Regional systems of innovation
Market pull and government push

Jorge Niosi
Professor
Department of Management and technology
Université du Québec à Montréal
Researcher
CIRANO

A presentation to the Annual Meeting of the
Canadian Research Network on
Regional Innovation Systems

Montreal

May 2000

Last modified October 2000

Abstract

National systems of innovation developed through a mix of government inducement (or government push) and market pull. Within national systems of innovation, regional systems of innovation display some similar characteristics: a combination of public policy and spontaneous market development has created clusters of competencies in specific sub-national regions. The effectiveness of governmental inducement and market pull depends, all things being equal, on the efficiency and effectiveness of public and semi-public institutions. This is particularly true in the new science based industries (SBIs), such as biotechnology and software, where the role of governmental institutions is more important than in traditional activities and even in older SBIs such as aerospace and electrical equipment manufacturing.

The paper will illustrate the role of market pull and public policy push in two science-based industries, and will shed light on market and government efficiencies and inefficiencies.

Introduction

One of the most fascinating dimensions of innovation is its agglomeration in a few countries and a few regions within each industrial country. Why do innovative activities cluster in a few nations, and within them, in a few dynamic regions?

Within the national system of innovation literature, authors have highlighted the key roles of both governmental forces and spontaneous market evolution. Most authors insist on the fact that each national system exhibits its own patterns of development and that multistability is a key dimension of NSIs. Multistability stands for a multiplicity of national institutional configurations that produce similar economic performance. In other words, similarities in aggregate performances hide major differences in the institutional configurations (Edquist and Lundvall, 1993). Thus for Saviotti and Gummett (1994), the defense research establishment was the dominant part of the British national system of innovation during most of its history. Similarly, in the United States the national security concerns manifested themselves in the strong presence of the federal defense research establishment (Mowery and Rosenberg, 1993). Conversely, when comparing Denmark and Sweden, Edquist and Lundvall (1993) insist on the fact that the Danish NSI has more been the product of spontaneous development than the outcome of technology policy. In sum, similar high levels of productivity are associated with very different public policy inducements and institutional frameworks.

In the regional development literature we find the same opposition between planned local growth and spontaneous market agglomeration. In the Marshallian regional district, the agglomeration of firms was mostly the result of market forces: firms tended to cluster in areas where there was abundance of some basic input, including specialized materials and labour force. No government inducement was necessary to attain that synergy.

In the Postwar period, the state usually went far beyond the provision of basic infrastructure services and assumed the roles of entrepreneur, regulator and animator (Cooke and Morgan, 1998). The economic theories of John Maynard Keynes and

François Perroux gained popularity, with their insistence on the new roles of the state in national and regional economic development. Government was thus supposed to aim at the equalization of national employment and income. In the 1960s as a public entrepreneur, national or provincial states created (or subsidized the creation of) industrial poles. Examples are the automobile pole in Southern Italy (Holland, 1972), the steel industrial pole in Quebec or the petrochemical pole in Northeast Brazil (Evans, 1979). The idea that the state could launch a process of sustained industrial development in backward regions through the fostering of "industrializing industries" was fairly widespread and indeed accepted. Cases of successful government policies concentrating new industries in a few regions include US federal defense expenditures in California, and French aerospace investments in the Toulouse area. However in the 1970s and 1980s evidence mounted showing that these industrial policies were not always yielding the expected results. The petrochemical and automobile poles in Southern Italy did not attract suppliers and customers as expected, and contributed more to national deficits than to regional development; similarly Northeast Brazil did not become a magnet for other chemical industries. The Quebec public steel corporation did not attract any car or other large metal-using manufacturers.

While in the 1970s and 1980s industrial policy increasingly became synonymous to inefficiency and ineffectiveness, new knowledge-intensive industries were growing that allowed the state to develop new roles as animator and provider of public goods. This time the market imperfections concerned mostly the supply of scientific knowledge, through which dynamic regional clusters could be nurtured. These industries were those related to information technologies, biotechnology and advanced materials. The state could foster the development of regional clusters of competencies through more decentralized and horizontal policies, including the creation of government laboratories and research universities. These institutions would produce the basic inputs of the new science-based industries, namely highly skilled personnel and new ideas. Evidence mounted to witness the key role of universities in biotechnology, and government laboratories and academic research in some areas of information technologies (Swan, Prevezer, and Stout, 1998; Niosi and Bas, 2000; Yarkin, 2000).

National and regional systems

National systems of innovation are defined in a variety of ways (see Table 1). All these seemingly different definitions converge on the idea of a set of interacting institutions aiming at the development of science and technology. These institutions convey a series of incentives nurturing R&D and other innovative activities in private firms, universities and government laboratories. As such, these incentives determine the performance of the private sector. However, performance is not simply the result of designing and implementing proper incentives. Efficiency (the cost at which a given output is produced) and effectiveness (the level at which an organization attains its goals) vary according to different factors, including the synergy (or complementarity) among its various components, the efficiency and effectiveness of each of its parts, and other factors. National systems of innovation are thus x-efficient and x-effective: their efficiency and effectiveness should not be taken for granted, but are to be considered as variables (Niosi, 2001).

Each advance nation is characterized by a concentration of innovation into a few major activities. Switzerland is well known for its chemical and pharmaceutical industries, heavy electrical equipment, and food products. Sweden has specialized in the mechanical industries, telecommunication equipment, aircraft, biopharmaceuticals and automobiles. Canada's strongholds are in telecommunication equipment, aircraft, pulp and paper, primary metals, biotechnology and energy technologies. Italy has developed several soft, light industries such as textiles, footwear, building materials, furniture and electrical appliances.

It is also well documented that, within industrial nations, a few regions concentrate most of the national institutions devoted to the development of industrial innovation. In Sweden, cities such as Stockholm and Gothenburg are first and foremost. In France the Paris region (Île-de-France) concentrates nearly 50% of the French innovative capabilities. In Canada, Toronto, Montreal, Ottawa and Vancouver are the four regional centers centralizing over 80 per cent of the nation innovative competencies.

However, regional systems of innovation (RSIs) are less well defined than national systems (Table 1). National systems are clearly defined by their frontiers, and the application of national legislation and public policy. This is not the case with regional systems. How much solidarity, and interaction among the units is necessary for a region to become a RSI? How much innovation and what type of innovation exist in an industrial district to be considered a RSI?

National policies often provide structure to NSIs, particularly in mission-oriented systems. These policies include procurement policies, R&D subsidies, tax credits for R&D, intellectual property policies and the like. But what types of policies, if any, are typical of RSIs? What levels of government typically implement those policies?

The literature on RSIs is fairly mute on these questions and most often tends to describe specific regions and successful policies. Definitions are in short supply. Thus we learn that Alsace is not a region because there is little interaction among the industrial units in the area, the latter being mostly branch plants of foreign-controlled firms with little R&D (Héraud et al., 1995). Conversely, Wales is deemed to be an RSI because it has developed a governance system through the Welsh Office (a government organization created in 1964) and the Welsh Development Agency (a non-government organization launched in 1976), two regional institutions with planning and catalytic goals (Cooke and Morgan, 1998). However, the Italian industrial districts of Emilia-Romagna are considered RSIs in spite of the fact that they have developed spontaneously, with no major participation of either the national or the provincial governments in the formation of such dynamic clusters. These agglomerations incidentally boast little indigenous innovation, but have developed instead strategic guideposts for the adoption of externally made industrial novelty. Development in Northern Italy thus occurred through the interaction dense networks of firms, intermediary associations (such as the local Chambers of Commerce) and locally-organized design and technology transfer centers for such regional industries as ceramics, textiles and footwear (Cooke and Morgan, 1998; Perry, 1999).

Also the geographical boundaries of regional systems are less than precise. Sometimes regions are cities (such as Montreal or Paris), sometimes they are provinces or other sub-national administrative units (such as Ontario, Tuscany, California or Wales), sometimes they are industrial areas whose boundaries are more or less well defined, such as Route 128 or Silicon Valley.

Finally, the panoply of policies adopted to nurture regional innovation systems is almost endless. It includes the support of research universities, government laboratories and or innovative firms. It also involves the creation of industrial, scientific and technological parks, policy incentives in favor of venture capital, the development of firm incubators and many other institutions (Tetsuno, 1986; Federwisch and Zoller, 1986; Cooke and Morgan, 1998; Swan et al., 1998; Acs, 2000).

Behind these causal ambiguities lies the fact that any regional concentration of competencies is the result of a complex set of governmental and market influences. In some cases, governments have set the stage for the synergies to development spontaneously. In other cases, governments have accelerated unplanned market trends. Almost as often, market trends have collided with government schemes and institutions, as government officials are either bounded rational, or are motivated by their own agendas and motivation, including serving their own reelection (Gick, 2000).

In the following part of this paper I illustrate this tangled web of government and market influences, including their inefficiencies and failures, using two activities where Canada supposedly enjoys some revealed technological advantages: aircraft and human biotechnology.

Defining regional systems

The above discussion suggests that any definition of RSIs should start defining regions. For the purpose of defining RSIs, regions will be considered in this paper as urban agglomerations. It does not make any difference whether these regions have an administrative jurisdiction (such as the Montreal Urban Community) or not (such as Silicon Valley). No cultural homogeneity is necessary either. Bilingual and bicultural regions such as Brussels and Montreal are perfectly acceptable. In Canada, the metropolitan census areas are the typical regions that we need to study. The reason for this choice is that most externalities (both knowledge externalities and venture capital activities) take place within a maximum of 50-100 km (Zucker et al, 1998). Sub-national jurisdictions (such as American states, or Canadian provinces) are far too large for most externalities to occur homogeneously across their territories.

On the basis of this general definition we will define RSIs as regions in which innovative activities take place. Innovative activities must be measurable by some universally acceptable indicator, such as the granting of patents to locally-based inventors or the launching of new products designed and developed in the area. In this paper we will use patents as a major indicator of innovation, and one that is often used by private firms and public institutions alike in both activities under consideration.

Canada's regional systems

Two clusters in one regional innovation system, Montreal, will be studied in this paper. Montreal will be compared with other Canadian urban agglomerations, such as Toronto, Vancouver, Ottawa, and Calgary for the purposes of drawing conclusions on market forces and government inducements. Both clusters are SBIs, one is older (aerospace) and one very recent (human biotechnology). The size and innovativeness of both clusters were measured through several indicators: the number of firms, total employment and patents were the most important. A list of the most prominent firms in Canada was built using several sources. Tentative conclusions are drawn from both case studies.

3.1 The aerospace industry in Montreal

Montreal is the center of Canada's aerospace industries. It hosts the major plants of Bombardier (third world producer of aircraft), CAE (first world producer of flight simulators) as well as Bell Helicopter Textron (first world manufacturer of helicopters) and Pratt and Whitney Canada (a large producer of aircraft engines). Thus Montreal lodges one third of Canada's key firms, over fifty per cent of Canada's employment and most of the patents obtained by Canadian aerospace companies from 1976 through 2000. Montreal produces most of Canada's aircraft, and all its aircraft engines, helicopters and flight simulators.

The aerospace industry in Montreal was formed through a combination of private initiatives (between the early 1920s until World War II) and federal government incentives (during and after the Second World War). The regional pole started to take shape in the 1920s when a first foreign producer of aircraft, the British Canadian Vickers, created a new plant in Cartierville, a northern suburb of Montreal. This was the first ancestor of today's Bombardier Canadair plant. In the 1920s there was a follow-the-leader movement of several companies towards Montreal. In a few years Montreal hosted at least four aircraft producers (Canadian Vickers, Belanca, Canadian Wright and Reed Aircraft). The arrival of the aircraft manufacturers was followed in the 1920s by a US assembler of aeronautical engines (Pratt & Whitney) that invested in a new plant in Longueil, a southeastern suburb of Montreal. By the early 1940s, Montreal was producing war airplanes. Then in the late 1940s CAE, a Toronto-based company already manufacturing in the area some electronic equipment related to aerospace, started producing flight simulators in Ville St-Laurent, a nearby municipality. In the 1980s Bell Helicopter Textron created in Mirabel one of its largest facilities to produce close to fifty per cent of the world commercial helicopters. Finally, in the early 1990s the Canadian government created the Canadian Space Agency in the Montreal area to coordinate research and related activities in the industry.

During WWII, the federal government strengthened the Montreal pole as the regional center of Canadian aerospace production. This was done through several measures. For one, it took over the foreign-owned production facilities each time the overseas parents threatened to close the Montreal operations. This happened in 1944, when Canadian Vickers (lately Canadair) closed its Montreal facility. The federal government then created a Crown corporation, Canadair, to take over and operate the company in order to produce civilian aircraft. In 1946, Canadair was sold to an American corporation that would become, in time, the General Dynamics Corporation. By 1976, Canadair was again taken over by the federal government and later resold, in 1986, to Bombardier of Montreal. Incidentally, in 1992 the federal government also facilitated the sale of Toronto's de Havilland from Boeing to Bombardier, to create a single large aerospace group under Canadian control. For two, Ottawa helped Bombardier, but also Bell Helicopter, CAE, P&WC and Rolls Royce Canada through different subsidies, procurement, export inducement, repayable loans and technology transfer from government laboratories.

In terms of the number of key firms, Toronto leads Montreal by nine to eight corporations. However, in all other variables, Montreal is a distant first. Montreal is the largest cluster in terms of patents: 64 per cent of all the patents obtained by Canadian private firms between 1976 and 2000 were granted to Montreal inventors. Toronto follows with 29 per cent. Winnipeg and Vancouver are distant third and fourth (Tables 2 and 3). With sixty-nine patents P&WC is by far the largest concentration of innovative competencies in Canada. Litton Systems Canada in Toronto is second with twenty-five patents. In this industry, however, only nine out of thirty key corporations have obtained patents. Most of them thus have no patents at all from eventual novelties invented in Canada. Companies without patented, Canadian-invented novelties include such large corporations as Bell Helicopter, Bombardier and Eurocopter Canada.

(Tables 2 to 4 here)

As to employment, Montreal is also the largest concentration of expertise in the Canadian aircraft industry. The Montreal census region hosts over 50 per cent of the total employees of the key corporations, followed again by Toronto (30 per cent) and Winnipeg (6 per cent). However, Table 2 shows that many of the new entrants did not choose Montreal as their location. In the 1990s, Raytheon chose Calgary, ACRO set up in Vancouver, and Honeywell in Toronto. The last major investment in Montreal's aerospace industry was that of Bell Helicopter Textron, in 1984. It is difficult to say whether the reluctance to set up in Montreal should be explained by diseconomies of agglomeration, reduced synergies between the new and the previous investments, or other factors.

The three main Canadian laboratories directly related to the aircraft industry, both under the aegis of the National Research Council are however located in Ottawa. These are the Aerodynamics Laboratory, the Flight Research Laboratory, and the Structures, Materials and Propulsion Laboratory. These three labs are under the aegis of NRC's Institute for Aerospace Research. (The Defense Research laboratories – some of them also linked to aerospace –are also located in Ottawa). By some reason, the federal government supported in Montreal the aerospace industrial pole but the other key elements of the system (namely the government laboratories) where located 200 km from the main cluster. They have conducted collaborative and contract research with some of the major corporations in Canadian industry, including Bell Helicopter (Canada), Bombardier (de Havilland and Canadair plants), CAE Electronics, Litton Systems, P&W Canada and Rolls Royce Gas Turbines Engines Canada. In 2000, NRC announced the creation of a fourth aerospace laboratory. This one will be located in Montreal, in order to create more synergies between government research and industrial innovation.

3.2 The Human biotechnology poles

In a previous paper it was shown that Toronto, Montreal and Vancouver are Canada's main clusters in biotechnology (Niosi and Bas, 2000). When we consider only human health biotechnology, the only important sector in Canadian biotechnology, then the picture is more blurred. Montreal leads Toronto in terms of the number of firms and total employment, but Toronto leads in every other indicator: patents, venture capital, market capitalization, and the number of firms traded in the stock exchanges (Tables 5 and 6). Also, the university research infrastructure in the Toronto area is larger than that of Montreal.

(Tables 5 to 7 here)

One mammoth corporation (Biochem Pharma) characterizes Montreal, concentrating almost all patents, market capitalization and employees of the region. This mega-firm is surrounded by some seventy small and medium-sized enterprises. Toronto's structure is much more diversified, with one large firm (Biovail) and some forty mostly middle-sized enterprises. Also, Toronto's firms are older in average than those of Montreal, and many of them have entered the stock exchanges.

The role of the Canadian government is again two-faced. Since 1983, the Canadian biotechnology strategy has fostered the growth of new Canadian biotechnology firms of all sectors and locations. The Strategy included above all, funding, and the strengthening of intellectual property regulations, and developing human resources. Funding was handed through different programs, including the Networks of Centers of Excellence, and the building or revamping of its laboratories. By 1998 this federal funding to biotechnology amounted to C$341 million against C$314 million spent by the private companies. Most of the funding went to the Federal Centers of Excellence Program and NRC Laboratories. The Centers of Excellence Program, launched in 1988, funded seven Centers in biotechnology, five of which were in human health biotechnology. These Centers supported the collaboration of university research, specialized biotechnology firms and governmental laboratories.

Out of five biotechnology research centers, three are specialized in human health. These are located in Montreal (Biotechnology Research Institute, launched in 1987), Ottawa (Institute of Biological Sciences, original launched in 1932 and several times revamped), and Winnipeg (Institute for Biodiagnostics, founded in 1992). We have shown elsewhere that only Montreal, Toronto and Vancouver have created dynamic clusters in biotechnology. By comparison, Winnipeg has also five firms, only of one being traded, with three patents in all. Ottawa is host to seven firms with eight patents; only two of these firms are traded in the stock markets. Finally, only Toronto, Montreal and Vancouver have large venture capital markets for biotechnology (Table 8). The supply of locally-based venture capital is a key success factor in this industry (Niosi, 2000).

When it comes to licensing, universities appear to have a major role, a finding that has proved true for other industrial nations, such as the UK and the USA. Large research universities, such as UBC, McGill University and the University of Calgary have granted more licenses than any NRC laboratory. Again, measured by licensing activities, some of Canada's human biotechnology clusters seem more dynamic than others, with Montreal and Vancouver among the most energetic, and Winnipeg and Ottawa among the less active, in this specific technology (Table 6). In other words, two of the three labs are located in regions where the most prominent success factors (abundant university research and venture capital) are absent.

It is difficult to avoid the preliminary conclusion that in this new technology, the Canadian government has located its laboratories without taking into consideration the particular dynamics of the industry. In order to avoid dispersion, to create synergies and reinforce the existing clusters, the three human biotechnology laboratories may have been more useful if located in the three largest Canadian cities, where private firms, university research and venture capital are.

Conclusion

Canada's first aerospace pole, Montreal, was created in the 1920s through market forces, mostly on the basis of the follow-the-leader behaviour of foreign aircraft body and engine producers. The government of Canada did not create the cluster, but it supported its renewal, development and consolidation during WWII and in the Postwar period. However, government laboratories remained far from the industrial clusters, eventually reducing innovative synergies in industry. The strategy was successful in terms of employment, production and exports, and created employment but little innovation in Montreal.

In the brand-new and promising activity of human health biotechnology, the government has rightly supported university research and venture capital across Canada. However, it has located only one (out of three) of its main laboratories -- Montreal's BRI -- in one of the three poles where firms, venture capital and university research are. This may suggest some kind of governmental blind action, sometimes acting against the market, instead of reinforcing market trends and avoiding the dispersion of efforts.

Canadian governments have implemented horizontal policies that helped science-based companies in all regions and all industries to grow. However, in selecting regional innovation systems, they somehow ignored the dynamics of the clusters in the two science-based industries under consideration. Canadian federal laboratories may sometimes be geographically far from the locus of the most dynamic regional clusters they are supposed to strengthen.

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Tables

Table 1: Defining national and regional innovation systems

National innovation systems "…The network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies." (Freeman, 1987) "… The elements and relationships which interact in the production, diffusion and use of new, and economically useful knowledge… and are either located within or rooted inside the borders of a nation state." (Lundvall, 1992) "…The set of institutions whose interactions determine the innovative performance…of national firms." (Nelson and Rosenberg, 1993) "A national system of innovation is the system of interacting private and public firms (either large or small), universities and government agencies aiming at the production of science and technology within national borders. Interaction among these units may be technical, commercial, legal, social, and financial, inasmuch as the goal of the interaction is the development, protection, financing or regulation of new science and technology." (Niosi, Saviotti, Bellon, and Crow, 1993)
Regional innovation systems "Regions which possess the full panoply of innovation organizations set in an institutional milieu, where systemic linkage and interactive communication among the innovation actors is normal, approach the designation of regional innovation systems"(Cooke and Morgan, 1998, p. 71)

Table 2: Patents in the Canadian aircraft industry

Company	Location	Founded	Employment	Aviation patents
ACRO Aerospace	Vancouver, BC	1994	325	0
Allied Signal Aerospace	Stratford, Ont.	1953	700	0
Bell Helicopter Textron	Montreal, Que.	1984	1750	0
Boeing Canada	Winnipeg, Man.	1971	700	7
Boeing Canada	Toronto, Ont.	ND	2250	3
Boeing Canada	Ottawa, Ont.	1960	760	5
Bombardier Canadair	Montreal, Que.	1944	1000	0
Bombardier de Havilland	Toronto, Ont.	1929	5300	2
Bristol Aerospace	Winnipeg, Man.	1930	1000	0
CAE Electronics Ltd.	Montreal, Que.	1912	4200	12
Derlan Aerospace	Cambridge, Ont.	1964	160	0
Devtek Aerospace	Kitchener, Ont.	1981	160	0
Field Aviation	Toronto, Ont.	1947	375	2
Field Aviation West	Calgary, Alta.	1952	300	0
Haley Industries	Ottawa, Ont.	1952	375	0
Héroux	Montreal, Que.	1942	750	0
Honeywell Canada	Toronto, Ont.	1999	1200	0
IMP Aerospace Group	Halifax, NS	1970	750	0
Indal Technologies	Toronto, Ont.	1951	150	10
Litton Systems Canada	Toronto, Ont.	1960	1000	25
Lockheed Martin Canada	Winnipeg, Man.	1970	600	0
Menasco Aerospace	Toronto, Ont.	1971	760	0
Messier-Dowty	Montreal, Que.	1939	220	0
Messier-Dowty	Toronto, Ont.	1939	408	0
MacDonald Detwwiler	Vancouver, BC	1969	1000	3
Orenda Aerospace	Toronto, Ont.	1946	500	0
Pratt & Whitney Canada	Montreal, Que.	1928	9000	69
Pratt & Whitney Canada	Halifax, NS	1987	410	0
Raytheon Canada	Calgary, Alta.	1991	30	0
Robert Mitchell Inc.	Montreal, Que.	1851	575	0
Rolls-Royce Canada	Montreal, Que.	1947	1100	6
Western Avionics	Calgary, Alta.	1975	75	0

Sources: Industry Canada: Strategis; US Patent and Trademark Office; Financial Post Survey of Industrials;

Table 3: Patents in Canadian aircraft (1976-2000)

Company	Montreal	Toronto	Winnipeg	Vancouver	Halifax	Ottawa	Calgary
Company #1	69	25	7	3	0	0	0
Company #2	12	10	0	0	0	0	0
Company #3	6	3	0	NA	NA	NA	0
Company #4	0	2	NA	NA	NA	NA	NA
NRC labs	NA	NA	NA	NA	NA	5	NA
Total patents	87	40	7	3	0	5	0

NA: Not applicable

Table 4: Other indicators, Canadian Aircraft

Variable	Montreal	Toronto	Winnipeg	Vancouver	Halifax	Ottawa	Calgary
Key firms	8	9	3	2	2	2	3
Employment	18595	11943	2300	1325	1160	1135	375
Employment (%)	50.4	32.4	6.2	3.6	3.1	3.1	1.1
Average number of employees per firm	2324	1327	766	663	580	568	135
Median number of employees per firm	1050	760	700	663	580	568	75
Average age of firms	69	45	43	19	21	44	28
Median age of firms	59	51	30	18	21	44	25

Table 5: Canada's Human health biotechnology clusters

	Montreal	Toronto	Vancouver	Ottawa	Edmonton	Calgary	Halifax	Winnipeg
Firms	70	54	37	8	13	6	4	5
Patents	66	193	44	8	17	24	1	3
Public firms	13	23	15	2	5	4	0	1
Employees	3170	2005	784	738	285	59	25	173
Market Capitalization	4708	4850	2479	171	248	50	NA	65
Average age of firms	8	14	11	18	8	7	5	8
Government laboratory	Yes	No	No	Yes	Yes (ARC)	No	Yes	Yes
Research university	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Venture capital	Yes	Yes	Yes	Little	No	No	No	No

Sources: BioteCanada: Canadian Biotechnology 1999, Ottawa.
US Patent and Trademark Office Database
Industry Canada: Strategis Database.
Canadian Biotechnology News.

NA: Not applicable

Table 6: Location of biotechnology licensees 1990-99

Location of licensee	BRI / NRC	McGill University	IBS / NRC	IMB / NRC	Dalhousie University	UBC	IBD / NRC	UTI (U o Calgary
	Montreal		Ottawa	Halifax		Vancouver	Winnipeg	Calgary
Same city	15 (65%)	13 (34%)	1 (8%)	2 (13%)	2 (100%)	29 (26%)	4 (80%)	5 (10%)
Other city, same province	1	4	3	4	0	1	0	1
Elsewhere in Canada	4	4	1	9	0	4	0	6
Total Canada	20 (87%)	21 (55%)	5 (42%)	15 (100%)	2 (100%)	34 (31%)	4 (80%)	12 (26%)
USA	3	16	7	0	0	34	0	28
Elsewhere abroad	0	1	0	0	0	2	1	5
Total abroad	3 (13%)	17 (45%)	7 (58%)	0	0	36	1 (20%)	33 (70%)
NA	0	0	0	0	0	41	0	2
Total licensees	23 (100%)	38 (100%)	12 (100%)	15 (100%)	2 (100%)	111 (100%)	5 (100%)	47 (100%)

Source: personal survey. The University of Ottawa declined to participate in the survey.

Table 7: Researchers in human health disciplines in public and semi-public institutions, Toronto and Montreal, 1998

Institution/Region	**Number of researchers 1997**
University of Toronto	765
York University	5
McMaster University	379
Total Toronto	**1149**
McGill University	417
Université de Montréal	348
UQAM	15
Concordia University	0
Total universities	780
NRC BRI	260
Total Montreal	**1040**

Table 8: Venture capital in human health in Canada, 1999

Census metropolitan area	Venture capital C$M and (%)	Number of SBFs financed, 1999	Average value of investments ($)	Median value of investments ($)
Toronto, Ont.	110 (35%)	11	7,9 M	1,3 M
Montreal, P.Q.	76 (24%)	23	2,6 M	1,7 M
Vancouver, BC	68 (22%)	11	4,9 M	3,0 M
Edmonton, Alta.	15 (5%)	2	7 M	7 M
Saskatoon, SK	14 (4%)	3	2,8 M	0,7 M
Quebec, P.Q.	11 (4%)	8	1,2 M	0,7M
London, Ont.	7 (2%)	1	7 M	7 M
Kingston, Ont.	2 (1%)	1	2 M	2 M
Calgary, Alberta	2 (1%)	1	2 M	2 M
Sherbrooke, P.Q.	0,6 (N.)	1	0,6 M	0,6 M
Halifax, N.S.	0,45 (N.)	1	0,45 M	0,45 M
Ottawa, Ont.	0,25 (N.)	1	0,25 M	0,25 M
Unknown place of investment	7,22 (2%)	14	0,5 M	0,6 M
Total	313.52 (100%)	78	4,0M	

Source: personal compilation from different sources