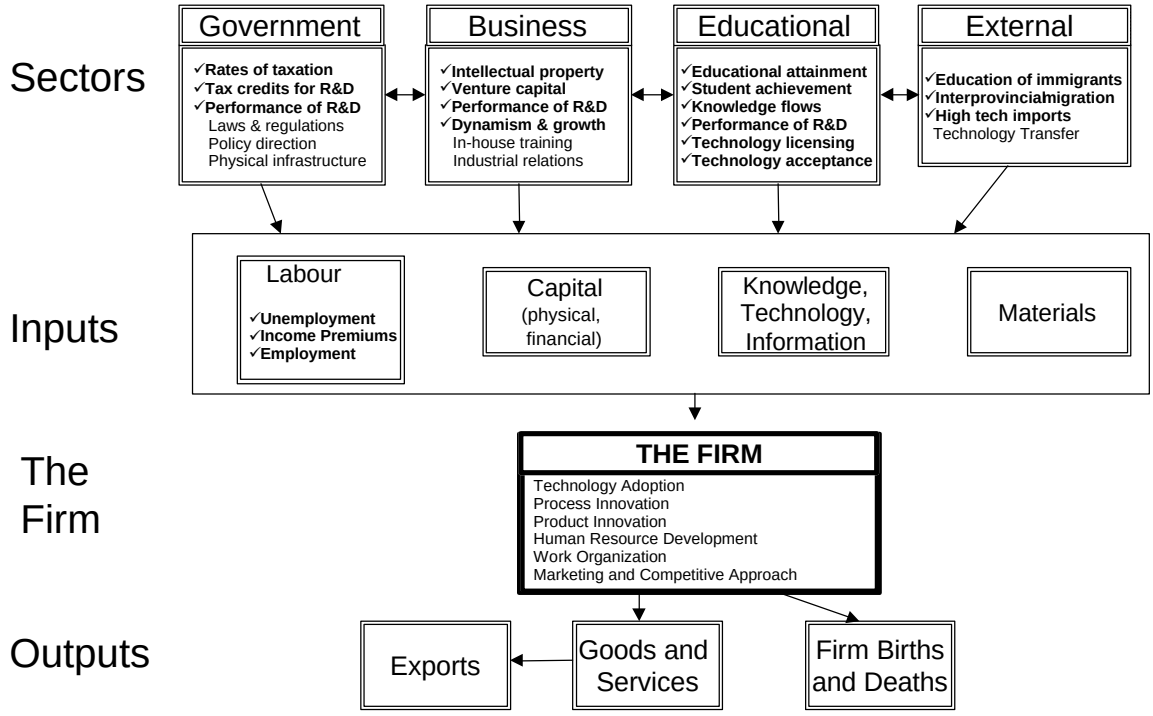
[2] http://www.bcstats.gov.bc.ca/DATA/BUS_STAT/hi_tech.htm

The advent of the "information economy" has added a new dimension to traditional economic production, and some efforts to describe it seem quite new as well. However, the input/output view can readily be adapted to the information economy. In FIGURE 1, the firm is at the centre of the productive system. As in the traditional model, the firm receives inputs, however knowledge, technology, and information are distinguished as a unique category. This can include patents and copyrights, software, information on production methods, etc. In addition, it is recognized that the other factors, labour, capital, and materials each have critical and increasing quantities of knowledge embodied in them.

The diagram then looks beyond the production inputs, to analyze their sources (the top row of boxes). For example, skilled labour may come from training courses in educational institutions, from in-house training, or from other provinces or countries. The sources for the inputs have been categorized as four "sectors." Within each sector, particular areas that bear on the production inputs are identified. These areas are the ones for which indicator variables have been sought out. The areas listed in bold, and ticked, are the ones for which data is available and has been collected by BC STATS. While the indicator variables have normally been sought out at the level of the source sectors, certain labour indicators, such as the unemployment rate, are not attributable to a single source sector. Such indicators have been grouped in a separate "labour" section.

Once the inputs are obtained by the firm, they are transformed in a way that depends on the firm's many characteristics. Some of the characteristics of most importance for high technology firms are listed within the FIRM box in the diagram.

FIGURE 1: Model of the High Technology Sector



Finally, the firm produces and sells goods and services, some of which are consumed locally, while the remainder are exported. This is depicted in the bottom row. It should be recognized that even with a simplified model such as the one set out here, it is possible to imagine a large number of interactions. That is, almost every box or element within the boxes could be joined by an arrow to every other box or element. In turn, a complete statistical system based on the model would track the flows of people, dollars, or information along each of the pathways (arrows). Such a comprehensive approach is neither practical, nor would it in the end necessarily lead to greater understanding and better policy. However, statistics are available on a significant number of the interactions, providing a strong database for future research.

INTERPROVINCIAL COMPARISONS

This issue of *BC Business Indicators* is a summary of *BC High Technology Sector Input Indicators Report*, currently available from BC STATS. Wherever possible the indicators selected for this publication have been presented for the provinces of Alberta, Ontario, and Quebec, in addition to BC. Comparisons to other provinces show the range of what is possible, or what has been achieved, within the Canadian context. The three provinces chosen for comparison with BC have the largest general economies, and they are the ones with the most extensive high technology sectors. Based on 1999 employment, these shares range from 4.2% to 4.7% of overall activity. The BC share for the same year was just over 3.5%, while the average for the rest of Canada was 1.9%.

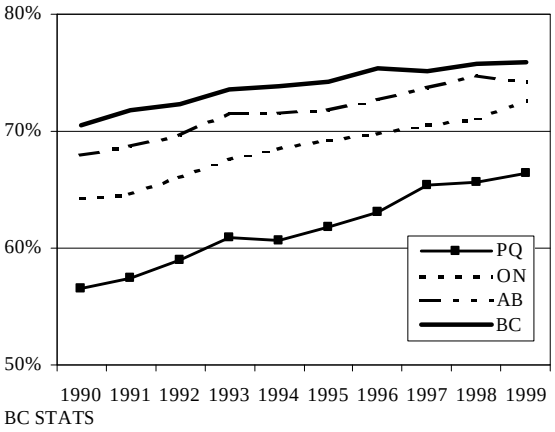
Another advantage of the comparisons to other provinces is that the basis for tabulating the statistics is consistent. Comparisons between jurisdictions where definitions, methods of collection, laws, and economic infrastructure vary are often of little or no use. That is why international comparisons, such as comparisons to US states, have not been included in this edition. Very careful study is needed before such comparisons can be used with confidence. Nevertheless, some international comparisons are a goal for future editions.

THE EDUCATIONAL SECTOR

The educational sector is identified in the model as a provider of "inputs" to high technology firms. This happens through providing individuals with skills and knowledge that are required for product development and production, and with the commercialization of research that is performed in the educational sector.

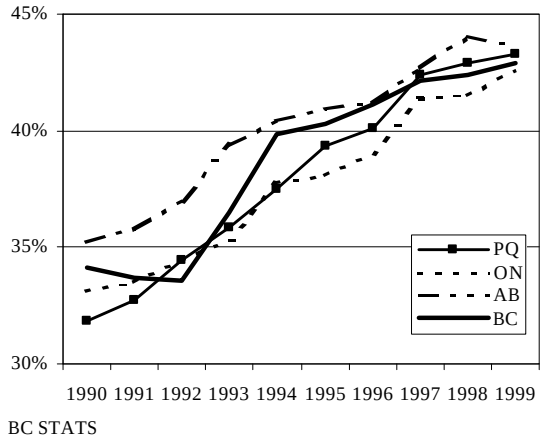
BC leads the high technology provinces with the highest percentage of its population older than 15 with a high school diploma (see FIGURE 2). However, the gap between BC and the other high technology provinces has narrowed over the 1990s. In 1990, BC's percentage of the population 15 years old and older with a high school diploma was seven percentage points higher than Ontario, and three percentage points higher than Alberta; in 1999, it was three percentage points higher than Ontario and two percentage points higher than Alberta.

FIGURE 2: Percentage of the Population 15+ with High School Diploma



Throughout the 1990s, BC trailed Alberta in the percentage of the population 15 years old and older with some form of postsecondary credentials (see FIGURE 3). Although the gap widened in 1992 and actually disappeared in 1996, it was the same size in 1999 as in 1990. However, the province of Quebec, which began the 1990s lower than BC, passed BC in 1997.

FIGURE 3: Percentage of the Population 15+ with Postsecondary Credentials



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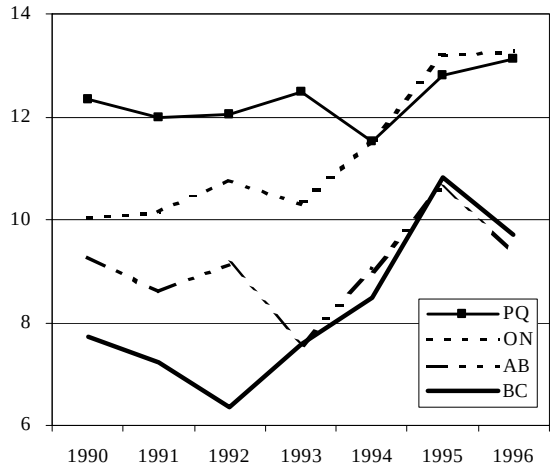
In terms of the number of Computer Science Bachelor degrees granted, BC showed dramatic improvement from 1992 through 1995 (see FIGURE 4). However, in 1996, the most recent year for which data is available, the number of graduates in computer science per 100,000 persons age 15 and older declined. Although Alberta started out considerably ahead of BC in this category, in 1996 BC had passed Alberta although both provinces showed a decline that year. BC still lags both Ontario and Quebec in this category.

FIGURE 4: BSc in Computer Science per 100,000 persons age 15 and older



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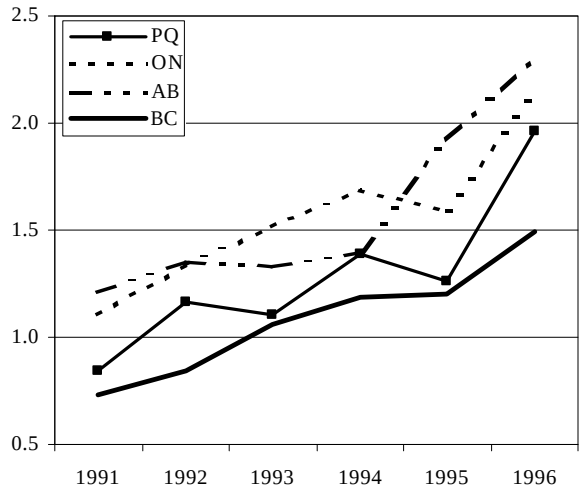
THE BUSINESS SECTOR

This set of indicators is concerned with the stimulus to business formation and growth that comes from internal research and development, patenting, and venture capital. It also measures results that are in part due to these stimuli, in the form of establishment entries and exits (see BCBI, February 2000), "gazelle" or high-growth companies, and the overall growth in the number of establishments.

Patent applications are a critical determinant of patents granted, although there is not necessarily a constant relationship in the number of patents granted per patent application. Patent applications per 10,000 population rose steadily through the early part of the 1990s (see FIGURE 5). BC lagged the high technology provinces through the period 1991 to 1996 while Alberta, which had experienced very little growth in applications in 1992 and 1993, leapt ahead of the leading high technology provinces in 1995.

FIGURE 5: Patents applications per 10,000 population



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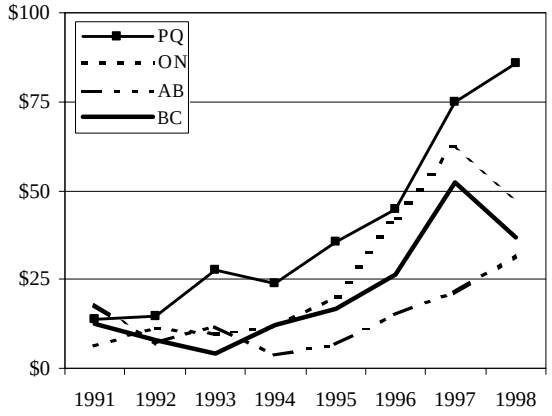
As the 1990s progressed, Quebec and Ontario became the most successful Canadian provinces in attracting venture capital investment. When normalized for population, all the leading high technology provinces were clustered around $13 of venture capital investment per capita in 1991 (see FIGURE 6). Alberta was actually the most

successful by this measure in 1991, obtaining over $18 per capita. By 1998, Alberta trailed the leading high technology provinces, with $32 per capita.

FIGURE 6: Canadian Venture Capital Investment Per Capita



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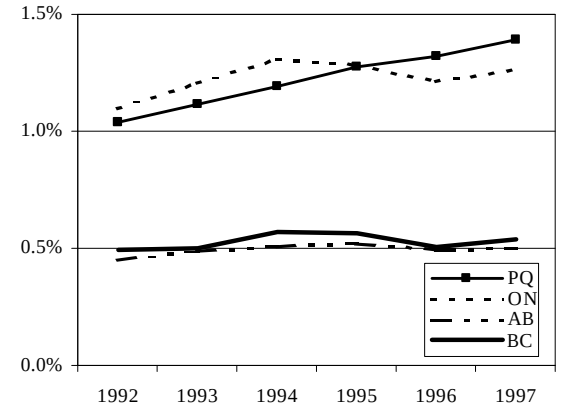
From 1992 to 1997, the Canadian ratio of business performance of R&D to GDP was entirely driven by Quebec and Ontario, due to the sheer magnitude of the R&D investments by businesses in those provinces. All other provinces, including BC and Alberta, were below the Canadian average. In 1997, the ratio of R&D performance by business to provincial GDP was over twice as large in Quebec and Ontario as in the next closest province, BC (see FIGURE 7).

FIGURE 7: Ratio of Business Performance of R&D to GDP



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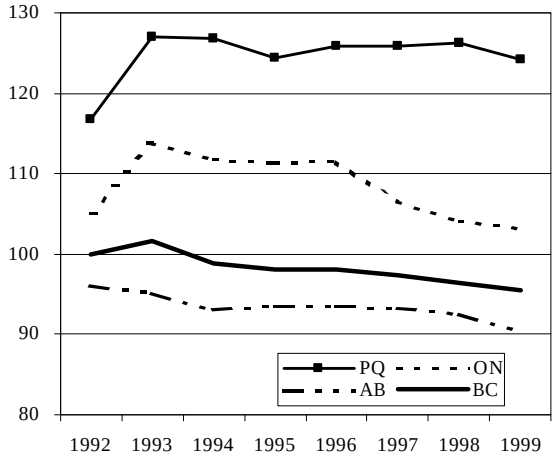
THE GOVERNMENT SECTOR

The government sector affects high technology firms by providing a regulatory, tax, and infrastructure environment, by funding research and development (R&D), and by directly performing certain R&D.

The overall level of taxation in BC for high-income single people has declined since its peak in 1993 (see FIGURE 8). This measure includes all taxes paid, including property and sales taxes. BC's position relative to Alberta and Ontario has changed little since 1992.

FIGURE 8: Index of Taxes Paid by Unattached Individuals Earning $80,000 Per Year



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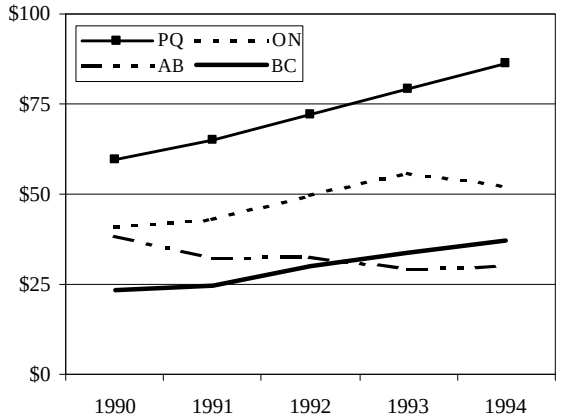
In 1990, BC received the least value of tax credits per capita from the federal Scientific Research & Experimental Development (SR&ED) Tax Credit program among the high technology provinces (see FIGURE 9).

FIGURE 9: SR&ED Tax Credits Received Per Capita (All Firms)



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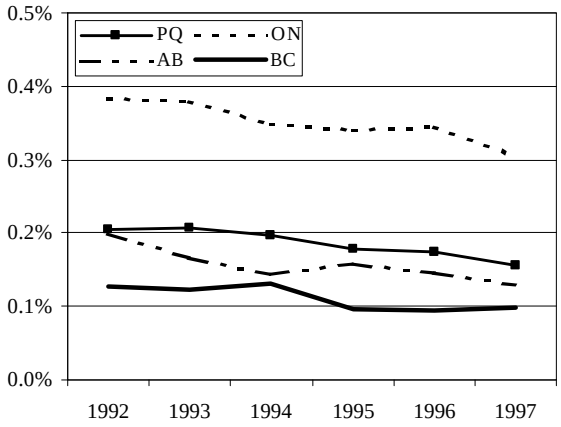
Despite a growing population, BC's per capita value of SR&ED credits received has

grown in the period 1990 to 1994. The credits received by firms in Ontario and Quebec have grown as well, while Alberta's credits received per capita shows a decline for the period.

Across Canada, the ratio of combined federal and provincial performance of R&D to GDP has been steadily declining over the period observed (see FIGURE 10). BC ranks tenth out of ten provinces in terms of this ratio—BC's ratio was less than half the Canadian average in 1997. This is largely because the BC ratio of federal government performance of R&D to GDP is the lowest in Canada.

FIGURE 10: Ratio of Combined Federal and Provincial Performance of R&D to GDP



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FURTHER RESEARCH IS REQUIRED

The model of the indicators and how they are believed to relate to changes in output of the high tech sector is a work in progress. The existence of the links, the strength of the relationships, even the lag between when a change observed in the input indicator will generate a change in an output indicator need to be investigated further. However, this article has presented a summary of the results of an extensive data collection effort which will support future attempts to model the high technology sector's interactions with other institutions.