

Benchmarks, Yardsticks & New Places to Look for Industrial Innovation & Growth

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Abstract

This paper presents new figures and proposes new metrics for industrial innovation in Canada. Two sources of new information are cited: Canadian taxation statistics; and a demographics research database that is currently under development. Although the figures are local to Canada, the approach is likely to apply internationally.

Highlights

We are involved in the development of a new foundation for science and technology policy development and for the study of endogenous technological change. Our work builds on two sources of new information. The first of these is Canada's taxation statistics associated with the administration and delivery of financial incentives for industrial research and development (R&D). The second is an expanded registry of science and technology (S&T) based business enterprises in British Columbia. Here are some highlights of what we are finding:

Taxation statistics

In delivering tax incentives for R&D, scientists in Canada's tax department annually view thousands of industries and their innovations, and observe a substantial amount of previously undocumented technological innovation in our midst. The innovations are current and dramatic in the lives of the business enterprises, qualify as R&D according to internationally accepted definitions, but do not show up immediately in national statistics. However, by looking directly into taxation statistics, here are some examples of what can be found:

- In 1992, Canada had 205 innovative firms per million inhabitants (firms of all sizes making significant investments in R&D).
- The comparable figure for Japan is 114 per million. We were unable to find comparable figures for the United States or Mexico.
- British Columbia was the most innovative province with 258 per million persons; Quebec was close behind with 254, while the rural and Maritime regions were between 80 and 140 per million.
- With 25.8% of Canada's population, Quebec accounted for 31.2% percent of the number of companies claiming R&D tax incentives and 48.5 percent of the dollar amount.
- In dollar terms, Quebec companies claimed approximately \$460 million of the \$949 million national total.
- On the same basis, with 12% of the population, 851 British Columbia companies claimed 8.6% of the tax incentive pie.
- Comparable figures for Ontario are just about on a par with its percentage of Canada's population but have dropped significantly between 1990 and 1992.

Industrial Demographics

As discussed in the body of this paper, a new research database is being developed to capture an expanded picture of industrial demographics in British Columbia. This work gives rise to the following observations:

- No accurate figure exists for the number of S&T based business enterprises in BC. A frequently cited business publication suggested the existence of approximately 2,700 in 1993.
- In contrast to this figure we have seen evidence for the existence of -10,000 S&T based business enterprises in 1994.
- Of these, 5,000 or more could be innovative business enterprises in BC with significant investments in R&D.

Comments

If these figures hold up and are found to be representative across Canada and in other countries there could be some interesting consequences. For instance it may turn out that a significant restructuring of S&T based industry has been happening in the shadows of the larger companies that are more usually taken to be representative of the R&D community. The agents for this may prove to be small and medium sized enterprises, some which have been helped by government policies and assistance programs, and some which have been oblivious to them.

Introduction

A frequent theme in Canadian S&T policies is to encourage industrial development and technological innovation to achieve increased international competitiveness. This theme, that of endogenous technological change, is at the forefront of modern economic growth theory (at the micro as well as the macro economic levels)^{1,2}.

The traditional way of evaluating the incidence of investments in innovation by Canadian industry is to conduct a secondary analysis of R&D data published by Statistics Canada or the Organization for Economic Cooperation and Development (OECD)³. The typical conclusion is that Canada ranks poorly on the list of G7 countries in terms of the amount of R&D conducted by the nation and by its domestic industries. Since the aggregate figures have changed little over the past twenty years, the conclusions have also changed very little. Some authors continue to lament the low investment in R&D in Canada in much the same terms as they did in 1971, and continue to base their argument on the remarkably consistent figures compiled by Statistics Canada over the years. Others use the same figures to conclude that Canadian science and technology policies over the years have been relatively ineffective, inadequately supported, or oriented incorrectly⁴.

But there have been significant policy changes since 1985. Canada has been moving away from S&T policies that are implemented via project-specific grants and other inducements by operational departments such as Industry Canada, Department of the Environment, etc. Now the major support program for industrial innovation is implemented via tax credits and rebates. It is administered by Revenue Canada under the Scientific Research and Experimental Development (SR&ED) incentive program. This program contributed approximately \$1 billion to Canadian business enterprises in 1992, and appears to be having a major influence on Canadian industrial R&D. At present five provinces add additional tax incentives of their own to build on the federal program and provide an additional competitive advantage to locate, remain or expand in their area. These provinces are Quebec, Ontario, Nova Scotia, New Brunswick and Manitoba. The details of the influence of these programs are not yet clear. The interesting point, however, is that it is not known how many qualifying companies exist and are aware of these incentives for R&D. Thus the cornerstone of policy support for industrial R&D in Canada is large in scope yet it supports an industrial community of uncertain size.

The SR&ED program and its provincial counterparts are the least studied sources of input to the R&D system in Canada. Fiscal measures to stimulate R&D have not yet found their way into mainstream Statistics Canada and OECD publications, probably for historical and definitional reasons. Statistics about the usage and impact

of the SR&ED program can provide an improved basis for the evaluation of fiscal and other policies for industrial innovation. In addition, this area of investigation is a potentially rich source of information with which to understand the relationship between expenditures on product, process or service development and any resulting socio-economic development.

For instance the stated purpose of the SR&ED program is to encourage Canadian companies to undertake research and development activities. It is, therefore, natural to ask

- What is the number of candidate companies for these incentives?
- How many of them know about the program?
- How many are using the program? And
- What impact is it having?
- Further, one would want to know how the answers vary over time.

We have been investigating the hypothesis that the picture of S&T activities in Canada has changed radically over the years and that the existing statistics do not adequately reflect these changes. Revenue Canada's experience with the SR&ED program seemed to show that the R&D community is significantly divergent from Statistics Canada and OECD figures. This is a puzzling discrepancy, since both agencies use comparable definitions for R&D, both employ careful verification techniques and both figure prominently in Canada's system of innovation.

Other informal data sources were investigated, such as industry associations, business compilations, and individual government-industry liaison officers. They all pointed to a populous, but less visible R&D community existing alongside the better-known community. Some of the less visible community was known to Revenue Canada, but the Income Tax Act shielded their existence from the community at large. Further anecdotal evidence is frequently voiced by Revenue Canada scientists stemming from their experience with public information seminars geared to industry at large. Their view is that the Department delivers incentives to only a fraction of companies that conduct eligible R&D. There appear to be many others who are potentially eligible under the SR&ED program and not claiming the financial benefits that might be available to them.

Taxation statistics

Although limited to companies claiming tax incentives, taxation statistics appear to be a promising new starting point from which to learn about R&D performance and impacts in Canadian industry. With the understanding that we were exploring the size and characteristics of science, technology and innovation in BC industry, Revenue Canada readily agreed to provide access to information about the use of the SR&ED Program. In offering co-operation (within the constraints of the Income Tax Act,) the representative of the Department remarked: "We are also interested in finding the size of our potential clientele, so we would like to support your activities [at CPROST]... It would benefit both the Department and the country if we had a method of identifying potential claimants"⁵.

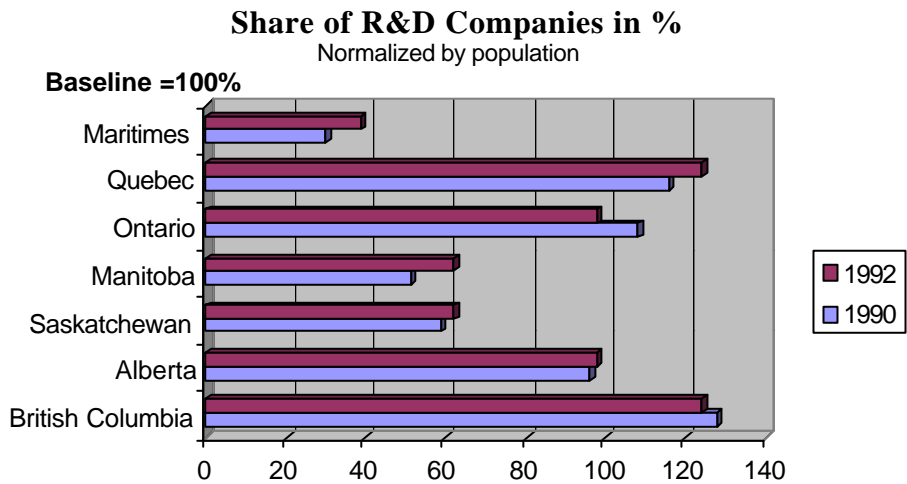
The Department recently provided some very interesting figures about the use

of R&D tax incentives across the country. The figures cited in the summary are from this source. Bear in mind that the figures are preliminary, many details are yet to come, and any conclusion would be premature. The following table shows how approximately \$1 billion in tax incentives were distributed by province in 1992. The figures are aggregated for companies claiming both refundable and non-refundable tax credits .

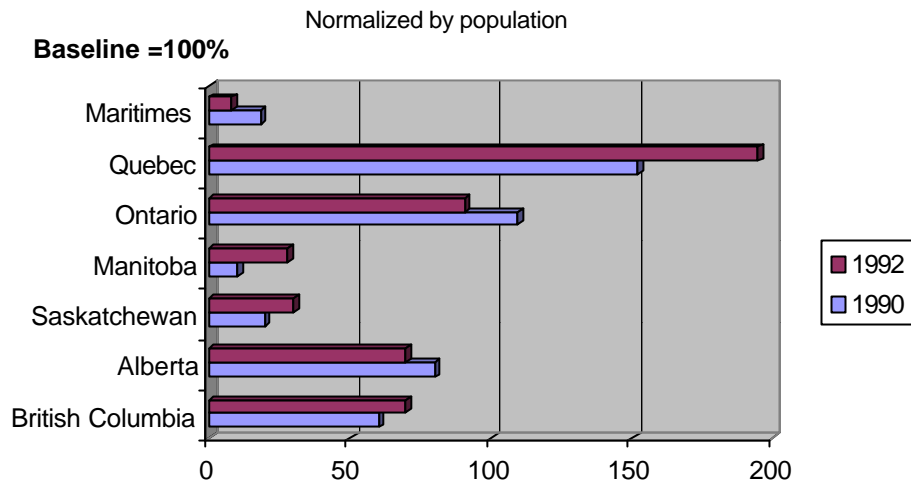
SR&ED Investment Tax Credits (\$millions) 1992 Calendar Year

<u>Province</u>	<u># of Companies</u>	<u>Amount (\$millions)</u>
British Columbia	851	82
Alberta	524	55
Saskatchewan	136	11
Manitoba	146	12
Ontario	2030	323
Quebec	1762	460
Maritimes & North	195	7
Total	5644	949

These figures show an uneven national distribution that becomes especially apparent when the figures are normalized by population and displayed graphically as follows: (Figures for 1990 are included for comparison.)



Share of Tax Incentives in %



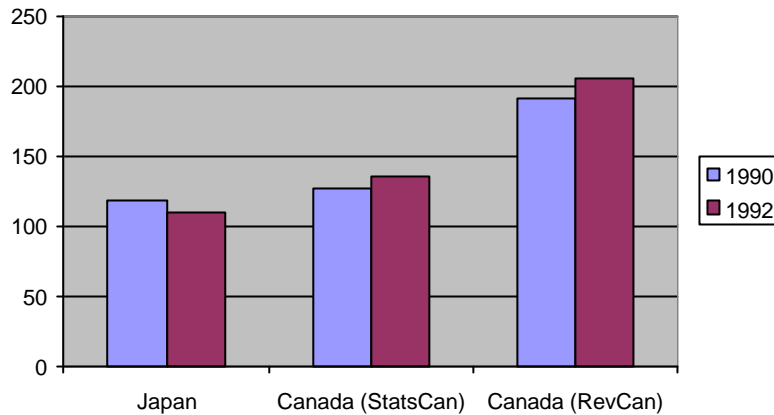
Three questions are suggested by these data:

1. What can we learn from the Quebec experience in attracting so much of Canada's R&D investments?
2. What makes BC an attractive spot for sheer numbers of R&D companies but prevents it from claiming a larger share of the overall R&D incentive "pie"? and
3. What can (or should) each province do to attract sufficient R&D to balance out taxes that originate in the home province and currently go elsewhere to support industrial innovation?

These figures also reveal a larger technology industry community than previously assumed³. The above figure of 5,644 is significantly larger than Statistics Canada figures for the same year and could be much larger again if every qualifying company took advantage of the tax incentive program.

Yet another interesting "indicator" comes out of these figures. We can ask how many innovative firms – defined as making significant investments in R&D – have been found to exist in Canada. The results, normalized according to population statistics, are illustrated in the following graph and compared with available figures for Japan⁴.

Innovative Firms per million population



Admittedly, we have lumped together firms of every size from SME's to industry giants. Dangerous though it may be, it is nevertheless tempting to speculate about the reasons for this finding. Perhaps Japan, compared with Canada, is a much more mature economy. Canada's economy is junior and is only now beginning to see an emergence of innovative new firms seeking niche markets in today's global setting, especially in the technology-based service industries. (So far we have been unable to find comparable figures for the United States and Mexico.)

Thus the actual industrial landscape is a questionable picture, and there is compelling evidence to suggest that the current population of this sector is much larger than previously thought. As John Alic has noted⁹:

Most countries undercount R&D, in part because statistical agencies miss a great deal of D&D which, by most official definitions, should be included. There are also allocation problems. For instance, the statistics for the United States show almost all R&D taking place in manufacturing industries, very little in the services. This is unlikely; it appears that much of the R&D in service firms escapes the surveys.

Chris Freeman, in a private communication, has also commented on this phenomenon:

It is generally agreed today that all the OECD countries are experiencing profound structural change associated with the diffusion of information technology. For a long time, it has been recognized that present methods of measurement underestimate the scale of scientific and technical activities in small firms, as well as excluding much software development.

As shown above, ready proof of this, although not with any precision about the total population of R&D enterprises, is readily available in Canada with its pace-setting reliance upon tax incentives for industrial R&D [Warda, 1994]. The proof arises from the administration of the tax incentive program, since the process includes direct verification of industrial R&D activities and expenditures, including those in the service industry.

All of this points the need for more extensive industrial demographics. In response we are developing a comprehensive registry of science, technology and innovation in BC business enterprise. The importance to policy makers is this: without

comprehensive industrial demographics, how can we understand the consequence of policy initiatives targeted at this sector? The questions boil down to how many candidate companies exist, how many are being reached, are the intended results being achieved, and what impediments do the companies and the policy administrators face. As mentioned above, there is substantial evidence that confirms Alic's view. In the particular case of Canada, industrial R&D may be understated and mischaracterized by a substantial margin⁵.

Industrial demographics

This observation forms the basis for a major study currently underway at SFU's Centre for Policy Research on Science and Technology [Lipsett, Lipsey and Schuetze, SSHRC Strategic Grant 809-94-0011]. The objective of the research program is to provide new evidence on firm-specific endogenous technological change as well as a new dimension for the study of S&T policy. We are in the process of conducting something akin to a census of science, technology and innovation in the business enterprise sector in BC. It will be used to track and analyze the size, employment and R&D investments of this sector over time. The work program for 1994-95 is designed to produce analyses of the use, importance and impact of major S&T incentive policies and programs. The process will be continued for three years to yield an historical series of the size, vitality and contributions to the economy of this important sector.

Our studies are limited to BC at this time. This is for two reasons. First, a Canada-wide study would be premature. Second, we are building on the co-operation and partnership of key provincial and federal agencies operating in BC. These organizations contributed a variety of databases consisting of thousands of candidate companies. One of the organizations offered its existing network of industry contacts to assist in verifying the existence, employment and technical activities of companies in the combined registry. Thus the BC situation will be a good pilot study, for Canada and internationally.

Methodology

The research team – which also includes Hans Schuetze, UBC; Gerry Goodchild, Revenue Canada; and Adam Holbrook, Industry Canada – is taking a collaborative approach to quantify the size, employment, activities and growth of this sector.

As suggested above, we are fortunate in belonging to a network of organizations with a common interest in the vitality of the S&T community in BC and with a common concern for understanding the composition and growth of this community¹⁰. We are harnessing this network to design a procedure to personally contact the majority of technology-based business enterprises in BC. We are gathering information about their numbers, their technical fields, products and services, employment characteristics, and, most importantly, whether or not they are investing in activities that are characteristic of R&D. This will be more than a registry of technology industries known to the general public. It will comprise a research database that includes many additional firms who wish to maintain privacy about their activities but could be included in aggregate statistics for the province and could be reached for research on innovation and other policy matters. In other words, the research database will be based on firsthand personal contacts and will amount to a mini census of science, technology and innovation in BC's business enterprise.

While we speak metaphorically of a technology industry census, it is not our plan to conduct a door-to-door survey as if for a population census. As mentioned above, several industry registries of BC companies are already in existence and have been made available to us. They were constructed over the years to meet the operational needs of a variety of government agencies, industry associations, and commercial ventures. The best of them were created by agencies whose personnel maintain direct contact with most of the entries. The databases exist in many different formats and contain a mixed collection of data for each entry. What they all have in common is that they were developed as job-specific tools with which to communicate and maintain a working relationship between the companies and agency personnel. By making certain that the information is current and by eliminating duplicate entries, the amalgamated database yields, in principle, a baseline registry of the target companies.

Work is now underway on this project and takes advantage of one or more of the following ingredients contributed by the cooperating organizations:

- database access
- in-kind staff time to update the information
- knowledge of a specific part of the community
- participation in an ad hoc interagency coordinating committee
- direct financial support
- technical assistance, and
- other advice and contacts.

Each of the database contributors is at the hub of an extensive network of industrial contacts, and deals with an overlapping subset of technology based industrial firms. We are in the process of linking these agencies, capitalizing on their relationships with their specific client base, and obtaining a composite picture of the industrial R&D community in BC. We expect soon to have current information about the numbers of such companies, fields of science and technology involved in their work, products and services, employment characteristics, and, most importantly, whether or not they are investing in activities that are characteristic of R&D.

The project entails a complex web of interactions between many people in many organizations. The contributing agencies participate in an informal coordinating committee to ensure the quality of the resulting database. The project relies on personal interviews rather than facsimile or mail surveys. The interviews are conducted by telephone to verify the existence, employment and technical activities of each company in the database. Contributing agencies specify any access restrictions stipulated by their clients and other requirements for confidentiality. Our role at Simon Fraser University is to provide project co-ordination, technical support, selected interviewing, consolidation, redistribution, and analysis. At a later stage, personnel from one or more of the contributing agencies will help conduct many of the telephone interviews.

By April of this year, eight organizations had supplied us with ten databases in a variety of formats and from a variety of platforms. We had to become adept at reading, merging and updating every one of them. The results to date have been surprising. We began with the expectation of identifying perhaps 6,000 technology-based companies

in BC, and with the further expectation that most of the companies would appear on most of the databases. At an early stage in the aggregation, there were over 22,000 records, which included a substantial number of duplicates within a single database. We used a variety of procedures to eliminate the duplicates, clean up the merged database, and prepare for the data verification stage. In the process, we ended up with close to 13,000 entries. Contrary to our expectations, comparatively few of the files submitted by each contributor were shared by any other contributor, even though all of the contributors are concerned to some extent with the same population of companies. These results are shown in the following table.

Database	Type of contributor	# companies		% Unique
		unique to contributor	of	
Contributor 1	Provincial agency	4753	7091	67
Contributor 2	Provincial agency	641	1805	36
Contributor 3	Federal agency	2576	4334	59
Contributor 4a	Provincial agency	151	499	30
Contributor 4b	Provincial agency	132	291	45
Contributor 5	Industry association	181	514	35
Contributor 6a	Federal agency	17	230	7
Contributor 6b	Federal agency	258	834	31
Contributor 7	Public Directory*	742	2686	28
Contributor 8	Industry association	56	155	36
		9507		73

*Number of companies in aggregated database: 12,959**

*(Estimated number of companies after data verification and update: ~10,000.)**

*basis for the figures given in *Highlights* at the beginning of the paper.

The merged list is neither current nor complete, but it does indicate a totally different size of the industrial community than previously reported. It is too early to estimate the number of R&D performing companies within this total, although a personal guess of 5,000 is not unreasonable and may turn out to be on the low side.

Concluding remarks

The lens of Canada's R&D tax incentive program reveals something interesting within BC's, and possibly Canada's, industrial landscape. The picture expands on that provided by Statistics Canada, but is still incomplete. Revenue Canada only knows about its historical and existing files of claims for tax incentives. As we have also shown, other networks of industry contacts exist, and by piecing their pictures together we can expand the picture further and build a more comprehensive mosaic of business enterprise and technological innovation.

It appears that many hitherto unknown companies have been taking root, conducting R&D and contributing significantly to employment and economic development. The population of the R&D community seems to be growing at a rapid pace. The growth dynamics, the fields of science and technology, the employment of

this community, and the nature of their markets are all largely unknown. It follows that if this community is the object of science and technology policy, as well as the study of economic growth, it is important to understand more fully its population and technical characteristics. We therefore offer for consideration in the public debate on industrial innovation and growth the following core "indicators" or "metrics"

Population of technology-based enterprises, region by region. As noted above it is crucial to find out the nature of the entire industrial mosaic, which includes the standard lists of known enterprises as well as the previously invisible and newly emerging populations.

Proportion of such companies performing or investing in R&D. Here R&D is interpreted to mean the definitions found in the Income Tax Act, which in turn are consistent with international usage. However, we underline the importance of explaining R&D in ordinary language so that it is not seen as an elitist activity.

Use by these R&D performers of government assistance programs. This enables us to determine, for example, the impact of specific policies and program and whether they are reaching their target.

Employment by such enterprises. This is a crucial indicator of the contribution of such companies to the economy. It is also a proxy, and relatively non-invasive measure of the size of the enterprise.

Fields of science and technology in which such enterprises are concentrated. This shows the technical direction of these firms and gives an indication of required educational background. With national and international trends towards services and information-based economies it is increasingly important not to exclude the social sciences from these classifications.

Location of markets. What markets are served by these enterprises?

Trends. How do these indicators (metrics) vary over time? This allows policy makers and analysts to assess the consequence of government S&T policies aimed at this sector of the economy. A one-time snapshot cannot accomplish this.

Where we go from here is a function of many things, not the least of which will be the dynamics of responses to this paper. We look forward to new insights, fresh developments, and clarified directions in the months and years to come.

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