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The evolution of Canada's biotechnology clusters
From local to inter-regional networks

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Theoretical issues

- **Regional and national innovation systems are "evolving complex systems" (Arthur et al, 1997, Barkely Rosser, 2003 and Forrester 2003). This is out of equilibrium economics: agents change their behaviour on the basis of the behaviour of other agents in the system. Innovation system theory will gain to adopt such a general perspective drawing from both evolutionary economics and systems theory.**

Definitions

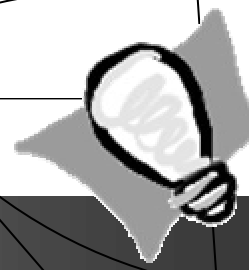
System

- “Any organized assembly of resources and procedures united and regulated by interaction or interdependence to accomplish a set of specific functions.”

Definitions

Complexity

- "A system is complex if it displays the following characteristics: 1) **dispersed interaction** among **heterogeneous agents** acting locally on each other in some space; 2) **no global controller** that can exploit all opportunities or interactions in the economy even though there might be some weak global interactions; 3) **cross-cutting hierarchical organisations** with many tangled interactions; 4) **continual adaptation** by learning and evolving agents; 5) **perpetual novelty** as new markets, technologies, behaviours and institutions create new niches in the ecology of the system; 6) **out-of-equilibrium dynamics** with either **zero or many equilibria** existing and the system unlikely to be near optimum." (J. Barkler Rosser: 2003).



The internal dynamics and networks taking place in regional innovation systems (RSIs) based on local knowledge externalities, local trust, and local resource flows. However RSIs evolve and as they grow, external networks become more important: successful companies are increasingly able to draw external resources and take advantage of out-of-the region opportunities.

(Powell et al, 2002)

In the literatures, national systems and regional systems of innovation have been considered either antithetical (de la Mothe & Paquet, 1998) or complementary concepts. We consider them to be complementary (Bellon & Niosi, 1994, Howells, 1999).

In a previous paper Banik and Niosi (2002) have shown that the evolution of biotechnology clusters involves a modification in the behaviour of the agents: in the 1990s, universities increasingly create intellectual property and technology transfer offices to manage biotech patents and licenses, venture capital firms create biotechnology portfolios out of their ICT-funding activities, etc.

Hypothesis

H1: Networks of venture capital firms (VCFs) and specialised biotechnology firms (SBFs) evolve from purely local and intra-regional to inter-regional networks

H2: Also, in large agglomerations of SBFs and VCFs, local links are more dense, while in smaller regions out-of-region links are more prevalent.

H 3: scientific boards are increasingly extra-regional

Database

Data come from Mary Macdonald & Associates register of all financings by Canadian and foreign VCFs to Canadian and foreign SBFs, between 1990 and 1999 inclusively. We have information on 329 financings of Canadian SBFs and 57 financings by Canadian VCFs of foreign-based SBFs, as well as 14 financings of Canadian SBFs by foreign-based VCFs.

CAVEAT: These data do not include financings by angels, investment bankers or floatation of shares or other debt documents.

Table 1: Canadian private investments in core biotechnology firms by city, 2001 (C$M)

City	Amounts invested C$M	(%)	Number of placements
Toronto, Ont.	**1100.0**	**62,0**	**11**
Montreal, P.Q.	**351.0**	**20,0**	**19**
Edmonton, Alta	**110.5**	**6,5**	**7**
Vancouver, B.C.	**102.3**	**6,0**	**3**
Victoria, B.C.	**27.8**	**1,5**	**1**
London, Ont.	**27.2**	**1,5**	**2**
Quebec, P.Q.	**23.2**	**1,5**	**2**
Kingston, Ont.	**15.5**	**1**	**1**
Winnipeg, Man.	**9.0**	**0,5**	**1**
Ottawa, Ont.	**5.5**	**0,5**	**2**
Calgary, Alta.	**5.5**	**0,5**	**1**
Saskatoon, Sask.	**0**	**0**	**0**
Maritimes	**0**	**0**	**0**
Total	**1777.5**	**100**	**50**

Canadian Biotech News: Canadian Biotech News Industry Report 2002

Table 2: Canadian venture capital in biotechnology by metropolitan area, 2001

Metropolitain area	Venture Capital Amounts C$M	(%)	Number of DBFs financed
Vancouver, B.C.	**168.99**	**34**	**15**
Montreal, P.Q.	**159.91**	**33**	**20**
Toronto, Ont.	**45.56**	**9**	**10**
Victoria, B.C.	**27.80**	**6**	**1**
Quebec City, P.Q.	**19.12**	**4**	**13**
Kingston, Ont.	**15.55**	**3**	**2**
London, Ont.	**13.10**	**3**	**2**
Belleville, Ont.	**10.99**	**2**	**1**
Fleurimont , P.Q.	**8.95**	**2**	**2**
Winnipeg, Man.	**8.45**	**2**	**5**
St-Hyacinthe, P.Q.	**7.85**	**2**	**1**
Saskatoon, Sask.	**2.19**	**0,5**	**2**
Ottawa, Ont	**1.45**	**0,5**	**2**
Halifax, N.S.	**0.75**	**0,5**	**2**
Total	**490.66**	**100**	

Source : Mary McDonald & Associates

Results

Table 3: Origin of financings of Canadian biotechnology companies
Private and publicly held, 1990-1999

Period	Same city	Other city	Total
1990-1994	61	31	92
1995-1999	117	120	237
Total	178	151	329

Source : Mary McDonald & Associates

In 1990-4, 66% of financings of all SBFs came from the same city. In 1995-9, just 49% of financings came from the same city. Hypothesis 1 is thus supported by our data.

The relationship holds for both the 89 publicly-quoted and the 130 private SBFs supported by venture capital. Between 1990-94 and 1995-99, the percentage of funding operations coming from the same city among publicly-quoted companies declined from 71% to 48%. Among privately-controlled SBFs, it fell from 63% to 50%.

However, still in the 1995-9 period, SBFs in the two largest Canadian cities (Toronto and Montreal) are mostly financed by local sources, even if the share of out-of-the-region funding increases.

Table 4: Toronto- Origin of financings of Canadian biotechnology companies
Private and publicly held, 1990-1999

Period	Same city	Other city	Total
1990-1994	17	2	19
1995-1999	41	11	52
Total	58	13	71

Source: Mary Macdonald and Associates

In Toronto, funding of SBFs by local VCFs represented 89% of financings in 1990-94 against 79% in 1995-99.

Table 5: Montreal- Origin of financings of Canadian biotechnology companies Private and publicly held, 1990-1999

Period	Same city	Other city	Total
1990-1994	22	4	26
1995-1999	49	34	83
Total	71	38	109

Source: Mary Macdonald and Associates

In Montreal, funding of SBFs by local VCFs represented 85% of financings in 1990-94 against 59% in 1995-99.

Table 6: Vancouver- Origin of financings of Canadian biotechnology companies
Private and publicly held, 1990-1999

Period	Same city	Other city	Total
1990-1994	11	3	14
1995-1999	22	33	55
Total	33	36	69

Source: Mary Macdonald and Associates

In Vancouver, funding of SBFs by local VCFs represented 79% in 1990-4 against just 40% in 1995-9.

In Saskatoon, out of 19 financings in only five did local venture capital participate . In Quebec City, all but one (1/15) VC financing came from Montreal or Toronto. In **the two other most important clusters, Calgary and Edmonton, all financings came from other Canadian regions.**

In all other Canadian cities, most of if not all financings came from other Canadian regions. However, the three most important clusters represent 68% of all financings in the 1990s. And two of them were still self sufficient by the late 1990s.

Foreign financings of Canadian SBFs

The funding of Canadian SBFs by US-based VCFs was constant at three financings per period. British VCFs increased the funding of Canadian SBFs from zero cases in 1990-4 to eight between 1995 and 1999.
All foreign financings represented just 4% (14 out of 329 funding operations) of all financings of Canadian SBFs.

Canadian financing of foreign-based SBFs

Canadian VCFs held constant the number of their financings of foreign-based SBFs at 28 per period.

Conclusion on foreign financing

Some moderate level of internationalisation is thus taking place. But most inter-regional networks occur within Canada, basically from Toronto and Montreal VCFs to other regions, including Vancouver and Albertan clusters. In a few cases, Vancouver-based VCFs are funding SBFs from other regions.

Table 7: Boards of directors of publicly held Canadian SBFs 2002

City	Same city	Other city	Of which USA	Total
Toronto	119 (59%)	82 (41%)	29	201 (100%)
Montreal	81 (62%)	49 (38%)	21	130 (100%)
Vancouver	53 (59%)	37 (41%)	21	90 (100%)
Canada	294 (56%)	229 (44%)	83	523 (100%)

Table 8: Scientific advisory boards of publicly held Canadian SBFs 2002

City	Same city	Other city	Of which USA	Total
Toronto	31 (41%)	45 (59%)	27	76 (100%)
Montreal	12 (18%)	56 (82%)	31	68 (100%)
Vancouver	13 (21%)	49 (79%)	20	62 (100%)
Canada	70 (28%)	180 (72%)	93	250 (100%)

Tables 7 and 8 show that while boards of directors are still recruited from the same region, scientific advisory boards are mostly extra-regional, and even international.

Conclusions

Both financial networks hypothesis have been confirmed. In the 1990s, financial networks have become progressively less local and more inter-regional, but inside Canada. Also, SBFs located in smaller regions are forced to look for VC outside the region. By the late 1990s, SBFs based in almost all regions are created financial networks outside their main location. Also, H3 has been confirmed: scientific advisory boards are in 2002, majority recruited from out-of-the city scientists.

Biotechnology in Canada is based on a national and regional financial system for innovation. Purely local networks subsist only in the two major cities, Toronto and Montreal.