



BUSINESS INDICATORS

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Defining the High Technology/Knowledge Sector in British Columbia

Introduction

As planners look increasingly to the high technology industry as a source of future growth, the need for a consistent monitoring mechanism is apparent. The lack of a widely accepted industry definition makes it difficult to assess the high technology industry's performance. The resulting uncertainties, in turn, hamper policy makers' efforts to develop effective policies and programs to assist the industry's growth and development.

This note is a summary of a more detailed paper, available on request from *BC STATS*. Here, we describe the first step in a project to define British Columbia's high-technology industry and to measure its employment and economic characteristics on an on-going basis. The task of defining the high technology industry is approached by reviewing and comparing the components (in terms of the Standard Industrial Classification (SIC)) identified by nine different high technology studies. Together, these studies consider many criteria commonly associated with high technology activity, such as research and development, employment of scientists, and production and use of advanced technology commodities. They agree almost unanimously on the inclusion of some industries and the exclusion of others. However, there are some gray areas where only a few of the studies identify an industry as possessing high technology characteristics. We plan to consult with technology experts who are familiar with the industry in BC before making a final determination in these instances.

A Modest Approach

The use of SICs to define the high technology industry is modest because data are readily available for standard industries and, thus, relatively inexpensive. However, there are several drawbacks to using SICs. To begin, the Standard Industrial Classification does not recognize industries of the 'new economy', including the high

technology and knowledge-based sectors, nor is it likely to do so in the near future. This is because Statistics Canada ensures consistency of historical data series and international comparability by holding its classification constant over many years and subjecting changes to agreement from NAFTA and the EU partners. Without an SIC code that applies specifically to high technology companies, their information is combined along with data from other companies producing similar products or using similar inputs.

SIC-based definitions are unable to capture the breadth of high technology or knowledge intensive activity in the economy. Industry Canada (1994) argues that "the innovation economy covers all industries, not just those known as high-tech industries." The survival of BC's resource industries, in the face of declining real prices and competition from developing countries, is a testament to the creativity of some resource companies, who have applied technology and knowledge to the production and marketing of their products. A study of the high technology industry based on SICs, however, will inevitably exclude some of these companies because they are included in classifications that, in aggregate, do not show high-tech characteristics. At the same time, the definition will include companies in high-tech SICs whose operations lag behind the industry norm. We propose to compensate for these inaccuracies by applying high-tech percentages to SIC totals wherever possible, and by updating these percentages as improved or new information becomes available.

Nine SIC-Based Definitions

The nine SIC-based definitions may be divided into four groups based on their methodologies: commodity list, research activity, expert allocation and company list. These methodologies are similar in that they use the existing statistical framework to create a high-tech industry as a composite of standard industries displaying

high-tech characteristics. They are all macro-level approaches that make inferences about the activities of companies by studying the industries to which they are classified.

However, they differ with respect to the indicators used to identify industries for inclusion in the high technology group. Some look at the use or production of high technology commodities, while others measure research and development performance or the employment of highly educated workers. We also review definitions that rely on expert opinion or the opinions of companies themselves to define the industry. After rating industries on one of these measures, most definitions select the top performers as the high technology industry. However, recognizing the potential for high technology companies to be found throughout the economy, other methods split SICs according to their performance on a given high technology measure and define the industry as a composite of parts of many SICs.

Commodity List Definitions

The commodity list approach examines industry inputs and outputs to separate the high-tech from the low-tech. This method starts by identifying a set of commodities which embody the results of extensive research and development and stand clearly on the forefront of progress in their field. Industries which use or produce these commodities relatively intensively are then identified through input/output (I/O) analysis or other methods that link commodities and industries. While commodity list definitions do not consider directly an industry's investment in research and development or its employment of highly educated workers, they do so indirectly through the selection of commodities for inclusion on the list.

Research Activity Definitions

The constraints of data availability have led many researchers to designate industries as high-tech based solely on their research activity: expenditure on R&D and/or employment of highly skilled labour. This approach identifies industries that are making the investment necessary to maintain or acquire a position on the leading edge of development.

There are several drawbacks to the use of research and development as an indicator of high-technology. First, while R&D measures identify industries working toward the development of new technological knowledge, they say nothing about the current stock of technological knowledge in an industry. Thus, industries benefiting from past R&D efforts are not recognized as high-tech. Second, R&D is often performed outside of the company itself, by contractors or the public sector, making it difficult to

assign to any particular industry. A special case of this issue is illustrated by foreign-owned companies, which tend to conduct R&D at their head office locations—frequently in their home country. In this case, the subsidiary in Canada may produce advanced products with state-of-the-art production equipment, but the industry would be excluded from the high-tech group on the basis of low domestic R&D. Given the extent of foreign ownership in Canada, a reliance on R&D indicators alone could misrepresent the industry.

Knowledge input indicators, such as education levels and occupational structure provide useful information about the human side of the input equation. There may be a lag before extensive research and innovation are reflected in the production of advanced products or services and, thus, the material flows of the I/O tables used by commodity list definitions. However, researchers, engineers, computer scientists, etc., are likely to be hired early in the product development process, making them good leading indicators of high technology activity. These measures may, however, exclude those manufacturing industries whose use of advanced manufacturing technologies may allow them to employ a relatively low-skill workforce.

R&D and human input measures are better than commodity list definitions at identifying high-technology activity in the service sector or knowledge industries. Services requiring substantial knowledge input are often missing from high-technology commodity lists, making it impossible to identify them as part of the high technology industry. Given that service industries account for more direct employment and GDP in British Columbia than manufacturing industries, the results of a methodology that recognizes their contribution should be considered seriously.

Expert Allocation Methods

In some cases, researchers have relied on their knowledge of the high-tech industry in forming a definition for analysis. BC's Ministry of Economic Development, Small Business and Trade (E&I, 1991) used this approach to select 23 four-digit manufacturing SICs to represent the high-tech industry in BC. As much as possible, these researchers selected standard industries, for which Statistics Canada data are available, to make-up the high-tech group. However, they also included industries that are not reflected in the current standard industrial classification system, such as biotechnology, medical devices, subsea and the environmental industry. Data for these industries was attained from various sources.

Company List Approaches

A final SIC-based approach works by linking a list of high-tech companies to Statistics Canada's Business Register (BR)¹ to determine the SIC to which they have been classified. Once the company list is SIC coded, each industry's representation is compared to the total industry size, in terms of the number of establishments represented on the BR. For example, if 40 of a possible 100 BC shoe companies were on a high-tech company list, the shoe company industry would score 40. Those industries with the greatest percentage of their total establishments represented on the list are considered to be high-tech.

The advantage of this approach is that it starts at a micro level, identifying the actual establishments involved in high-tech activity. It therefore has the potential to provide results that reflect the distinct mix of high-tech activities in a particular region. However, to yield useful results, this approach requires an accurate, up-to-date company list that is based on an acceptable definition of the industry. In theory, the list should include every establishment with a specific set of high-tech characteristics in the study region. Since the match rate of the list to the BR is never 100%, some companies will not be included in the SIC profile. We assume, however, that the match process is random and that the BR is free of systematic bias (i.e., all SICs are equally well represented).

Table 1: The High-Tech Industries and the Gray Area: number of definitions citing each of 40 industries

SIC	Industry	Definition Method				Total Score
		Commodity List	Research Activity	Expert Allocation	Company List	
		out of 4:	out of 2:	out of 1:	out of 2:	out of 9:
3211	Aircraft & aircraft parts	4	2	1	1	8
3359	Other communication & electronic equipment	4	2	1	1	8
3911	Indicating, recording & controlling instruments	3	2	1	2	8
3351	Telecommunication equipment industry	4	1	1	1	7
3352	Electronic parts and components	4	1	1	1	7
3361	Electronic computing & peripheral equipment	4	1	1	1	7
3741	Pharmaceutical & medicine	4	2	1	0	7
3362	Electronic office store and business machines	3	2	1	0	6
3372	Electrical switchgear and protective equipment	3	1	1	1	6
3379	Other electrical industrial equipment industries	3	1	1	1	6
3369	Other office store and business machines	2	1	1	1	5
3381	Communications & energy wire & cable industry	3	1	1	0	5
3711	Industrial inorganic chemical industries N.E.C.	3	1	0	1	5
3731	Plastic and synthetic resin industry	2	1	1	1	5
3799	Other chemical products N.E.C.	3	2	0	0	5
3912	Other instruments and related products	2	1	1	1	5
3192	Construction & mining machinery & materials handling	2	1	0	1	4
3194	Turbine & mechanical power transmission equipment	2	1	0	1	4
3242	Commercial trailer industry	2	1	0	1	4
3256	Motor vehicle plastic parts industry	2	1	1	0	4
3259	Other motor vehicle accessories, parts and assemblies	2	1	0	1	4
3271	Shipbuilding and repair industry	2	1	0	1	4
3311	Small electrical appliance industry	3	1	0	0	4
3321	Major appliance industry	3	1	0	0	4
3331	Lighting fixture industry	2	1	0	1	4
3341	Record player, radio & television receiver industry	3	1	0	0	4
3399	Other electrical products industries N.E.C.	2	1	0	1	4
3712	Industrial organic chemical industries N.E.C.	3	1	0	0	4
3761	Soap and cleaning compounds industry	2	1	0	1	4
775	Engineering & scientific services	1	1	1	0	3
7721	Computer & related services	1	1	1	0	3
3111	Agricultural implement industry	1	1	0	1	3
3121	Commercial refrigeration and air conditioning equipment	1	1	0	1	3
3199	Other machinery and equipment industries N.E.C.	2	1	0	0	3
3994	Musical instrument and sound recording	3	0	0	0	3
86	Health and social services	1	1	0	0	2
777	Management consulting services	1	1	0	0	2
779	Other business services	1	1	0	0	2
3999	Other manufactured products industries N.E.C.	2	0	0	0	2
7722	Computer equipment, maintenance and repair	1	0	1	0	2

¹ The Business Register is a database maintained by Statistics Canada that contains descriptive information about all Canadian businesses. It serves as the central frame from which Statistics Canada conducts its census and sample surveys. The data are gathered mainly from Revenue Canada Taxation's Payroll Deduction Account file and, thus, represent the universe of business entities with paid employees in Canada.

Summary

There is consensus amongst the studies consulted for this paper in their selection of 31 four-digit SICs as high-tech. The unshaded portion of Table 1 lists all manufacturing SICs chosen by at least four of a possible nine definitions and all service SICs chosen by at least three of a possible six definitions. These industries exhibit strong high-tech characteristics and their inclusion in the high technology definition is relatively certain.

The definitions also point with less certainty to a smaller group of industries: the gray area. These industries were selected by only two or three of a possible nine definitions. More information about the nature of the activities carried out by these industries is required to make a decision regarding their inclusion in the high technology group.

References

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