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BIO-MEDICAL AND MEDICAL SPIN-OFF COMPANIES

from Canadian Medical Schools and Affiliated Research Institutes

MHA Thesis

Final Submission: December 29,1999

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Executive Summary

Although biotechnology is a relatively a new industry it is expected to have a major impact on our economy and society in the near future. The field of medicine will be affected dramatically. The spin-off phenomenon is also relatively new. Little information has been available on their effect, especially on a national basis. As a study of medical and biomedical companies created from technology developed in Canada's medical schools and affiliated research institutes, this thesis set out to answer five questions related to biotechnology and spin-offs. The five questions and a brief description of their relevance follow:

1. Which Canadian companies are biomedical spin-offs? Prior to this study a cross-Canada list did not exist.
2. Who funded the founding technology of biomedical spin-off companies and the careers of the founding scientists? The Medical Research Council, which made this study possible, was interested in identifying the companies its funding had helped to create.
3. What is the rate of spin-off creation? Experts in related fields assumed that the rate of spin-off formation had been escalating and this assumption needed to be confirmed.
4. How are these spin-off companies impacting the economy? The extent of the spin-offs economic contribution in terms of jobs created, revenues and exports is a important component of their description and analysis.
5. Which provinces have been "players" in this industry? Each of the larger provinces have taken a different approach to the biotechnology industry and to the formation of spin-offs. Comparing the results on a provincial basis was intended to shed light on the relative successfulness of these various approaches.

My original research confirmed that the spin-off phenomenon is thriving in Canada. Their rate of formation has increased dramatically in the last decade. As of 1998 the number of spin-offs created in the 1990's was already more than quadruple the number created in the 1980's. The rate of formation in the province of Québec was one of the lowest in the country in the 1980's; it is now the highest. The dramatic change in Québec is due to *multiple* levels of *consecutive* governments, working *together* (and with other players), on a *consistent* basis, to implement *complementary* policies. New Québec companies in targeted industries such as biotechnology are offered an array of subsidies, refundable tax credits and non-

financial support. Critics of these policies question the viability of these companies once public support is withdrawn. This would be a good question to address in a follow-up study.

Several provinces offer good examples of programs that encourage spin-off formation. Government policies that favour spin-off formation and the biotechnology industry should focus on the proven programs. As a result I have concluded that consistent support should be directed to improving the commercialization process (especially as a function of universities and research institutes), the funding of basic research, the use of peer-review evaluations wherever feasible, the creation of regional clusters of specialization, and the integration of municipal, provincial and federal programs.

The spin-offs that participated in this study are on average only seven years old, the approximate half-way mark in their product development life cycle. Even so, they are already contributing to the economy in terms of employment, research and development expenditures and, in 50 per cent of the cases, product sales, the majority of which are exports.

These Canadian medical and biomedical spin-offs are participating in the development of the next generation of diagnostics, devices, therapies and vaccines targeted at the most pervasive and life-threatening diseases and disorders. If only a small percentage of the 83 spin-offs participating in this study should develop their products to their full potential their impact on Canadian society will be very positive in both economic and social terms.

Most of these spin-offs give credit to the federal government for their start in terms of funding the development of their founding technology and financially supporting the careers of their founding scientists. The Medical Research Council of Canada was the most frequently named source of this financial support. Evidence of bias in favour of the organization conducting the survey (in most cases, the MRC) was found.

These spin-offs are true to their roots: they continue spending 20 per cent of their research and development budgets in universities and research institutes.

Introduction

It is becoming increasingly difficult to pick up a newspaper and not read about Canada's brain drain and how Canada is losing (or will lose) unrecoverable ground in the new information-based economy. There is also considerable discussion about how innovation is crucial to increases in our productivity. Alarmist news stories about medical problems for which there are no known treatments are also receiving a lot of coverage. Antibiotic-resistant bacteria, E-coli, cancer, strep A and Alzheimer's frequently make headlines. These potentially fatal or disabling health problems are dreaded because there is no cure and their current treatments strain our health care systems.

Potential cures for each of these medical problems are being developed by companies which started from technologies developed in Canadian universities or affiliated research institutes. Encouraging the creation of companies like these can help Canada address both the economic and health care issues facing it today.

The creation of companies around technology developed in a university setting is a fairly recent phenomenon. Most spin-offs have been formed in the last two decades.[1] The traditional commercialization route for academics and universities with an entrepreneurial bent was to license their innovations to established companies. In the medical field this pattern usually meant that large international pharmaceutical companies gained the most economic benefit from the innovations. Fortunately for Canada, entrepreneurial academics and universities started taking an alternate route to retain more of the economic benefits. This alternate route is to transfer the technology to a company formed specifically to develop and commercialize the innovation. Canada is fortunate that the innovative academics and university administrators were becoming increasingly dollar-conscious and equity-inspired because setting up a company consumes much more time and effort than negotiating a license.[2] Canada benefits from spin-off formation because the innovation and the

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[1] Bordt, Michael and Reid, Cathy "Survey of Intellectual Property Commercialization in the Higher Education Sector,1998", 1999, Statistics Canada Science and Technology Redesign Project, Ottawa, p.22

[2] Livingstone, Angus *UBC Spin-off Company Formation and Growth*, 1997, University of British Columbia, Vancouver, p.5

entrepreneurial founders of the company remain in Canada. For example, the University of British Columbia has found that over 90% of their spin-off companies remain in British Columbia.[3] The jobs the companies create for university graduates (and many others), the companies' sales, and their return on investment stay too. In the opinion of the National Biotechnology Advisory Committee "the key to a strong national value-capture strategy for Canada is to ensure that Canadian companies can move as far down the product development path as possible".[4] Spin-offs are key to that strategy.

The field of medicine is going to change dramatically in the early part of next century. New diagnostics, vaccines, therapeutics and cures will become available because of breakthroughs being made in the field of biotechnology. With scientists in universities and research institutes across Canada developing the basis of potential breakthroughs for a long list of new and old diseases and medical disorders, Canada can expect to benefit economically and socially. Breakthroughs are already finding their way into our health system through companies which are spin-offs. For example, a set of blood test kits used to test for breast, ovarian and gastrointestinal cancers was brought to market by a spin-off. Another spin-off's drug delivery technology improves the oral administration and performance of existing medications thereby reducing their side effects. A third example is a spin-off which provides bio-implant products for bone and tissue regeneration and restoration. Yet another has produced sustained release insulin implants.

Spin-offs in the fields of health sciences and biotechnology are the most numerous. Their numbers and their potential to benefit Canada both economically and socially have led to increased interest and study. Of course the entire field of biotechnology is of interest because of its potential benefits.

It is common for people knowledgeable in the fields of medical research, biotechnology and technology transfer to assume that the number of Canadian spin-offs is "mushrooming". But statistics which confirm this impression are hard to come by. Until very recently there was

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[3] Ibid, p.33

[4] Strachan, Graham *Leading in the Next Millennium (National Biotechnology Advisory Committee Sixth Report)*, 1998, Industry Canada, Ottawa, p.16

no measure of the size of the biotechnology industry in Canada that had the confidence of the experts in the field. The economic impact of spin-offs in the medical and bio-medical industries could only be guessed at based on anecdotal evidence.

I was motivated to start this study after discussing all of these issues with some very knowledgeable people in the medical research, venture capital and biotechnology fields. The seminars and conferences I attended and the literature I read confirmed both the excitement and the void.

Here is one of the motivating quotes from the literature:

"Biotechnology is big, both as an economic driver in the next millennium and as an enhancer of Canadians' quality of life."[5]

Questions to be Addressed

The thesis prospectus outlined five questions that would be addressed by this study. These were:

1. Which Canadian companies are biomedical spin-offs?
2. Who funded the founding technology of biomedical spin-off companies and the careers of the founding scientists?
3. What is the rate of spin-off creation?
4. How are these spin-off companies impacting the economy?
5. Which provinces have been "players" in this industry?

1. Which Canadian companies are biomedical spin-offs?

The starting point of this thesis was finding as many as possible of the companies that had been created from technology developed in Canadian medical schools and affiliated research institutes. A cross-Canada list did not exist prior to this study. The universities' lists

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[5] Strachan, Graham *Leading in the Next Millennium (National Biotechnology Advisory Committee Sixth Report)*, 1998, Industry Canada, Ottawa, p.9

of their own spin-offs are usually not complete and do not apply a consistent definition of spin-off.

2. Who funded the founding technology of biomedical spin-offs companies and the careers of the founding scientists?

Given that biomedical spin-offs represent a unique opportunity for Canada to commercialize new technology at a critical stage in the development of the industry, it is important to understand which types of funds and organizations founding scientists depend on while they are developing these technologies. If the sources are government organizations we need this information in order to help preserve consistent levels of funding as a minimum. If the sources are in other domains we need to know which domains so that government policy can encourage that support.
This question has two parts:
What funds did the scientists who started biomedical companies rely on over the course of their careers?
Which funds did they rely on when they developed the technology which was transferred to a corporate entity?
Financial, office and moral support for this study was provided by the Medical Research Council of Canada. Their principal mandate has been to fund research conducted in medical schools and affiliated research institutes. Before this study was completed they were aware of a number of companies whose founding scientists and technologies were supported with MRC grants. But they needed more than anecdotal evidence of their impact on the Canadian economy and society. With this study they expected to find more of these companies and to also determine their impact in terms of products, jobs, revenues, etc.

3.What is the rate of spin-off creation?

The number of new biomedical start-ups being created has been steadily increasing since the spin-off phenomenon became a viable alternative to licensing in the late 70's. Knowledgeable people in the industry are under the impression that the number of new spin-offs is "mushrooming". This question is intended to confirm this impression with hard numbers.

4. How are these spin-off companies impacting the economy?

Are the spin-offs contributing to the Canadian economy and to what extent? Are the spin-offs creating jobs? Are these jobs for well-educated individuals? How much are their revenues and exports? Are they paying taxes? Have the spin-offs in turn created new companies? How are the spin-offs financed? Are they foreign-owned? How much do they spend on R&D? To what extent do they finance university- and institute-based research? The answers to these questions are intended to provide a clear picture of how biomedical spin-offs are contributing to the economy.

5. Which provinces have been "players" in this industry?

In addition to a Canada-wide analysis the data was expected to lend itself to a province-by-province comparison. The provincial comparison was expected to be of interest from a policy perspective because different approaches, policies, and programs implemented by the provinces have influenced the development of this industry in different ways.

Literature Review

As the name of the survey "Biomedical Spin-off Companies" suggests, this study focuses on the intersection of three areas of interest: biotechnology; medicine; and spin-off companies. Most of the literature reviewed concentrates on only one of these three areas. Biotechnology is the subject of most of the reports described below and spin-offs is the subject of the remainder (or it is part of a more general discussion of technology transfer and commercialization). The medical, health care or health sciences industry is usually included in these reports as a subset of either the biotechnology industry or a spin-off database. In Canada three sectors comprise 80 per cent of the biotechnology industry (health care, agriculture and environment). Health care is the dominant sector, representing almost 50 per cent of biotechnology in Canada.[1]

***Leading in the Next Millennium: National Biotechnology Advisory Committee Sixth Report 1998*; Industry Canada**

This is a comprehensive report which presents a well-researched analysis of the challenges facing Canada's biotechnology industry. It identifies pharmaceutical products and agricultural products as "the largest and most vigorous biotechnology sectors in Canada." (p.2) It begins by emphasizing the importance of the industry to Canada in the next millennium in terms of both its economic status and its role in world affairs. It asks the federal government to affirm the industry's significance through the "political championship of biotechnology in Canada". (p.1,79) Another 40 recommendations describe exactly how the federal government could fulfill this goal.
Several recommendations are aimed at strengthening technology transfer in Canada. One recommends that the federal government work with the provincial and municipal levels of government and with other stakeholders to "increase support for mechanisms such as regional clusters, bio-incubator facilities and Networks of Centres of Excellence." (p.42) One series of recommendations focuses on improving the

[1] Groote, Joyce, Hough, Paul and Walter, Rick *Canadian Biotechnology '98: Success from Excellence*, 1999, BIOTECanada, Ottawa, p. 16

capabilities of university technology transfer offices. One is specifically directed at government assistance for smaller universities. (p.39)

***Survey of Intellectual Property – Commercialization in the Higher Education Sector, 1998*, February 1999, Statistics Canada, Michael Bordt and Cathy Read**

This is a fact-filled research paper based on a survey of Canadian universities and degree-granting colleges conducted in the summer of 1998. 74 of the 81 academic institutions contacted identified 366 spin-off companies. 66 are in the health sciences field and 90 are in the biotechnology/biology field.

The research paper also reports that only 62% of universities "are actively managing . . . their IP."(p.8). The paper also reports results in areas such as intellectual property policies (ownership and reporting), research contracts, number of patents and rate of spin-off formation.

In the section "Exploiting IP: Licensing and Spin-offs" it states two reason for a university to give preference to spin-off formation over licensing. One is to nurture a technology that requires further development to demonstrate its commercial applicability. The second is "for the institution to invest in its own future" . . . by taking "equity in the business in lieu of licensing fees". (p.21) (The economic and social benefits of creating a spin-off are noted in the conclusion.)

***Commercializing University Research: The Case of Spin-offs*, 1997 Natural Sciences and Engineering Research Council of Canada (NSERC) and The Conference Board of Canada, Brzustowski and Nininger**

This report is third in a series on the subject of "university-industry synergy". It is a positive up-beat description of the spin-off process in Canada. It includes a section written by Denys Cooper which is based on survey conducted in 1994 by the National Research Council (NRC) on Canadian spin-offs, a survey conducted in 1995 by NSERC and data gathered by NRC's Industrial Research Assistance Program (IRAP). The descriptive portion is based on interviews of executives from both spin-off companies and university technology transfer offices.

The IRAP data shows that before 1980 there was very little spin-off formation. (p.3) The rate of formation has increased dramatically in each five year period since then. It also highlights that sales and employment in spin-off companies doubled from 1992 to 1993. The report describes the transition of technology transfer offices from concentrating on licensing to existing companies to developing the skills, policies and procedures to spin-off brand new companies. Not surprisingly the conceptual model presented was from the University-Industry Liaison Office at UBC, one of the more proactive technology transfer offices in Canada.

The report emphasized the human factor in everything from university attitudes to a spin-offs' chance of success.

***Canadian Biotechnology '98: Success from Excellence*, BIOTECanada's First Report on the Canadian Biotechnology Industry**

This report was published in the spring of 1999 (as this thesis was being completed). It resulted from a collaboration of BIOTECanada, the recently amalgamated association of Canadian federal biotechnology associations, and Statistics Canada. As noted in the Introduction this survey was long overdue because, up until this point, there was no credible or complete source of information on the size and economic impact of the biotechnology industry in Canada.
The report states that its data is not comparable to the sources most frequently quoted in the past: the Ernst & Young industry reports on Canadian Biotechnology; and Contact Canada's Canadian Biotechnology annual directories. The following chart compares these sources, the BIOTECanada report and this study.

Database Comparison

	Ernst & Young (97)[2]	Contact Canada (99)[3]	BIOTECanada/ StatsCan (98)[4]	MRC (98)
Financial Data	1995-96	1997	1997	1997-98
Employment Data	1995-1996	1998	1998Q2	1998-99
Companies Responding	71	505	210	119
Includes:		traditional biotech, new companies	biotech users	Medical companies including new
Excludes:		Contract research; Service providers	Service providers; new co's, trad'l biotech; contract research	Service providers; contract research
Response Rate	32%		74% (52% for financial data)	54%

Figure 3-1

This BIOTECanada report provides up-to-date data on 210 firms which are developing biotechnology products or are using biotechnology products to develop other products.(p. 15)

The data from the 210 firms was extrapolated to 282 biotechnology firms in Canada. The extrapolation was based on the percentage of the 210 respondents which met the above definition of biotechnology firm applied to the number of firms which had not responded. (p.11) Unfortunately it is difficult to judge from the information provided whether or not this is a valid assumption. It may not be if a number of the non-respondents did not respond because they knew they would not qualify as a biotech company. Total biotech sales were calculated using the same extrapolation method and

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[2] Goudey, John and Nath, Deepika, *Canadian Biotech '97: Coming of Age*,_1997, Ernst & Young, Toronto

[3] Haynes, Fred *Canadian Biotechnology 1999 Directory*,_1999, Contact International Inc. Georgetown, Ontario

[4] Groote, Joyce, Hough, Paul and Walter, Rick *Canadian Biotechnology '98: Success from Excellence*, 1999, BIOTECanada, Ottawa

the respondents estimates of the percentage of their sales, R&D etc attributable to biotechnology. (p.11) $1.13 billion is the first credible estimate of biotechnology sales in Canada. Employment in the biotechnology industry is estimated at 9,823 and R&D expenditures at $585 million. (p.12)
Other BIOTECanada data will be presented in subsequent sections of this thesis as a comparison to data in this study.

***Report on UBC Spin-off Company Formation & Growth*, 1997 by Angus Livingstone**

This report was very well-received when it was released in the fall of 1997. Based on a (second) survey of UBC's spin-off companies it provided an interesting perspective of a very successful technology transfer operation through the survey results, the discussions of the results and the explanations and commentary on spin-offs in general.
Concrete data clearly illustrated the economic benefits of the spin-off companies for the university and the country. The following table summarizes some of this data:

UBC Spin-offs

Number	71
Employment	1,502
Revenues*	$42.4 million
Research contracted to UBC*	$3.6 million
UBC's Equity in the spin-offs	$5.6 million
Royalty Revenue*	$700,000 **

* 1996-97

** estimated

Figure 3-2

Livingstone emphasizes the increased effort and cost the university must invest in creating a spin-off compared to the more traditional option of licensing technology to existing companies. The main advantage to creating a spin-off is to increase the likelihood of keeping these economic benefits in the region, province and country. (Given that bigger (and possibly international) companies may still buy the technology, (but at a later stage) by buying the spin-off company, means that creating a spin-off does

not guarantee that all of the benefits will remain in Canada, but the longer the technology stays in Canada the greater the positive economic impact.)

The report also discusses the support the spin-offs receive from government agencies. The UBC spin-off companies receive approximately $2 million each year from government agencies. In terms of the number of companies supported the MRC comes second after NSERC. Livingstone makes the point that funds are not the only benefit the spin-off receives when a granting agency decides to fund a spin-offs research: the company also receives increased investor confidence in the technology because of the granting agencies' independent stamp of approval. (p.28)

***Public Investments in University Research: Reaping the Benefits,* May 1999, The Expert Panel on the Commercialization of University Research, Pierre Fortier**

This report makes a number of recommendations which focus on "university research supported with federal funds" (p.i) The goal of the recommendations is to "increase wealth creation in Canada" rather than to "produce new revenue streams for universities" because in the U.S. the revenues from commercializing research contributes less than one percent of university budgets (p.iv). (But this is still a huge amount of funds.) It notes that the investment and the level of commitment required to form a spin-off company is far greater than the original public investment in the research (p.viii). It makes a number of recommendations which would enhance spin-offs rate of formation from reductions in personal taxation (p.23) to government investment in universities' commercialization infrastructure (equal to 5% of their investment in research).(p.33) It uses OECD statistics to show that the share of national R&D performed in Canadian universities is one of the highest of the G-7 countries. In 1997 American universities performed the least national R&D at 14.3%; Canadian universities performed the second-highest share of national R&D at 21.1%; and Italy performed the highest at 23.8%. (p.2) It states that Canada "cannot afford the present haphazard and unprofessional approach to managing our investment in knowledge".(p.21) It recommends that universities be required to adopt specific intellectual property management policies to be eligible for federal funds. These policies include mandatory reporting to the university of intellectual property developed with the support of federal funds. Intellectual property created from research supported totally by federal funding would be owned by the university. To encourage

the creation of intellectual properties universities should provide incentives such as sharing of equity or license income (p.iv-viii) These policies were recommended because our "economic and social advantage is increasingly a function of our ability to translate scientific discoveries into market opportunities". (p.21)

***Ontario Biotechnology Task Force Report*, December 1998, Graham Strachan**

This report urges the Ontario government to move quickly to foster the growth of the biotechnology industry in the province. The recommendations are grouped into three main areas: human resources; innovation; and infrastructure. Most of the ideas are not new; in fact the report frequently cites the successful initiatives in other jurisdictions, especially Quebec's. For example it describes BioContact Quebec as "Canada's premier annual biopharmaceutical conference". (p.11) It contends that "well-funded marketing campaigns" such as BioContact Quebec, "attracts much needed investment, labour talent and corporate partnering away from Ontario". (Ibid) The report would also like Ontario to imitate Quebec's and B.C.'s commercialization centres (where "companies that emerge from universities and research institutes ... remain for 2-5 years). (p.13) On the subject of Scientific Research and Experimental Development tax credits the report describes Quebec's policy as well as New Jersey's. (p.15)
Other recommendations include:

- *refundable* tax credits for 50% of patent protection costs;
- an Entrepreneurial Awards Initiative for faculty and research scientists to encourage sabbaticals with biotechnology companies and spin-off formation; and
- delayed repayment loans.

The report also includes a number of statements and statistics which are of relevance to this thesis. Some of these are:

- "Quebec has captured the leadership position in Canada for biotechnology" (p.6);
- "Over 40% of Canadian research and development in biotechnology takes place in Ontario" (p.7);
- "Approximately 70% of start-up biotechnology companies are created from science developed at universities", (p.8);
- "80% of companies graduating from ... commercialization centres succeed compared to 20% of companies that were not developed through such centres" and

- "Given the long cycle for developing biotechnologies from the laboratory bench to the marketplace (7-15 years), the cash burn rate of this industry is unique" (p,14).

This report maintains that seed financing is available for companies which are at the very beginning of their product development life cycle. Public funding is generally available at the end of the product development life cycle. In between, when the company is starting commercialization and later when commercialization is developing, private sector funds are more difficult to raise. (Ibid)

The report also notes the steps that have been taken recently by the Ontario government. These include the $500 million Ontario Research and Development and Challenge Fund and the Premier's Research Excellence Awards.

***Canadian Biotechnology 1998*, January 1998, Fred Haynes**

Canadian Biotechnology 1998 is the sixth edition of a directory published by Contact Canada. This edition provides data on 746 Canadian organizations which use biotechology and 483 organizations that provides services to the industry. 558 of the 746 users of biotechnology are companies; 563 are in the field of human health care. Each directory also includes articles written by people involved in these organizations or in related government departments. A couple of articles report on an investment being made in a company whose Canadian origins was the first Canadian medical school spin-off, Pasteur Mérieux Connaught. Technology Partnerships Canada is contribtuting a $60 million "repayable investment" in the company's cancer vaccine research program. Biomira Inc. is another medical school spin-off which (along with numerous other organizations) is involved in the research program. (p.77) (Both spin-offs are participants in this study).

An article by Daniel Levac of the NRC Biotechnology Program describes his organiztions contributions to the biotechnology industry in 1996-1997. Some of the contributions were summarized in terms of number of spin-offs (4) and number of companies in "incubators" (22). (p.68)

Another article was contributed by two professors from the University of Toronto's Rotman School of Management. Their study was based on companies in a series of Canadian Biotechnology directories. They conclude that "intellectual property, capital

and alliances with appropriate partners form the foundation of success in the biotechnology industry". (p.63) They found that alliances with pharmaceutical companies or universities increase biotechnology firms' chances of survival whereas alliances with other biotechnology firms or government labs decrease survival rates. (p.62)

An article by Bern Phillip of Alberta Economic Development Corporation describes initiatives in his province that foster biotechnology development. It started in 1979 with the development of the Alberta Heritage Foundation for Medical Research (AHFMR). The Technology Commercialization Program is operated through the AHFMR. The Alberta Research Council sponsors research on products and processes "for which a recognized market exists". (p.31). ARC Biotech is their biotechnology division.

James Donovan of the Greater Quebec Economic Development Corporation contributed an article about biotechnology in Québec City. He describes a $85 million research infrastucture expansion; $3 million directed to early stage technology transfers and the BioContact annual conference.

Dr. Jean-Maurice Plourde of the Quebec Bio-Industries Council describes some of the results of "Quebec's efforts to establish biotechnology as a cornerstone of its industrial development strategy". It also notes the importance of the NRC's Biotechnology Research Institute in Montreal in both research and development and the fostering the formation of small firms. It notes the impact of Biochem Pharma and its subsidiaries. (Unfortunately Biochem Pharma did not participate in this study.)

***Canadian Biotechnology 1999*, January 1999, Fred Haynes**

The most recent edition of this annual directory provides data on 1,317 organizations. 693 are users of biotechnology and 624 provide services to the biotechnology industry. The number of users is less than the number reported in the 1998 edition because of a change in definition. Contact Canada's definition of biotechnology user no longer includes contract research organizations (which have also been excluded from this study's definition of biomedical company).

Of the 693 users 505 are companies. The other 188 are in the government, university, hospital and not-for-profit sector. Haynes emphasizes the significance of their role in the industry: "These latter play a **primary role** in providing the pool of scientific intellectual

property available in Canada for commercialization. Continued support of basic research and its infrastructure in Canada is **essential** to maintain this resource." (p.14)

***Canadian Biotech '97: Coming of Age*, Ernst & Young's 4th Report on the Canadian Biotechnology Industry, 1997, Goudey & Nath**

This report presents information Ernst & Young collects on Canadian biotechnology companies. It is presented both in regional and international contexts. 59% of their "core" biotechnology companies are in health care. (p.1) Core biotechnology companies are defined as "those whose business is completely or substantially biotechnology related". (p.xi)
Their survey results place the province of Québec in a leadership position in terms of number of companies, growth in number of companies, commercialization and production, revenue, and integration and leveraging of infrastructure. Ontario is the leader in average R&D spending per company.
Compared to the United States Canada has: more small companies, revenue equal to 6% of the U.S., and employment equal to 9%. Canada has a slightly higher percentage of public companies with a positive net income.

Summary

The reports reviewed above have a fair amount of consensus in their recommendations. In general these reports support active government encouragement of biotechnology R&D and its commercialization. Not doing so is simply too risky – our productivity, balance of payments and standard of living may be at stake.

An ancillary recommendation is the need for integration in this support. Two areas frequently identified as in need of support are the technology transfer process and regional clusters.

Methodology

The focus of this thesis and the main source of data is a survey I conducted in 1998. The survey took the form of a questionnaire which was mailed to 195 companies from the offices of the Medical Research Council of Canada and under their letterhead. The covering letter was signed by Marc LePage, Director of Business Development and Partnerships. I assumed that the Medical Research Council would add credibility to the survey and therefore increase the response rate. It was expected to be further enhanced by the personalized covering letters from Marc LePage because he knows a majority of the company contacts.

Company Names

The first step was to obtain the names, addresses and contact names for as many of the estimated (maximum of) 300 Canadian biomedical spin-offs as possible. I was also interested in finding the names of the founding scientists. I contacted each of the technology transfer offices of the 16 Canadian universities with medical schools. Their response varied from extremely co-operative and informative to co-operative and not very informative to neither co-operative nor informative. Because some technology transfer offices did not maintain lists of their spin-offs I had to resort to other sources. The most useful proved to be:

- the Medical Research Council's files and personnel;
- other granting agencies such as the Natural Sciences and Engineering Research Council;
- industry directories such as Contact Canada's Canadian Biotechnology 1998 and Pharma, BioPharma and Nutraceuticals Canada 1998; and
- attendance lists for conferences such as BioContact Quebec.

I also tried to obtain spin-off names from some of the research institutes, especially in Ontario and Québec, where I thought the lists were least complete, but did not obtain as many as I would have liked.

I continued to add names to the list of potential spin-offs (and to later mail them questionnaires) as I proceeded with the next stages of the study.

I accumulated a list of 254 potential spin-offs. Of these 195 were sent questionnaires.

Technology Transfer Personnel

As noted above some of the technology transfer personnel were very helpful in providing lists of spin-off names, addresses and founding scientists. They also commented freely on the spin-off phenomenon and how it should be studied. Technology transfer personnel from two of the universities were surprisingly negative. They criticised the spin-off process for being incompatible with university research functions and were particularly disparaging of the success of some universities. These officers questioned both the successful universities' definitions of spin-offs (too loose) and their statistics (unrealistic). One officer stated that some universities were creating too many spin-offs because "the vast majority" of technologies will not support a company because they are too "incremental". Another officer asked me to report his concerns about the spin-off process. In his opinion spin-offs are problematic for universities because the spin-offs are under-capitalized for two to three years. He also provided examples of conflicts of interest which arise when a researcher is both a professor supervising graduate students and a company shareholder.

This contrast in attitudes is a concern. Michael Stinson, who reviewed the draft of this thesis, explained why in his written comments. "... I believe that universities that have a positive attitude to technology transfer create many more spin-off companies, develop more innovative technologies, attract and retain better scientists, and create much more economic and social benefit. I also believe that a negative attitude to technology transfer generates the opposite effect and (the) spin-offs that are created are done so in spite of and without the assistance of the technology transfer office."[1] Stinson's point about attracting and retaining better scientists reminded me of a discussion which took place at a meeting of technology transfer managers held at NSERC offices in Ottawa. Some of the managers reported that a well-developed technology transfer office was becoming a prerequisite for researchers being recruited by their universities.

[1] Michael Stinson, Medical Research Council, Associate Director, Life Sciences Research Investments, personal communication

Questionnaire Design and Testing

The questionnaire design and testing stage consisted of several steps: obtaining advice from experienced people in the industry; writing the questionnaire; circulating it within the MRC for feedback; and testing it on a small sample.

Before designing the questionnaire I sought the advice of both Angus Livingstone, who conducted UBC's most recent surveys and Fred Haynes, president of Contact Canada. They provided useful insights into their survey procedures. I incorporated their ideas wherever practical and prepared for a time-consuming follow-up phase in order to obtain a reasonable response rate.

I circulated drafts of the questionnaire to five employees of the MRC (Michelle Campbell, Michael Obrecht, Marc LePage, Genny Cardin and Louise Desjardins). They recommended useful changes to the key questions on the funding of the spin-offs founding technology and the careers of the founding scientists. Réjean Héroux provided French versions of the questionnaire and the covering letter.

The questionnaire was divided into the following sections:

Introduction and Instructions

A. Company
B. Survey Contact
C. History
D. Support for the Founding Technology and Scientists
E. Economics
F. Comments
G. Confidentiality
H. Returning the Questionnaire

In some sections the information was printed in advance of mailing so that the respondents did not have to duplicate data already on file. For example Sections A and B were usually completed in advance. In Section C the description of the founding technology and a list of the founding scientists were frequently provided for review only as well.

The key sections were C. History, D. Support for the Founding Technology and Scientists, and E. Economics. The History section included a series of ten yes/no questions to assist me in determining the company's position on a "spin-off" continuum. It also requested the company's year of incorporation.

Section D asked an open-ended question on the sources of funding for the company's founding technology and for the careers of the founding scientists. The

survey participants were asked to list the funding sources and categorise them as having been:

Principal (critical);
Secondary (significant); or
Other (minor).

The instructions recommended that "the founding scientist or someone else knowledgeable about the history of the company and the founding scientists" answer Section D.

Section E included a series of questions about the company's: stage of development; industry; medical targets; number of products; patents and licenses; main business; employees; sales revenue; exports; research and development expense; corporate income taxes; institute- and/or university –based research; capital; stock exchanges; foreign ownership; second-generation spin-offs; and fiscal year-end. The instructions recommended that someone in Finance or Administration answer this section.

The Confidentiality section asked respondents to indicate which sections must remain confidential (i.e. "for internal use only at the MRC and/or reporting in aggregate form") and which sections could be disclosed. They could indicate that an entire section must be kept confidential or only specific questions.

The questionnaire was printed on bright yellow paper to help the survey contacts remember it and find it during the follow-up phase.

Sample: The questionnaire was sent to a sample of 13 companies to test it. Before the subsequent general mailing six completed questionnaires were received. To obtain the six questionnaires I made thirty telephone calls or 2.3 per company. I also sent second copies of the questionnaire to four (30%) of the sample. Two of the 13 companies completed the questionnaire without prompting.

By the time the survey was completed an additional four companies from the sample sent in questionnaires bringing the sample's response rate up to 77%.

As a result of the feedback received from the companies participating in the sample I removed the deadline stated in Section H, Returning the Questionnaire (because one company disposed of the questionnaire once the deadline has passed) and I began including return envelopes.

Database

I created a database to store the company names, addresses, fax numbers, contact names and mailing dates. I also entered information on the company's founding

technologies and founding scientists. I used word processing software in conjunction with this database to personalise the covering letters, print mailing labels and pre-print company data available in the database on the questionnaire. The company name and address, contact name, telephone and fax numbers were printed on the first page of the questionnaire. Wherever possible the description of the founding technology and the names of the founding scientists were printed on the second page.
The database was subsequently expanded to include all the data collected in the questionnaires.

Data Collection

Data collection was the most time-consuming part of the study by far.
Companies which did not respond within four to six weeks were sent a fax reminding them to complete the survey which had been sent to them on such-and-such date. The fax offered them a second copy of the questionnaire in case they had "misplaced" the original. Many reminder phone calls were also made. Some companies received multiple phone calls, faxes and copies.

University of British Columbia

The University of British Columbia has the most successful, well-documented and publicised spin-off program in Canada. The report on its 1997 survey results is reviewed in the Literature Review section of this thesis.
As noted above I discussed the MRC survey with Angus Livingstone, Associate Director for the University Industry Liaison Office at UBC. When I mentioned my intention to survey the UBC spin-offs he expressed concern about the possibility of the UBC spin-offs suffering from "survey burnout". To avoid this possibility he agreed to provide the MRC with data UBC had on file and to include the questions they did not have data for in their 1998 survey. This would reduce the time and effort the spin-offs would spend completing these surveys by not having to provide data already in UBC's files, not having to provide data in duplicate and not having to deal with two organisations.
At that time UBC had 29 spin-offs in its Life Sciences category. It very generously provided the MRC with data for 26. One of companies closed. Another spin-off did

not participate in the UBC survey but subsequently participated in the MRC study. This left only one active UBC spin-off in the Life Sciences field which did not participate in the MRC survey.

Response Rate

Overall this survey had a 54% response rate. Without UBC's co-operation (i.e. if the UBC spin-offs are excluded) the response rate would have been 48%.

Overall Response Rate

	With UBC	Without UBC
Number of questionnaires mailed	220	195
Number of completed questionnaires	119	94
Response Rate	54%	48%

Figure 4-1

Figure 4 - 2, Response Rates, graphs the response rate by province and region. Ontario and Québec had similar response rates. B.C. and Atlantic Canada were considerably higher. The prairie provinces had the lowest response rate.

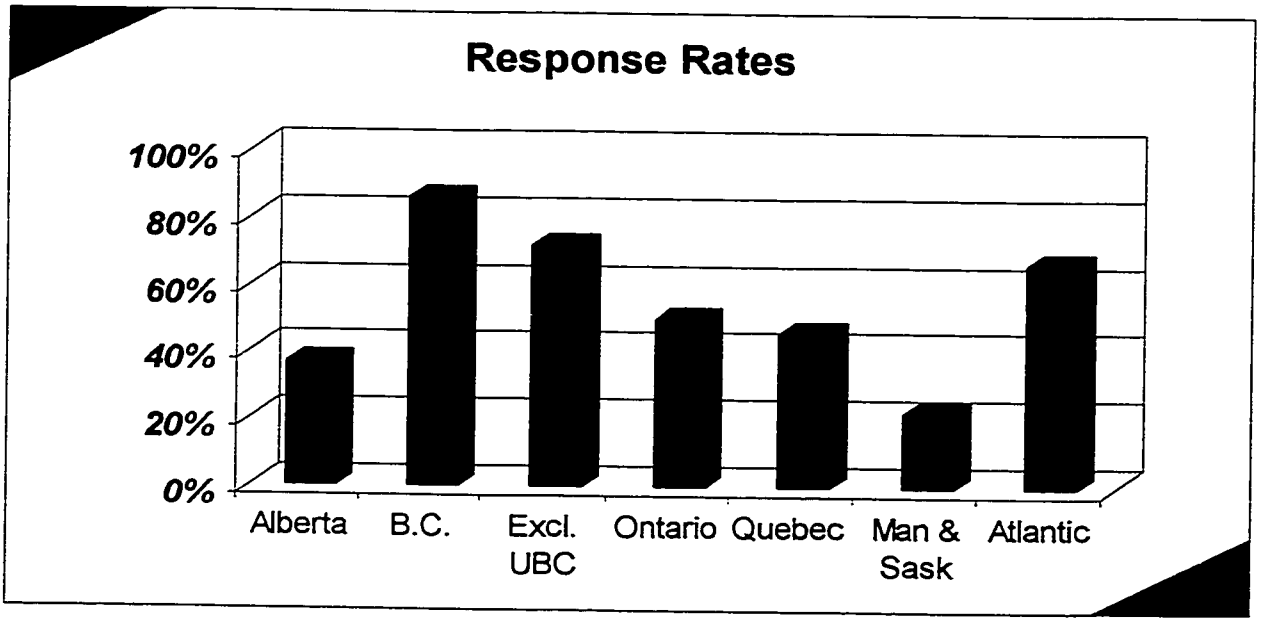

Figure 4–3

Figure 4- 4, Respondents by Province, shows that most of the respondents are from the three largest provinces, Ontario, Quebec and B.C.

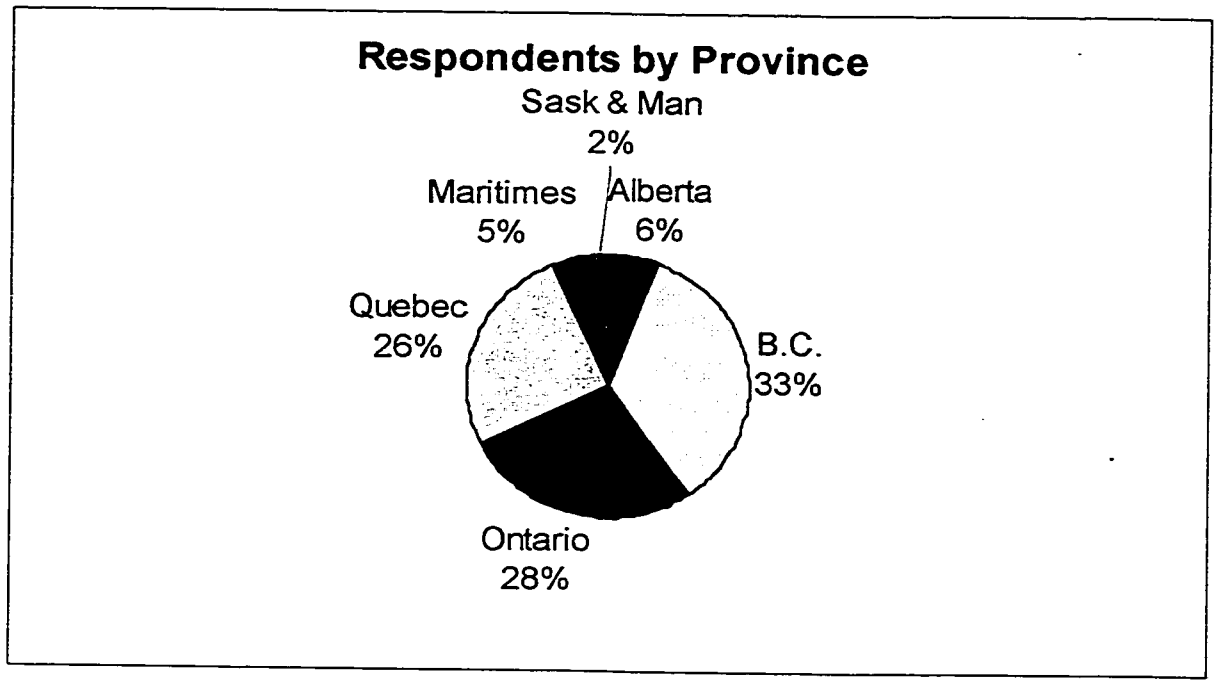

Figure 4-4

Data Verification

The data provided in the questionnaires was compared to data found in other sources. The most frequently used alternate source of data was a published annual report. Other sources included press releases, web sites and newspaper articles. Whenever I judged the alternate source of data to be more reliable than the questionnaire, as in the case of annual reports, I altered the questionnaire data. The most frequently occurring error concerned revenue. The questionnaire asked for the "company's net sales from Canadian operations". Unfortunately a number of companies (often those flush with cash from their initial public offering) included interest revenue in their responses. (In one case the interest was $350 thousand.) One company reported capital raised in 1998 as sales. Published data replaced questionnaire data in another instance where numbers were rounded up (considerably) to the nearest 10 million dollars. In several cases I noticed companies without any income reported corporate income taxes. These were in fact capital taxes.

Definitions

The title of the questionnaire was "Survey of Biomedical Spin-off Companies". The terms biomedical, spin-off and companies require definitions.

Company: For the purposes of this study I defined company as an organisation which had been incorporated. Without incorporation it was not likely that the founding technology had been legally transferred from a university and/or scientist to a new entity.

Biomedical: The term biomedical company refers to a firm in the health care sector of the biotechnology industry. To define biotechnology I referred to a number of sources starting with a seminar I attended entitled "An Introduction to the Science of Biotechnology". Biotechnology was defined very broadly as "the use of biological organisms, cells or processes to produce commercial goods or services".[2] Biotechnology is therefore an enabling industry. The term biotechnology is commonly used in a more restricted sense that is sometimes referred to as new, second-generation or advanced biotechnology. The new biotechnology is based on advances in genetic engineering, recombinant DNA, monoclonal antibodies and modern molecular cell biology. [3] In BIOTECanada's report on their survey the biotechnology industry "is defined not only by those companies developing biotechnology products but also by those using biotechnology to develop other products in addition to providing a variety of services".[4]

This same report also defines the health care sector of the biotechnology industry by listing a number of therapeutics including drug delivery systems, diagnostics such as biosensors, and gene therapies including gene constructs.[5]

Similarly in this study the term biomedical refers to the health care sector of the new biotechnology industry. Whether or not advances in genetic engineering are used is how I distinguish biomedical from medical.

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[2] Barran, Paul *An Introduction to the Science of Biotechnology*, 1998, British Columbia Institute of Technology, Burnaby, B.C., p.1

[3] Industry Canada, *Bio-industries, Part I: Overview and Prospects*, Sector Competitiveness Frameworks Series, 1996, Bio-industries Branch, Industry Sector, p.1

[4] Groote, Joyce, Hough, Paul and Walter, Rick *Canadian Biotechnology '98: Success from Excellence*, 1999, BIOTECanada, Ottawa, p.15

[5] Ibid, p.14

Spin-off: There is no universally accepted definition of a university spin-off. In fact this can be a contentious issue. It is frequently raised when discussions touch on the number of companies institutions claim as spin-offs.

To give my thesis maximum flexibility in defining a spin-off I used a series of questions to determine where each responding company would be placed on a continuum. On one end of the continuum are companies that are unequivocally spin-offs and on the other end are those which are unequivocally not. (Since I could not be certain where each company would be placed on the continuum until I received a completed questionnaire I have collected data on a number of companies which are not spin-offs.)

NSERC and the Conference Board employed a strict definition of university spin-off in their 1997 report on University-Industry Synergy. Their definition follows:

"... a university spin-off or start-up has been defined as a new firm created by a university and/or a university researcher specifically to transfer and commercialize inventions and technology developed at the university. This does not include firms set up by professors to undertake their consulting work, or companies set up by graduates where no technology transfer has occurred. It also does not include companies that existed prior to the transfer of technology from the university, or companies established by the university/university researchers for which technology transfer was not a key factor in the development of the company's products/services."[6]

This is the definition which I used to establish both ends of the continuum. I also used it to design the questions which established my spin-off criteria.

After creating questions based on the NSEC definition I added several questions which would give a little more leeway to the definition.

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[6] Warda, Jacek and Zieminski, Janusz *Commercializing University Research: The Case of Spin-offs*, 1997, The Conference Board of Canada, Natural Sciences and Engineering Research Council, Ottawa, p. 2

Question 10 appears below: (emphasis added)

10. Your answers to the following set of Yes/No questions will help us to determine whether or not your company is a "spin-off" and if so, what type.

Definitive spin-off:

a. Was the company **created by a university researcher and/or a university?** ___Y ___ N

b. Was the company **specifically created to transfer and commercialise inventions and technology** developed at the university? ___ Y ___ N

c. Was the **technology transfer a key factor in the development of the company's products** and/or services? ___Y ___ N

Potential spin-offs:

d. Did the **company exist prior** to the time the technology was developed? ___Y ___ N

e. If the company existed before the technology was developed was the company **reconstituted around the university technology?** ___Y ___ N

f. Was the company formed around technologies from **multiple sources**, including a university? ___Y ___ N

g. Was the company created **to fund research at the university** with the aim of developing technologies for license by the company? ___Y ___ N

h. Was the company created to provide **a specialised service** which was originally offered through an existing university department? ___Y ___ N

i.Was the company formed by a university researcher to undertake **consulting work?** ___Y ___ N

Not spin-offs:

j. Was the company formed by graduates of a university but **without a transfer of technology** to the company? ___Y ___ N

Yes answers to questions a, b, and c established that a company was definitively a spin-off. On the other hand yes answers to d, i or j would suggest that the company was not a spin-off.

Questions e-h compromise the strict definition by adding extenuating factors as criteria that may suggest that a company could be considered as a spin-off though not as strictly.

Categorising the respondents:

Once the data was collected I placed the companies into one of four categories, which would represent four areas on the continuum. The four bio-medical spin-off categories became: Definitely (a bio-medical spin-off); Probably; Unlikely; and No (not a bio-medical spin-off). (The results are displayed in Figure 4-5, Spin-off Continuum.)

For each company I reviewed: their answers to Question 10 including any comments; descriptions of their founding technology and main business; any other relevant comments made on the questionnaire; and notes on their history I had made from prior reviews of annual reports, media releases, and Medical Research Council files.

Companies were placed in the Definitely category if they answered yes to questions a, b and c.

They were also placed in this category if they answered yes to a and b or b and c since b is the strongest criteria. Some of these also answered yes to f, g, h, and i. None of these answered yes to j (no tech transfer). Only one answered yes to e (reconstituted).

Companies were placed in the Probably category if they answered a and c of a, b, and c.

Twenty-five of the UBC companies (all but one) were placed in the Probably category given that I did not have answers to Question 10 to verify that they were definitely spin-offs. In one case where the UBC company did not participate in the survey with UBC staff but did subsequently complete the questionnaire by mail I could confirm

that the company would be categorized as Definitely a spin-off and this company was placed in that category. The reason I did not include the UBC companies in the Definitely category has to do with a difference in the definition of spin-off. The definition I used as a starting point is the one used by NSERC and the NRC. It emphasizes the transfer of technology from the university and/or university researcher to the company.[7] UBC's definition permits three different scenarios only one of which involves the immediate transfer of founding technology. ("A UBC spin-off company is a new enterprise created either to: (1) license a UBC technology; (2) fund research at UBC with the aim of developing technologies for license by the company, or (3) provide a service which was originally offered through an existing UBC department.") [8]
Other companies were placed in this category if they answered yes to combinations of a, c, d, e and f or if I was not sure that their founding technology or main business fit the definition of bio-medical.

Companies were placed in the Unlikely a spin-off category if they answered yes to only a of a, b, and c or if their answers were contradictory, for example yes to both c and j.

Eight companies were placed in the, Not a spin-off category because they answered yes to j there was no transfer of technology (usually companies providing contract research);and if their business was obviously not in the bio-medical field (for example, medical information systems).
Four companies were spin-offs but not of medical schools or affiliated research institutes. (Instead they were spun out of other companies, the Department of National Defence and the BC Cancer Agency.)
One company's founding technology and founding scientists were not Canadian.
Many were service organisations only. Others simply stated they were not "biomedical". One stated the technology was developed within the company, Another company said its status as a spin-off was "the fictitious wish" of one of the universities' technology transfer offices.

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[7] Warda, Jacek and Zieminski, Janusz *Commercializing University Research: The Case of Spin-offs*, 1997, The Conference Board of Canada, Natural Sciences and Engineering Research Council, Ottawa, p. 2

[8] Livingstone, Angus *UBC Spin-off Company Formation and Growth*, 1997, University of British Columbia, Vancouver, p.3

The results of categorising the 105 participating companies are displayed in Figure 4- 5, Spin-off Continuum. The y-axis for this graph and the next several represents the number of companies in each category.

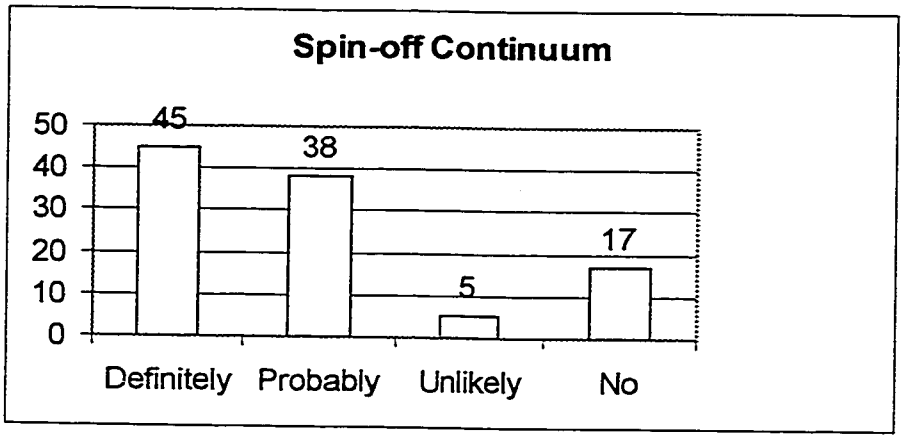

Figure 4–5

I subsequently reduced the number of groups from four to two: spin-offs and non-spin-offs in order to simplify the analysis portion of this study. The relative size of the two groups is displayed in Figure 4-6, Two Categories.

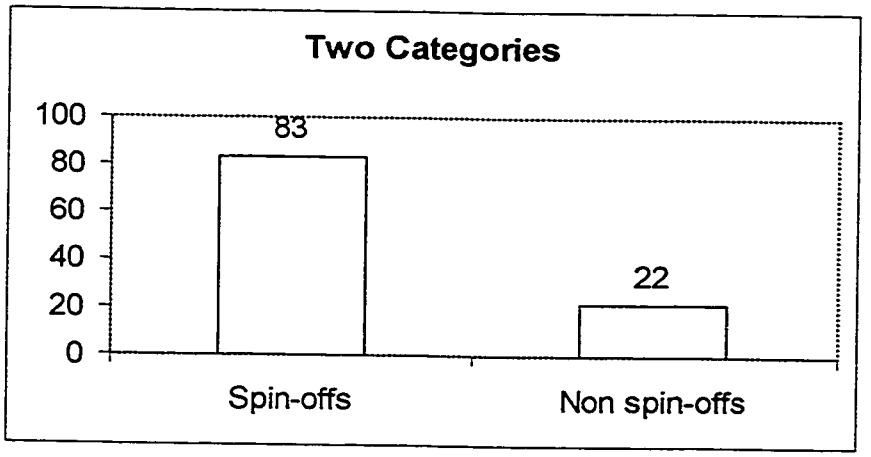

Figure 4-6

Looking at Figure 4 -7, Two Categories by Province, you can see the B.C. and Alberta have the highest proportion of spin-offs to non-spin-offs (5:1) and Ontario has the lowest (2.6:1).

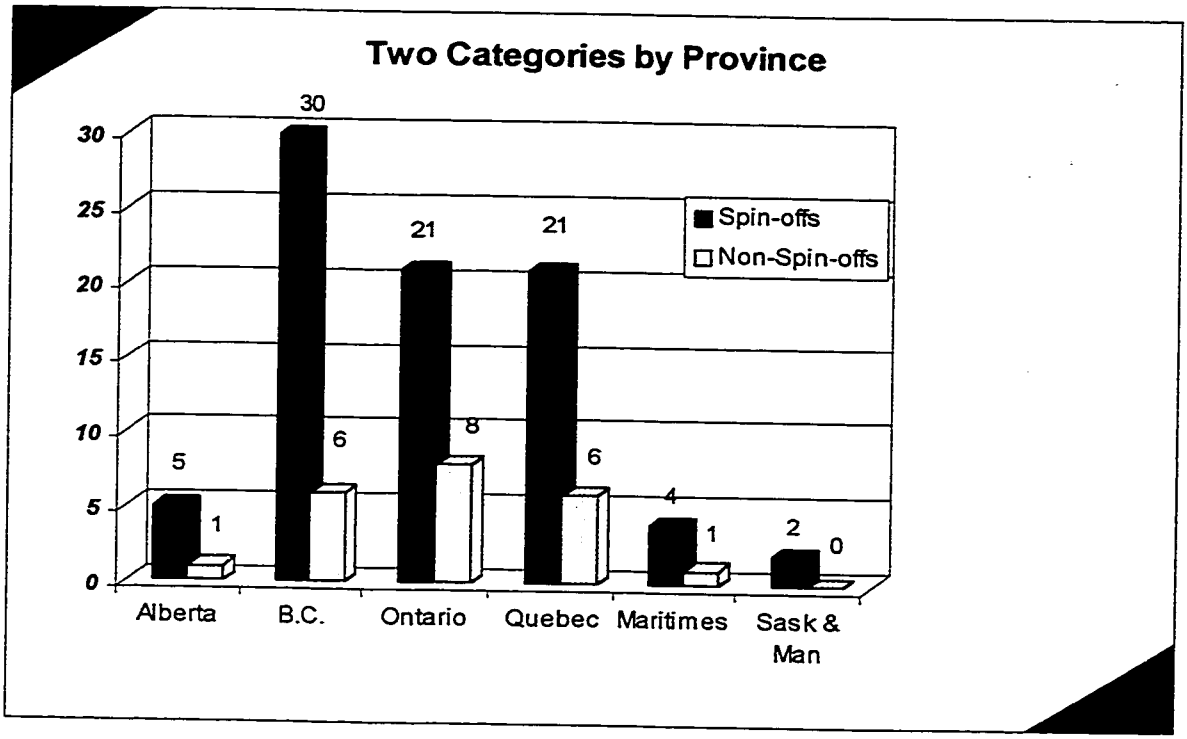

Figure 4–7

As noted above the four main defining criteria for the companies are:

Company – referring to incorporated legal entities;

Bio- referring to advanced biotechnology;

Medical – referring to health care; and

Spin-offs – referring to how the company was founded.

I rated the importance of each of these criteria to the study as follows:

1. Spin-offs
2. Medical
3. Company
4. Biotechnology

I used this rating to determine how I would apply each of the criteria. Eventually the fourth criteria, biotechnology, was modified. Spin-offs was rated of primary of importance for a number of reasons. From the beginning the spin-off phenomenon was the major object of study. This was the area I personally was most interested in studying for the reasons noted in the Introduction and the Thesis Prospectus. Also the first part of the questionnaire was devoted to questions designed to determine whether or not a company was a spin-off.

Medical was rated as next in importance to this study because it was being conducted for the Medical Research Council and their primary interest is, of course, medical. Health care was of interest to me personally because my university

department is Health Administration and because I find the advances being made in medicine by companies such as the ones participating in this study fascinating. In addition, the universe of firms was defined and limited by contacting only those technology transfer offices associated with universities which have medical schools. (Later other sources did provide the names of medical spin-offs from other universities.) Company was next in importance because it was necessary to have a cut-off to ensure that companies which were closer to the idea stage than the legal entity stage were excluded. These ratings left biotechnology with fourth place.
Once I applied the spin-off criteria to the 117 respondents I determined that 83 were in the spin-off group. Figure 4 -7, Two Categories by Province, shows that these companies represent all parts of the country and also that the three largest provinces are well represented.
Companies not in the health care industry were eliminated on an ongoing basis from the beginning of the study. Companies were eliminated if they simply stated they were not biomedical (as a reason for not completing the questionnaire); and if they were in the veterinary, aquatic, telemedicine, medical information systems or contract research business only. On the other hand a company developing dental products was included.
I decided not to apply the biotechnology criterion because it would have reduced the sample to a size which may not have been worth analysing. Applying the biotechnology criterion would have resulted in eliminating another 7 to 21 companies. (Seven companies were definitely not biotechnology firms and I was uncertain about another 14.) *As a result of this decision the thesis became a study of medical and biomedical spin-offs rather than simply biomedical spin-offs.* By broadening the survey to include both medical and biomedical firms not only did I keep the number of firms under study at a reasonable number for analysis but I also ensured the sample was representative of the total number of medical and biomedical spin-offs in Canada. Using the number of Canadian spin-offs identified by Statistics Canada in 1998 and the NRC in 1995 as a comparison, this study of spin-offs represents over half of medical and biotechnology spin-offs (in all fields) identified in Canada.

Percentage of Identified Medical and Biomedical Spin-offs

Number of Spin-offs:	Statistics Canada 1998 Intellectual Property Survey[9]	National Research Council 1995 Database[10]
Total	366	455
Medical/Health Sciences	66	83
Biotechnology/Biology	90	69
Medical And Biotechnology	156	152
MRC Survey Medical & Biomedical	83	83
% of Identified Medical and Biotechnology Spin-offs	53%	55%

Figure 4-8

If I also take into consideration that:

- not all biotechnology spin-offs are in the medical sector (according to the BIOTECanada report 46% are);[11] and
- the 83 spin-offs in this study are all active (closed companies were excluded);

then I can safely conclude that *the 83 spin-offs participating in this study represent well over half of the medical and biomedical spin-offs in Canada.*

Most of the remainder of this thesis will concentrate on analysing the data obtained from the 83 medical and biomedical spin-offs. (The data obtained from the other 22 companies will be used to differentiate the characteristics of spin-offs from those which are not.)

Qualifications

The data in this study is not complete in that it has not captured information on all Canadian medical and bio-medical spin-offs. It is also not complete because some participants did not answer all of the questions.

There are two characteristics of the database which cause distortions in the results reported in this study. One is caused by the UBC spin-offs extremely high response

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[9] Bordt, Michael and Reid, Cathy "Survey of Intellectual Property Commercialization in the Higher Education Sector,1998", 1999, Statistics Canada Science and Technology Redesign Project, Ottawa

[10] Warda, Jacek and Zieminski, Janusz *Commercializing University Research: The Case of Spin-offs*, 1997, The Conference Board of Canada, Natural Sciences and Engineering Research Council, Ottawa

[11] Groote, Joyce, Hough, Paul and Walter, Rick *Canadian Biotechnology '98: Success from Excellence*, 1999, BIOTECanada, Ottawa, p.16

rate. The generous assistance of the UBC University Industry Liaison Office in conducting the survey on MRC's behalf resulted in a response rate for British Columbia of 86 per cent. As a result information reported for B.C. is often not comparable to information reported for the other provinces with much lower response rates (22 - 67 per cent).

The second distorting influence is the relative size of the oldest spin-off participating in the study, Pasteur Merieux Connaught. The magnitude of this 85 year- old company relative to the much younger spin-offs in the study can have an overpowering effect on the results reported for Ontario and the country.

The influence of these two factors is taken into consideration as much as possible in the reporting and discussion of results in subsequent chapters.

Summary

The survey was conducted from the offices of the Medical Research Council. 195 questionnaires were mailed under their letterhead. 25 questionnaires were completed with the assistance of the University of British Columbia. The overall response rate was 54 per cent. I determined that 83 of the respondents were definitely or probably spin-offs. Most of these spin-offs are from Canada's three largest provinces. I have concluded that the spin-offs which participated in this study comprise more than half of all medical and bio-medical spin-offs in Canada.

CHARACTERISTICS

This chapter describes the companies which participated in the survey based on the data they provided on the questionnaires.

Company Status

The companies were asked to select one of four descriptions that best described their current stage of development. The four stages and their descriptions were:

Concept – initial stage, raising capital;

Early Stage – obtained at least one round of financing and continuing research and development to produce products;

Active - established facilities and developing or selling products; and

Closed – ceased operating.

The last category, closed, did not prove to be a useful selection for the questionnaire. None of the companies who completed the questionnaire checked this category. A few survey contacts did respond to say that their companies had ceased to operate but they did not complete questionnaires. In addition, several questionnaires were returned unopened with no forwarding address.

I decided not to collect any more data regarding companies which had ceased to operate for two reasons: 1) the difficulties I expected to encounter in trying to find and confirm closures; and 2) to avoid replicating, even in part, the work being done on the exit rates of spin-offs and biotechnology firms by Denys Cooper at the National Research Council and Joel Baum and Brian Silverman at the University of Toronto.

The result is that the 83 spin-off companies participating in this study were categorized using only three stages. The proportion of companies at each of the concept, early and active stages are presented in Figure 5 -1, Spin-off Companies' Stages.

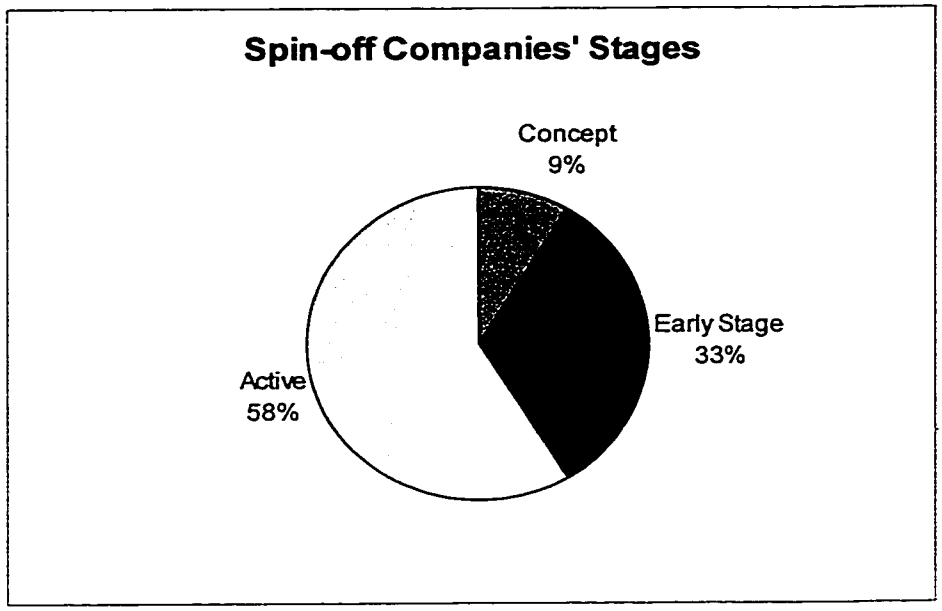

Figure 5 –1

The 366 spin-offs identified by Statistics Canada's survey of Canadian Academic Institutions appear to be much more mature in terms of their stage of development. See Figure 5–2, Comparison of Stages of Development.

Comparison of Stages of Development

Stage	Statistics Canada 1998 Intellectual Property Survey[1]	MRC 1998 Survey
	Percentage of Spin-offs	
Concept	2	9
Early	12	33
Active	69	58
Merged	2	-
Inactive	5	-
Closed	6	-
Not known	4	0
	100	100

Figure 5–2

There is a much higher proportion of spin-offs in this study in both the concept and early stages.

[1] Bordt, Michael and Reid, Cathy "Survey of Intellectual Property Commercialization in the Higher Education Sector,1998", 1999, Statistics Canada Science and Technology Redesign Project, Ottawa, p. 22

To explain this difference I compared the age of the companies. As Figure 5–3, Year of Incorporation Comparison shows, the MRC survey companies are much younger. 82% of the spin-offs in this study were incorporated in the 1990's compared to only 62% of the Statistics Canada spin-offs. Having more companies in the concept and early stages is consistent with the difference in ages.

Year of Incorporation Comparison

Year of Incorporation:	Statistics Canada 1998 Intellectual Property Survey[2]	MRC 1998 Survey
	Percentage of Spin-offs	
Before 1980	6	1
1980 – 1984	10	7
1985 – 1989	15	10
1990 – 1994	31	44
1994 – 1998	31	38
Unknown	7	0
	100	100

Figure 5–3

Targets

The companies were asked to indicate the diseases and/or disorders which are the target of their principal products or services. Over twenty targets were identified. The responses to this question are summarized in Figure 5-4, Targeted Diseases/Disorders, where the y-axis represents the number of spin-offs naming the specified targets. Almost 40% of the spin-offs named more than one disease or disorder. The targets grouped under the "Other" category include arthritis, dental implants, drug delivery, skin disorders, bone disorders, inflammatory bowel disease, asthma, inflammation, opthamology, hepatitis and tuberculosis.

[2] Ibid

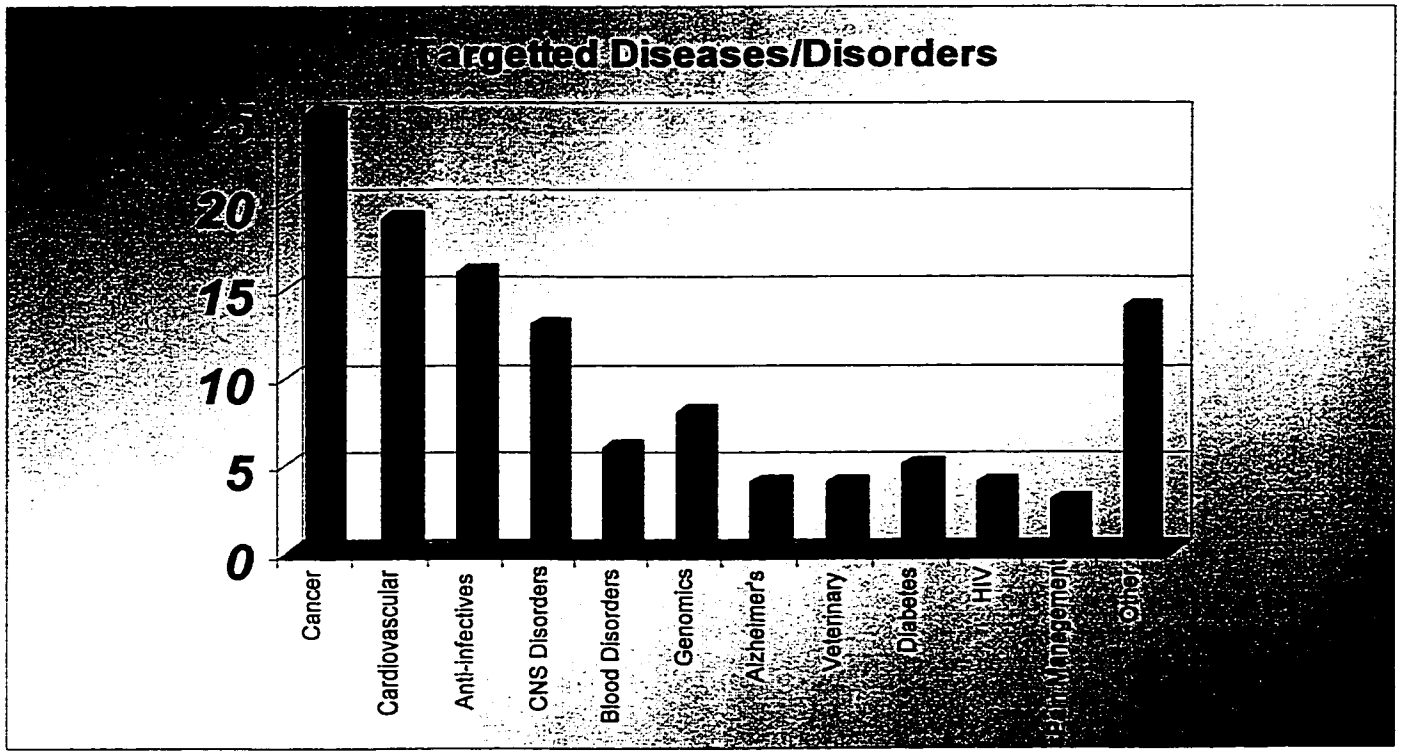

Figure 5-4

Cancer, cardiovascular disease, anti-infectives, CNS disorders and "Other" all had more than ten companies targeting them. These results are similar to results published by the Life Sciences Research Investments in January 1999. In their "Status of Research, Development and Clinical Trials" they categorize biopharmaceutical medical products under development in Canada. Their five highest-ranking categories are identical to the five highest-ranking categories in this study.[3] These are cancer, cardiovascular, anti-infectives, central nervous system and blood disorders.

[3] Life Sciences Research Investments, *Canadian Biopharmaceutical Companies: Status of Research, Development and Clinical Trials*, 1999, Industry Canada and the Medical Research Council of Canada, Ottawa, p.1

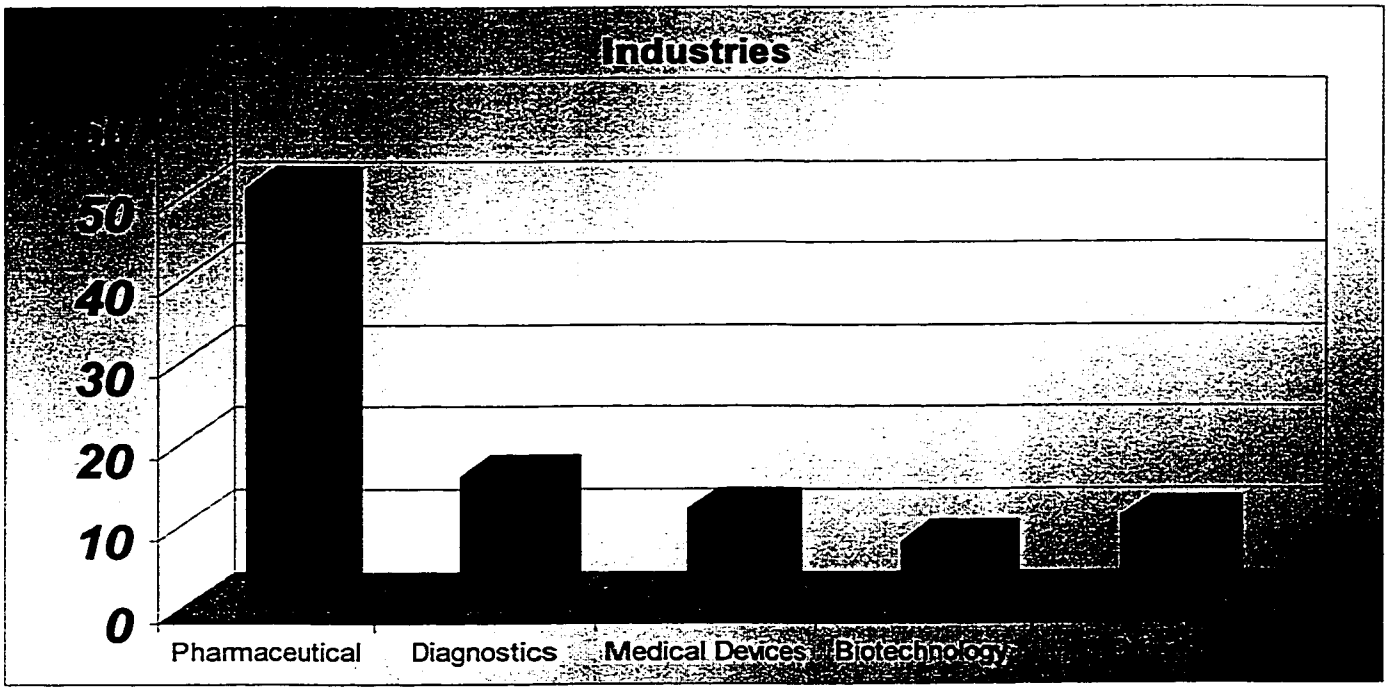

Figure 5-5

Industries

The companies were also asked to check or name their industry or industries. Over 60% checked "Pharmaceutical". Figure 5–5, Industries, graphs the industries checked or named (in the case of Biotechnology) by the respondents eight or more times. The vertical axis represents the number of spin-offs naming the specified industries.

Rate of Formation

In 1914, Canada's first spin-off was incorporated. Dr. John Fitzgerald was with the Faculty of Medicine's Department of Hygiene at the University of Toronto when he created Connaught Laboratories to commercialize a diphtheria antitoxin. Connaught Laboratories (now known as Pasteur Merieux Connaught) is a participant in this study and is therefore the oldest spin-off in this study.

None of the other spin-offs in the study were incorporated until 1980. Most remarkably, over 80% of the spin-offs were incorporated in the 1990's (excluding 1999). The spin-offs "Year of Incorporation" is displayed in Figure 5-6.

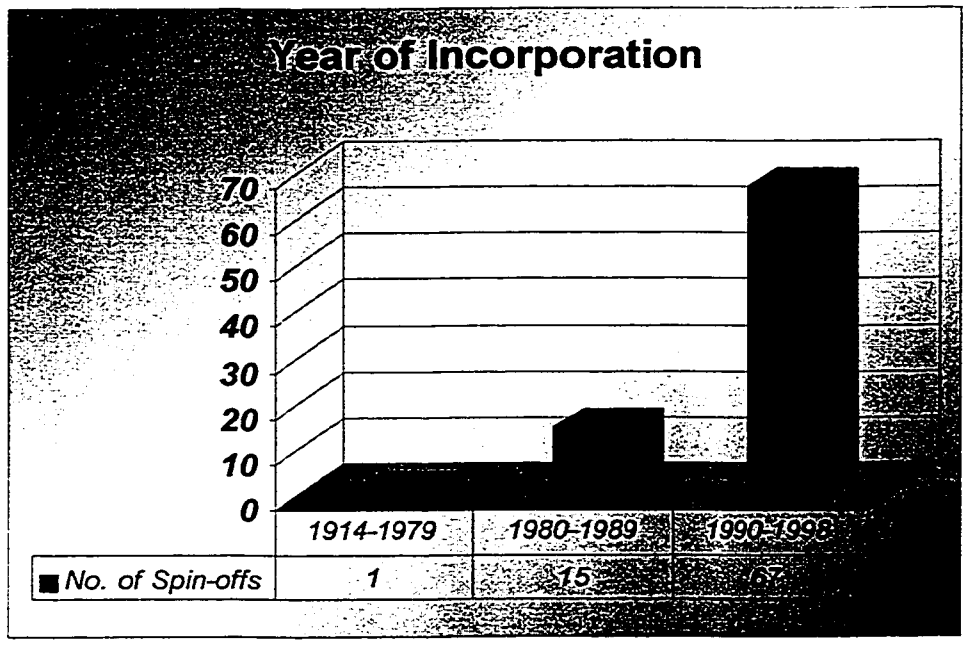

Figure 5-6

This data confirms the widely-held impression that the rate of medical and bio-medical spin-off formation has been accelerating since the phenomenon really got underway. In this study the number of spin-offs created in the 1990's (until the end of 1998) is 4.5 times the number that were created in the 1980's. The rates of spin-off formation are:

1980 – 1989: 1.5/year

1990 – 1998: 7.4/year

There are a number of positive developments which explain why the rate of formation has accelerated so dramatically in the 1990's.

Support for positive changes in each of the following areas was found in the literature and in discussion with experts in the field:

- the availability of capital;
- changing attitudes of academics;
- the work of technology transfer offices;
- industry receptiveness;
- an improving regulatory framework; and
- quality research.

Availability of Capital: There has been a major expansion of venture capital in Canada over the past five years.[4] Perhaps more significantly to this discussion, the availability of seed capital has also increased. In the last three or four years seed capital has become more available across Canada, whereas prior to that time-frame the supply of seed capital was mainly in Ontario and Quebec with a lesser amount in B.C.[5]

For example, the "MRC-inspired" Canadian Medical Discoveries Fund (CMDF), a labour-sponsored venture capital company, began investing in early stage and pre-commercial health research ventures in 1995. According to the National Biotechnology Advisory Committee's (NBAC) Sixth Report "the government-industry partnership between the MRC and CMDF has proven extremely successful at building relationships between Canada's academic-based researchers and its business community".[6]

Michelle Campbell, who at the beginning of this study was the Executive Assistant to Council at the Medical Research of Canada and is currently with the Strategy and Liaison Group at the head office of the MRC in the United Kingdom, provided extensive comments on CMDF's impact in her written review of the draft of this thesis. "You had to be around in the biotech community in the early 1990's to

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[4] Strachan, Graham *Ontario Biotechnology Task Force Report*, 1998, Toronto, p.14

[5] Mary Macdonald, comments at the 1998 Ottawa Life Sciences Conference

[6] Strachan, Graham *Leading in the Next Millennium (National Biotechnology Advisory Committee Sixth Report)*, 1998, Industry Canada, Ottawa, p.41

understand how all-pervasive was the belief that there was no VC in Canada, and there was absolutely nothing we could do about it. The sense of doom and futility was palpable. Biotech was dying a slow, strangled death despite our best efforts. By 1996, we had emerged into a whole new reality.... The major change was CMDF....What CMDF did was demonstrate that it was possible to invest in a biotech company without closing your eyes and throwing your money to the winds. They showed how it was possible to do business due diligence on science and ideas. Others quickly started pouring their money wherever CMDF did, and confidence quickly grew that it really *was* possible to invest intelligently in this sector. Very quickly, CMDF had many competitors, and the funding environment was a whole new experience. The same thing happened with seed funding: the earlier CMDF/UMDI (University Medical Discoveries Inc.) went, the more other companies followed them there. All of a sudden, multiple companies are fighting over researchers' inspirations, each trying to offer a better deal than the last (a beautiful sight, ain't it?)."[7]

According to reports prepared for the MRC and CMDF by Macdonald and Associates, CMDF was the number one venture capital investor in life sciences companies in 1997 both in terms of total amount invested and by number of investee companies. It maintained this position through the first half of 1998. (Of the seven venture capital companies that made it to the top four of these two lists only two (Royal Bank Capital Corp and MDS Health Ventures Inc) were not labour-sponsored venture capital companies (LSVCC's) or companies sponsored by the government of Quebec. The LSVCC's and provincially-sponsored venture capital companies were: CMDF; Sofinov; BioCapital; Fonds de Solidarité; and Working Ventures Canadian Fund.)[8]

Changing Attitudes: The most recent Ernst & Young publication on the Canadian Biotechnology Industry reported that in Ontario the "gap between scientists and entrepreneurs is closing" and that the "research culture at universities is changing" to one which is more conducive to commercialization.
It continues that the scientists' willingness "to consider commercial aspects of their research" combined with less resistance to "entrepreneurism, management and

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[7] Michelle Campbell, Strategy and Liaison Group, MRC UK, personal communication

[8] Macdonald and Associates Limited, *Venture Capital and Life Sciences: An Analysis of Canadian Venture Capital Investment Trends in the Life Sciences Sector,* Toronto October 1998,p.14, and April 1998, p.10

industry funding ... is making it easier to commercialize research".[9] In the past unfavourable comparisons between Canadian and American scientists had been made concerning their entrepreneurial attitudes.

According to Michelle Campbell, the Networks of Centres of Excellence played a key role in culture changes. She remembers Jeremy Carver, of GlycoDesign, once stating in a conference presentation "that if the one and only accomplishment of the NCE's was that they created a new generation of young and eager scientists who thought commercialisation and development were legitimate and important parts of science, that the entire program would be well and fully justified. (Fortunately we got that and much more.)"[10] Michelle expanded on the role the NCE's played in the 1990's. "In the early 1990's, spin-offs were in the doldrums. Existing companies were falling apart and new ones were not being created with any enthusiasm.... The NCE's prompted a much more careful, considered and planned approach to creating spin-offs, with the infrastructure to help bring those new companies the expertise and back-up they needed. The result was two-fold: 1) the NCE's were incredibly successful in the health area, because recognising the lack of receptor capacity they deliberately and systematically set out to create the receptors they needed (thus ensuring that science-push and technology-pull would be equally eager); and 2) for the first time Canada began consistently building strong, well-backed up, competent companies with a really good shot a long-term survival.... The NCE model was particularly successful in the biotech sector, which was almost entirely health-oriented....the NCE model seemed to have been tailor-made for Canadian health biotech in the early 1990's....If you look at early CMDF investments ... you will discover a really disproportionate number of them are NCE spin-offs....The net effect was an enormous spurt in company creation, but even more importantly, a great increase in *high-quality* company creation."[11]

Technology Transfer Offices: UBC's report on spin-offs exemplifies the role some universities' technology transfer offices have had on the rate of spin-off formation (UBC's first spin-off companies in the life sciences category were incorporated in

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[9] Goudey, John and Nath, Deepika, *Canadian Biotech '97: Coming of Age*, 1997, Ernst & Young, Toronto, p. 46

[10] Michelle Campbell, Strategy and Liaison Group, MRC UK, personal communication

[11] Ibid

1981). Many technology transfer offices have followed UBC's lead and have become increasingly proactive toward spin-off formation in the 1990's.

Some agencies, such as NSERC's Intellectual Property Management Program and the NRC's Industrial Research Assistance Program, have encouraged the work of technology transfer offices with financial support.

Industry Receptiveness: The NBAC report also credits "Canada's industrial base" for "quickly gaining the critical mass necessary to successfully take ideas from the laboratory and convert them into products for the marketplace".[12]
The MRC-PMAC (Pharmaceutical Manufacturer's Association of Canada) Health Program played a role. "Despite its very large history of controversy, the bottom line is that a huge number of Canada's leading health researchers took part in PMAC collaborations, and contrary to popular mythology, managed to remain Canada's best researchers while they did so, and brought a legitimacy to university-industry interactions which has played a huge role in breaking down the long-standing barriers between business and academia."[13]

Regulatory Framework: Although it requests further changes, the NBAC report also notes that "Canada's intellectual property rights and regulatory frameworks have been enhanced in many respects since . . . 1991".[14]
According to Michelle Campbell, the "major changes to the regulatory environment - the establishment of C-91 – were also health focused. The rate of increase of pharmaceutical R&D investment in Canada is extraordinary – 10 or 15 fold since C-91 was introduced. Pharmas depend on biotechs for innovation, and you will not grow a healthy biotech sector without a strong pharma presence."[15]

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[12] Strachan, Graham *Leading in the Next Millennium (National Biotechnology Advisory Committee Sixth Report)*, 1998, Industry Canada, Ottawa, p.40

[13] Michelle Campbell, Strategy and Liaison Group, MRC UK, personal communication

[14] Ibid, p.46

[15] Michelle Campbell, Strategy and Liaison Group, MRC UK, personal communication

Quality Research: Of course, credit is also due to Canada's researchers. Not only have they developed more entrepreneurial attitudes but they are also renowned for producing top quality research on a cost-effective basis.[16]

Each one of the above factors has had a positive impact on commercialization activities including spin-off formation. Working in combination these factors have resulted in an incredible increase in spin-off formation, especially in the last decade.

In a conversation with Peter Munsche, the University of Toronto's Assistant Vice-president of Technology Transfer, I noted several factors which he used to explain the increase in spin-off formation. These were:

- in 1990 academics at the University of Toronto were given the option to assume personal ownership of intellectual property;
- new pools of capital have been created to finance new companies, for example the Canadian Medical Discoveries Fund;
- there was a change in attitude on the part of younger academics who were more interested in becoming entrepreneurs; and
- there was also a change in attitude on the part of universities which were more interested in assisting the academics become entrepreneurs.

He summarized the situation something like this: there *were* companies being created before attitudes were as positive as they are today; but now that something is being done to help the spin-offs, they are really increasing.[17]

I also spoke with Monique McNaughton, an Intellectual Property and Contracts Officer at the University of Toronto. She discussed the impact of the change in their intellectual property ownership policy. As noted above, in 1990 the University of Toronto gave inventors the option to assume full title to the intellectual property they had developed at the university. In that year a dozen disclosures were made. 85 disclosures were made in 1998. She attributes the academics' increased willingness to commercialize to the change in policy. Before the change in policy the emphasis was on publishing findings, now the academics patent first, then publish.[18]

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[16] May, Robert "The Scientific Wealth of Nations", Feb 7, 1997, *Science*

[17] Peter Munsche, Assistant Vice-president, Technology Transfer, University of Toronto, personal communication

[18] Monique McNaughton, Intellectual Property and Contracts Officer, University of Toronto, personal communication

The number of Canadian spin-offs (in all industries) reported by 14 universities to the Association of University Transfer Managers (AUTM) doubled during the 1994 -1997 period. (In the United States the number increased by 50% during the same period.)[19] If the spin-offs in this study are grouped the same way (pre-1994 and 1994-97) the number of spin-offs incorporated in 1994-97 (34) is only 76% of the number which incorporated before 1994 (45).

Compared to the rates of formation published in the Statistics Canada 1998 Intellectual Property Study, this study's rates of formation are much lower. The lower rates are, of course, due to a lower number of companies under consideration. The Statistics Canada Study did not publish rates of formation by industry. What can be compared is the percentage increase from one decade to the next.

Rate of Formation Comparison

	Statistics Canada 1998 Intellectual Property Survey[20]	MRC 1998 Survey
Type of Spin-off	**All Canadian**	**Canadian Medical & Bio-medical**
1980 – 1989 Number of Spin-offs Incorporated	92	15
1980's Rate	9.2	1.5
1990 – 1998 Number of Spin-offs Incorporated	230	67
1990's Rate	25.5[21]	7.4
Increase in the rate of formation	177%	393%

Figure 5-7

Without additional data, I can only speculate on why the increase in the MRC rate of spin-off formation (393%) is so much higher than the Statistics Canada increase (177%). Two differences in the data may be relevant:

[19] AUTM's 1991-1997 Licensing Surveys cited in Fortier, Pierre *Public Investments in University Research: Reaping the Benefits Draft Report,* 1999, The Expert Panel on the Commercialization of University Research, p.11

[20] Bordt, Michael and Reid, Cathy "Survey of Intellectual Property Commercialization in the Higher Education Sector,1998", 1999, Statistics Canada Science and Technology Redesign Project, Ottawa

[21] recalculated from the data provided in the Statistics Canada Study (p.22); the rate published in their text (p.23) used 10 years instead of 9 years.

1) The MRC spin-offs do not include companies which have closed; and
2) The MRC spin-offs are in the medical and bio-medical industries only.

If more of the closed companies are older companies (incorporated in the 1980's), the MRC rate of formation for the 1980's would be understated.

If any of the developments in the 1990's discussed above affect the medical/bio-medical industries to a greater extent than other industries, then these differences would increase the MRC rate in the 1990's.

If any of these developments impact only the medical and bio-medical industries, such as the formation of the CMDF, these developments would also account for the difference in the increase in rates of formation.

Average Age

The average age of the 83 spin-off companies is 7.4 years.

If Pasteur Merieux Connaught is excluded the average age drops by 1 year to 6.4 years.

These low ages are as expected given that most of the companies were incorporated in the last decade.

Company Size

Both the biotechnology and medical industries have very long (7 – 15 years) product development lifecycles. Companies in these industries generally do not generate sales for an extended period of time. As a result, sales cannot be used to gauge company size when the average age is low such as in this study.

Instead, the number of people the spin-offs employ is usually used as an indicator of company size. The participants were asked for the number of people they employed

in Canada as well as the number of contract personnel not included in the first number.

The majority (89%) of the companies have less than 50 employees. Many of the companies (44%) have less than 10 employees. Figure 5-8, No. of Employees, shows how many companies fall into the specified employment ranges.

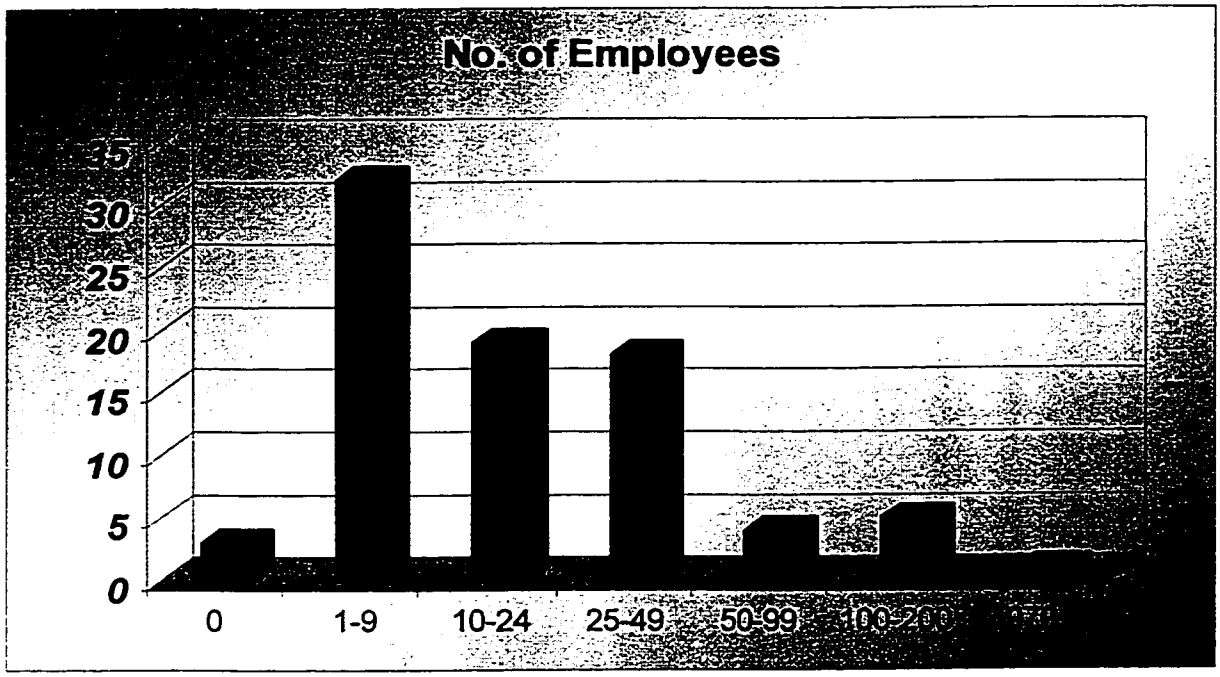


Figure 5-8

These results are comparable to those of other studies. For example, BIOTECanada's recent study found 72% of their biotechnology companies had fifty or fewer employees.[22] Ernst & Young's survey had the same result, with 30% of their biotechnology companies with 10 or fewer employees.[23]

Products, Patents & Licenses

Some of the survey questions in this section had very low response rates. Although 73 of the 83 spin-offs participating in this study answered the question on number of products only 35 answered the question on number of patents and only 27 on the

[22] Groote, Joyce, Hough, Paul and Walter, Rick *Canadian Biotechnology '98: Success from Excellence,* 1999, BIOTECanada, Ottawa, p.17

[23] Goudey, John and Nath, Deepika, *Canadian Biotech '97: Coming of Age,* 1997, Ernst & Young, Toronto, p.2

number of licenses. The averages and ratios reported below are based on the number responding to the question, not the number of spin-offs in the study.

Some of the spin-offs reported pending patents as well as issued patents. The pending patents were included in the total patents reported below. The ratio of pending to issued (excluding Connaught) is 2.25:1.

The number of companies without products outnumber the number with products by a ratio of 2:1. This finding is consistent with the findings reported above: In an industry with a long product development life cycle, young companies are unlikely to have any products. (See Figure 5-9, Spin-off Products, Patents and Licenses).

The number of companies reporting having any patents was the same as the number reporting not having any patents.

More spin-offs reported licensing technology from other companies than spin-offs reporting licensing technology to other companies. Again, this is consistent with the

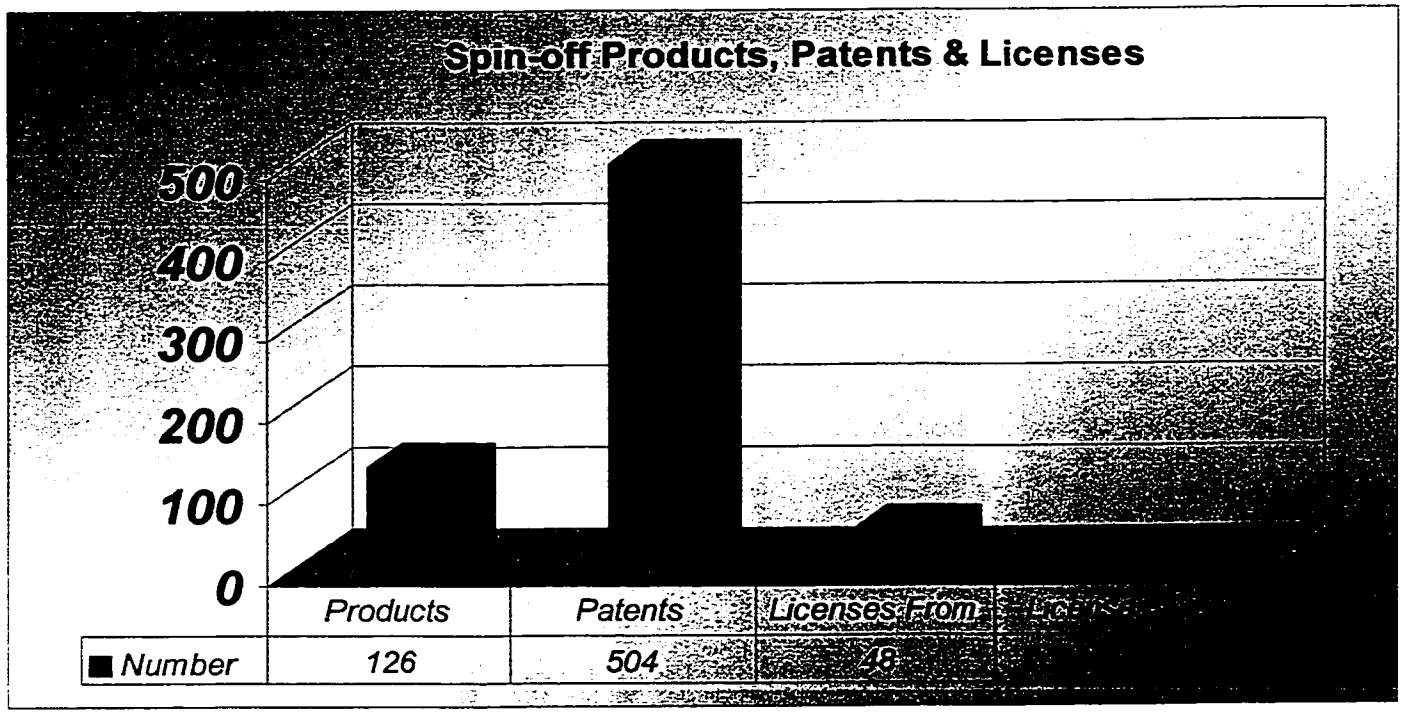


Figure 5–9

expectations of young companies, especially in a technology industry. The actual number of products, patents and licenses reported by the spin-offs is distorted by the oldest and largest participant – Pasteur Merieux Connaught.

Figure 5-10 reports the same data excluding Connaught. On average, the spin-off companies have 1.5 products each. Excluding Connaught this average becomes just under 1 each. Companies with products have on average 9.5 each; excluding Connaught they have approximately 6 each. This data and similar data for patents and licenses is displayed in Figure 5–11, Average Number of Products, Patents and Licences.

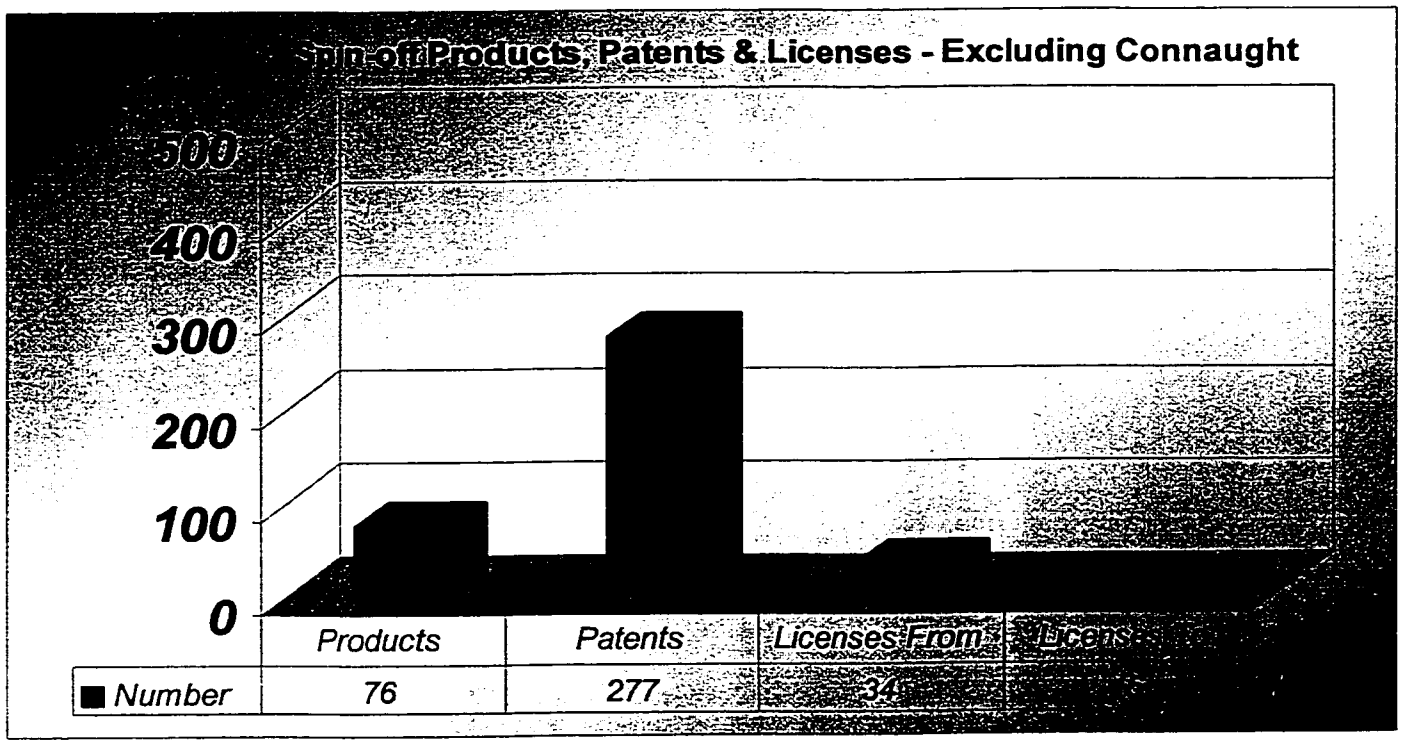


Figure 5-10

Average Number of Products, Patents and Licences*

	Products	Patents	Licenses from	Licenses to
Average	1.7	14.4	1.8	0.6
Average excluding Connaught	1.0	8.1	1.3	0.6
Average of companies with products, patents, licenses	5.0	28.0	3.4	4.2
Average of companies with products,etc. excluding Connaught	3.2	16.3	2.6	5.0

*based on the number of spin-offs which responded to each question

Figure 5–11

Stock Exchanges

Twenty-three or 28% of the spin-offs are public companies. They are listed on three of the four Canadian exchanges and two exchanges based in the USA. Six spin-offs have multiple listings. The Toronto, Vancouver and NASDAQ exchanges have over five spin-offs listed on each. Figure 5 -12, Stock Exchanges, displays all the exchanges the spin-offs are listed on.

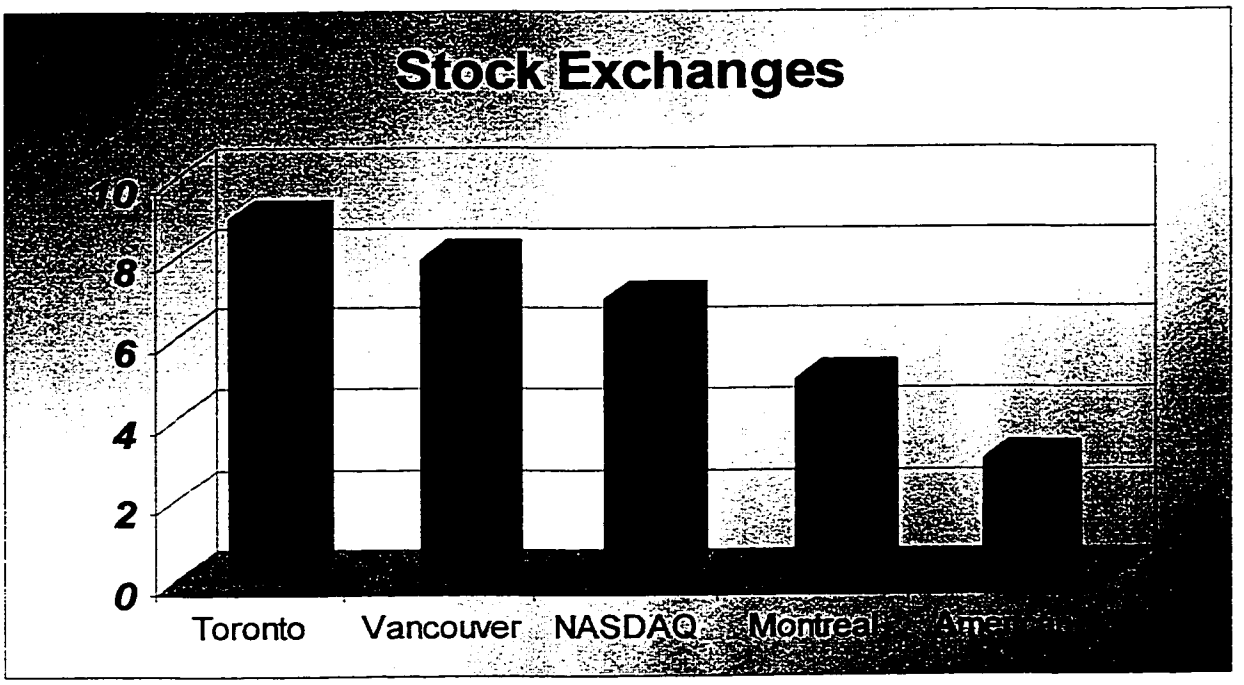


Figure 5–12

Number of Spin-offs by Province

When I first saw a table in Statistics Canada's recent study on Intellectual Property, I was struck by the similarity of two sets of numbers: their numbers on patents held by province; and my numbers on number of biomedical/medical spin-offs by province.

	Statistics Canada 1998 Intellectual Property Survey[24]	MRC 1998 Survey
	Patents Held, % of National Total	Number of Spin-offs
British Columbia	32	30
Quebec	21	21
Ontario	20	21
Atlantic	2	4
Prairies*	25	7
	100%	83

* The large difference in the Prairies can be attributed to their focus on an industry other than health care; i.e. agriculture.

Figure 5-13

Universities

This section groups the spin-offs by university. Figure 5-14, Number of Spin-offs by University, shows how many spin-offs were affiliated with each university according to the affiliation of the spin-offs' founding scientists. Note that if not all of the founding scientists for a given spin-off were from the same university then each university was given credit for the spin-off. I also gave credit to the Robarts Research Institute (RRI), not only because it was the most frequently named research institute, but also because there were three spin-offs whose founding scientists were associated with the RRI but not with any university. I also gave credit to NCE's where I knew the founding scientists were affiliated with the NCE.

[24] Bordt, Michael and Reid, Cathy "Survey of Intellectual Property Commercialization in the Higher Education Sector,1998", 1999, Statistics Canada Science and Technology Redesign Project, Ottawa, p.18

Number of Spin-offs by University*	
BRITISH COLUMBIA:	
UBC *(1st)*	26
Victoria	2
ONTARIO:	
Toronto *(2nd)*	8
Queens	4
Ottawa	4
Robarts	3
McMaster	2
Waterloo	1
Western	1
QUEBEC:	
McGill *(3rd)*	7
Laval *(4th)*	5
Montreal	3
Sherbrooke	3
ALBERTA:	
Alberta *(4th)*	5
Calgary	1
ATLANTIC:	
Dalhousie	3
Memorial	2
Acadia	1
MANITOBA	1
SASKATCHEWAN	1
National Centres of Excellence	6
* and Robarts Research Institute and Networks of Centres of Excellence	

Figure 5-14

Some of the conclusions in Chapter 8, Provincial Comparisons, led me to certain expectations about the break-down of spin-offs by university. Of course I expected the majority of the British Columbia companies to be affiliated with the University of British Columbia. Given Montreal and Quebec City's proactive policies I expected virtually all spin-offs in Quebec to be affiliated with universities in these two cities. Whereas I expected Ontario's to be spread across the province.

It turns out that Ontario *is* spread out over more universities and institutes (7) than any other province. But Quebec is not far behind with five universities and institutes, including the University of Sherbrooke which is not in Montreal or Quebec City. (The three spin-offs affiliated with Sherbrooke are not also affiliated with another university or institute in another part of the province or country). Virtually all the British

Columbia spin-offs *are* associated with the University of British Columbia. After the University of British Columbia (with 26 spin-offs) the two highest ranking universities in this study are Toronto (8) and McGill (7). As expected the top three universities, in terms of numbers of spin-offs, are from the three largest provinces. As noted in the chapter on Provincial Comparisons, size is not the only factor in determining the number of spin-offs in a province, or, in this case, from a university. Toronto is by far the largest medical school in Canada but it is not proportionately ahead in terms of number of spin-offs according to the affiliations of those participating in this study. Part of the reason is that the University of Toronto is not aware of all of its spin-offs and therefore could not provide a complete list. (McGill also expressed doubts about the completeness of its list of spin-offs.) According to Peter Munsche at the University of Toronto, there may be a number of companies which were spun-off of the University of Toronto teaching hospitals. (I did contact at least four of the teaching hospitals but had limited results.)

Alberta ranks fourth with the University of Alberta receiving credit for 50% of that province's spin-offs. Alberta has the highest proportion of spin-offs associated with the national Networks of Centres of Excellence. Four companies named the Canadian Bacterial Diseases Network located in Calgary.

The large disparity between the University of British Columbia and the other Canadian universities is due to more than the fact that the University of British Columbia helped conduct the survey and increased the response rate for its spin-offs (which in itself speaks volumes about their University Industry Liaison Office's capabilities, general attitude and state of affairs). The disparity exists because the University of British Columbia has a complete list of its spin-offs and has tried to maintain a relationship with its spin-offs. As noted above most of the other universities do not know who all their spin-offs are (notable exceptions are Queen's and Laval). In addition more UBC scientists have created two spin-offs compared to scientists from other universities. Of the seven scientists who are named as founding scientists for two spin-offs four are affiliated with UBC.

Although some of the universities do not have medical schools they have still managed to spin-off companies in the medical field. These universities are Acadia, Victoria and Waterloo. Each of their spin-offs was associated with a Faculty of Science. The departments were chemistry, biochemistry and microbiology.

Summary

Most of the spin-offs are less than ten years old. There were 4.5 more spin-offs created in the 1990's than in the 1980's. Just over 50 per cent of the spin-offs are in the active stage of development. Over 60 per cent are in the pharmaceutical industry. The majority of the companies have less than 50 employees; almost half have less than 10. On average the spin-offs have one product each. Twenty-eight per cent of the spin-offs are listed on public stock exchanges. The university with the most spin-offs participating in this study is UBC. It achieved this standing because: it maintains an ongoing relationship with its spin-offs; four of its scientists have created more than one spin-off in the medical field; and it has had a proactive approach to spin-off creation for some time. The University of Toronto, with the largest medical school in Canada, placed a distant second. With McGill University in third place and the University of Alberta in fourth, the four largest provinces are represented in the four highest rankings in terms of number of spin-offs participating in this study.

Sources of Funds

The objective of this portion of the study was to determine which sources of funding supported the spin-offs both in terms of financing the development of their founding technology and in terms of financing the careers of their founding scientists. The Medical Research Council was particularly interested in knowing how its funding of basic research impacts the Canadian economy. Before this study began, it knew on an anecdotal and individual "success story" basis that scientists which had been long-term recipients of MRC grants were starting companies. But it did not have a database which could quantify their impact. The MRC also sensed that there were more companies in Canada starting out with a technology that had been developed with funding from the MRC than it was aware of. Given that the federal government invests over five billion dollars each year in science and technology[1] and that the MRC distributes $240 million a year in grants for medical research, it expected the results of the funding questions to indicate that the formation of medical and biomedical spin-offs has benefited from MRC funding.

Each company was asked the same open-ended question about the funding of its founding technology and the careers of each of the founding scientists. They listed the principal (or critical), secondary (or significant) and other (or minor) sources of funding separately. The companies were permitted multiple responses for all categories of funding. Many companies chose not to list other (minor) sources of funding. The companies were also asked to categorize the sources (in case I was not familiar with the source) as:

- Government;
- Not-for-profit;
- University;
- Industry;
- Canadian; and/or
- Foreign

[1] Bordt, Michael and Reid, Cathy "Survey of Intellectual Property Commercialization in the Higher Education Sector,1998", 1999, Statistics Canada Science and Technology Redesign Project, Ottawa

During the data entry phase of the study I added additional categories to provide for categories not anticipated at the beginning of the study (e.g. equity) and to sub-divide categories requiring more analysis (for example, government was divided into federal and provincial).

Founding Technology

First, each Canadian source of funding named for the founding technology of the 83 spin-offs was placed in one of the following categories:

- Federal Government;
- Provincial Governments;
- Equity;
- Not-for-profit; and
- University.

The results show that the federal government dominates all levels of funding (principal, secondary and minor). Equity is the second most important source of funding for the spin-offs founding technology (as principal and secondary sources) of funding. The other three sources (provincial governments, not-for-profit organizations and universities) pale in comparison to the federal government and equity as sources of funding for the development of the spin-offs' founding technology.

Only as a minor source of funding does not-for-profit organizations rate higher than equity.

The results are displayed in Figure 6-1, Canadian Funding Sources – Founding Technology. The vertical axis indicates the number of times a fund in a particular category was named.

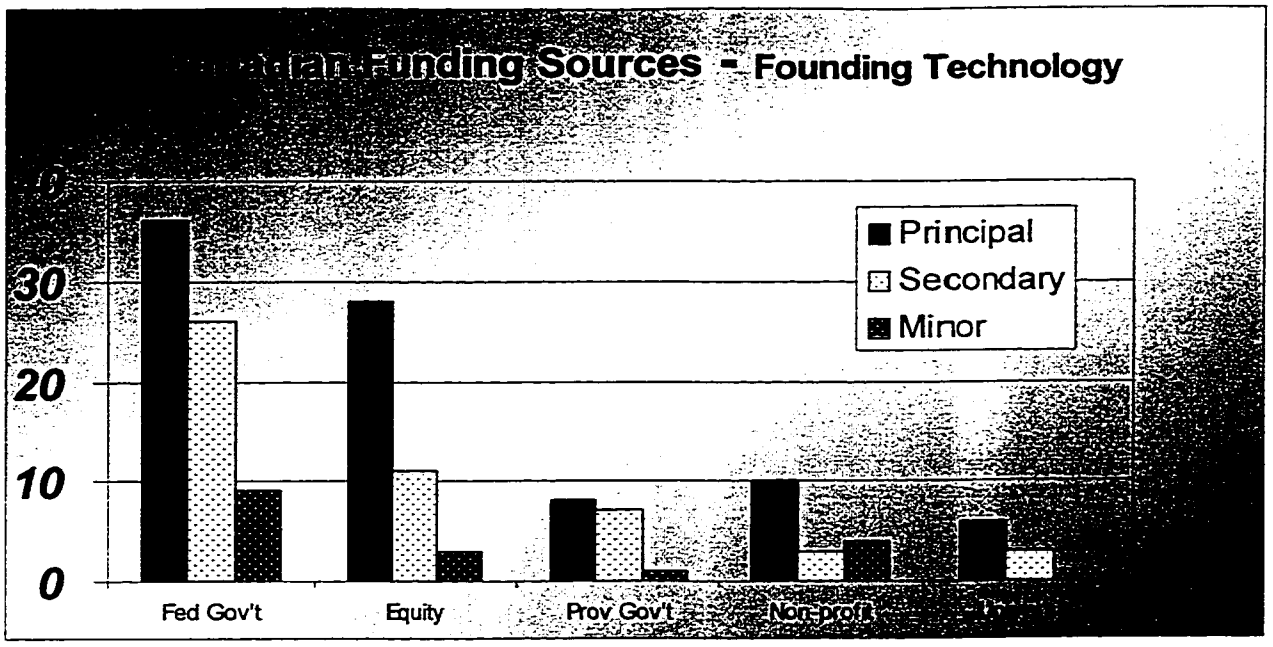


Figure 6–1

Agencies of the federal government were named by 36 spin-offs (43 per cent) as a principal source of funding for their founding technology. As principal, secondary and minor sources of funding, federal agencies were named by 71 spin-offs (85 per cent).

In the next two graphs the vertical axis changes to a percentage: the percentage of companies naming a particular federal agency or program. This change was made in order to compare funding sources named by the spin-off companies to those named by the companies which are not spin-offs, which are far fewer in number (22 versus 83). The companies which are not spin-offs are not representative of all non-spin-offs in Canada. They are simply the companies which participated in the survey but did not meet the definition of spin-off.

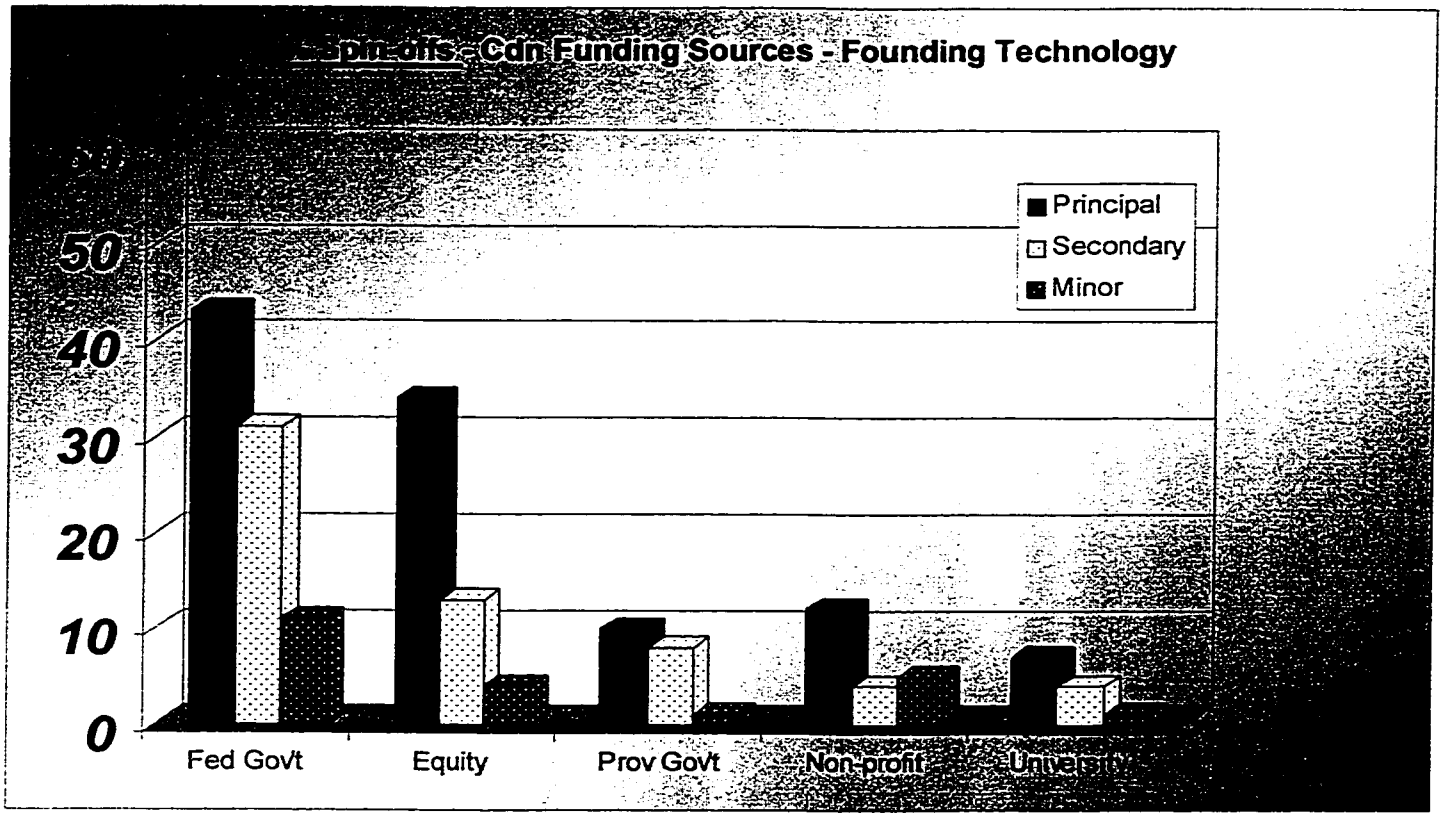


Figure 6-2

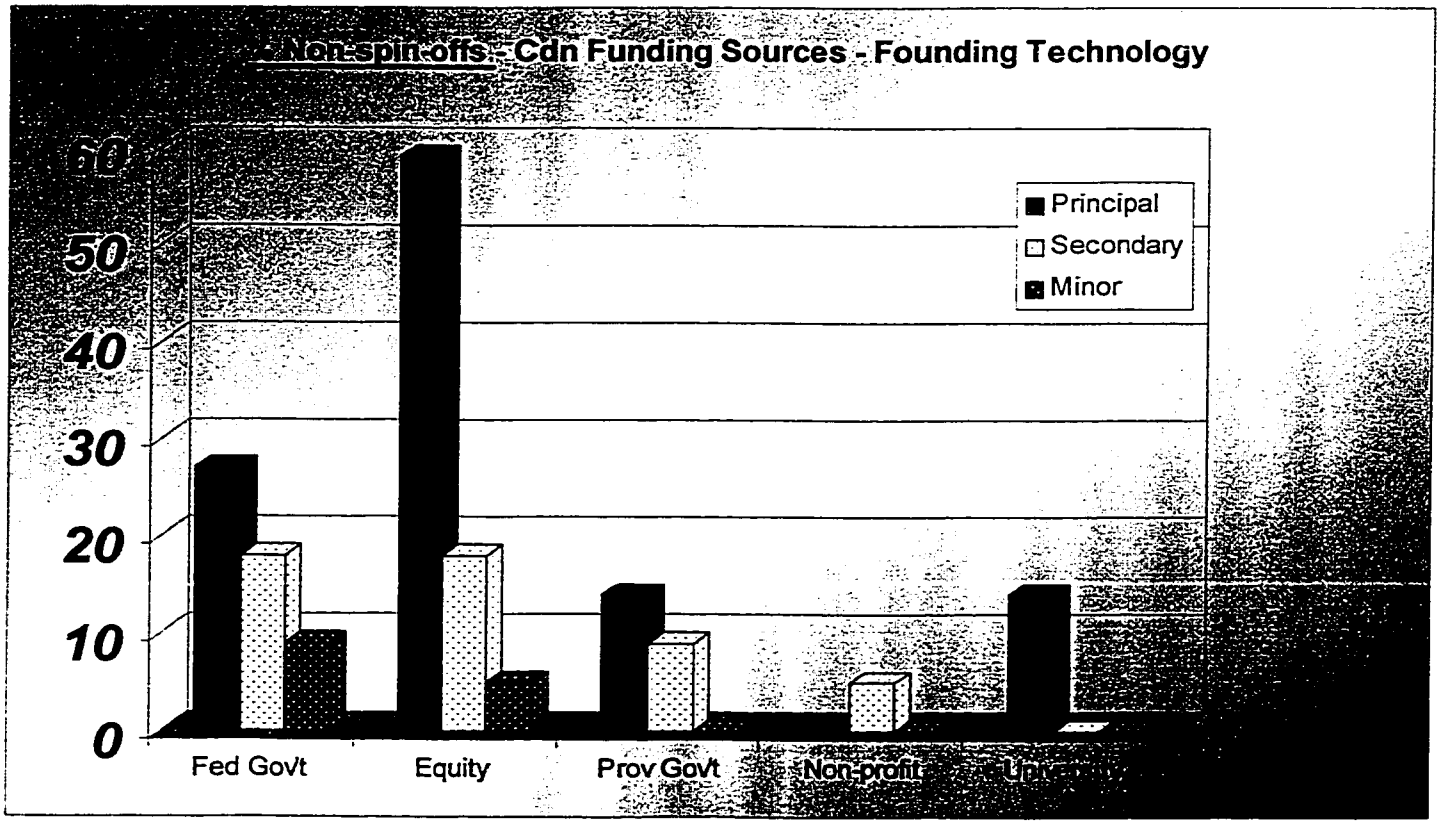


Figure 6-3

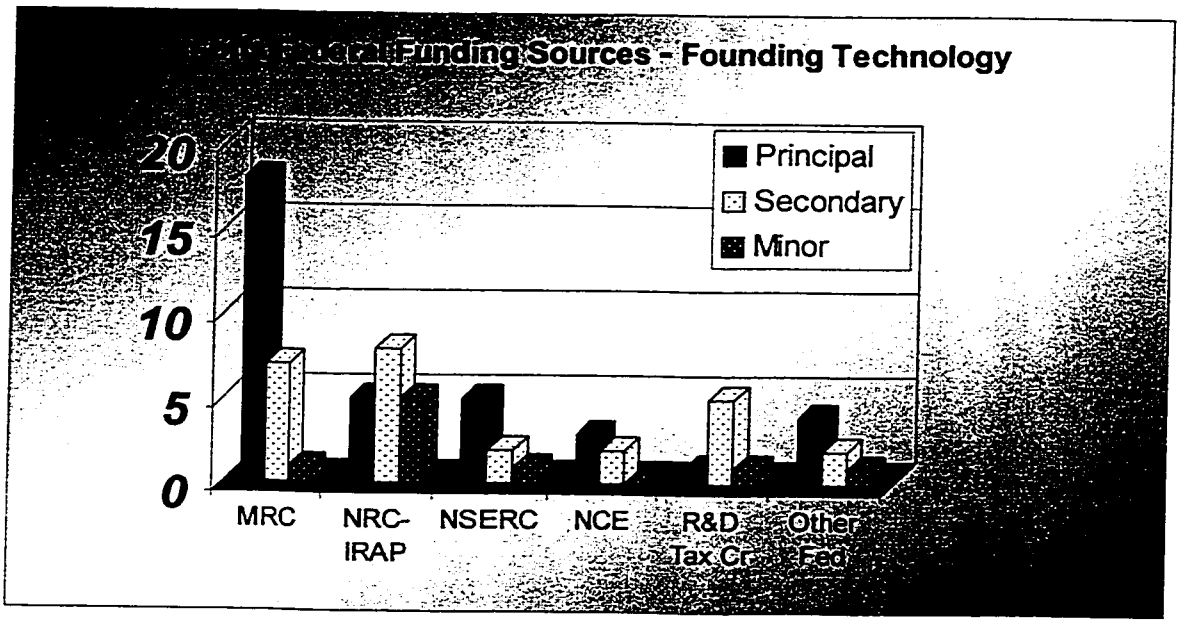
By comparing the two graphs one can see that the companies which are not spin-offs rely on equity financing for their founding technology far more than the spin-offs (59% versus 34%). The spin-offs receive more funds for the development of their founding technology from the federal government. Although to a much lesser extent, spin-offs are also more likely to have received funds from not-for-profit organizations than companies which are not spin-offs. Companies which are not spin-offs consider the provincial governments and universities as sources of funding for their founding technology more often than the spin-offs. Given that spin-offs develop their founding technology in a university setting by definition I would have expected spin-offs to give more credit to universities than companies which are not spin-offs. But this is not the case (for reasons yet to be determined).

Figure 6-4, Spin-offs Federal Funding Sources – Founding Technology, shows the breakdown of the federal category into the specific programs named by the spin-off companies. Of all the federal sources the MRC was named most often (18 times) as a principal source of funding for the spin-offs founding technology. The NRC's Industrial Research Assistance Program (IRAP) and NSERC tied for second place as principal sources of funding. The NRC/IRAP program was named most often (8 times) as a secondary source of funding. As a secondary source, the MRC placed second with 7 occurrences. Scientific Research and Development Experiment tax credits placed third with five spin-offs naming it as a secondary source of funding for its founding technology.
The low showing for the R&D tax credits was in line with expectations, since the spin-offs' founding technology was developed in a university or research institute.

The following programs are included in the "Other" sub-category:

- Atlantic Canada Opportunities Agency;
- Canadian Genome and Technology;
- IDRC Ottawa;
- Industry Canada;
- Industry, Science and Technology Canada; and
- Western Economic Development Fund.

Figure 6-4



The next two graphs compare spin-offs to non spin-offs with respect to federal sources of funding.

The graphs reveal that a spin-off company is more than twice as likely to name the MRC as a principal source of funding for its founding technology. The opposite is true for the NRC/IRAP program: companies that are not spin-offs named NRC/IRAP as a principal source of funds for its founding technology more than twice the number of times as a spin-off company. For the other agencies and programs the difference is not as apparent.

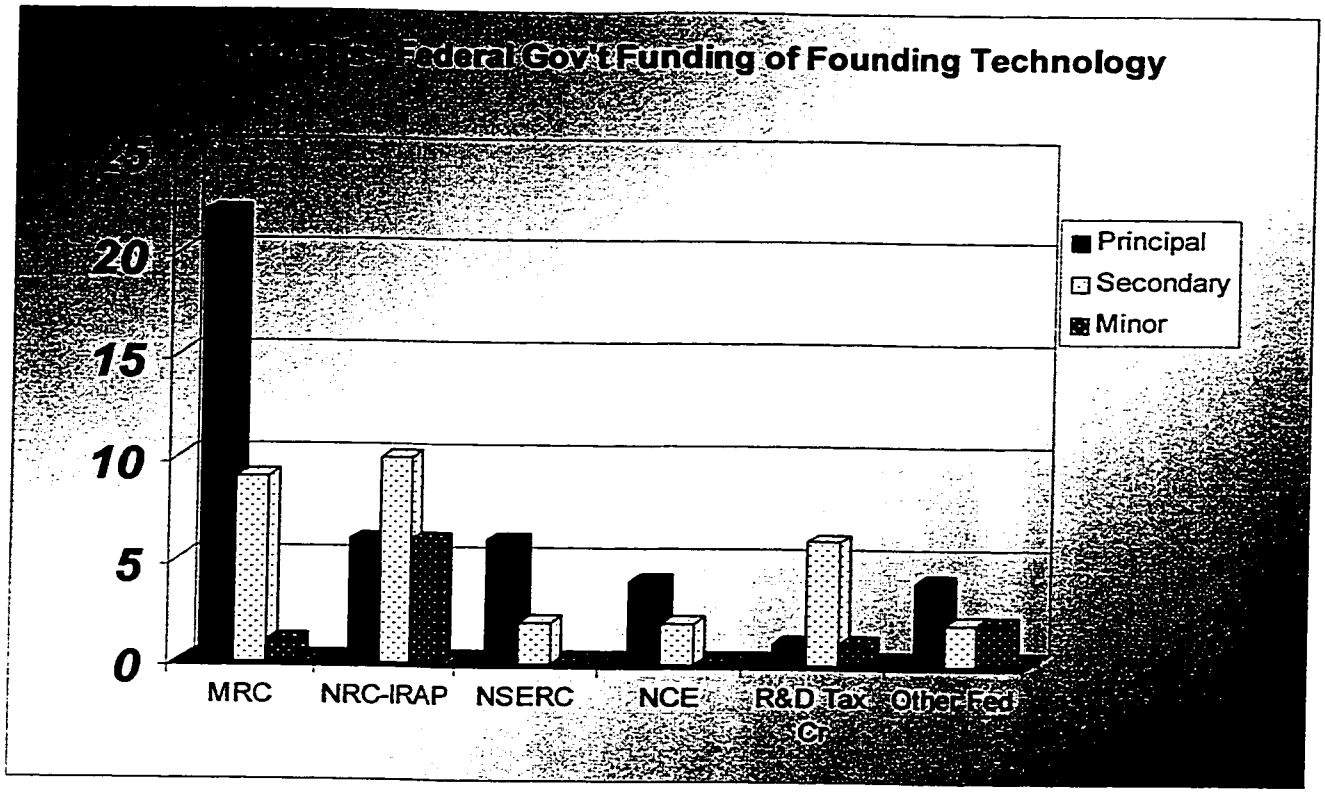


Figure 6-5

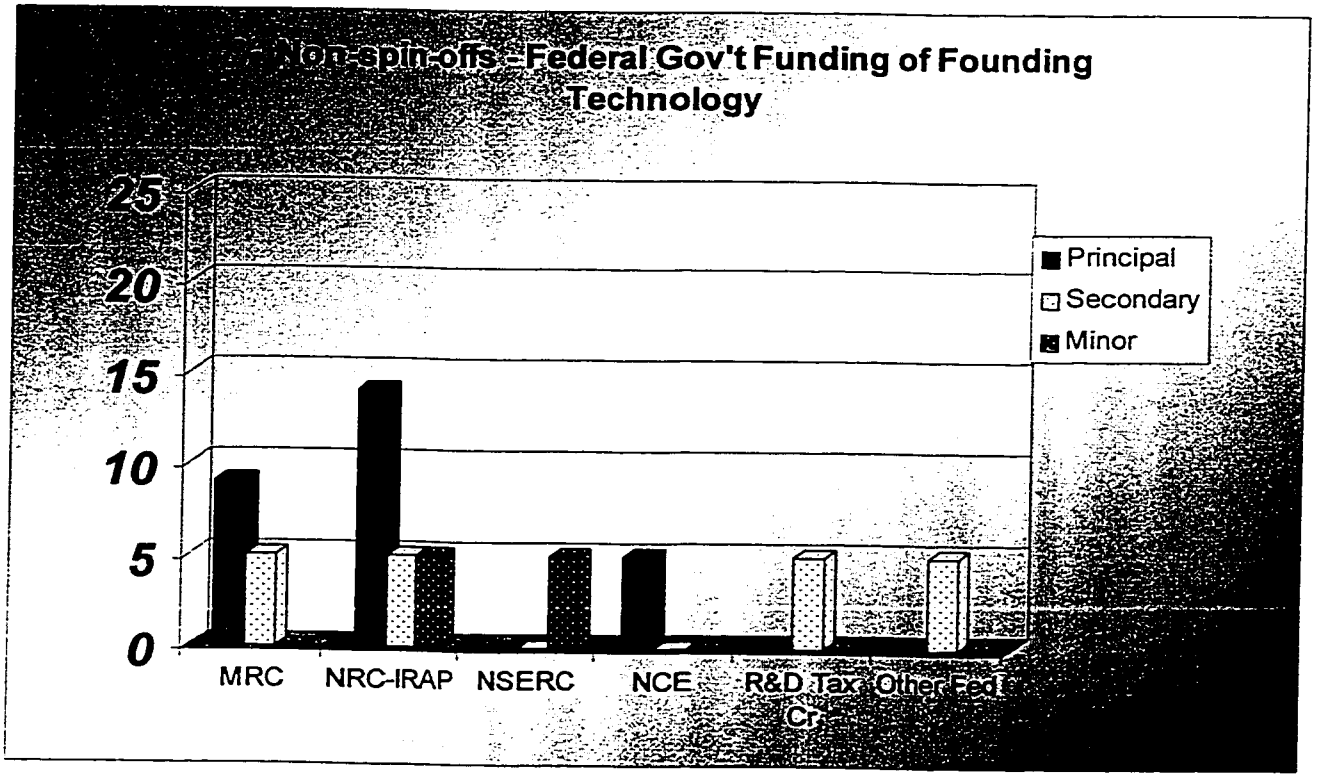


Figure 6-6

It should be noted that there is a small difference in the response rates for this question. 91% of the 83 spin-off companies answered the question on the funding of the company's founding technology whereas 82% of the 22 companies which are not spin-offs answered this question.

The equity category was divided into five sub-categories:

- Venture capital;
- Personal;
- Public;
- Industry; and
- Other

Venture capital was named most often as a source of equity financing and industry was named least often. Industry refers to large pharmaceutical companies and companies related to the spin-offs. The results are shown in Figure 6-7, Equity Breakdown.

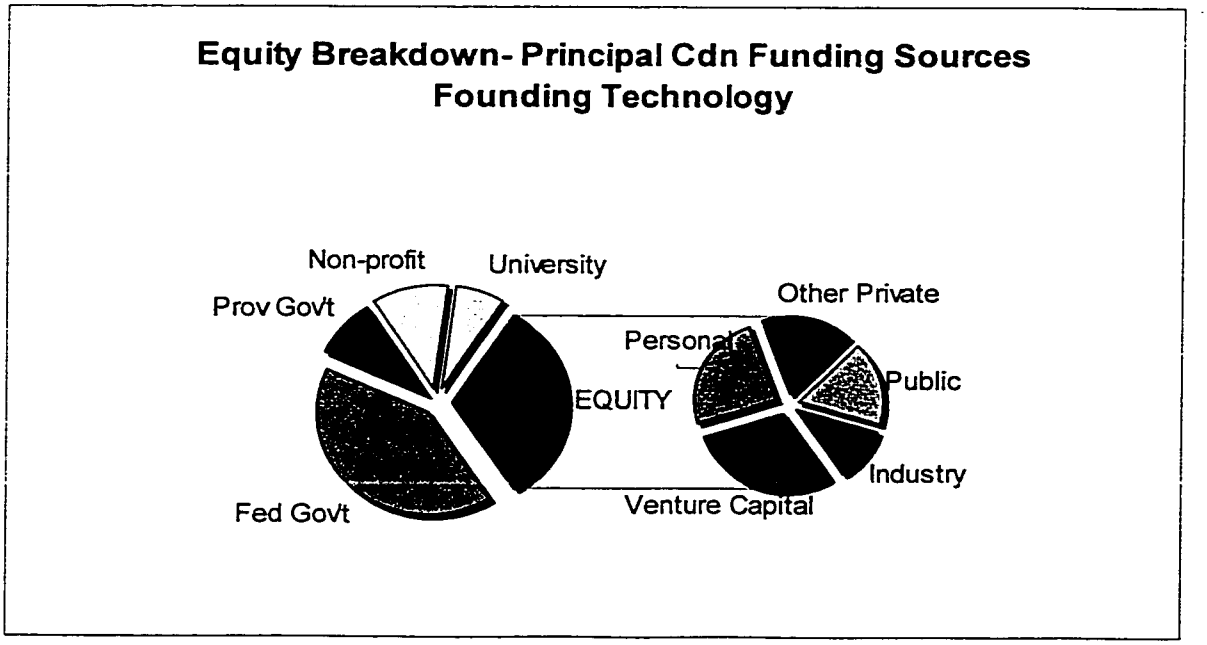


Figure 6–7

The next two graphs compare the spin-offs' and non-spin-offs' sources of equity financing. The main difference is the non-spin-offs' higher reliance on equity as a source of funding their founding technology overall. 59% of the 18 non-spin-offs who answered this question name a type of equity financing as a principal source of funding for their founding technology whereas only 34% of the 76 spin-offs who answered the question do the same. The companies which are not spin-offs rely on venture capital to a much greater degree (23% versus 10%). They are also more dependent on public sources of equity and industrial sources.

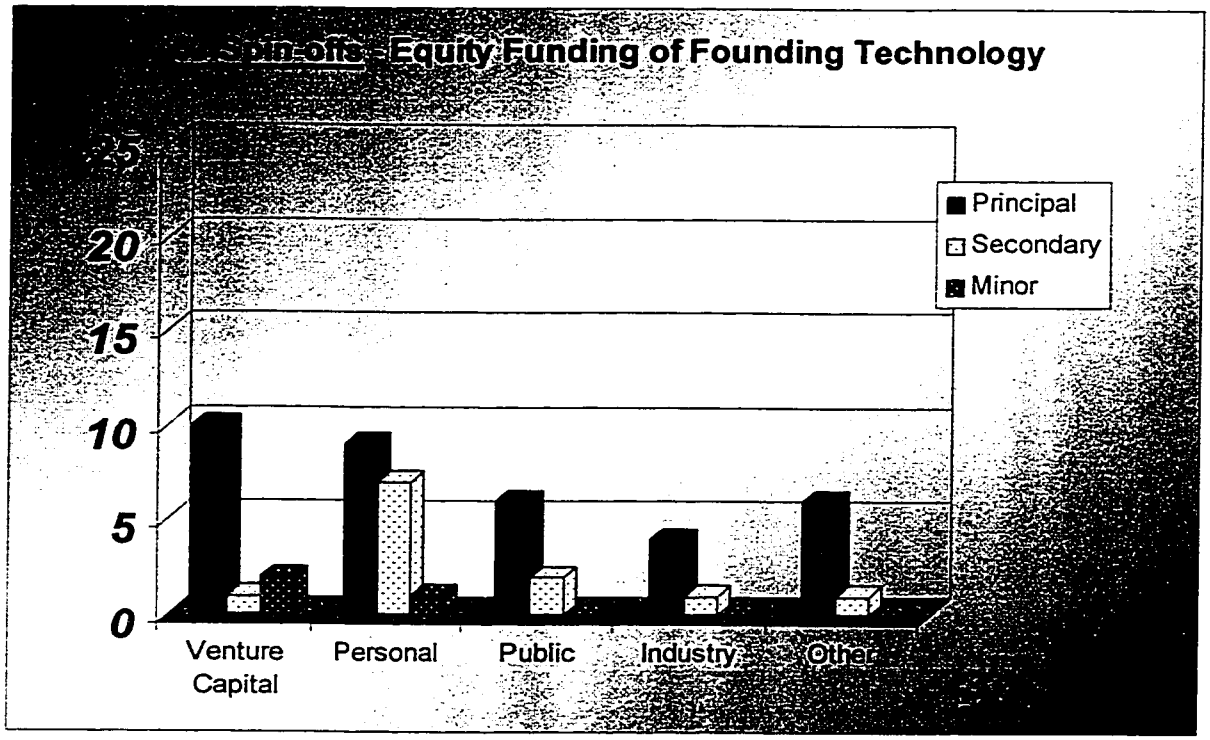


Figure 6–8

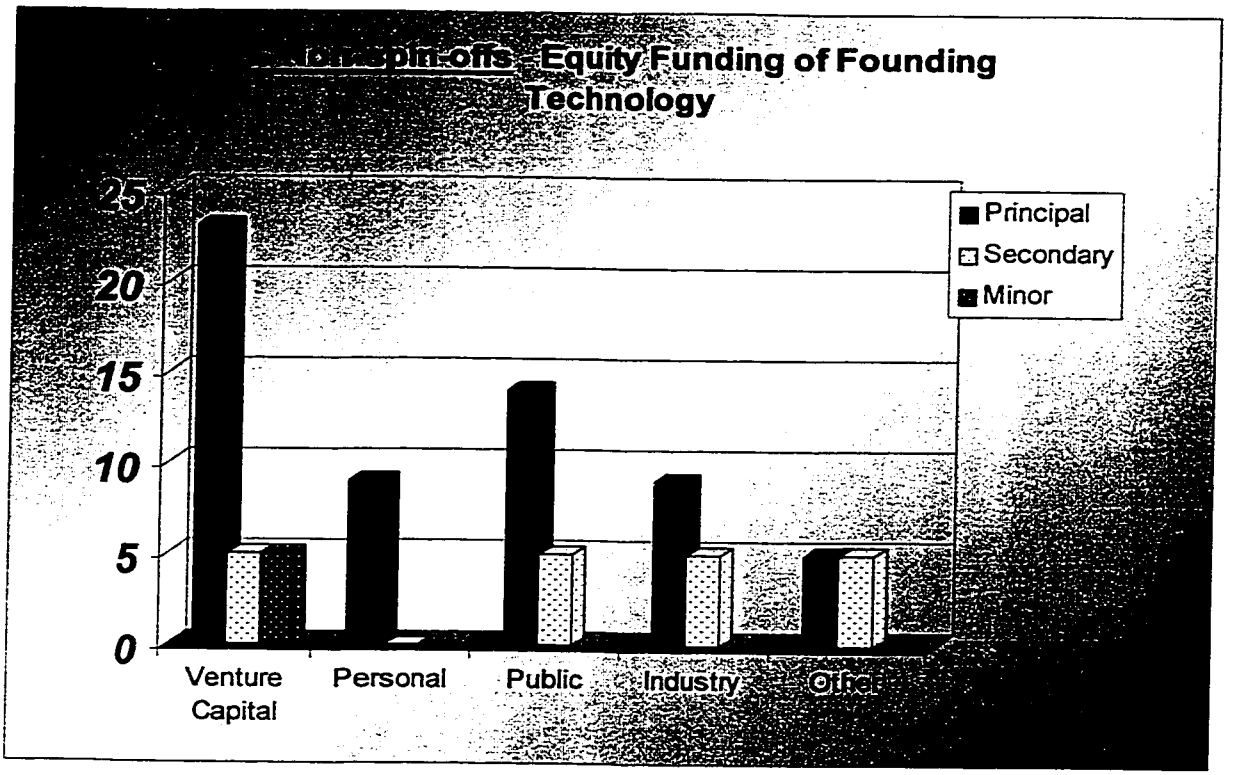


Figure 6–9

Figure 6-10, Non-profit Breakdown shows that the National Cancer Institute of Canada was named most often in this category as a principal source of funding of the spin-offs' founding technology.

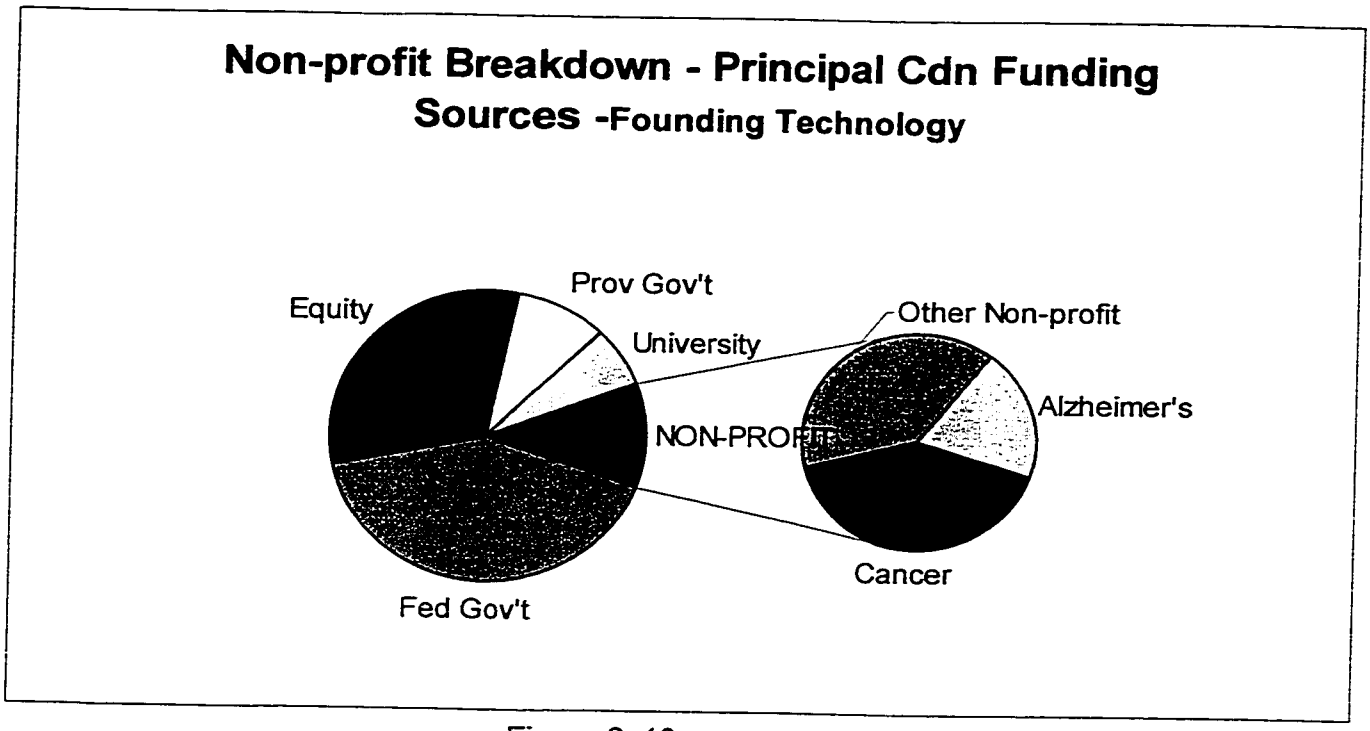


Figure 6–10

Up to this point the sources of funds under consideration have been Canadian sources only. 31% of the spin-offs developed their founding technology with financial assistance which originated outside Canada. These foreign sources included large pharmaceutical companies, foreign governments, not-for-profits, foreign universities and public equity.

The next two graphs add foreign sources of funds to complete the picture of how founding technology is funded.

Foreign sources of funds for the development of the spin-offs founding technology make up 11% of the principal sources and 18% of the secondary sources. I have included graphs of both principal and secondary sources of the foreign sources of funds because their sub-categories' ranking differ significantly. In Figure 6-11, Principal Foreign Sources – Founding Technology, funds from industry is the highest-named source. In Figure 6-12, Secondary Foreign Sources – Founding Technology, the National Institute of Health (USA) and other government sources represent almost 50% of foreign sources with not-for profit and industry making up the remainder equally.

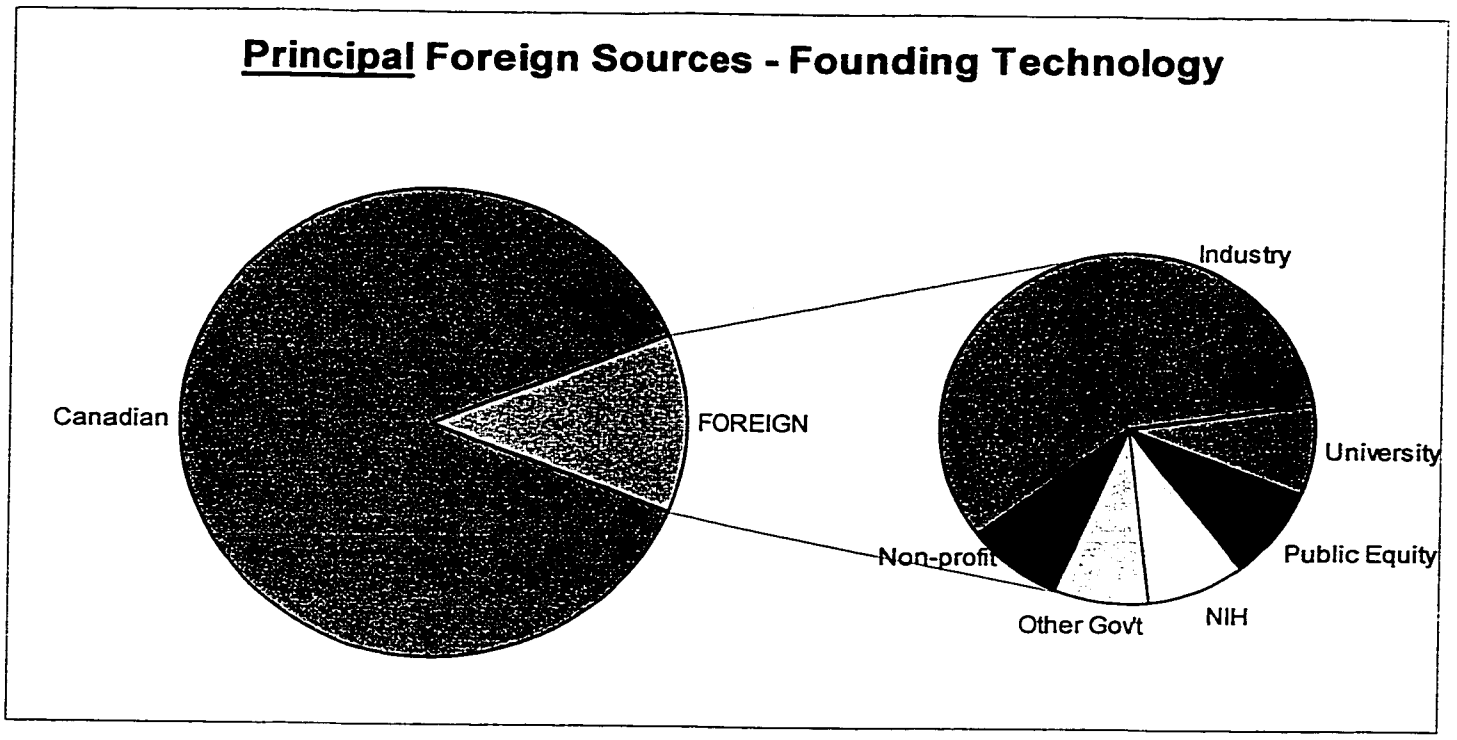

Principal Foreign Sources - Founding Technology
Canadian
FOREIGN
Industry
University
Public Equity
NIH
Other Gov't
Non-profit

Figure 6-11

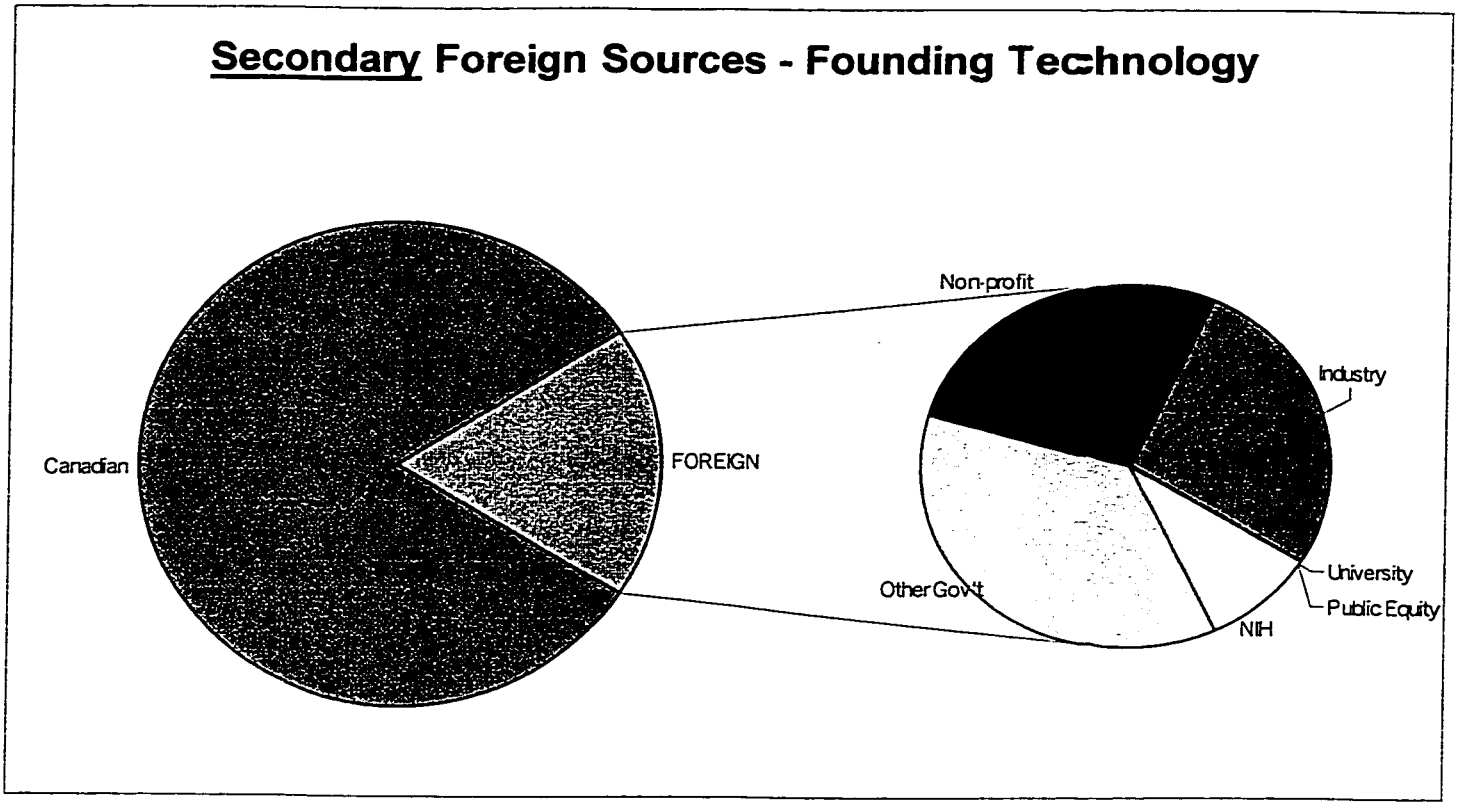


Figure 6–12

Founding Scientists

In a similar fashion the participants in the survey were asked to name the principal, secondary and minor sources of funding for the careers of the founding scientists.

It should be noted that the data provided as answers to this question may not be as reliable as the answers to the question on the funding of the founding technology. In answer to the question on the founding scientists some of the respondents simply indicated that the answer was the same as the answer to the question on the founding technology. Or they completed the question for one scientist and indicated that the same answer applied to the remaining scientists.

For example, the first graph in the series on the funding of the founding scientists, Figure 6-13, Canadian Funding Sources – Founding Scientists – Number of Scientists, shows Equity as a principal source for 14 of the founding scientists. Equity was not expected to be named for the founding scientists so frequently, if at all (as it was for the founding technology)

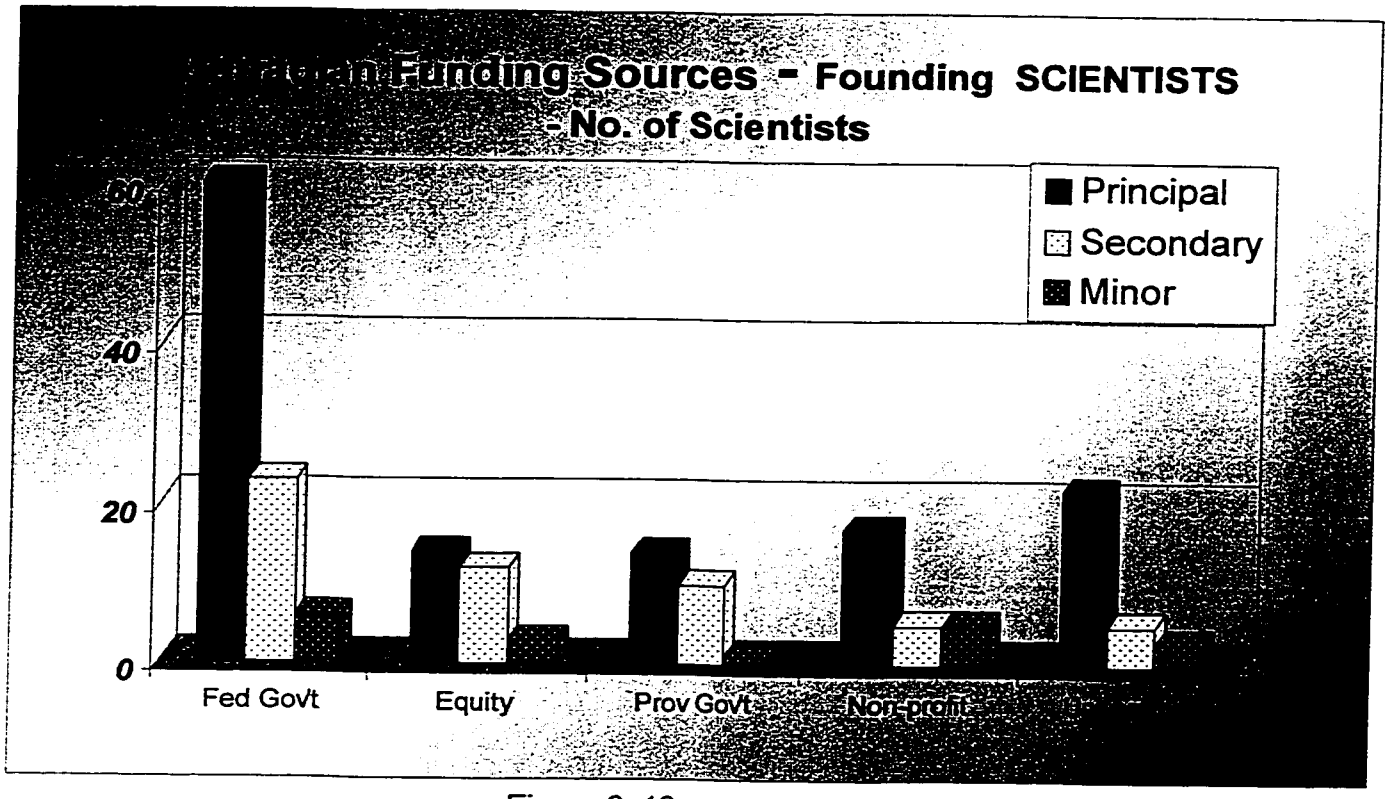


Figure 6–13

As a principal source of funding for the careers of the founding scientists the federal government is by far the most-named source. Universities came second with not-for-profits, provincial governments and equity close behind.

The next two graphs compare the results of the founding scientists from companies which are spin-offs to the results of those which are not. The vertical axis indicates the percentage of companies in which one or more scientists named the source of funding.

Equity was not an expected response for the founding scientists. Double-checking the questionnaires revealed several cases where the respondent simply referred the reader back to the answer to the founding technology question. In two cases the equity responses referred to University Medical Discovery Inc., a subsidiary of the Canadian Medical Discoveries Fund, which provides capital to "Canadian researchers to demonstrate and protect the full potential of their medical discoveries".[2]

[2] Canadian Medical Discoveries Fund internet site

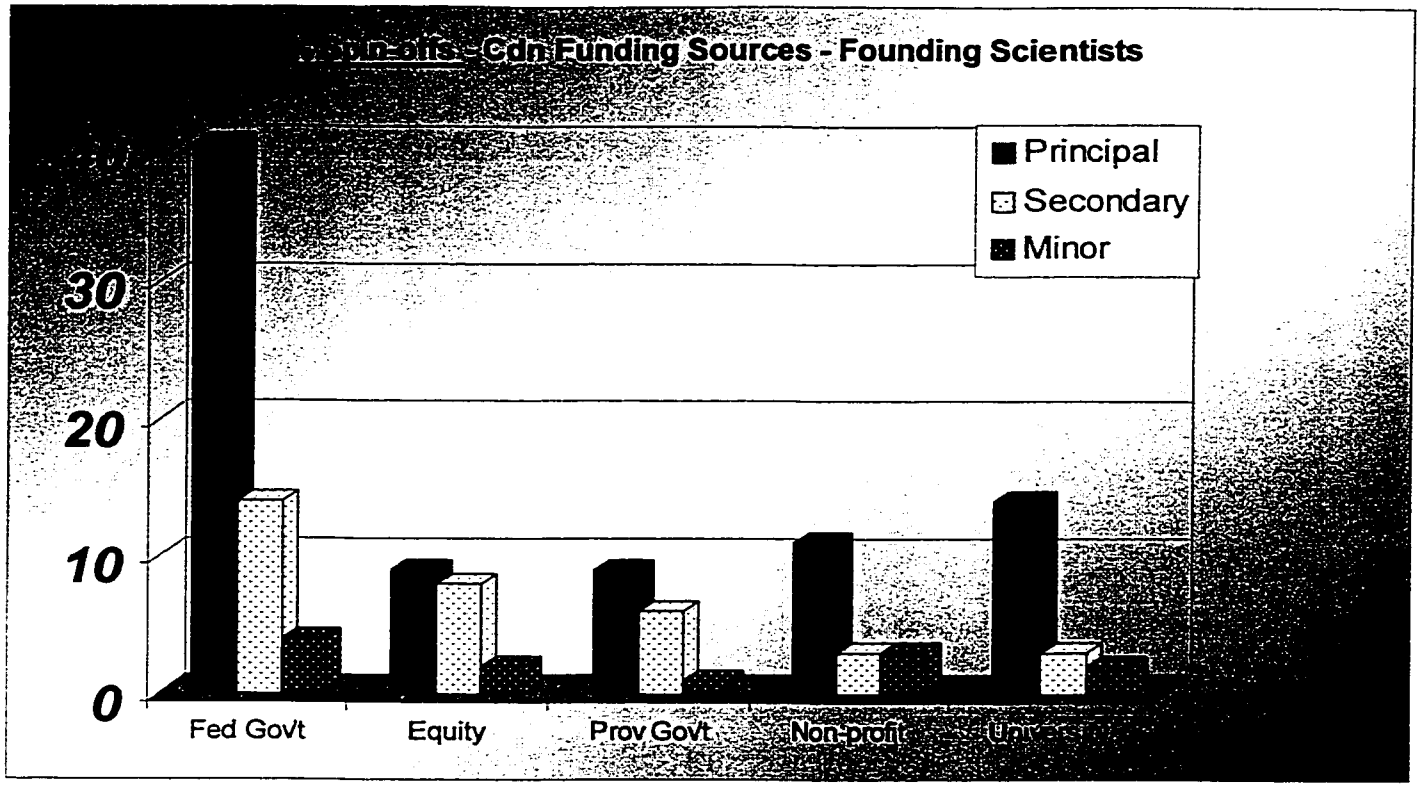


Figure 6–14

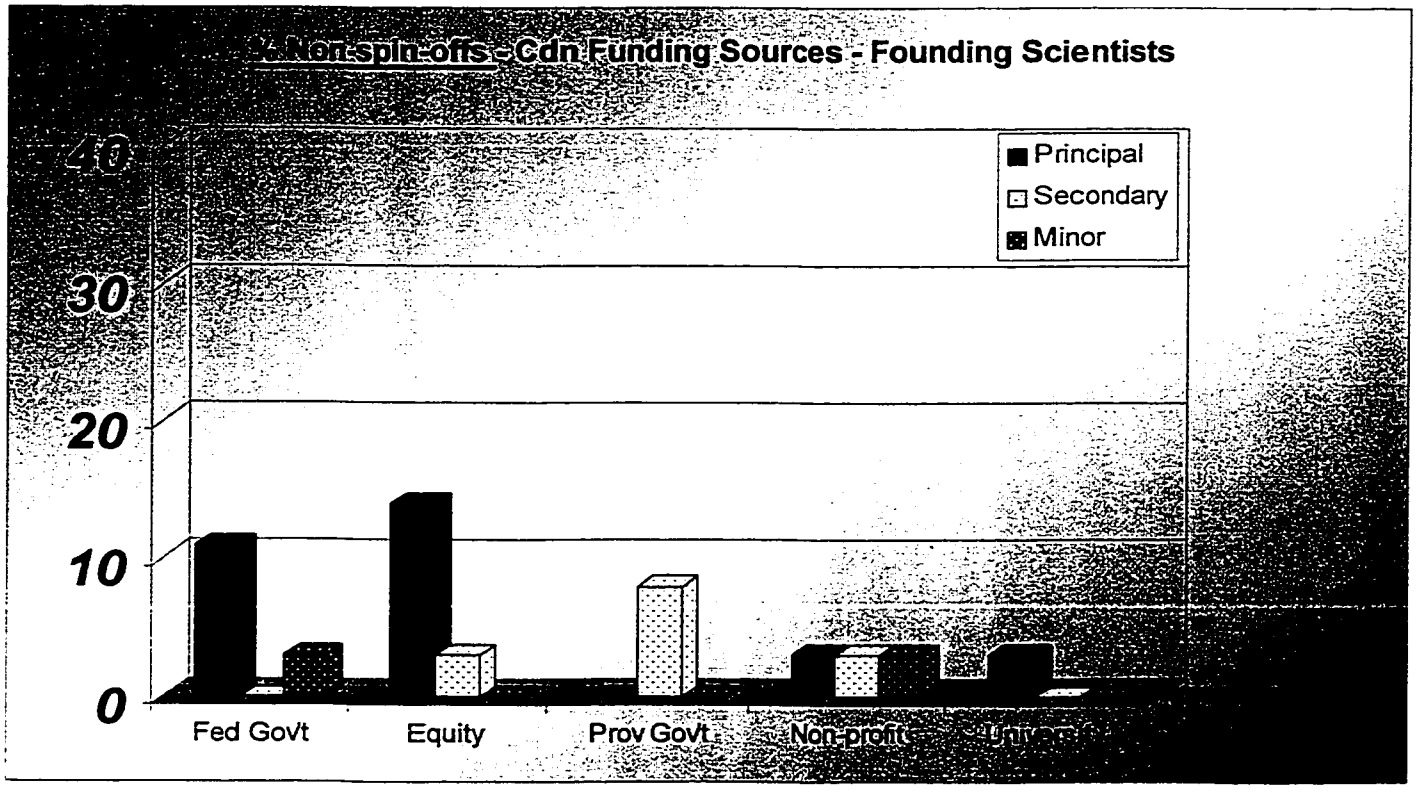


Figure 6–15

The differences between the two graphs can be partially explained by differences in response rate. All of the 83 spin-offs answered the founding scientist funding question for at least one of the founding scientists, whereas only 68% of the 22 companies which are not spin-offs responded to this question.

That being noted, these two graphs still show that scientists starting companies from university-developed technology are far more likely to have secured funding from federal agencies and programs. As can be expected, they are also more likely to name a university as a source of funding. The spin-off scientists also benefit from more grants from not-for-profits.

The scientists from companies which are not spin-offs are slightly more likely to name equity as a principal source of funding and provincial government agencies and programs as a secondary source. Usually a government grant from an agency which uses a peer review evaluation process, such as the MRC, gives the scientist additional credibility with other granting agencies in all sectors.

Figure 6-16, Federal Funding Sources – Founding Scientists, shows how many scientists in the spin-off companies named various federal agencies and programs as principal, secondary or minor sources of funding for themselves. 41 (26%) of the 158 spin-off founding scientists named the MRC as a principal source of funding making it the highest-named principal source of funds in all categories.

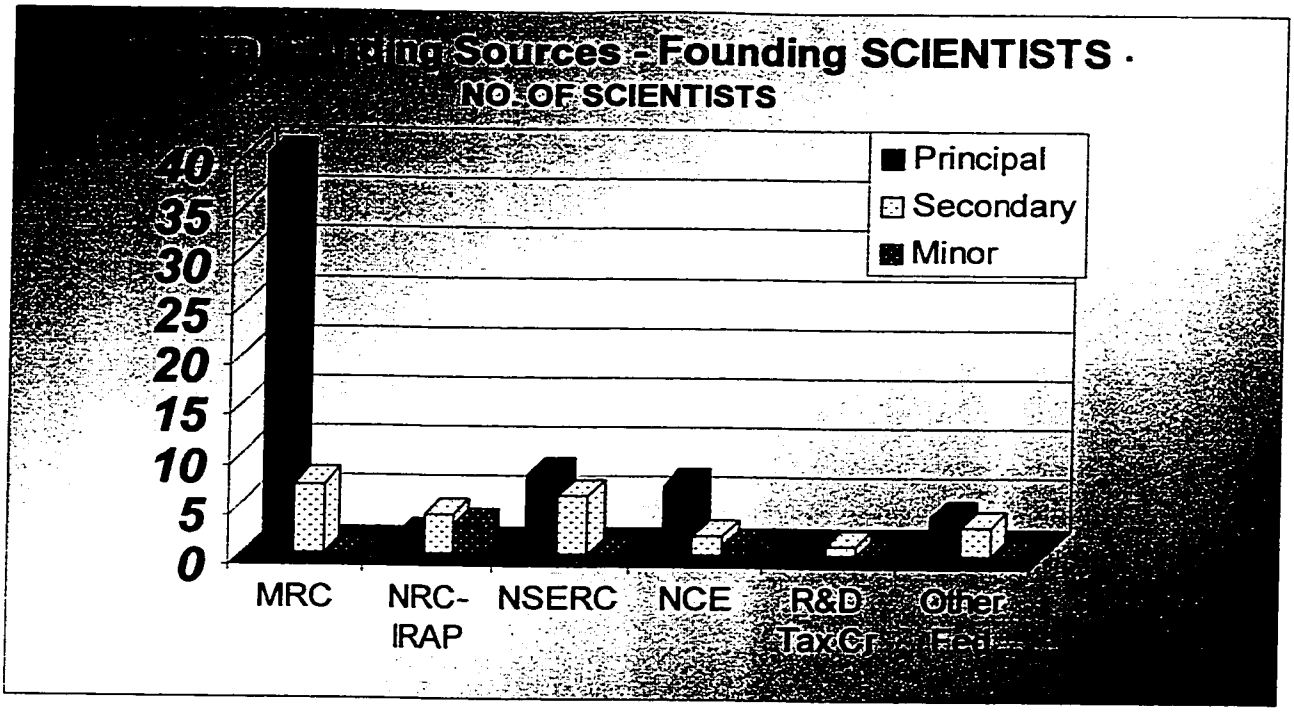


Figure 6–16

The Question of Bias

The MRC is the dominant source of funding for the founding scientists and, to a lesser extent, for the spin-offs founding technologies. The MRC was named as a principal source of funding for the founding scientists over five times more often than the second highest source (NSERC). Are these results reasonable? Is it reasonable for the MRC to be the most-named source of funding for both the founding technology and the founding scientists?

Initially the results appear reasonable if you consider that:

1) all of the spin-offs are in the medical and biomedical industry sectors;
2) all of the founding technologies originated in universities; and
3) the MRC's principal mandate is to fund medical research performed by scientists associated with medical schools.

But is it reasonable for the MRC to be named more often than not-for-profits and provincial governments combined? Perhaps. Or perhaps there was a bias that resulted in the dominance of the MRC. First I considered whether there was bias in the selection of companies. It's true that the first companies on the mailing list were

those provided by the MRC, mostly CMDF and UMDI companies. But considerable time and effort was spent obtaining lists of potential spin-offs from across the country; principally from the technology transfer offices of the 16 universities with medical schools. Although MRC personnel were familiar with many on the mailing list, they were also surprised at the number they had not heard of. I have concluded that there is no reason to suspect bias in the selection of companies sent questionnaires.

The second question is whether or not there was bias on the part of the respondents because the survey was from the MRC?

To answer this question I made two sets of comparisons. As noted above, almost all the UBC spin-off companies were surveyed in person by UBC personnel. All other companies were surveyed by mail or fax. These questionnaires were attached to a covering letter on MRC letterhead. If the questionnaire answers were biased towards the surveyor these should be evidence of:

1) the UBC surveyed companies naming the MRC as a funding source less often than the other companies; and
2) the UBC companies naming UBC as a funding source more often than the other companies.

It turns out that there is evidence of both.

Figure 6-18 shows that 8% of the UBC-surveyed spin-offs named the MRC as a principal, secondary or minor funding source of their founding technology whereas 40% of all other spin-offs did so. The results from the question on the funding of the founding scientists are less dramatic: 19% compared to 33%. (See Figure 6–17.)

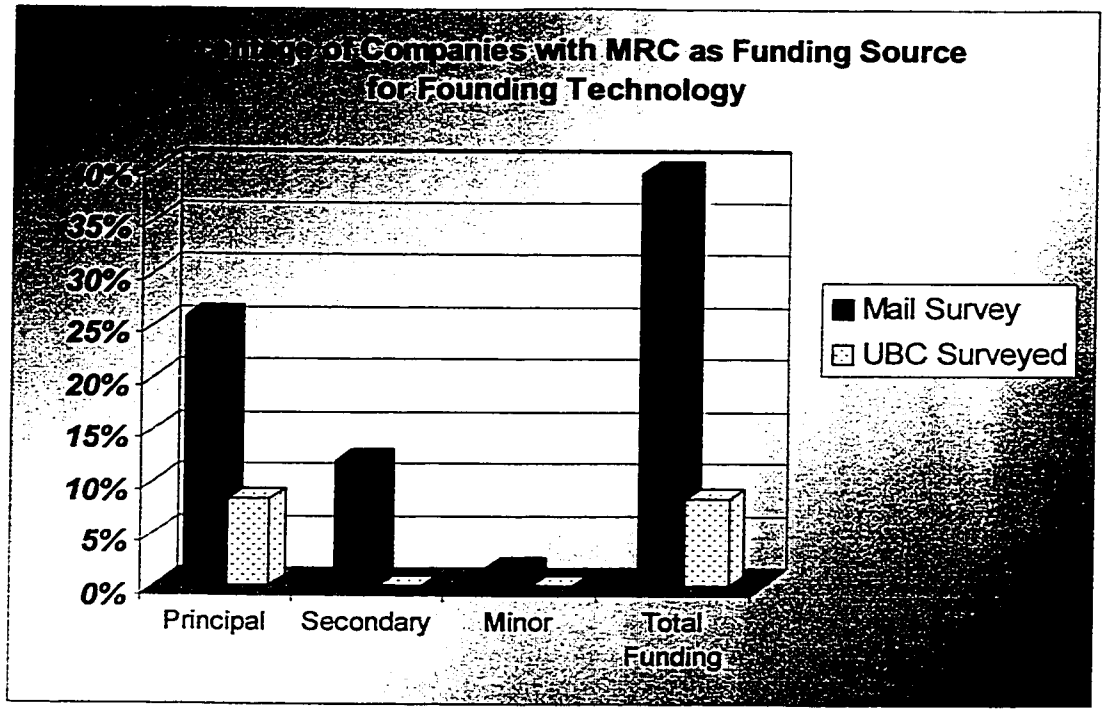


Figure 6-17

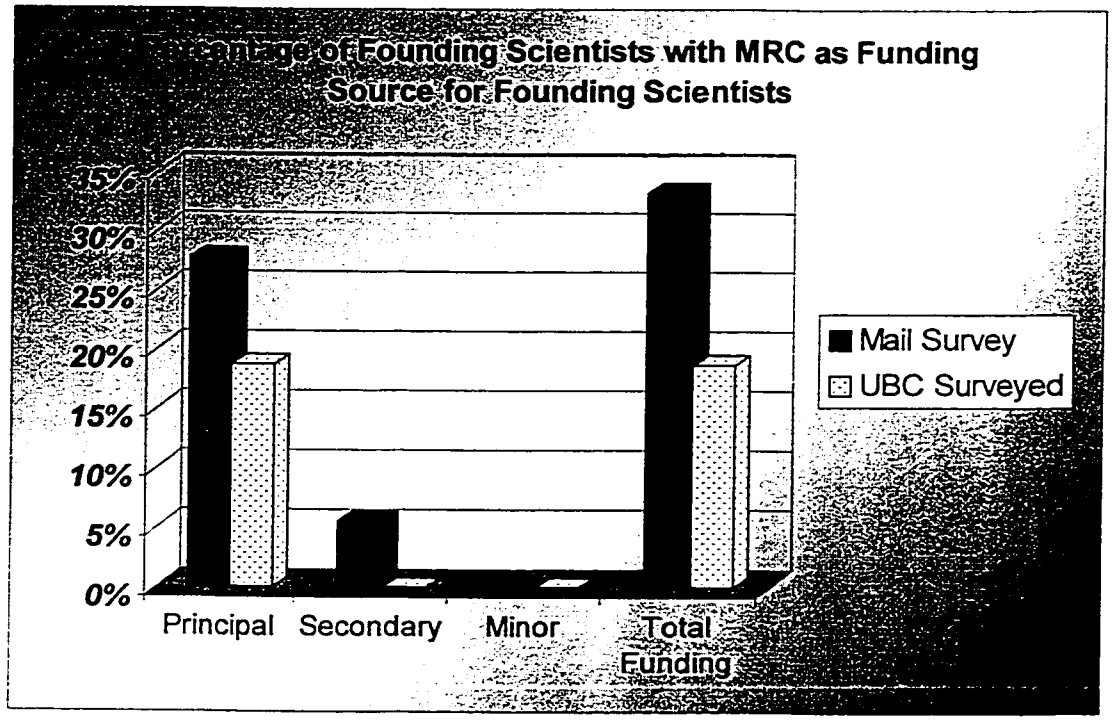


Figure 6-18

Figures 6-19 and 6-20 compare the number of times a university is named as a principal, secondary or minor source of funding for the two groups of spin-offs. 17%

of the UBC-surveyed spin-offs named their university as a source of funds for their founding technology. In all cases the university was named as a principal source. 12% of the other spin-offs named university as a funding source and these were spread out over all three categories (principal, secondary and minor).

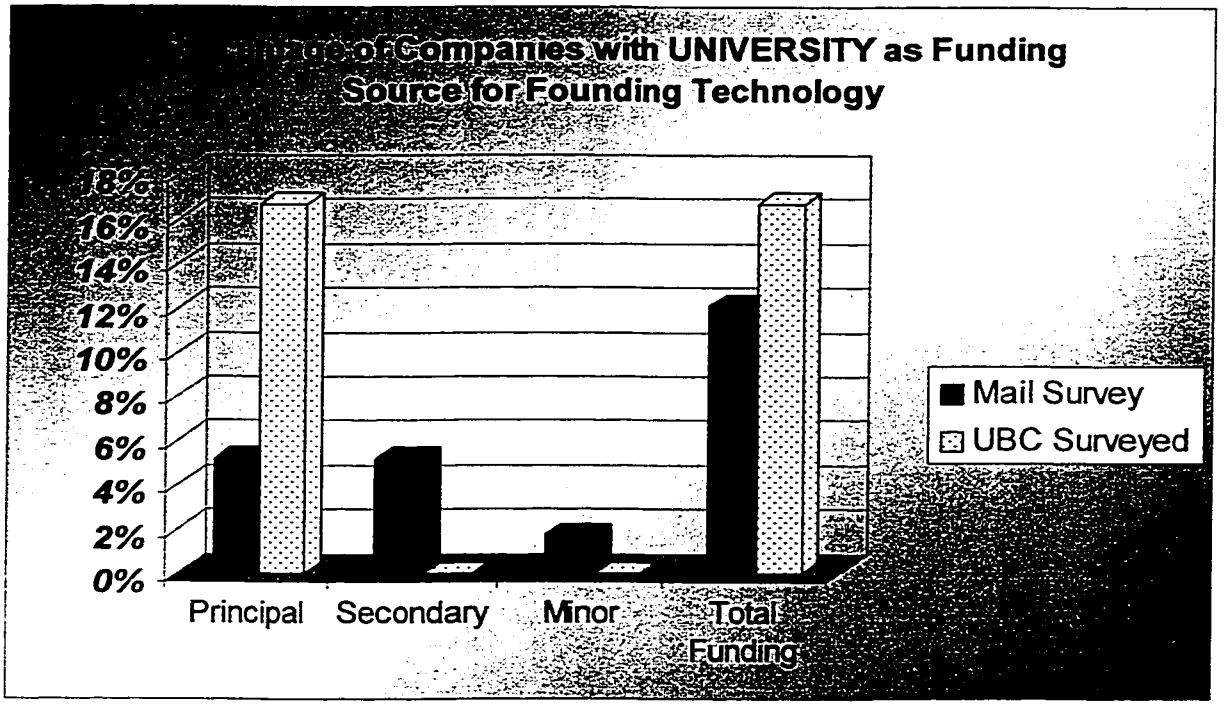


Figure 6–19

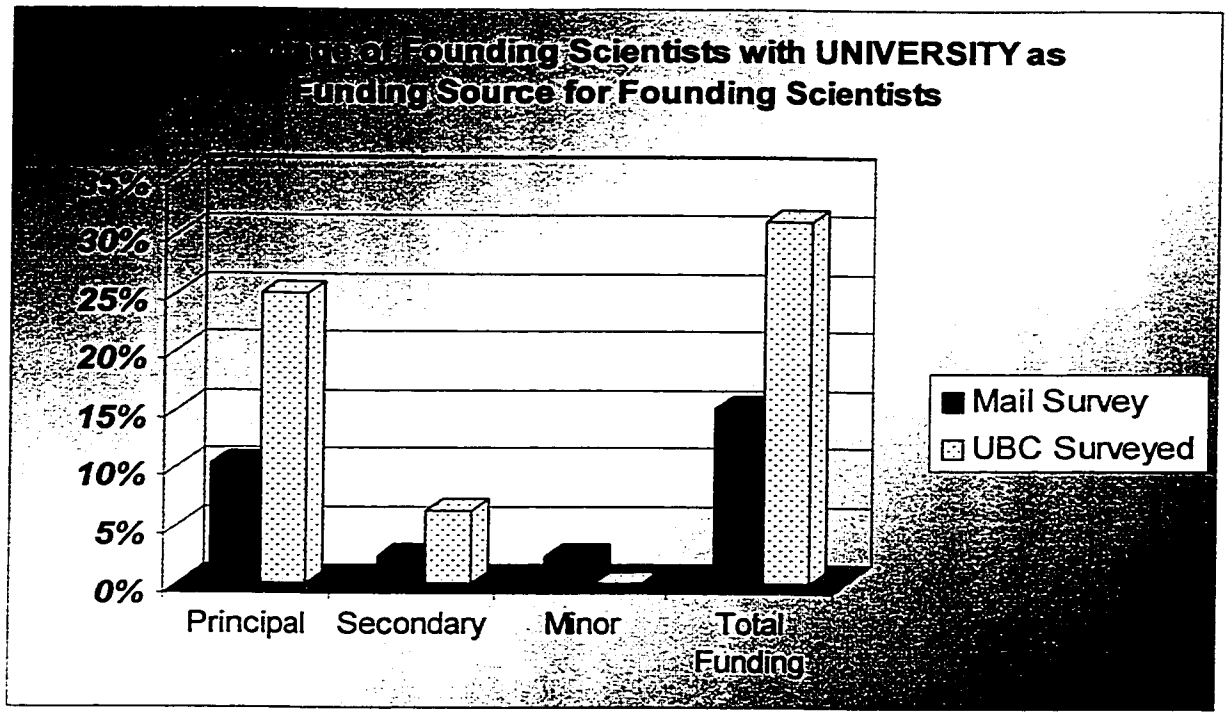


Figure 6–20

31% of the UBC founding scientists named UBC as a funding source; whereas only 15% of the founding scientists from the other spin-offs named their university.

UBC spin-offs who completed the questionnaire with UBC personnel did report lower funding support from the MRC and higher funding support from universities. It is most pronounced for the principal source of funding of the founding technology. Do these differences reflect a bias towards the surveyor or do they reflect another factor? For example, does UBC have programs which fund founding technologies? I reviewed the questionnaires of the UBC spin-offs again and found that the details which were provided by half of the respondents who listed the university as a source of funding referred to employment at the university. This leads me to conclude that the UBC spin-offs were biased in the responses they provided to the UBC personnel and that it is likely that the other spin-offs were biased in the responses they sent to the MRC. I have concluded that the results of this study is overstated in favour of the MRC and therefore the federal government.

Summary

The federal government and equity were the two main sources of funds for the development of the spin-offs founding technology. The Medical Research Council

was the most frequently named source of federal funds and venture capital was the most frequently named source of equity. Companies that were not categorized as spin-offs were more reliant on equity and less on the federal government. The federal government is by far the dominant source of funding for the careers of the founding scientists. Again the MRC is the most frequently named source of federal funds. I found evidence of bias in favour of the organization conducting the survey. The MRC was named more frequently on a relative basis by the spin-offs which were part of the survey conducted by the MRC than those which were not. The spin-offs who were surveyed by UBC named the university as a source of funds more often than those which were surveyed by the MRC.

Economic Impact

The draft report on "Public Investments in University Research: Reaping the Benefits" contends that we should not be measuring the success of Canada's commercialization efforts "by the number of licenses negotiated or the number of spin-off firms created, but rather by the economic and social benefits generated by these activities".[1] This chapter and a following one analyzes the economic and social benefits of the spin-offs in this study.

For the majority of the spin-offs it is difficult to quantify their benefits because they have no sales or products. Sixty-one per cent have not existed long enough to have completed a product development life cycle, which ranges from seven to fifteen years.[2] They are, on average, under 6.5years old (excluding Connaught).

Figure 7-1 confirms that age is a determining factor by comparing spin-offs incorporated in the1990's to those incorporated before 1990. The percentage of spin-offs without sales or products is higher for the younger spin-offs.

Comparison of "Older" and "Younger" Spin-offs

	Spin-offs Incorporated **Before 1990**		Spin-offs Incorporated **After 1989**		**Total**	
	Number	%	Number	%	Number	%
No. of Spin-offs	16	100	67	100	83	100
Without Sales	5	**31**	40	**61***	45**	55*
Without Products	7	**47***	42	**71***	49**	66*
Without Employees	1	**6**	5	**7**	6	7
Without R&D Expense	0	**0***	4	**7***	4	6*
Without Univ. Research	5	**38***	22	**37***	27	37*

*The percentage is based on the number answering the question.

** I suspect that the reason there are more companies without products than without product sales is that some spin-offs included license revenue in their product sales answers.

The table also shows that most of the spin-offs, regardless of age, do have employees and do spend on research and development in their own laboratories and or in universities and research institutes.

---

[1] Fortier, Pierre *Public Investments in University Research: Reaping the Benefits Draft Report,* 1999, The Expert Panel on the Commercialization of University Research, p.12

[2] Strachan, Graham *Ontario Biotechnology Task Force Report*, 1998, Toronto, p.14

1997-98 Economic Impact of 82 Canadian Medical and Biomedical Spin-offs*

	Total	Spin-offs with Responses		Spin-offs with Activity	
		Number	Average	Number	Average
Sales	$ 59,575,000	79	$ 754,114	37	$1,610,135
Exports	$ 44,505,000	79	$ 563,354	35	$1,271,571
Total Employees	2,433	82	30	74	33
Scientists	392	24	16		
Technicians	141	13	11		
Admin Staff	97	19	5		
R&D Expense	$ 130,904,000	66	$ 1,983,394	61	$2,145,967
University/Institute Research	$ 24,685,000	66	$ 374,015	44	$ 561,023
Corporate Taxes	$ 1,222,000	78	$ 15,667	9	$ 135,778

* excluding Connaught

1997-98 Economic Impact of 83 Canadian Medical and Biomedical Spin-offs*

	Total	Spin-offs with Responses		Spin-offs with Activity	
		Number	Average	Number	Average
Sales	$ 184,575,000	80	$ 2,307,188	38	$4,857,237
Exports	$ 113,255,000	80	$ 1,415,688	36	$3,145,972
Total Employees	3,353	83	40	75	45
Scientists	467	25	19		
Technicians	291	14	21		
Admin Staff	192	20	10		
R&D Expense	$175,904,000	67	$ 2,625,433	62	$2,837,161
University/Institute Research	$24,685,000	66	$ 374,015	44	$ 561,023
Corporate Taxes	$1,222,000	78	$ 15,667	9	$ 135,778

*including Connaught except for University/Institute Research

Figure 7-2

Sales and Exports: 80 spin-offs reported over $184 million in annual sales; almost $60 million if Connaught is excluded. The average of those companies who have sales (37) is $1.6 million. Almost 75% of the sales of the spin-offs excluding Connaught are exports.

The average sales revenue per spin-off in this study, excluding Connaught, is comparable to the average sales per UBC spin-off. Including Connaught the average sales in this study is 63% of the BIOTECanada average. (See Figure 7-3, Sales Revenue.)

Sales Revenue

	Sales	Number of (continuing) Companies	Sales / Company
BIOTECanada 1997[3]	$1.0 billion	282	$3.546 million
MRC 1997-98	$185 million	83	$2.229 million
MRC excl. Connaught	$60 million	82	$732 thousand
UBC 1997[4]	$42 million	58	$724 thousand

Figure 7-3

Canada has a negative balance of payments for the medical products industry. By developing innovative medical products, the exports of spin-offs can help Canada to reduce this imbalance and prevent the imbalance from increasing as the new generation of biomedical products replaces the current set of products.

Employment: The spin-offs employ over 3,400 people including Connaught and over 2,400 excluding Connaught. The 25 spin-offs which answered the questions on the number of scientists employ 467 scientists. The average number of scientists employed is 19. Similarly 14 spin-offs reported employing 291 technicians for an average of 21 per spin-off. If Connaught is excluded the averages drop to 16 scientists and 11 technicians per spin-off for a total of 27 science-oriented staff per spin-off formed since 1979 and responding to the relevant questions. In percentage terms the results are: 28 per cent of the employees in spin-offs who reported an employee breakdown are scientists and technicians. If Connaught is excluded the percentage of scientists and technicians employed jumps to 56 per cent.

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[3] Groote, Joyce, Hough, Paul and Walter, Rick *Canadian Biotechnology '98: Success from Excellence,* 1999, BIOTECanada, Ottawa, p.21

[4] Livingstone, Angus *UBC Spin-off Company Formation and Growth,* 1997, University of British Columbia, Vancouver, p.25

The average employment in this study is in line with the results of other studies. The MRC average of 41 is higher but comparable to BIOTECanada's average of 34.8. The MRC average excluding Connaught is comparable but again higher than the average for UBC. (See Figure 7-4, Employment.)

Employment

	Employment	Number of (continuing) Companies	Employment / Company
BIOTECanada 1998[5]	9,823	282	34.8
MRC 1997-98	3,403	83	41.0
MRC excl. Connaught	2,433	82	29.7
UBC 1997[6]	1,502	58	25.9

Figure 7-4

Corporate taxes: Only 9 spin-offs reported paying corporate income taxes. These total $1.222 million for 1997-98, an average of 136,000 each.

R&D Expenses: 67 spin-offs reported spending almost 176 million dollars on research and development in 1997 (131 million excluding Connaught).

The Circle of Research Funding

The spin-offs were also asked to report how much of their R&D expense was incurred in universities and research institutes. I added this question to the questionnaire after attending a meeting of university technology transfer managers from across Canada at the offices of NSERC. I learned at that meeting that some managers thought that the "raison d'etre" of technology transfer offices was to increase the number of external contributions to research in their universities. At that point I recognized how spin-offs completed the circle of research funding.

[5] Op cit, p.12

[6] Op cit, p.3

The Circle of Research Funding

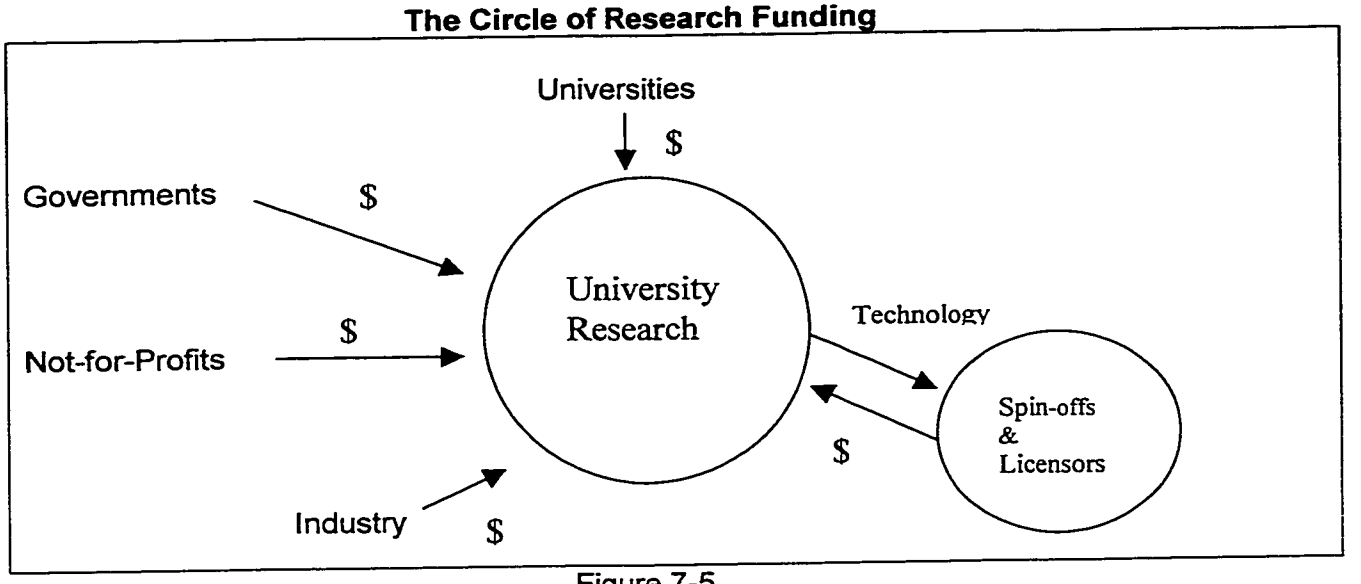

Figure 7-5

This study shows that the technology transfer offices are assisting in creating additional sources of research funds. The spin-offs in this study (excluding Connaught) spent over $24 million in universities and research institutes. The 66 spin-offs created who answered this question (excluding Connaught) spent on average $374,000 each on university and/or research institute-based research.

22 of the spin-offs conducted all of their 1997-98 R&D in universities and/or research institutes.

35 spin-offs (excluding Connaught) reported the total amount they have spent on university and institute-based research since they were incorporated. In total they have spent $219 million dollars in universities and research institutes. On average these 35 spin-offs have spent in total over $6.254 million each on university R&D.

Foreign Ownership

Some of the companies are foreign-owned so not all of the economic benefits accrue to Canada. Twenty-three spin-offs (28%) reported foreign ownership. In the majority of cases the percentage owned is under 50%. Four are foreign controlled. In Figure 7-6, Percentage

of Foreign Ownership, the vertical axis is the number of spin-offs who reported foreign ownership within the specified ranges.

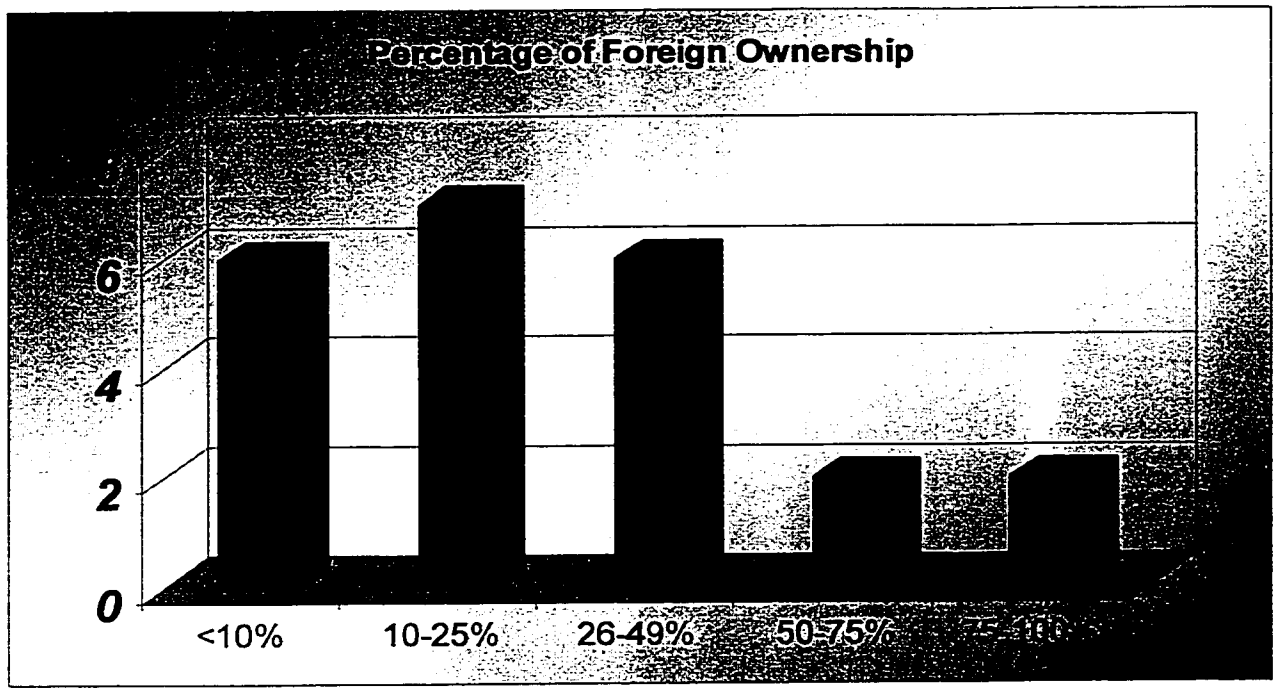

Figure 7-6

Of the 18 spin-offs who reported the counties of the owning shareholders which had an ownership position over half named the USA. The UK, Switzerland, France and Sweden were also named once or twice each. Given our geographical proximity and close economic ties with the USA these results are in line with expectations. (See Figure 7-7, Foreign Ownership Countries.)

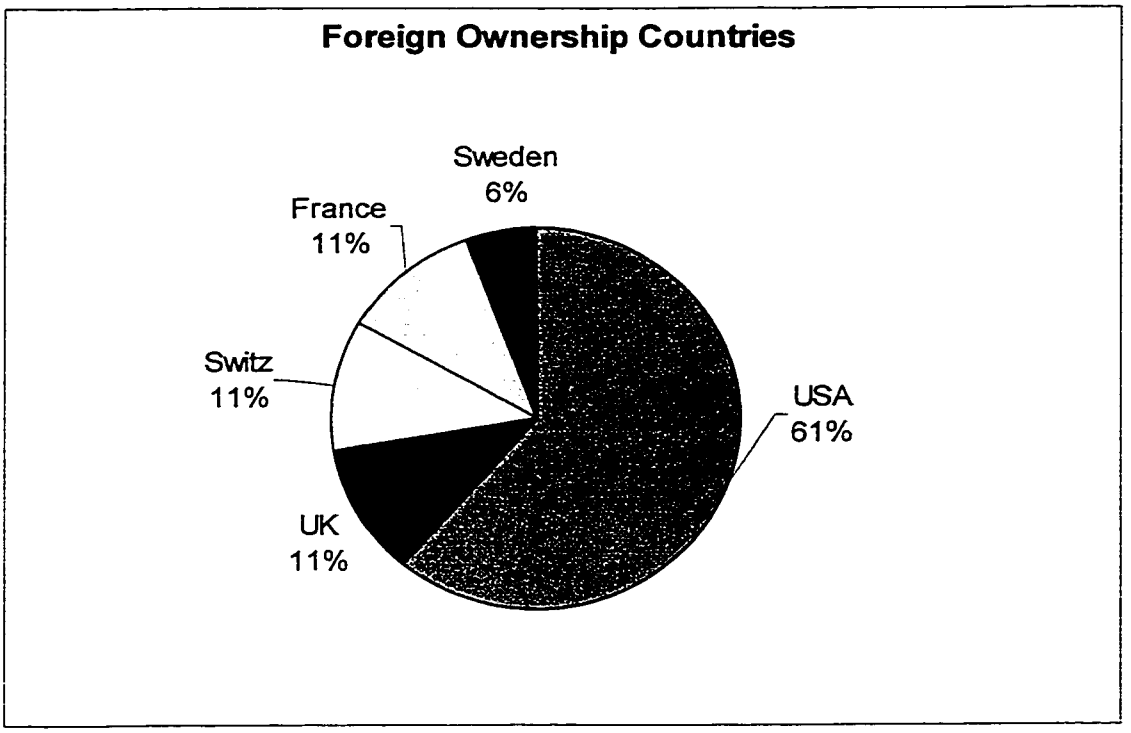

Figure 7-7

Second Generation Companies

Not only are the spin-offs contributing directly to the Canadian economy and society but they are also contributing indirectly by creating or encouraging spin-offs of their own. Seven of the spin-off companies identified nine companies which were created by:

- former or current employees;
- the spin-off company; or
- licensing intellectual property.

Five second generation spin-offs were created by the original spin-off. Three were formed by former or current employees. One was formed by former or current employees who licensed intellectual property from the original spin-off.

Spin-offs:	Second-Generation Spin-offs:
Cangene	Genescope
Biomira	Altarex
Allelix	Resolution Pharmaceuticals Base 4 Bioinformatics
ID Biomedical	ID Vaccine
Theratechnologies	Andromed Ecopia Biosciences
Octopus Diagnostics	Medmira Laboratories
Vancouver Island Antibodies	Immunoprecise Antibodies

Figure 7-8

Given the increase in the spin-offs rate of creation I expect we will see more second-generation spin-offs in the not too distant future.

Summary

Although most of the spin-offs are fairly young, especially when the length of their product development cycle is considered, they are already having a positive impact on the economy. In 1998 the spin-offs created since 1979 (i.e. excluding Connaught) employed over 2,000 people, 56 per cent of which are scientists and technicians. In 1997-98 they sold $60 million worth of products, 75% to customers outside Canada. The average spin-off spent $2 million dollars on research and development. 19% of their R&D budgets were allocated to universities and research institutes. They also contributed over $1 million dollars in corporate income taxes. In addition nine second generation spin-offs have been created by the companies or their employees.

Provincial Comparisons

Funding

From the point of view of comparing provincial policies the results from the survey are disappointing. Overall the number of respondents who indicated that provincial agencies were principal, secondary or even minor sources of funding for the founding technologies or scientists was low. Each province has under ten responses for its provincial agencies. Some provinces have none at all.

Is this surprising? What are the possible explanations for this?
It is somewhat surprising if you consider that the provincial government funding of university research and development is about a third of federal government funding. [1] In another sense it is not surprising because the provinces fund infrastructure more than individuals or companies. They concentrate their resources on funding the universities, the hospitals and the research institutes in terms of buildings, facilities teaching and medical salaries.[2]

On the other hand one might expect some provincial funding agencies to be more prominent. For example, in Québec there is the Fonds de la Recherche en Sante (FRSQ) which invests in health research. One possible explanation for its poor showing in this survey is that it targets a different stage in the development of the scientists' careers. The FRSQ invests earlier in the development of physicians' research careers than its federal counterpart, the Medical Research Council.[3] Perhaps the funds invested in the training portion of the scientists' careers are significant overall but spread over a larger number of doctors. As a result when a mature scientist reflects on a long career the agencies which provided grants at later stages may be more prominent in his or her mind because they were more recent, lasted longer and were higher dollar figures.

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[1] Statistics Canada "Estimates of Canadian Research and Development Expenditures (GERD) in the Health Field, 1970 to 1997, Science and Technology Redesign Project, Ottawa

[2] Marc LePage, Director of Business Development and Partnerships, MRC, personal communication

[3] Ibid

The province with the best showing, *on a proportionate basis*, is Alberta. (I emphasize on a proportionate basis because overall Alberta did not have very good results because of the very low number of responses we received from that province. Its response rate was the second lowest at 37%. This represents eight companies of which five were considered spin-offs.) Of the five spin-offs in Alberta, three gave provincial agencies credit as a principal source of funds for their founding technologies. Another spin-off gave a provincial agency credit as a secondary source. In all cases the agencies were the Alberta Heritage Fund for Medical Research (AHFMR) and the Alberta Research Council (ARC). The relative success of the AHFMR might be explained by their two-pronged approach to funding. This agency funds both basic research and commercialization programs,[4]

The three provinces with the majority of the spin-offs participating in this study are Ontario, Québec and British Columbia. None of them had more than a few companies indicating that any provincial agencies financed the development of their founding technologies. British Columbia had the most with three spin-offs naming provincial agencies as principal sources and two as secondary sources. Ontario had the least with only one company naming a provincial agency as a principal funding source, the Ontario Centre for Materials Research (OCMR).

Provincial Agencies Named as Funding Sources for Founding Technology

British Columbia	B.C. Science Council Technology B.C. Technology Assistance Program B.C. Health Care Research Foundation B.C. Health B.C. 21
Alberta	Alberta Heritage Foundation for Medical Research Alberta Research Council
Québec	Fonds de la Recherche en Sante de Québec Centre Québécois de Valorisation des Biomasses et des Biotechnologies Office de Planification et Development Québec
Ontario	Ontario Centre for Materials Research

Figure 8-1

Is Ontario's poorer showing an indication of its government policy, (or lack thereof)? The chart above shows that the biomedical spin-offs founded in Ontario are not drawing on the support of as many of

[4] Ibid; Philip, Bern "Biotech Alberta: Partners for the Future", *Canadian Biotechnology 1998 Directory*, 1998, Contact International Inc. Georgetown, Ontario, p.32

the provincial agencies spin-offs in other provinces are. Unfortunately the number of responses naming a provincial source of funds is too low to compare differences in provincial policies. Fortunately there is other data from the survey which can be analyzed to compare the provinces.

Number of Participants

First a comparison of the number of spin-offs from the larger provinces.

Number of Spin-offs by Province

Québec	21
Ontario	21
British Columbia	30
Alberta	5

Figure 8-2

British Columbia's large showing must be discounted because its higher response rate (86% versus 54% overall) was due to the generous assistance of UBC in surveying their spin-offs. Ontario and Quebec have the same number of spin-offs participating in this study. This *might* indicate equivalent participation in the industry in terms of spin-off formation.

These numbers can be compared to those from BIOTECanada's very recent survey and Contact Canada's 1999 biotechnology directory.

	Contact Canada 1999[5]		BIOTECanada 1998 Survey[6]		MRC Survey
	No. of Biotech Companies	No. of Estimated Companies In Health Care (30%)	No. of Biotech Companies	No. of Estimated Companies in Health Care (46%)	No. of Medical & Biomedical Spin-offs
Québec	201	**60**	87	**40**	**21**
Ontario	177	**53**	71	**32**	**21**
B.C.	128	**38**	56	**26**	**30**
Alberta	44	**13**	20	**9**	**5**

Figure 8-3

The biggest difference amongst the three sources of data is the relative difference between Ontario and Québec. At one extreme is BIOTECanada's survey where Quebec is substantially ahead of Ontario; at the other is the MRC survey where they are equal. The Contact Canada and

[5] Haynes, Fred *Canadian Biotechnology 1999 Directory*,_1999, Contact International Inc. Georgetown, Ontario, p.14-15

[6] Groote, Joyce, Hough, Paul and Walter, Rick *Canadian Biotechnology '98: Success from Excellence*, 1999, BIOTECanada, Ottawa, p.16

BIOTECanada databases indicate that Québec is underrepresented in this study. One obvious example of a company which did not respond to the MRC survey is Biochem Pharma, perhaps Canada's most successful biomedical spin-off yet. To improve the usefulness of some of the comparisons made in the next section publicly-available information on Biochem Pharma has been included (*where indicated*).

Economic Indicators

Economic indicators such as employment, R&D expenditures and sales revenue are other bases of comparison.

Employment by Province

	BIOTECanada Survey:[7] Estimated* Health Care Employment		MRC Survey: Medical & Biomedical Spin-off Employment	
Québec	2,137	32%	510	29%
Ontario	2,204	33%	498 **	20%
British Columbia	868	13%	689	28%
Alberta	668	10%	297	12%

*based on: the reported total employment; percentage of employment in health care (46%); and the percentage of employment in each province

** excluding Connaught

Figure 8-4

Based on the data accumulated for this study Québec has the highest percentage of total spin-off employment (for companies incorporated in the last two decades). BIOTECanada's employment results for Ontario and Québec are very close with Ontario slightly ahead. The BIOTECanada survey not only asked for current employment levels but also employment projections for the year 2001. In 2001 the existing companies in Quebec projected employing more people than the existing companies in Ontario projected.[8]

Should we expect Quebec's employment to be higher than Ontario's as this study reports? Should they be very close as BIOTECanada reports? Just because they are the two largest provinces does not mean they are the same size. Whether you consider population or Gross Domestic Product, the province of Ontario is considerably larger.

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[7] Ibid, p.16-17
[8] Ibid, p.47

Comparison of Québec and Ontario from Statistics Canada Data[9]

	Population in 1998 (millions)		Gross Domestic Product in 1997 (billions)	
Québec	7.3	24%	$185.4	22%
Ontario	11.4	38%	347.1	40%
Canada	30.3	100%	856.1	100%

Figure 8-5

In terms of 1997 GDP Ontario is 87% per cent larger than Québec. But, as the data in Figures 8-3 and 8-4 show, in terms of number of spin-offs (or biotech companies) and jobs created by the spin-offs (and biotech companies) Québec is either ahead of Ontario, equal to Ontario or very close to Ontario.

On the other hand Quebec's research and development expenditures are lower than Ontario's. Ontario spin-offs (including Connaught) reported spending $81 million on research and development, almost half of the total reported. The Quebec companies (including Biochem Pharma) spend $55 million. Excluding Connaught and Biochem Pharma (because institute- and university-based R&D is not publicly available) Québec has by far the highest proportion of its R&D spent in universities and research institutes. 73 per cent of R&D in Québec is spent in these sites whereas only 22 per cent is in Ontario. This difference is probably because of Quebec's 40 per cent refundable tax credit on 80 per cent of research conducted in "recognized research centers". (This credit is double the credit available for general R&D but slightly less than an initial amount available to small business.)[10] The results are presented in Figure 8-6, Spin-off R& D Expenditures by Province.

[9] Statistics Canada "Canadian Economic Observer", 1999, Ottawa and Internet site

[10] Quebec Ministry of Trade, Commerce, Science and Technology *Advantages of Conducting Business in Quebec*, 1997, Montreal, p.20

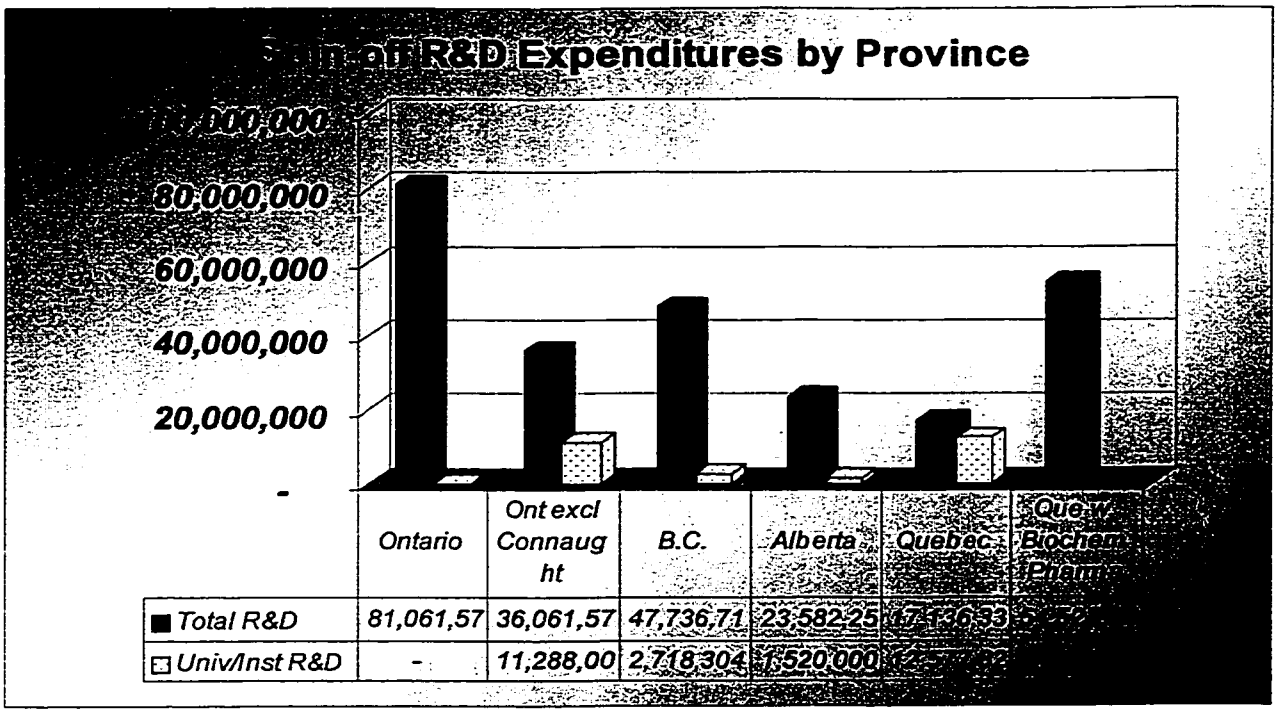

Figure 8-6

Figure 8-7, Average Spin-off R&D Expenditures by Province, takes into account differences in the number of spin-offs *reporting this information*. Alberta reported the highest R&D expenditure on an average basis, at $5.895 million. Québec reported the highest university- and institute-based research on an average basis, at $740 thousand.

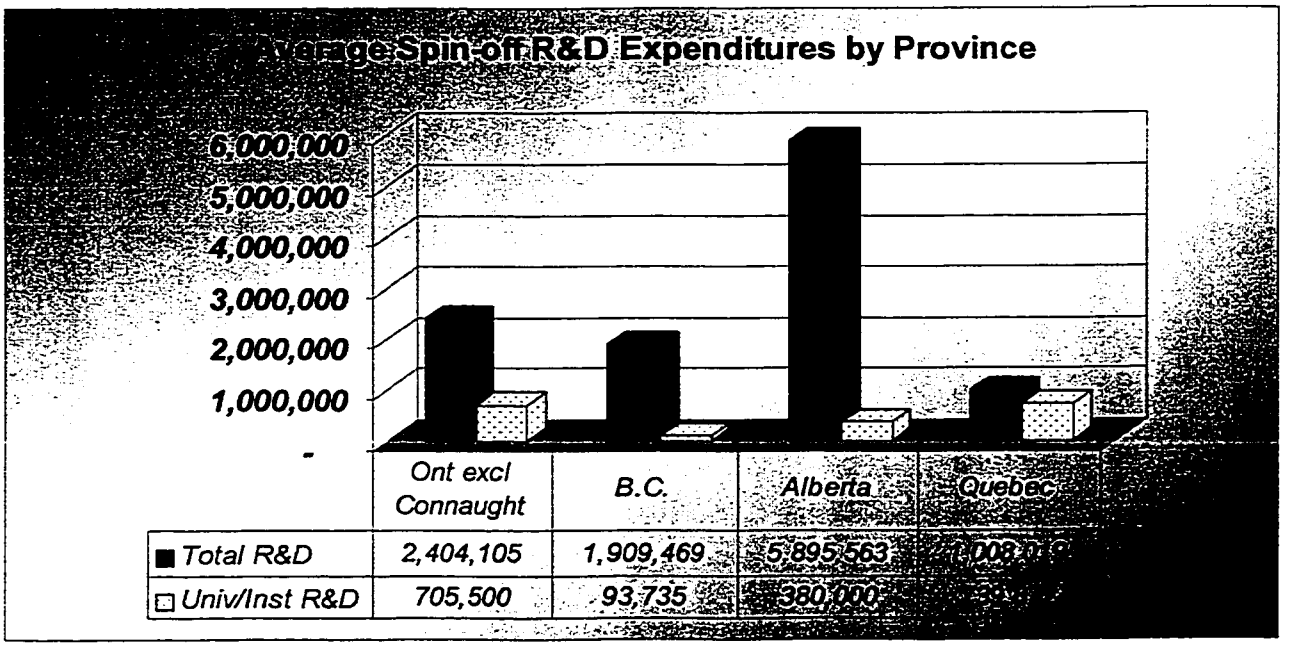

Figure 8-7

Sales Revenue by Province

	BIOTECanada Survey:[11] Estimated* Health Care Sales Revenue (millions)		MRC Survey (excl. Connaught): Biomedical Spin-offs Sales Revenue (millions)		MRC Survey (incl. Connaught and Biochem Pharma): Biomedical Spin-offs Sales Revenue (millions)	
Québec	$193	34%	$ 3.1	5%	$137.7	43%
Ontario	204	36%	16.4	28%	141.4	44%
British Columbia	23	4%	11.2	19%	11.2	4%
Alberta	51	9%	9.4	16%	9.4	3%

*based on: the reported total sales revenue; percentage of revenue in the health care sector (50%); and the percentage of revenue in each province

Figure 8-8

In this study Québec ranks as one of the lowest provinces in terms of sales revenues. The sales data (except for Atlantic Canada) is reported in Figure 8-8, Sales Revenue by Province. But when Biochem Pharma and Connaught sales revenues are added to the comparison Québec's sales revenues are almost as high as Ontario's just as they are for the BIOTECanada survey.

Why are Quebec's spin-off sales in this study so low?

Younger companies usually do not have any sales revenue. To determine if Quebec's low sales in this study can be accounted for by a difference in the ages of the companies the average age was calculated and graphed as was the year of incorporation.

[11] Groote, Joyce, Hough, Paul and Walter, Rick *Canadian Biotechnology '98: Success from Excellence,* 1999, BIOTECanada, Ottawa, p.16-17

Average Age and Rates of Formation

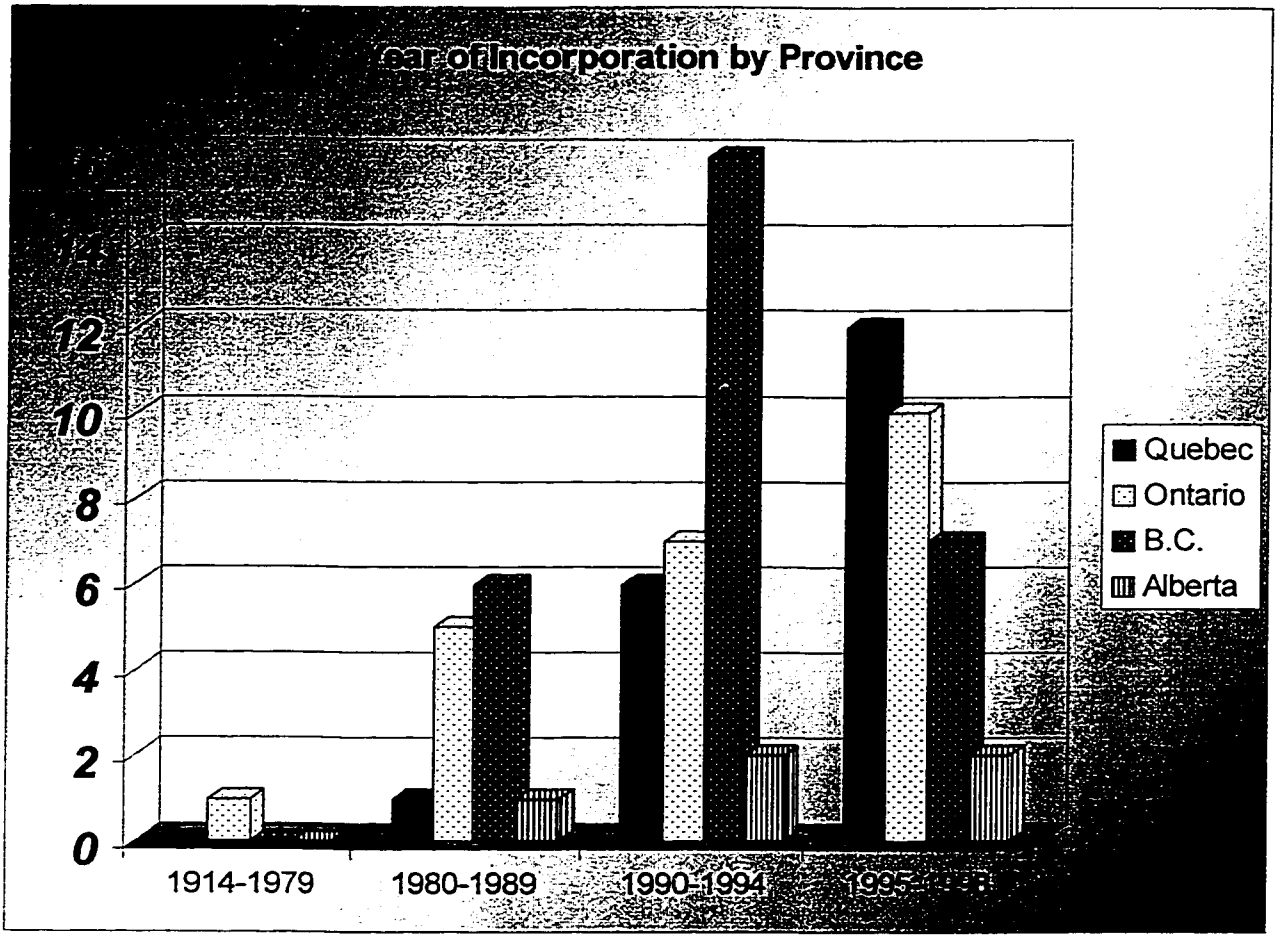

Figure 8-9

Since this section focuses on spin-off formation the spin-offs were not categorized according to the current location of their head office; instead they were categorized by the province of their affiliated university.

Figure 8-9, Year of Incorporation by Province, shows that, of the larger provinces, Quebec and Alberta are the only provinces with all of their spin-offs being incorporated after 1989 except for one.

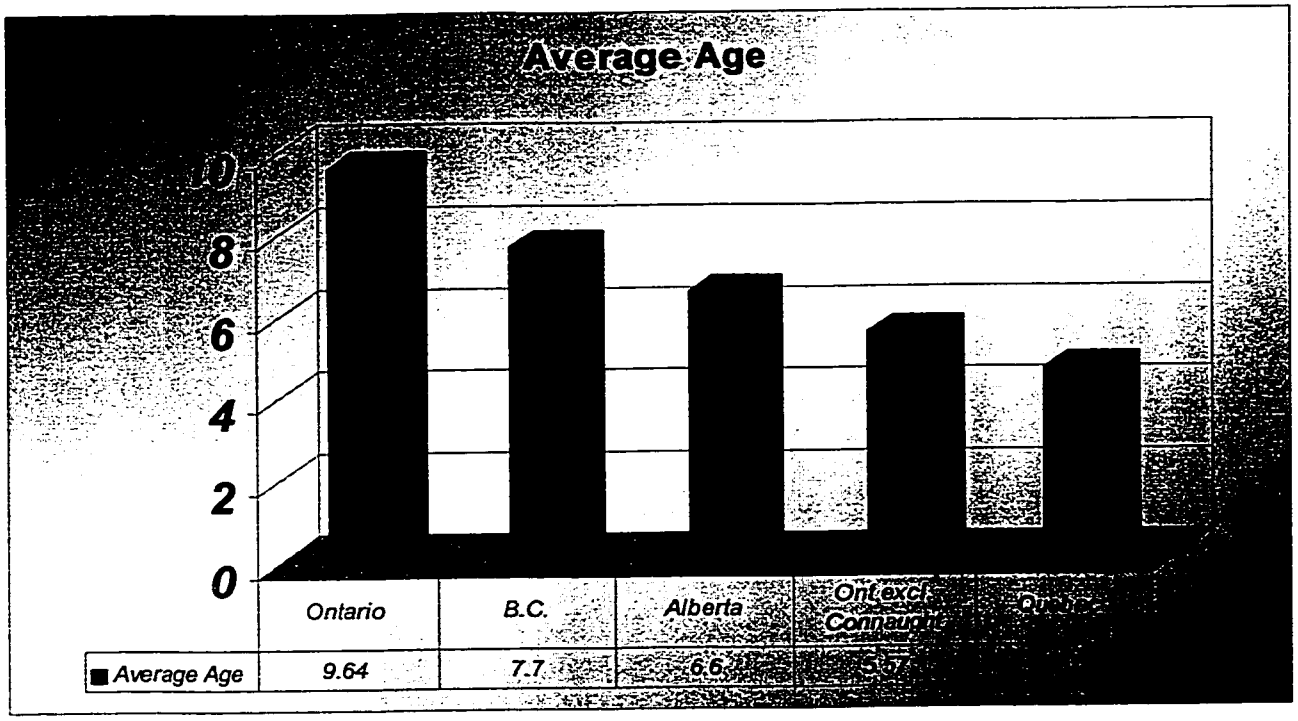

Figure 8-10

A comparison of the average age of the provinces shows that Quebec does have the lowest average age. (See Figure 8-10.) Ontario is the second lowest if Connaught is excluded. (Pasteur Merieux Connaught is the oldest Canadian spin-off, incorporated in 1914.) The average age of Ontario's spin-offs excluding Connaught is 20% greater than Quebec's. This difference in age explains in part why Quebec's sales are much lower but given the magnitude of the difference (less than one year) it appears to be only a small part.

Next I considered the rates of spin-off formation over time.

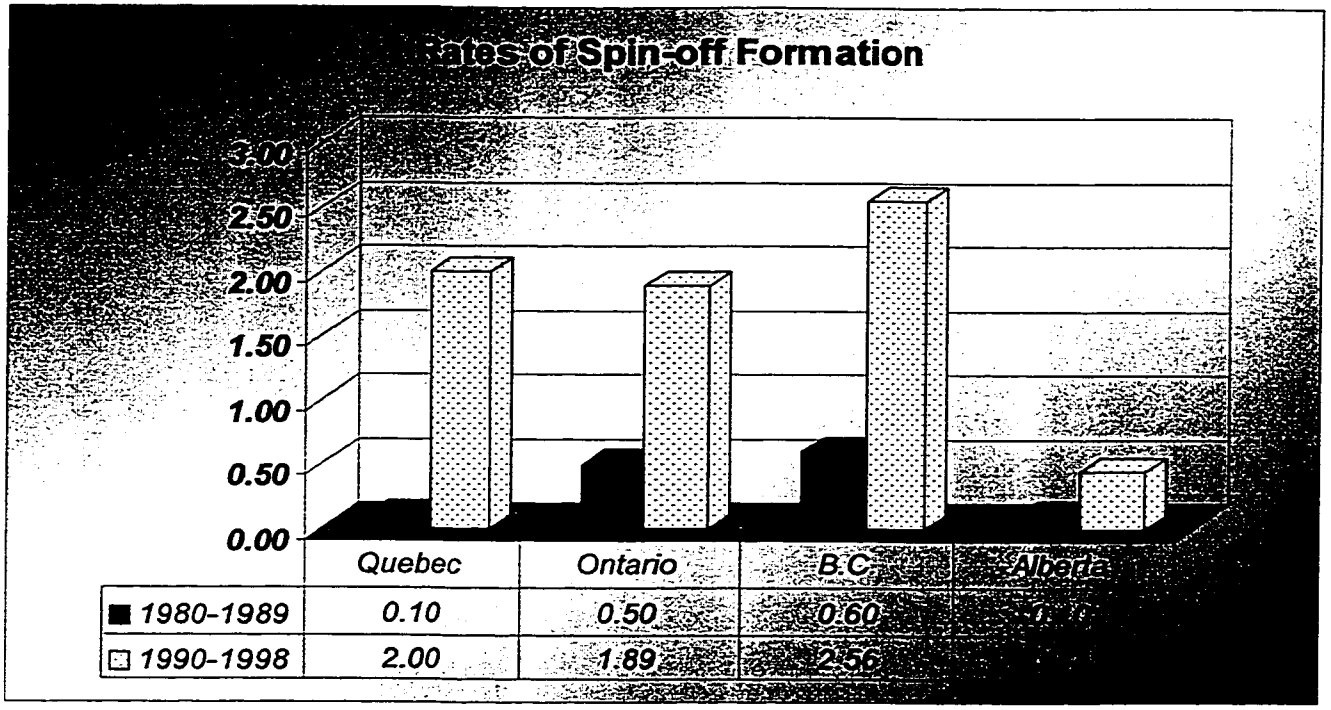

Figure 8-11

Figure 8-11, Rates of Spin-off Formation, shows that Quebec and Alberta had the lowest rate of spin-off formation in the 1980's. B.C. has the highest rate of spin-off creation in the 1990's (as it did in the 1980's), with Quebec coming in second and Ontario coming in third. But if the 1990's is spilt into two as in Figure 8-12, 1990's Rates of Spin-off Formation, it is apparent that Quebec has overtaken the other provinces in recent years. B.C. has slowed down to third place, whereas Ontario has increased its pace to take second place.

(Quebec's earlier low rate of spin-off formation was confirmed by Denys Cooper of the NRC. He maintains a database on Canadian spin-offs which is described in the NSERC/Conference Board of Canada report.)[12]

[12] Denys Cooper, National Research Council, Director, Strategic Alliances, personal communication

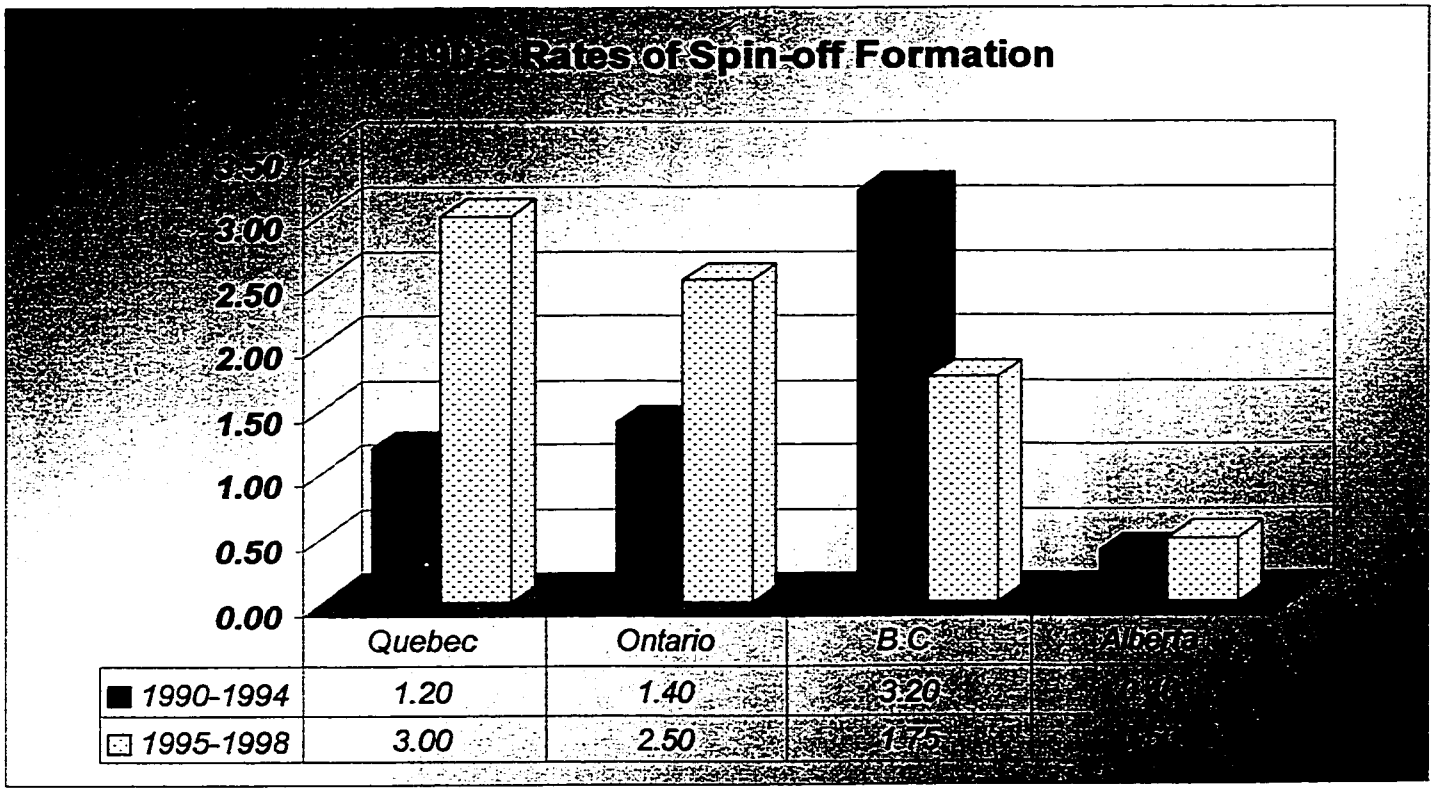

Figure 8-12

Quebec's rate of spin-off formation has grown from one of the lowest at .10 per year in the 1980's (compared to B.C.'s .60 and Ontario's .50) to the second lowest in the first half of the 1990's to the highest from 1995 -1998 when three companies in this study were formed per year in Quebec.

Why has Quebec's rate of spin-off formation gone from the lowest in the 1980's to the highest in the second half of the 1990's? Why are Quebec's spin-offs (including Biochem Pharma) performing on an equivalent basis to Ontario's spin-offs in terms of employment, sales and R&D expenditures even though Ontario is the largest province in terms of population and GDP? Perhaps it *can* be explained by government policy.

Quebec's Approach

In the 1980's the biotechnology industry became a top priority in Québec– for all levels of government. For example, the Montreal Chamber of Commerce recognized biotechnology as one of three industries that should be fostered in that city.[13] The cities of Québec and Sherbrooke as well as Montreal started

[13] Strachan, Graham *Leading in the Next Millennium (National Biotechnology Advisory Committee Sixth Report)*, 1998, Industry Canada, Ottawa, p.28

working with their chambers of commerce, corporate service companies, industry and the provincial government to create industrial clusters. The provincial government introduced several tax measures which included: a 20% refundable tax credit for the salaries of in-house researchers (40% for start-ups); a 40% refundable tax credit of 80% of researcher's salaries and university research contracts; and a two year income tax exemption for newly recruited foreign researchers.[14] (The 1999-2000 provincial budget extended the tax holiday from two years to five and now includes experts other than researchers. In addition small- and medium-sized businesses will be offered an additional 15 per cent refundable tax credit for R&D expenses which exceed their average expenditures for the prior three years. In the budget document "An Integrated Fiscal Strategy for the Knowledge-based Economy" the Québec government recognized that "innovations... determine the long-term economic growth of industrialized countries and are the source of wealth creation".)[15] In the 1990's several venture capital companies were given subsidies.[16] Société Innovatech du Grand Montréal is one such firm. It was founded in 1992 to develop technological innovation in high technology industries, including health sciences. It provides capital, technical know-how and credibility.[17]

In 1987 the National Research Council opened the Biotechnology Research Institute (BRI) in Montreal. It employs or provides facilities for 500 to 700 scientists. Their mission is to perform research in advanced molecular biology and biochemical engineering that would advance the pharmaceutical and environmental industries. In 1994 Montreal's two medical schools, the BRI and two multi-national pharmaceutical companies created the Montreal Center for Structural biology.[18]Recently the NRC and the private sector have made plans to expand this facility.[19] Not only does the BRI provide research facilities for the scientists but it also encourages the development of small companies and provides

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[14] Quebec Ministry of Trade, Commerce, Science and Technology *Advantages of Conducting Business in Quebec*, 1997, Montreal, p. 19-20

[15] Quebec Ministry of Finance, *An Integrated Fiscal Strategy for the Knowledge-based Economy,* 1999-2000 Budget, 1999, Quebec City, p.4

[16] Quebec Ministry of Trade, Commerce, Science and Technology *Advantages of Conducting Business in Quebec*, 1997, Montreal, p. 19-20

[17] Goudey, John and Nath, Deepika, *Canadian Biotech '97: Coming of Age*, 1997, Ernst & Young, Toronto, p.37

[18] Quebec Ministry of Trade, Commerce, Science and Technology *Advantages of Conducting Business in Quebec*, 1997, Montreal, p.8

[19] Levac, Daniel "NRC a Leader in the Biotechnology Sector in Canada", *Canadian Biotechnology 1998 Directory*, 1998, Contact International Inc. Georgetown, Ontario, p.67-69

commercialization assistance.[20] This assistance can be in the form of strategic alliances, fee-for-service activities, incubation and training.[21]

In 1994 BioContact Québec held its first conference in Quebec City. It quickly became Canada's premier annual biopharmaceutical conference bringing together investors and biotechnology companies from across Canada and more recently internationally.[22] 800 participants network and have the opportunity to learn about the projects 80 companies are working on.[23]

According to James Donovan, vice-president of the Greater Québec Economic Development Corporation and co-president of BioContact Quebec, 1994 was a threshold year for biotechnology in Québec City. This was the year the technologies, the people and the funding came together. BioContact Québec was one of the major factors because it gave young researchers with possibilities somewhere to showcase them, to network and to make contacts with people providing specialized services and capital. This was the year Société Innovatech Québec et Chaudiere Appalaches was started. It provided funds and technological risk assessment. Its technological risk assessment focused on peer reviews with the peers coming from all over North America. The credibility derived from solid peer reviews brought in smaller funds which syndicated with Innovatech. In 1994 Québec City had seven biotechnology companies. Now it has 40. [24]

There are policies that encourage spin-off formation outside Quebec. The survey respondents from B.C. listed a number of provincial agencies which played a role in the funding of their founding technology or the careers of their founding scientists. These are listed above in Figure 8-1. But the major factor in B.C. has not been a provincial program but the University-Industry Liaison Office of U.B.C. It encouraged the spin-off phenomenon long before it was recognized by most other

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[20] Plourde, Jean-Maurice "Biotechnology Focus in Quebec", *Canadian Biotechnology 1998 Directory*, 1998, Contact International Inc. Georgetown, Ontario, p.51-54

[21] Goudey, John and Nath, Deepika, *Canadian Biotech '97: Coming of Age*, 1997, Ernst & Young, Toronto, p.37

[22] Strachan, Graham *Ontario Biotechnology Task Force Report*, 1998, Toronto, p.11

[23] Montreal Exchange "The Montreal Exchange and Biotechnology: An Invaluable Partnership", *Canadian Biotechnology 1999 Directory*, 1999, Contact International Inc. Georgetown, Ontario, p.23-33

[24] James Donovan, Vice-president, Greater Québec Economic Development Corporation and Co-president of BioContact Quebec, personal communication

universities in Canada. UBC's leadership position was due to its early recognition of the benefits of spin-offs and its willingness to devote resources to foster their creation.
Survey respondents from Ontario named only one provincial program. There are others but some of them may be too recent to have had an impact on companies that exist today, for example, the Ontario Research and Development Challenge Fund, the Premier's Research Excellence Awards and Access to Opportunities. Ontario's tax incentives include the Scientific Research and Experimental Development tax credits and a 100 per cent same-year tax write-off of costs incurred to acquire intellectual property and technology.

What the province of Quebec demonstrates is that to have a major impact it may not be enough to have a number and variety of programs. What is needed is integration: the integration of the programs and polices of all levels of government. This integration is what Quebec has accomplished and which no other province has. In Quebec there has also been consistency in government policy over a number of years. Other provinces may change their programs every few years. For example, in the late 1980's Ontario provided funding for technology transfer offices. But the program only lasted a couple of years.[25]

The integration of provincial and municipal programs in Québec is evident by simply noting some of the people who work together. For example when I spoke with James Donovan he explained to me that he wore two hats: one as vice-president of the Greater Québec Economic Development Corporation; and one as co-president of BioContact Quebec. His fellow co-president is Martin Godbout who was also the founding president of Société Innovatech Québec et Chaudiere Appalaches. As noted previously Innovatech is a provincially-funded venture capital company. Quebec's success with BioContact Quebec, with spin-off formation, and with cultivating the interest of biopharmaceuticals companies is the result of close cooperation of multiple levels of government and their agencies as well as dedicated personnel.

[25] Denys Cooper, Director Technology Networking, NRC, personal communication

Summary

The data provided by the spin-offs on sources of funding for their founding technologies and the careers of their founding scientists does not support any conclusions about provincial policies except that the companies did not weight provincial support very highly if at all. Data provided in other sections of the questionnaire do indicate regional differences. Quebec is currently leading the country in terms of rate of spin-off formation. When the relative size of Ontario is taken into consideration it is apparent that Ontario should be the leader in all measures of the biomedical industry but it is not. Although other provinces have policies that benefit spin-offs in the bio-medical sector, they pale in comparison to the integrated programs which have been implemented in Quebec by all levels of government.

Social Benefits

While reading about the spin-offs' founding technologies, missions and product plans I developed an appreciation for the extent to which health care will change in the early part of the next century. These spin-offs are working on new diagnostics, devices, vaccines and therapies for the prevention, diagnosis and treatment of cancer, infections, cardiovascular disorders, central nervous system disorders, Alzheimer's disease, diabetes, HIV, and a number of other medical problems. (See Figure 5-4.) Many are based on recent breakthroughs in genetic research.

Here are some excerpts from the descriptions of some of the spin-offs' main businesses and founding technology.

- Innovative regeneration technologies for bone and tissue
- DNA-based products for the rapid identification of bacteria and antibiotic-resistant genes
- Sustained release insulin implants
- Anti-infective compounds focussing on multi-drug resistant bacteria
- Bioactive bone tissue repair and regeneration products
- Ion-channel modulating drugs for the prevention of sudden cardiac death and the treatment of severe pain.
- Point-of-care diagnostic products
- Use of a certain protein in the early detection of Alzheimer's disease
- A therapeutic agent to resolve and prevent deadly blood clots.
- Anti-inflammatory proteins derived from viruses
- Genetic information on the root causes of common diseases
- Vaccines that stimulate the immune system to fight cancer
- Specialty plasma products
- Vaccines to treat cancer
- Pharmaceutical products developed from the by-products of the pulp and paper industry.
- Anti-cancer therapeutics based on strategies involving apoptosis (programmed cell death)

- Anti-inflammatories used in the treatment of Alzheimer's disease
- Anti-cancer drugs
- A monoclonol antibody that enhances responses by the immune system to HIV infection
- Drug delivery systems to increase the precision of gene-based drugs
- Dental implants. Biomaterial for engineering cartilage tissue
- Disease risk management tools
- Products based on the herpes simplex virus to treat cancer, nervous system disorders and cardiovascular disease
- Pharmaceuticals that will efficiently and specifically attack human cancer cells
- A pulmonary surfactant for use in the treatment of premature infants suffering from respiratory distress syndrome
- Non-invasive testing, rapid prototyping and 3D modeling
- Treatment of inflammatory bowel disease
- A nucleic acid probe DNA detection system for diagnosis of infectious diseases such as tuberculosis
- Monoclonal anti-cancer and anti-viral antibodies of human origin.
- A gel formulation with a thermoreversible property to prevent the transmission of pathogens causing sexually transmitted diseases
- An anti-inflammatory which may be effective for asthma.
- Home-based diagnostic kits for tuberculosis and venereal diseases
- Patented small molecule with anti-tumour activity
- Pharmacogenetic marker which identifies responders and non-responders in Alzheimer's disease clinical trials
- Rapid diagnostic devices and miniaturized instrumentation.
- Transdermal systems that deliver pharmaceuticals through the skin
- Photodynamic therapies which selectively kill or alter disease-causing cells while sparing healthy ones
- Prevention of the adverse effects of bacterial toxins while the bacterial infection runs its course for gastrointestinal diseases
- Blood test kits for bone marrow transplantation matching and diagnosis of rheumatoid arthritis.
- Photodynamic treatment of cancers affecting bone marrow
- Artificial circulatory assist devices

These companies are developing innovative ways of dealing with some of the most pressing medical problems today from multiple–drug resistant bacteria to cancer. Their potential benefit to society is enormous.

One example is the Canada-wide cancer vaccine initiative being led by Pasteur Merieux Connaught (which was started in Canada as Connaught Laboratories by Dr. John Fitzgerald to develop his diphtheria anti-toxin). This $350 million project was launched in1998 with a $60 million commitment from Industry Canada's Technology Partnerships Canada program. Research centres, universities and small and medium-sized biotechnology companies (including other spin-offs which participated in this survey) will work with Pasteur Merieux Connaught to focus on eight forms of cancer.

Fortunately the media gives good coverage to new medical developments, the scientists responsible for the innovations and the companies developing the new products. For example, in Ottawa two spin-offs who are becomingly increasingly well-known quickly come to mind: World Heart; and Apoptogen. Public awareness of the spin-offs' potential is crucial to maintaining the support of the public for continued public investment in companies like these.

Summary & Conclusions

Summary of Answers to the Questions Identified in the Thesis Prospectus and Introduction

The objectives of this thesis were stated in terms of five questions the study set out to address. These were:

1. Which Canadian companies are biomedical spin-offs?
2. Who funded the founding technology of biomedical spin-off companies and the careers of the founding scientists?
3. What is the rate of spin-off creation?
4. How are these spin-off companies impacting the economy?
5. Which provinces have been "players" in this industry?

Overall the study was successful in answering these questions even though one or two questions were not answered as completely as I would have liked. Each answer is discussed separately below:

1. Which Canadian companies are biomedical spin-offs?

A list of over 200 companies that were potentially biomedical spin-offs was compiled. 119 of these companies participated in the survey. 83 of the 119 respondents were defined as spin-offs in the medical and biomedical industry. I have concluded that this set of 83 spin-offs represents well over half of the medical and biomedical spin-offs in Canada.

The companies' names have not been listed in this report in order to respect the confidentiality requests made by a number of participants. The list has been made available to another government organization which maintains a database of Canadian spin-off companies in all industries. From this study's list of spin-offs twenty-five new company names were added to this industry-wide database.

2. Who funded the founding technology of biomedical spin-offs companies and the careers of the founding scientists?

The founding technologies of the spin-offs in this study were financed primarily by the federal government and a variety of equity sources. The federal government was also named by 60 per cent of the founding scientists as a principal source of funding for their careers. The Medical Research Council was the most frequently named source of federal funds for both the founding technology and the careers of the founding scientists. Unfortunately survey responses were found to be biased in favour of the organization conducting the survey, which was the MRC for 71 per cent of the participating spin-offs.

Equity was the second most named category of financing for the spin-offs' founding technology. Where equity funded the founding technology it was provided by venture capitalists, the scientists themselves, other private sources, public exchanges, pharmaceutical companies and related companies. Venture capital was named most often. Universities were second to the federal government as a source of funding for the careers of the founding scientists.

The answer to the founding technology part of this question is summarized in Figure 10-1.

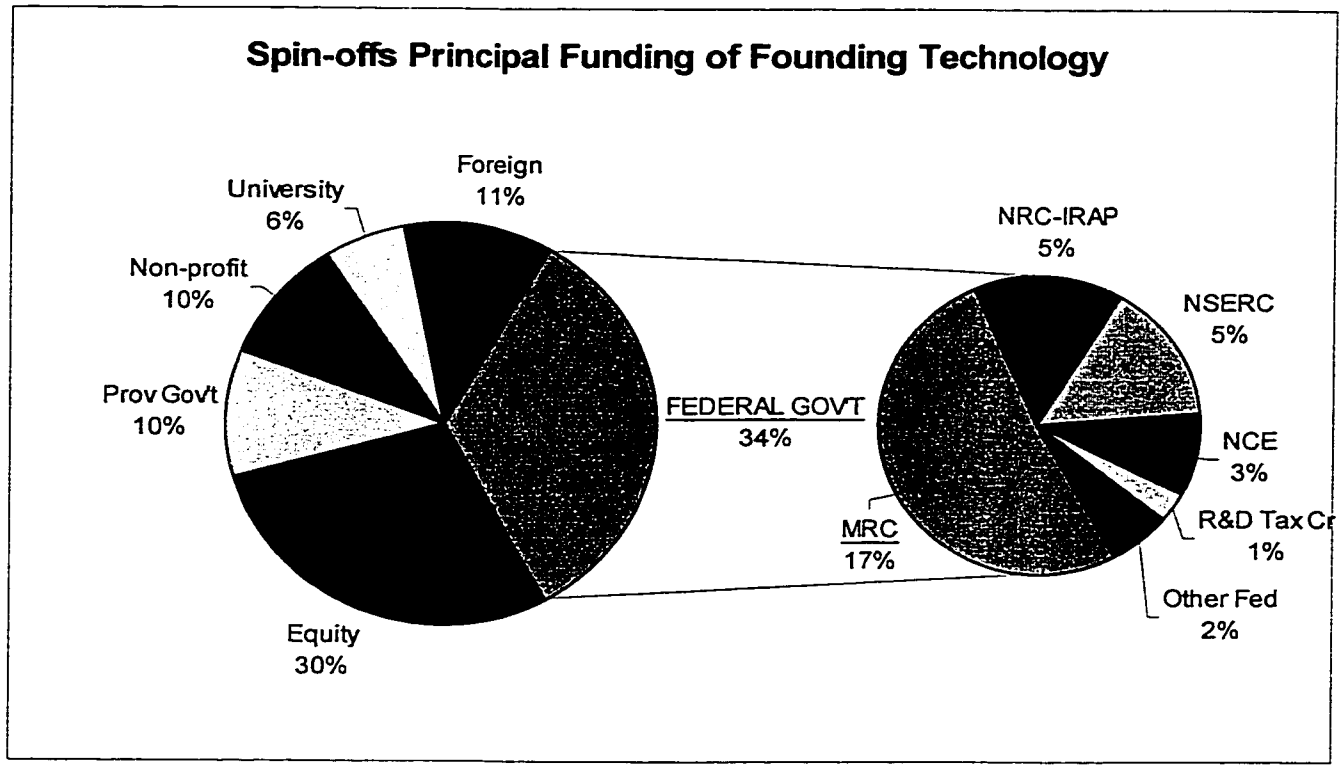

Figure 10-1

The creation of biomedical spin-offs in Canada is very dependent on the federal government for its funding of the development of founding technologies. The federal government funds the development of the technologies both directly, in the form of grants, and indirectly, by subsidising labour-sponsored venture capital companies.

3. What is the rate of spin-off creation?

This study confirms that the number of new medical and biomedical spin-offs *is* "mushrooming". Their rate of formation has been accelerating since the early 1980's, with incredible growth in the 1990's. 18 per cent of the spin-offs in this study were created in the 1980's; 43 per cent in the first half of the nineties; and 37 per cent in the four years from 1995-98. At the end of 1998 the number of spin-offs formed in the 1990's was already 4.5 times the number formed in the 1980's.

4. How are these spin-off companies impacting the economy?

Sales of almost $60 million were generated in 1997-98 by 47 per cent of the medical and biomedical companies which participated in this survey and were incorporated since 1979 (i.e excluding the first Canadian spin-off, Pasteur Merieux Connaught). 75% of the spin-off's sales are exports. These 82 spin-offs employ almost 2500

people and 56% of their employees are scientists and technicians. The spin-offs spent over $130 million on R&D in 1997-98, 19 per cent in universities and research institutes. They paid over $1 million in corporate taxes. Seven of the spin-offs have generated nine spin-offs of their own.

Not all the areas I set out to address in this section were addressed. For example, I intended to compile a better picture of how the spin-offs were financed in general (in addition to the financing of the founding technology). Unfortunately I found that the quality of the responses received for the particular question addressing this subject (#30) was quite low. In retrospect I see that the question expected too much of the participants and was too unwieldy. As a result I cannot report on the sources of financing beyond the development of the founding technology.

5. Which provinces have been "players" in this industry?

As expected Canada's three largest provinces are creating the most medical and biomedical spin-offs. In one province (B.C.) the technology transfer capabilities of its major university is seen as largely responsible for that province's success in creating spin-offs. In another province (P.Q.) government policy has been a major factor in its turnaround from one of the lowest producers of spin-off companies to the highest. In yet another province (Ontario) sheer volume as the province with largest economy and the largest medical school appears to be the reason it creates the number of spin-offs that it does.

If the first two factors – excellent technology transfer services and proactive government policy – could be combined in a robust Canadian economy, Canada's rate of spin-off creation would continue to increase at a healthy rate.

Just as UBC's University Industry Liaison Office has been the Canadian technology transfer leader in spin-off creation, Québec has become the provincial leader in how a new industry can be encouraged. Their approach has been both integrated and consistent. Successive governments at all levels have worked together to create regional clusters of researchers, incubators, established companies, venture capitalists and other service companies. BioContact Québec, perhaps the best known result of this co-operation, started in 1994 and has since grown to host the première biotechnology conference in Canada connecting 800 participants with 80 new projects annually.

Other Findings

- Conducting surveys requires a lot of determination, time and effort to obtain a good response rate.

- The spin-offs in this study are on average seven years old. Most of the spin-offs have less than 50 employees; 45 per cent have less than 10. 35 per cent have already developed products.

- The potential impact of the medical and biomedical spin-offs on our health care system is phenomenal. These companies are developing innovative diagnostics, devices, therapies and vaccines for all of our major medical diseases and disorders. If only a small percentage develop to their full potential they will produce tremendous benefits for our society.

- The spin-offs which were categorized as having benefited the most from MRC grants are, on average, younger than the other spin-offs. These 33 spin-offs are also less reliant on foreign capital. Even though they are younger their average sales, exports, corporate taxes and university- and institute-based R&D is higher than the other spin-offs. 88 per cent of their $29 million in sales are exports. They spend $44 million on R&D, 45 per cent in universities and research institutes. (See Appendix B, Report to the Medical Research Council)

Conclusions

Based on my review of the literature and the results of this study I am of the opinion that:

- the biotechnology industry will have a considerable impact on our economy and society; medicine in particular will change dramatically;
- the development of biotechnology-based products is a very expensive and time-consuming process;
- the vast majority of investors cannot evaluate these technologies and therefore cannot select individual projects for investment without incurring above-average risk;

- government funding both reduces the dependence of new projects on equity funding and provides an additional level of evaluation that equity investors can subsequently rely on to reduce their risk;
- there are a number of regions, provinces, states and countries which have already realized the significance of a pro-biotechnology policy;
- the creation of critical mass through regional clusters (including areas of specialization) can improve the development of the biomedical industry;
- spin-off creation is fostered by an integrated approach involving: universities and research institutes; all levels of government; private and public sources of financing; and networking organizations.

I have concluded that government support for the development of the biotechnology industry is crucial to Canada's economic and social standing in the next century.

- As a minimum this support must encourage improvement in the commercialization process and foster, as well as provide, funding of scientists and companies. Increased support for the commercialization of technology developed in universities and research institutes should emphasize the continued development of the universities' technology transfer capabilities and the increased use of incubators. Government funding should utilize peer-review evaluations wherever practical not only because of their reputation for objectivity and fairness, but also for the "stamp of approval" investors subsequently rely on.

- Regional clusters and specialization will increase the competitiveness of Canada's biotechnology industry. The integration of municipal, provincial and federal programs is the preferable route to creating new clusters and strengthening existing ones.

- It is critical that policies and programs supportive of the biotechnology industry are not altered significantly (or eliminated) with changes in government. Given the long product development cycle in the biotechnology industry and the degree of specialization required to develop new technologies, this consistency and integration maybe just as important as the type of program implemented.

Areas for Future Study

The province of Québec is frequently held up as an example of how, and to what extent, provincial governments should support the biotechnology industry. Support for Québec as a role model was found in this study's comparison of provincial rates of spin-off formation. This study found that Québec increased its rate of formation from one of the lowest in the 1980's to one of the highest in the 1990's.

The array of publicly-funded support available to small companies in selected industries in Québec is more extensive than in any other province. The province of Québec offers tax holidays to immigrant scientists, their managers and other experts. There's also refundable tax credits for portions of researchers salaries and research contracts. Québec also subsidizes venture capital companies. There are also government-supported incubators and industrial clusters. These offerings are in addition to the refundable tax credits for R&D expenses, including "super-deductions".

Critics of Québec's "hand-outs" question the ability of the publicly-funded companies' ability to sustain themselves once they are no longer eligible for the subsidies and tax relief. They speculate that the businesses are too small to attract the private funding that they need and that a period of "radical consolidation" is about to commence.[1]

An interesting follow-up study to this thesis would attempt to answer the critics' question by assessing the successfulness of the companies which participated in this study in another year or two and then comparing the results on a provincial basis. If the critics of Québec's policies are correct, the Québec-based companies will not be as viable and as economically successful – in terms of product development (time to market), financing, sales, exports, job creation – as those based in the other provinces. If the critics are not correct, there should be no significant difference in survival rates or other measures of economic success. Either way, the analysis will be valuable from a public policy development perspective because it will help to determine how much public support is optimal.

[1] Bowley, Graham "Good Science and Public Funds Lift Canadian Biotechs", *Financial Times,* 15-11-1999, London, England, p.23

There are many other areas on the subject of biomedical spin-offs that require further study. For example, a better understanding of how spin-offs develop could help to better identify their needs. Another topic is the financing of companies in between the basic research stage and the public company stage: What type of financing is available; and is it meeting the needs of these companies? Reports prepared by Macdonald and Associates indicate that labour-sponsored venture capital companies and venture capital companies subsidized by the province of Québec figure very prominently in the life sciences sector.[2] A study of companies financed by these venture capital companies would also produce useful information about the need for government-sponsored venture capital companies.

Given the importance of the biotechnology industry and the role spin-offs can play in this industry, it is imperative that public policies directed at both of these fields continue to be studied.

[2] Macdonald and Associates Limited, *Venture Capital and Life Sciences: An Analysis of Canadian Venture Capital Investment Trends in the Life Sciences Sector,* Toronto October 1998,p.14, and April 1998, p.10

Acknowledgements

I relied on a number of experts to provide me with advice before, during and after conducting the survey. The interviews were conducted before I started the survey and the reviewers provided feedback on the draft of the thesis document. While I was conducting the survey I worked part-time for the Medical Research Council on a contract basis and benefited from consultations with a number of members of the MRC's staff. I think I mentioned everyone in the body of this thesis. Thank-you everyone for your advice, enthusiasm and support.

Reviewers

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Survey Respondents

I especially wish to thank the people who took the time to complete the surveys.

Seminars and Conferences Attended

The Leading Edge: Pushing the Life Sciences Technology Envelope, Ottawa Life Sciences Council, November 1998

An Introduction to the Science of Biotechnology, British Columbia Institute of Technology and BIOTECanada Human Resource Council, September 1998

Health Care Transitions; Integrated Systems; Enabling Technologies and the Community, Ottawa Life Sciences Council, November 1997

Into the Next Millennium: Biotechnology Financing and Intellectual Property, Ottawa Life Sciences Council, May 1997

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SURVEY OF BIOMEDICAL SPIN-OFF COMPANIES

The results of this survey will be used by the Medical Research Council to help it determine the economic impact of granting programs. Your assistance in the form of a completed survey will be much appreciated.
If portions of the survey must remain confidential you can indicate that requirement in the final section.
We recommend that Section D (History) and Section E (Support for the Founding Technology and Scientists) **be completed by the founding scientist** or someone else knowledgeable about the history of the company and the founding scientists. Section E (Economics) would best be completed by someone in Finance or Administration.

A. Company

1. Name

2. Mailing Address

3. Telephone Number

4. Facsimile Number

B. Survey Contact

5. Name

6. Title

7. Telephone Number

8. Facsimile Number

C. History

9. In what year was the company **incorporated**? _____

10. Your answers to the this set of Yes/No questions will help us determine whether or not your company is a "**spin-off**" and if so, what type.

Definitive spin-offs:
a. Was the company created by a university researcher and/or a university? ____Y ____ N

b. Was the company specifically created to transfer and commercialize inventions and technology developed at the university? ____Y ____ N

Aussi disponsible en francais.

«SpinoffCo»

Potential spin-offs:
d. Did the company exist prior to the time the technology was developed? ____ Y ____ N

e. If the company existed before the technology was developed was the company reconstituted around the university technology? ____ Y ____ N

f. Was the company formed around technologies from multiple sources, including a university? ____ Y ____ N

g. Was the company created to fund research at the university with the aim of developing technologies for license by the company? ____ Y ____ N

h. Was the company created to provide a specialized service which was originally offered through an existing university department? ____ Y ____ N

i. Was the company formed by a university researcher to undertake consulting work? ____ Y ____ N

Not spin-offs:
j. Was the company formed by graduates of a university but without a transfer of technology to the company? ____ Y ____ N

11. Briefly describe the **founding technology** or attach a short description.

____ Attached or:

«Founding_Technology»

12. Please list the names of the **scientists** who were most closely involved in the development of the company's original intellectual property.

Name	Institution	Faculty	Department
«ScientistsFirstName» «ScientistsMiddleName» «ScientistsLastName»	«Institution»		«Department»

D. Support for the Founding Technology and Scientists

13. Please list the names of **funding sources** which helped to finance the development of the **company's founding technology**. Also check off the appropriate description.
(A similar question follows for the founding scientists.)

Principal Sources of Funding: (Critical) _____ _____	___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign ___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign
Secondary Sources of Funding: (Significant) _____ _____	___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign ___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign
Other Sources of Funding: (Minor) _____ _____	___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign ___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign

Examples of sources of funding include:

Federal government sources:
- Granting Councils:
  - Medical Research Council
  - National Science and Engineering Research Council
- Federal Departments:
  - National Research Council
- Federal Programs:
  - Networks of Centre of Excellence

Provincial government sources:
- Universities
- Hospitals
- Research Institutes

Not-for-profit agencies

Foreign Funding:
- National Institute of Health (U.S.A.)
- International Agencies:
  - Howard Hughes
  - JDFI

14. Please complete one of the following tables for each of the founding scientists to indicate which of the following organizations and **programs supported the founding scientists.**

Name of Founding Scientist:	_____
Principal Sources of Funding: (Critical) _____ _____	___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign ___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign
Secondary Sources of Funding: (Significant) _____ _____	___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign ___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign
Other Sources of Funding: (Minor) _____ _____	___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign ___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign

Examples of sources of funding include:

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- Granting Councils:
  - Medical Research Council
  - National Science and Engineering Research Council
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- Federal Programs:
  - Networks of Centre of Excellence

Provincial government sources:
- Universities
- Hospitals
- Research Institutes

Not-for-profit agencies

Foreign Funding:
- National Institute of Health (U.S.A.)
- International Agencies:
  - Howard Hughes
  - JDFI

If the founding scientists' Curriculum Vitaes list their grant history please attach them to this questionnaire.

Name of Founding Scientist:	_____
Principal Sources of Funding: (Critical) _____ _____	___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign ___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign
Secondary Sources of Funding: (Significant) _____ _____	___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign ___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign
Other Sources of Funding: (Minor) _____ _____	___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign ___ Government ___ Non-profit ___ University ___ Industry ___ Canadian ___ Foreign

Examples of sources of funding include:

Federal government sources:
- Granting Councils:
  - Medical Research Council
  - National Science and Engineering Research Council
- Federal Departments:
  - National Research Council
- Federal Programs:
  - Networks of Centre of Excellence

Provincial government sources:
- Universities
- Hospitals
- Research Institutes

Not-for-profit agencies

Foreign Funding:
- National Institute of Health (U.S.A.)
- International Agencies:
  - Howard Hughes
  - JDFI

If the founding scientists' Curriculum Vitaes list their grant history please attach them to this questionnaire.

15 .Was a founding scientist **refused a grant** for research on the founding technology?

____ Yes ____ No

If you answered yes please complete the remainder of the question:

In your opinion, the decision was:

_____ the best decision based on the knowledge at the time

_____ inappropriate because of flaws in the evaluation system, or

_____ made as it was because of another factor; please describe: _____

_____

Which agency refused the grant? _____

Who did fund the research? _____

E. Economics

16. Which of the following best describes the **"status"** of the company?

____ Concept (initial stage; raising capital)

____ Early Stage (obtained at least one round of financing & continuing R&D to produce products)

____ Active (established facilities & developing or selling products)

____ Closed (ceased operating)

17. Which **industry** is your company in?

____ Pharmaceuticals ____ Medical Devices

____ Diagnostics ____ Medical Software

____ Health Care Services ____ Production Techniques

____ Other: _____

18. What disease/disorder is the **target** of your principal products or services?

____ Anti-infectives ____ Blood Disorders

____ Bone Disorders ____ Cancer

____ Cardiovascular Disease ____ CNS Disorders

____ Diabetes ____ Genomics

____Veterinary

19. How many **products** has your company brought to market? _____

20. How many **patents** does your company hold? _____

21. How many **licensing agreements** does it have to:

    license technology from others? _____

    license technology to others? _____

22. Please describe your company's **main business**.

    _____

    _____

    _____

23. How many people does your company **employ in Canada**?

    In total _____

    as scientists _____

    as technicians _____

    as administrative staff _____

    in manufacturing _____

    others _____ _____

24. How many **contract employees** are not included in the above numbers? _____

25. What is your company's **net sales** from Canadian operations? $_____

26. What percentage of sales is derived from **exports**? _____%

27. How much did your company spend on **Research & Development** in the last fiscal year?

    $ _____

28. How much has the company paid in **corporate income taxes**?

    In total $ _____

    Last fiscal year $ _____

29. How much has the company spent on **institute and/or university-based research**?

    In total $ _____

    Last fiscal year $ _____

30. How much money has been raised from:

	Total	Last Fiscal Year
Research grants	$_____	$_____
Government grants (other than research)	_____	_____
Government loans	_____	_____
Private sources: Venture capital	_____	_____
Other private	_____	_____
Public exchanges	_____	_____
Totals	_____	_____

31. Is your company listed on a **stock exchange**? ____ Yes ____ No

If yes, please name the exchange below:

_____

and enclose copies of the company's recent annual reports.

32. Is part (or all) of your company **foreign-owned**? ____ Yes ____ No

If yes, what percentage? _____% and by which country? _____

33. Have any **second-generation spin-offs** been created? ____ Yes ____ No

If yes, please list the names and locations of any companies that were formed by:

former or current employees? _____

your company? _____

licensing your intellectual property? _____

34. What is your company's **fiscal year-end**? _____

F. Comments

If you have comments in addition to the information provided above please write them here:

_____

_____

_____

G. Confidentiality

Which sections of this questionnaire must remain confidential (for internal use only at the MRC and/or reporting in aggregate form) and which sections may be disclosed?

	Disclosure Permitted	Confidential All Questions	Confidential Specified Questions:*
A. Company	____	____	_____
B. Survey Contact	____	____	_____
C. History	____	____	_____
D. Support for the Founding Technology and Scientists	____	____	_____
E. Economics	____	____	_____
F. Comments	____	____	_____

*Alternatively you can just write "C" beside the data you wish kept confidential.

H. Returning Your Questionnaire

Please mail or fax your completed questionnaire to:

Business Development Branch
Medical Research Council of Canada
1600 Scott Street, 4th Floor
Postal Locator 3105A
Ottawa, K1A 0W9

Fax No.: (613) 941-1040

A return envelope is enclosed.

Any **questions** can be directed to Lynn Honsberger at (613) 954-5320.

Thank-you for your valuable contribution to this project.

Report to the Medical Research Council

MRC Companies and Founding Scientists

I provided the Medical Research Council with a list of 33 companies which had named the MRC as a principal source of funding for their founding technologies or their founding scientists. Similarly I also provided a list of 41 scientists who named the MRC as a principal source of funding for their careers. I have not included the lists in this report because some of these companies requested that the section on support for the founding technology and scientists be kept confidential.

Characteristics

I compared the characteristics of the "MRC spin-offs" to the spin-offs not included on this list.

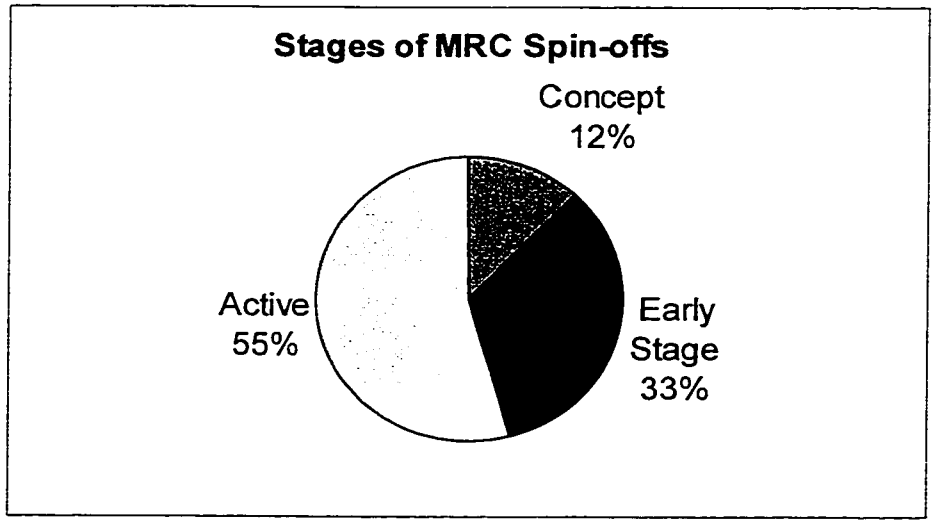

Figure B-1

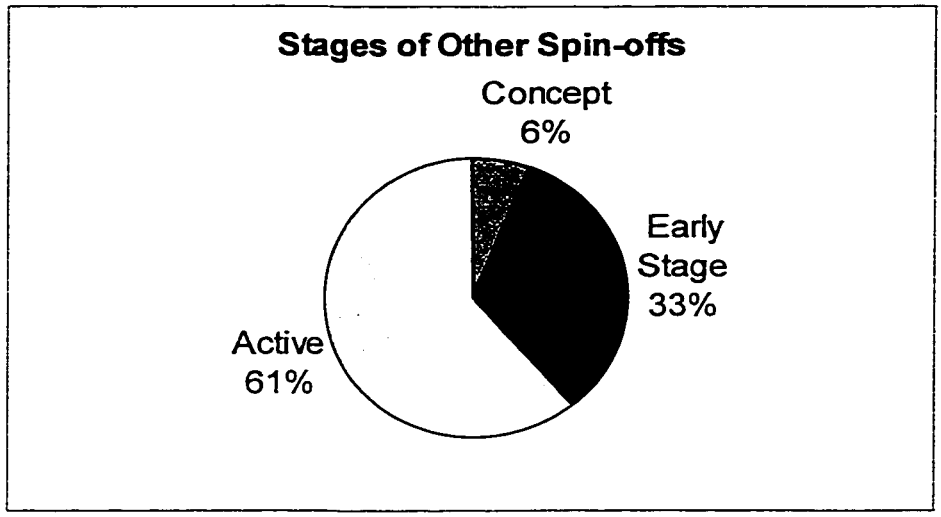

Figure B-2

Figures B-1 and B-2, Stages of MRC Spin-offs and Stages of Other Spin-offs, show that more of the MRC spin-offs are in the concept stage and fewer are in the active stage than the other spin-offs. More companies in the concept stage led me to expect that the MRC spin-offs would be younger.

Figure B-3, Year of Incorporation, (where the vertical axis is the number of spin-offs incorporated in a given year) shows that the MRC spin-offs are younger. The oldest MRC company is 14 years old. Their average age is 5.1 years; the average age of the other spin-offs is 6.4 (excluding Connaught).

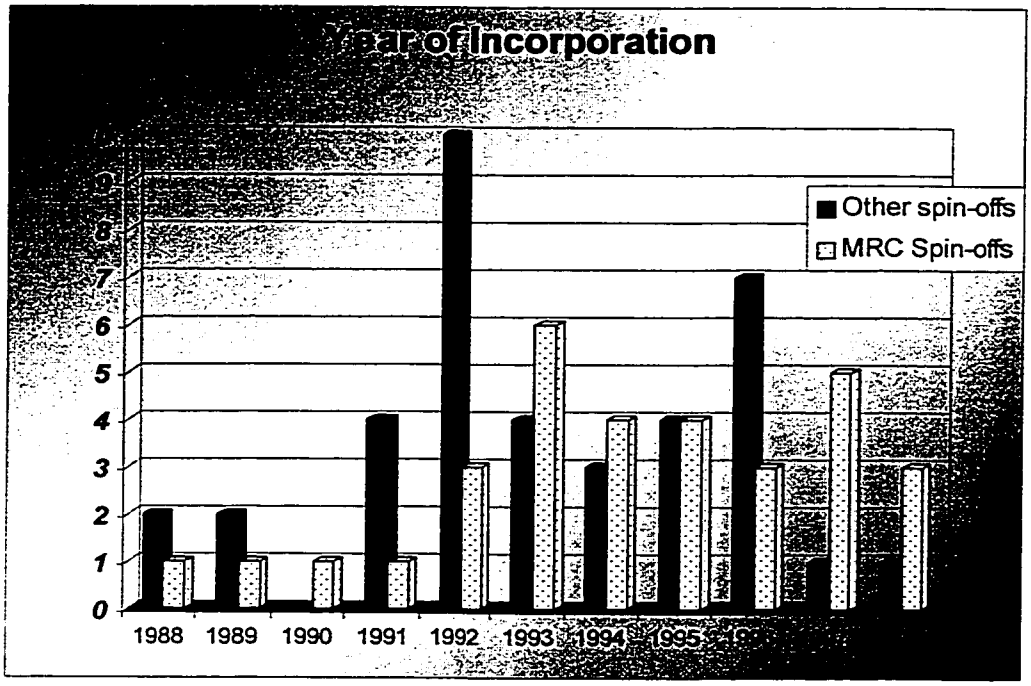

Figure B-3

A comparison of the two groups' stated industries as in Figure B-4, Industries Comparison, shows that they are similar except for in the diagnostics sector where fewer of the MRC companies are found.

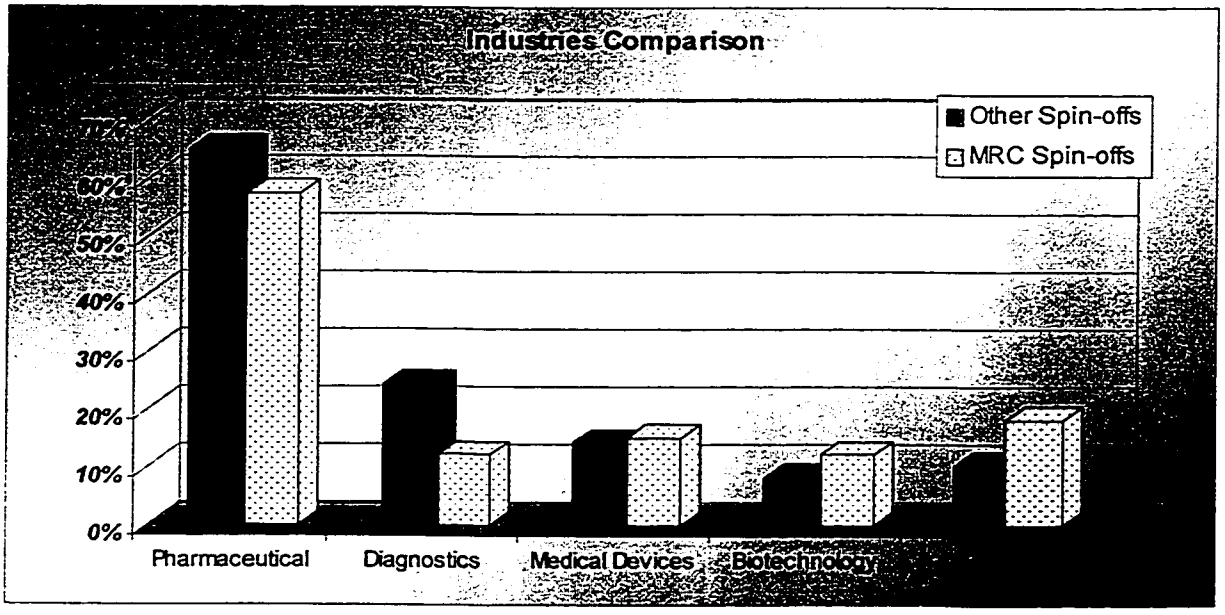

Figure B-4

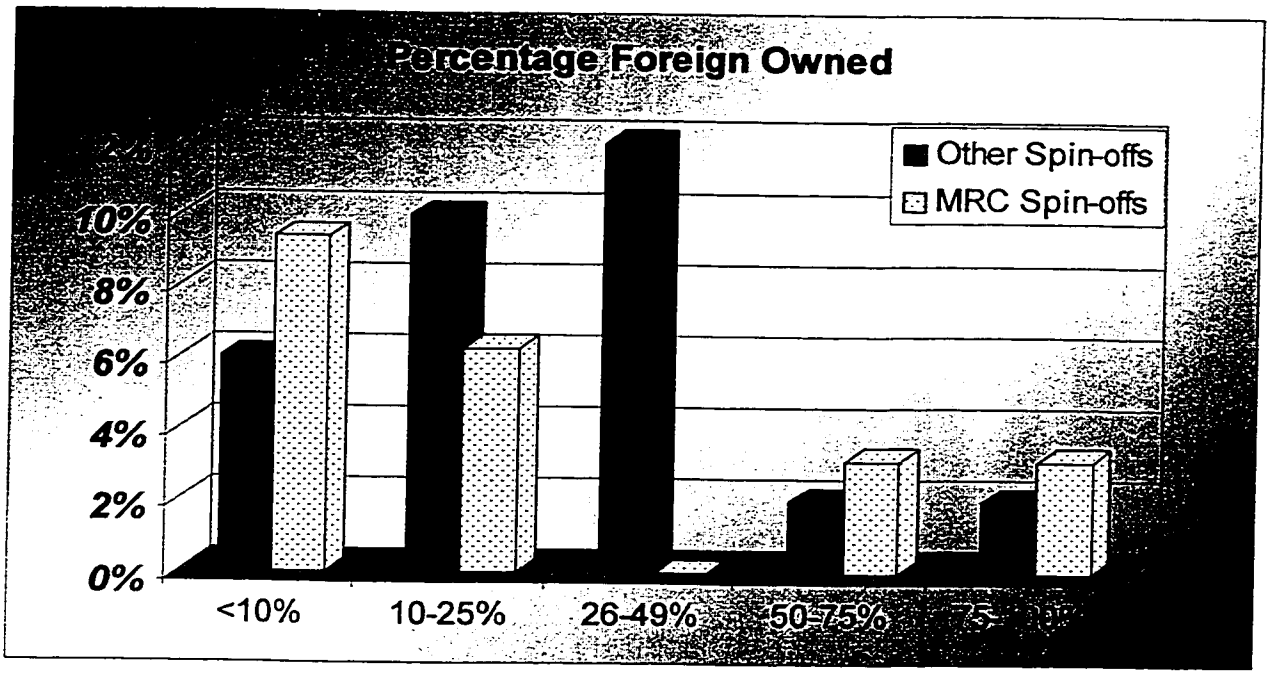

Figure B-5

MRC spin-offs are less likely to be foreign-owned. If they are foreign-owned the percentage that is foreign-owned is likely to be lower.

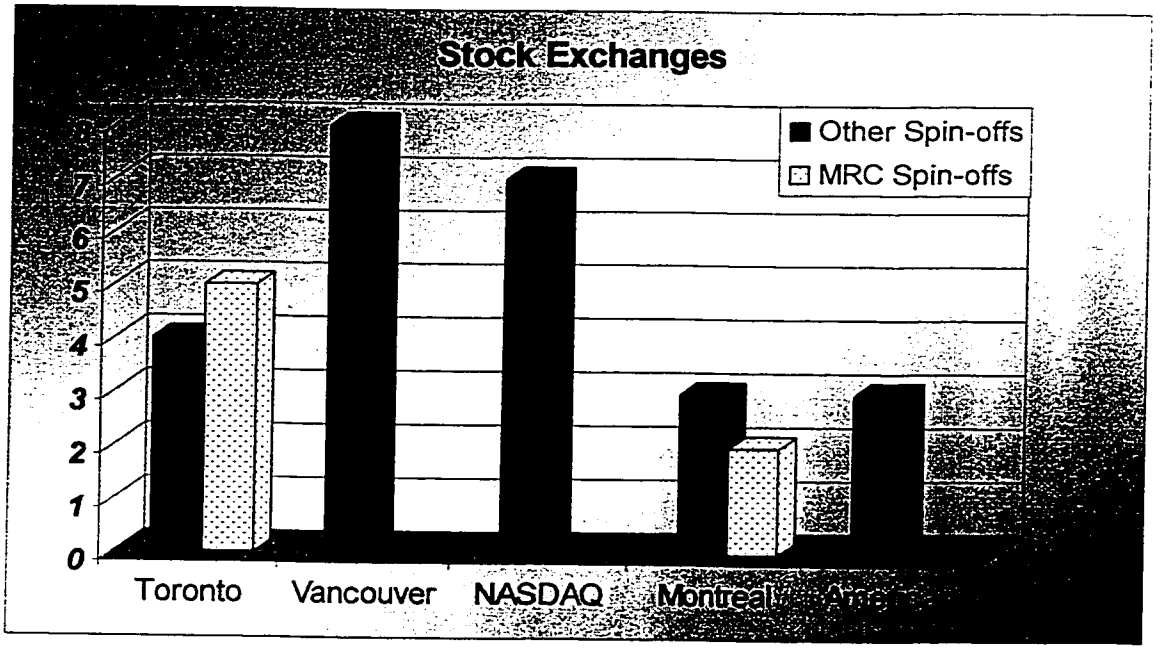

Figure B-6

The Other Spin-offs are listed on five stock exchanges whereas the MRC spin-offs are listed on the two traditional Canadian stock exchanges only: Toronto and Montreal. (See Figure B-6, Stock Exchanges, where the vertical axis represents the number of spin-offs listed on each exchange.)

Based on the percentage of foreign ownership and their choice of stock exchanges, it appears that the MRC spin-offs are less dependent on foreign capital than the other spin-offs.

Economic Impact

In 1997-98 the MRC spin-offs had sales of over $29 million. 88 per cent or over $25 million were exports. They employed 1,070 people, 32 on average per company. They spent $44 million on R&D, 45% or $20 million in universities or research institutes. They paid $800 thousand in corporate taxes.

Comparison to Other Spin-offs

The comparisons in this section exclude the Connaught data.

In general the MRC spin-offs are performing better than the other spin-offs on a per company basis. As Figure B-7, Comparison of Spin-off Averages, shows the MRC spin-offs are outperforming the other spin-offs in every category except for R&D expenditures.

Comparison of Spin-off Averages			
	MRC Spin-offs	Other Spin-offs	Spin-offs Total
Employees	32.4	27.8	29.7
Sales	$ 960,833	$ 627,551	$ 754,114
Exports	$ 847,067	$ 389,653	$ 563,354
R&D	$ 1,900,609	$ 2,027,674	$ 1,983,394
Univ/Inst R&D	$ 760,923	$ 122,525	$ 374,015
Taxes	$ 27,621	$ 8,592	$ 15,667

Figure B-7

In Figure B-8, Percentage of Spin-off Totals, the two groups of spin-offs are compared as percentages of the total for each economic category. The first two columns show that the 33 MRC spin-offs comprise 40 per cent of the 82 spin-offs excluding Connaught and the other spin-offs make up 60 per cent. Therefore the MRC spin-offs are outperforming the other spin-offs on a relative basis in any category where they contribute more than 40 per cent of the total.

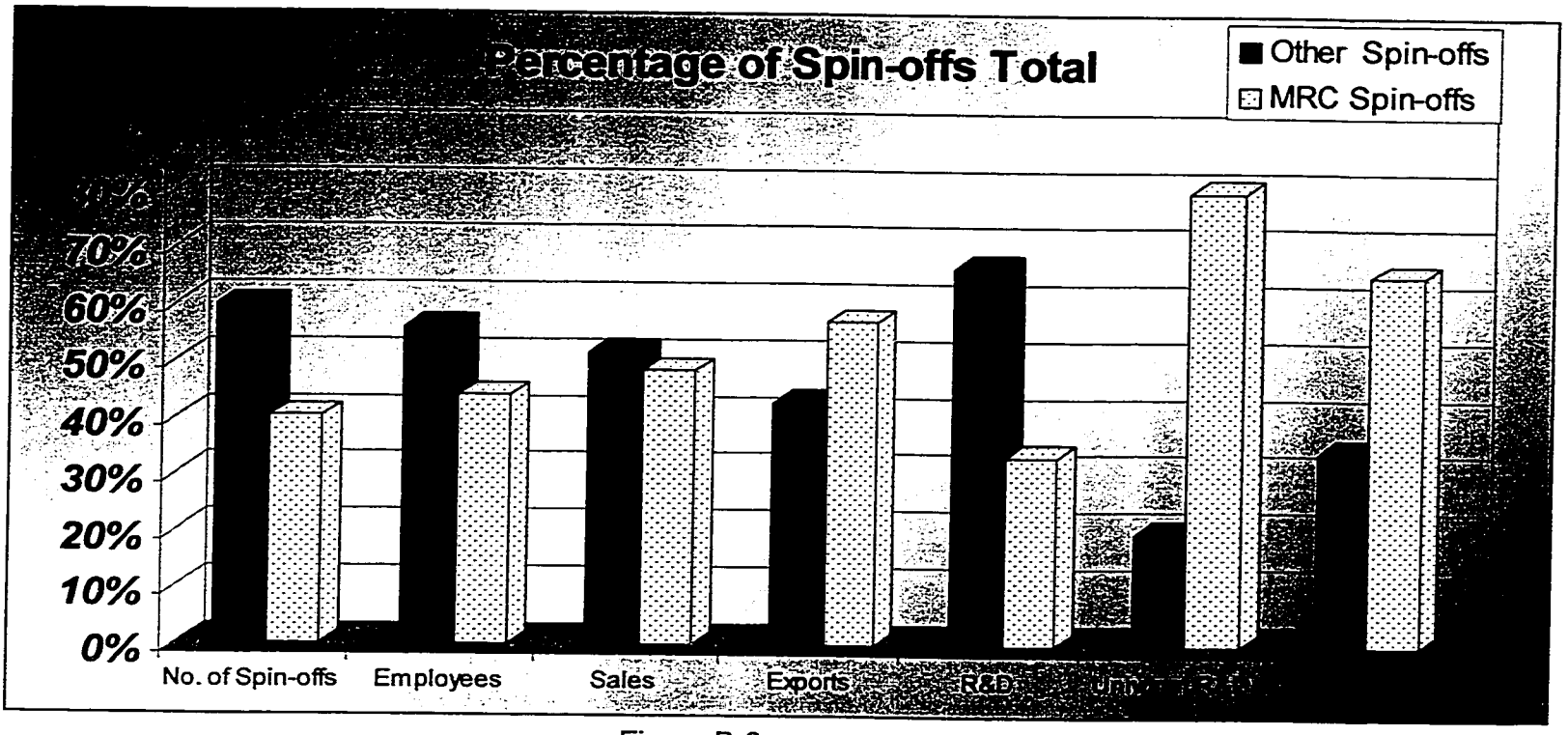

Figure B-8

Even though they are fewer in number the MRC spin-offs' total exports, university- and institute-based research and corporate taxes exceed the totals for the other spin-offs. See Figure B-9, Comparison of Economic Impact. This performance is not in line with the assumption that younger companies generally have not developed as much as older companies and therefore do not have as great an economic impact. On average the MRC spin-offs are 1.3 years younger. In addition a larger percentage of the other spin-offs are in the "active" stage of development than the MRC spin-offs. To explain this anomaly I can only assume that the MRC spin-offs which are in the active stage have been more successful economically.

Comparison of Economic Impact			
	MRC Spin-offs	Other Spin-offs	Spin-offs Total
Number of Spin-offs	33	49	82
Employees	1,070	1,363	2,433
Sales	$ 28,825,000	$ 30,750,000	$ 59,575,000
Exports	$ 25,412,000	$ 19,093,000	$ 44,505,000
R&D	$ 43,714,000	$ 87,190,000	$ 130,904,000
Univ/Inst R&D	$ 19,784,000	$ 4,901,000	$ 24,685,000
Taxes	801,000	421,000	1,222,000

Figure B-9

Summary

The MRC spin-offs are young and on the increase. Compared to the non-MRC companies they have less foreign ownership. They list their stocks on the traditional Canadian stock exchanges. Although they are young they outperform the other spin-offs economically on a per company basis. They contribute almost $29 million in sales, 88 per cent or $25 million in exports. They have over 1000 employees in Canada and they spend almost $43 million on R&D, close to $20 million in universities and research institutes.

MRC-funded technology and scientists are creating companies that are more productive and have a greater economic impact at a younger age than the other spin-offs.

THESIS PROSPECTUS

on the subject of

BIO-MEDICAL SPIN-OFF COMPANIES

from Canadian Medical Schools and Affiliated Research Institutes

Student: **Lynn Honsberger**

Student Number: **166095**

Principal Thesis Advisor: **Pran Manga, Ph.D.**

Program: **Master of Health Administration**

Thesis Prospectus

Bio-medical Spin-off Companies
from Canadian Medical Schools and Affiliated Research Institutes

A. INTRODUCTION

Focus

This thesis will focus on the creation and economic impact of biomedical companies whose founding technologies originated in Canadian medical schools or affiliated research institutes.

Significance

The creation of companies from technology which was developed in a university setting is a recent phenomena. (Almost all spin-off companies have been formed in the last two decades.) Many claims are being made about their significance including:

- as a form of technology transfer, spin-offs are preferred to licensing because the technology and jobs remain in local (Canadian) economies;
- to keep well-educated people in Canada we need the jobs these types of companies can provide;
- the type of innovation the founding scientists bring to their companies is critical to the success of a knowledge-based economy; and
- without spin-offs a Canadian biomedical industry may not be sustainable and the trade deficit in health care technology will only grow.

These claims are unsubstantiated because there is a lack of Canada-wide information on biomedical spin-off companies. For example, there is no Canada-wide list of only the names of these companies.

Biotechnology is expected to become a significant and critical component of the Canadian economy. According to Strachan (1998,p.35) medical research is the genesis of most leading-edge practices in biotechnology. A number of government departments in the areas of industrial development, education, finance, science and technology are interested in developing policies and programs which will maximize the potential of this industry. These programs are needed to encourage the creation of spin-off companies and counter the difficulties they encounter at every stage of development. For example, supporting the creation of a spin-off company can take the technology transfer office at the University of British Columbia up to ten times more effort than it would take to license the technology to a multi-national pharmaceutical company. (Livingstone,1997, p.5) Information about the creation of spin-offs,

their current activity and the programs which may have influenced them would be of value to these government departments.

Studying the economic impact of companies started from Canadian medical schools is of interest to me personally for a number of reasons. First the biotechnology industry is a relatively new and growing sector of the knowledge-based economy with many opportunities. Secondly it allows me to draw on my three areas of expertise: finance (I am a Chartered Accountant); high technology (where I have spent most of my career to-date); and health administration (my current area of study). I have been considering the biotechnology industry as a source of employment and thesis topics for two years. It has been a year since I began investigating bio-medical spin-offs as a potential thesis.

The number of organizations who could make use of the information this thesis would generate is also very appealing. Canadian medical schools and research institutes, the Medical Research Council and other granting agencies, as well as a number of government departments are very interested in obtaining well-researched information on the creation and economic impact of bio-medical spin-off companies in Canada.

B. Methodology

Literature Review

The literature review will concentrate on government and university reports on the subjects of spin-offs, the biotechnology industry, (particularly the biomedical sector) and the financing of research. There is excellent information available on spin-offs in British Columbia (compliments of UBC). Canada-wide information is less available and less current. For example, the data referred to in a 1997 government report on spin-offs refers to surveys conducted in 1994 and 1995. (Warda and Zieminski, 1997) According to Ward and Zieminski, academia, the private sector and government are interested in spin-offs, a "rapidly expanding phenomenon of growing economic importance". (1997, p.i)

Questions to be Addressed

This thesis would address the following questions:

1. Which Canadian companies are bio-medical spin-offs?
2. Who funded the founding technologies of biomedical spin-off companies and the careers of the founding scientists?
3. What is the rate of spin-off creation?
4. How are these spin-off companies impacting the economy?
5. Which provinces have been "players" in this industry?

1. Which Canadian companies are bio-medical spin-offs?

To answer this question "bio-medical spin-off" must first be defined. Secondly, a list of potential companies must be compiled from a variety of sources across the country.

2. Who funded the founding technologies of biomedical spin-off companies and the careers of the founding scientists?

This question has two parts because financing the career of the founding scientist is just as critical as financing the development of the founding technology.

3. What is the rate of spin-off creation?

People knowledgeable in the industry think the number of new biomedical start-ups is "mushrooming". This impression needs to be confirmed. Trends will identified based on information such as dates of incorporation, stock exchange listings, and closures.

4. How are the spin-off companies impacting the economy?

Information about jobs, revenues, exports, taxes paid, second-generation companies, financing, foreign ownership of the companies, number of patents, R&D expenditures and (to complete the cycle) the companies' financing of university and institute-based research will be sought in order to answer this question.

5. Which provinces have been "players" in this industry?

In addition to a national analysis the data will lend itself to a comparison by province. A provincial comparison will be of interest to policy analysts because the provinces have implemented different approaches, policies and programs which have influenced the development of this sector.

Approach

Survey:

To answer these questions I will conduct a survey of as many of the bio-medical spin-off companies in Canada as possible. To increase the response rate I will send the questionnaire under the letterhead of the Medical Research Council. Personalized covering letters will be signed by Marc LePage, Director of Business Development, who knows well over 50% of the contacts personally.

Unless a company indicates otherwise, all information obtained from the surveyed companies will be kept strictly confidential. Data that could identify individual companies will not be revealed.

Definitions:

How to define a spin-off company is currently something of a contentious issue in Canada. (In their efforts to publicize their successes, some technology transfer offices have used definitions which are too broad.) The number of criteria referred to in the literature can be used to produce a continuum of definitions depending on which criterion is used as a cut-off. The questionnaire is designed so that the companies can be categorized as spin-offs given any definition on the continuum.

The biomedical sector will be defined as a subset of the biotechnology industry.

Company names:

Sources of company names include:

- the technology transfer offices of the 16 Canadian universities with medical schools
- the Medical Research Council
- other granting agencies
- industry directories
- conference attendance lists

Obtaining addresses and contact names is a second, but crucial, part of this step.

Industry experts estimate the number of Canadian bio-medical spin-offs to number 300 or less.

Database Design:

A database will be designed using Access 97 to store the companies' basic information, survey status and the questionnaire data.

Questionnaire Design and Testing:

This step includes obtaining advice from experienced people in the industry; writing the questionnaire; circulating it for feedback; and testing it on a small sample.

The questionnaire will have sections for:

- basic company and contact information;
- the history of the company including date of incorporation, questions to confirm it is a spin-off, its founding technology and its founding scientists;
- financial support for the founding technology and scientists;
- economic information including products, number of employees, sales, exports, taxes, expenditures on university research; financing, public listings, foreign ownership, second generation spin-offs and fiscal year-end;

- comments; and
- the confidentiality of each section.

Questionnaire Administration:

Follow-up by telephone and fax will be crucial to obtaining a good response rate. Coordination with the University of British Columbia will also improve the response rate. (The University of British Columbia has the most successful, well-documented and publicized spin-off program in Canada. The report on its most recent survey is excellent and was well- (and enviously-) received. Since their University-Industry Liaison Office wants to reduce the possibility of "their" companies suffering from "survey burn-out" working with this office to survey the UBC companies is feasible.)

Data entry:

Alternative sources of information such as annual reports and industry directories can be used to verify the data and provide some of the missing data.

Analysis:

Significant sources of funding for founding technologies and founding scientists will be identified.

The financial data including employment by category, capitalization, annual sales, exports, R&D expenditures and taxes paid will be studied to determine the economic impact of the companies. Totals and averages will be analyzed by age of company to indicate trends.

Comparisons will be made by province or region. These comparisons will take into consideration differences in the policies and programs the provinces have implemented for the biotechnology industry. Quebec is often cited as the province with a long-standing, consistent policy of encouraging biotechnology. For example, Quebec offers a 40 per cent tax credit for corporate expenditures on external researchers and university research contracts; in-house researchers are given a 20 per cent credit. Quebec has also formed a number of venture capital companies and provided them with subsidies.

The universities' approaches to technology transfer vary widely from high levels of encouragement and support to minimal or none. Regional differences will be analyzed taking into account these variations in university support.

An analysis of the spin-offs' potential social benefits will be included by considering the descriptions of the spin-offs' technologies, target markets and products.

Benefits to the universities and research institutes in terms of the spin-offs investment in their research will also be included in the analysis. UBC has found that the contributions made by spin-off companies originating from all UBC faculties comprise 30 per cent of the total dollar value of its industry-sponsored contract research. (Livingstone,1997, p.12)

Success Stories:

Successful companies which illustrate some of the points made in the analysis will be described.

Conclusions:

Conclusions will be drawn regarding the economic impact of bio-medical spin-offs. Trends, such as rate of creation and rate of failure, will be identified.

A number of policy implications will be discussed. Some of the discussion will focus on the programs that should be continued, for example, those which will have been identified as significant sources of funds for the founding scientists and those that support technology transfer offices. The policies implemented in the jurisdictions which have been identified as having the most success with bio-medical spin-off companies will be highlighted. Policies and programs which are needed to address areas that continue to hamper the creation or success of these companies will be recommended.

Presentations:

The results of the survey may be presented to appropriate audiences such as the Medical Research Council, AUTM (Association of University Technology Managers (of North America)), and the Ottawa Life Sciences Council.

Table of Contents

The Table of Contents will be similar to the one below:

Economic Impact
- Employment
- Sales, Exports
- R& D Expenditures
- Patents
- Financing
- Taxes Paid
- Research

Provincial/Regional Analysis
- Comparisons
- Variations in Provincial Policies
- Variations in University Policies

Social Benefits
Success Stories
- Company descriptions

Conclusions
- Significant Sources of Funding
- Economic Impact
- Trends
- Policy Implications

Appendices
Bibliography

Timeline

If the work on this thesis goes according to plan it should be completed according to the following timeline:

Obtaining company names and addresses - October 1998

Questionnaire design and testing - October-November 1998

Database design - November-December 1998

Questionnaire administration - December 1998-March 1999

Data entry - January-April 1999

Analysis - May-June 1999

Report writing - September 1999

Planned Interviews

Michelle Campbell, Executive Assistant to Council, Medical Research Council

Denys G.T. Cooper, Ph.D., Director, Technology Networking, Industrial Research Assistance Program, National Research Council

John Cosmopoulos, Technology Transfer Officer, Research Services, University of Ottawa

Fred Haynes, Ph.D., President, Contact Canada (publisher of biotechnology directories)

Marc LePage, Director, Business Development, Medical Research Council

Angus Livingstone, Associate Director, University-Industry Liaison Office, University of British Columbia

Peter Munsche, Assistant Vice-president, Technology Transfer, University of Toronto

Statistics Canada personnel regarding the upcoming release of their "Biotechnology Firm Survey"

Others will be attempted in the course of the research.

Seminars and Conferences

The Leading Edge: Pushing the Life Sciences Technology Envelope, Ottawa Life Sciences Council, November 1998

An Introduction to the Science of Biotechnology, British Columbia Institute of Technology and BioteCanada Human Resource Council, September 1998

Health Care Transitions; Integrated Systems; Enabling Technologies and the Community, Ottawa Life Sciences Council, November 1997

Into the Next Millennium: Biotechnology Financing and Intellectual Property, Ottawa Life Sciences Council, May 1997