Bioscientists and Biotechnology: A Canadian Study

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Introduction

How to explain the growth of biotechnology firms and clusters?

One major response came from Zucker et al. (NBER): Star Scientists in universities are major creators and suppliers of new knowledge to Specialised Biotechnology Firms (SBFs).

Introduction

Another response:

Innovation in biotechnology - process that implies knowledge flows and networking between new biotechnology firms, incumbent firms, research institutions and large pharmaceutical enterprises.

(Kenney, 1986; Swann et al., 1998; Pisano et al., 1988).

Concept of Star Scientist

Thus, Firms grow if they interact with star scientists and are located in clusters hosting star scientists (Zucker et al., 1994, 1995, 1998)

Concept of Star Scientist

What is a Star Scientist (Zucker et al.)?

An academic scientist in life sciences who has discovered more than 40 genetic sequences between 1990 and 1995.

Concept of Star Scientist

Commercial exploitation of a discovery can be very fast

Consequently,

Many Star scientists try to collect the fruits of their discoveries. Either, they

1) entered instead into contractual agreements (linked) or
2) started their own for profit enterprises (affiliated) (Zucker et al., 1994, 1995).

Three main questions

Is it the same pattern that we can identify in Canada?

What is the importance of the presence of star scientists for the development of biotechnology firms and clusters?

Do academic linkages really matter and how important are these linkages?

Theories: Endogenous growth literature and localised knowledge spillovers

- Geographical proximity of academic scientists favours knowledge transfer to private firms

- Important debate on agglomeration economies and on the idea that the self-reinforcing mechanisms are spatially delimited

Theories

Technology = non rival good that is costly to discover but costless to replicate

In High-tech areas, technology instead possess natural excludability or is constituted in a large part of tacit knowledge

Theories

Biotechnology: + rival human capital,

not a public good easy to codify

In fact, Zucker et al.(1994,1995) found that SBFs are generally in geographical proximity to the scientists who have discovered genetic sequences.

Theories

Situational effect of contacts between firms and university researchers = shape by the particular role of the scientist in the firm (Audretsch & Stephan, 1996).

Thus,

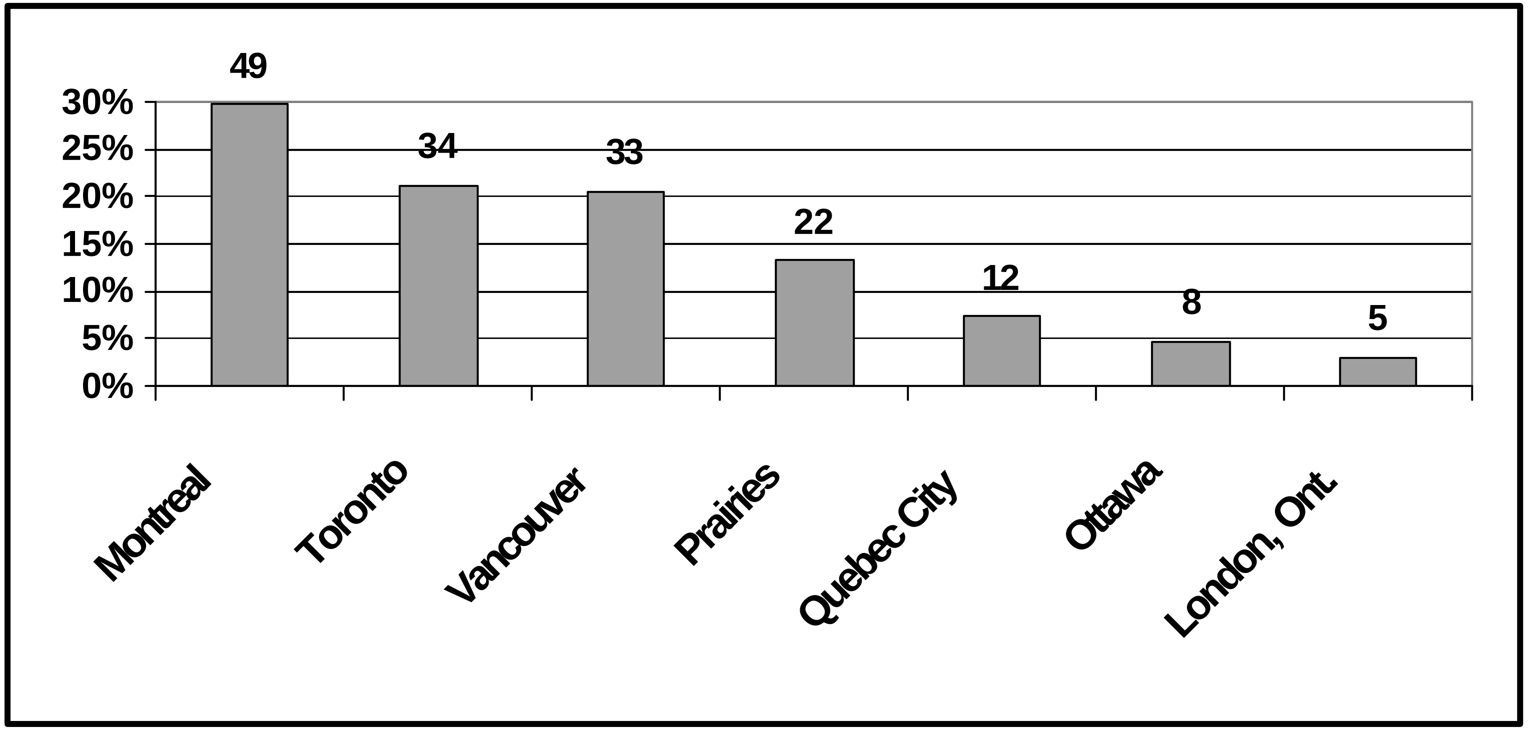
When knowledge is transmitted by formal links between scientists and firms, geographical proximity is less necessary.

Canadian Biotechnology

- 4 500 dedicated biotechnology companies in the world,
- 1 350 in the United States and,
- 391 in Canada (Can. Stat., 2001)
- Revenues of more than $2,5 billion (Canada)
- 70% in the human health sector
- Geographically, Quebec (32,4%), Ontario (31%) and British Columbia (20%) with a few SBFs found in all provinces through the rest of Canada.

Canadian Human Health Biotechnology

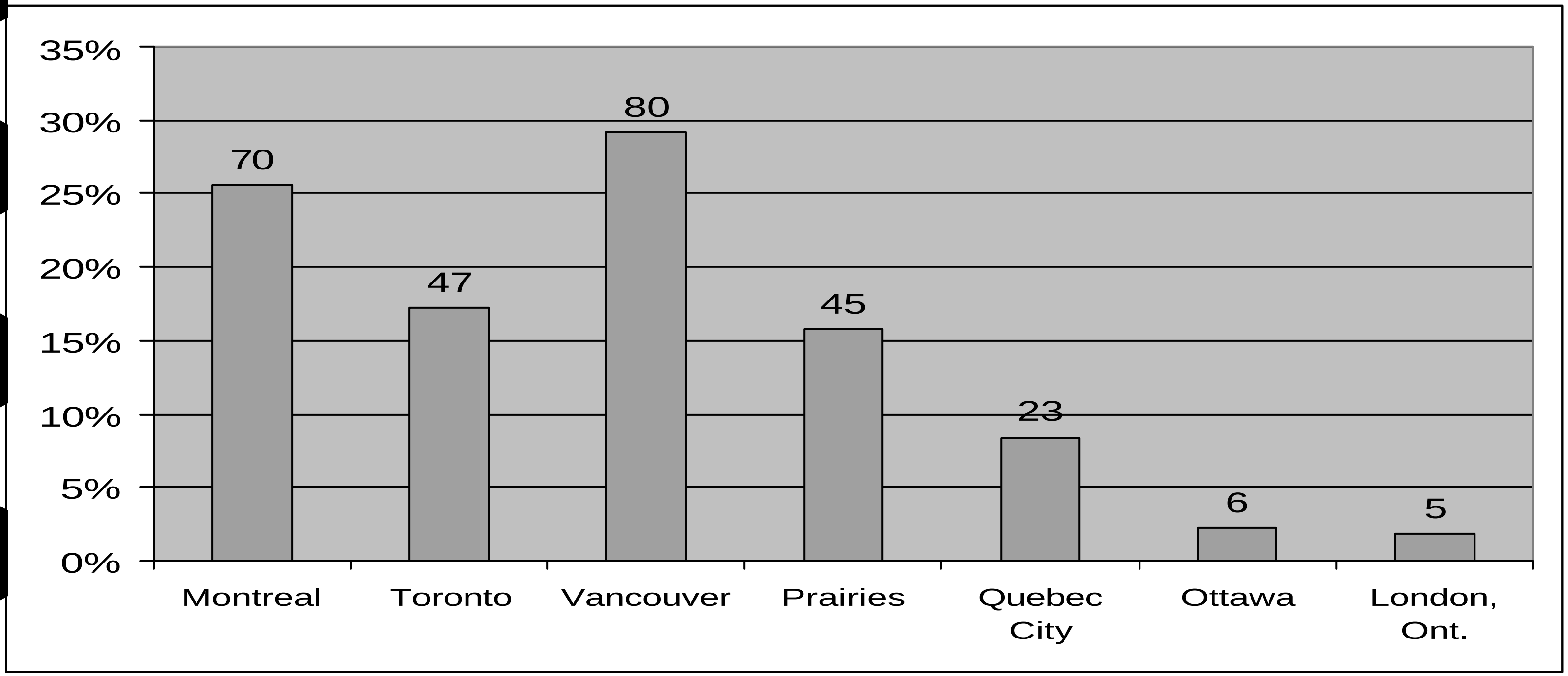
Figure 1: Regional distribution of studied SBFs[a]



[a]Total number of studied firms by region and percentage of the population

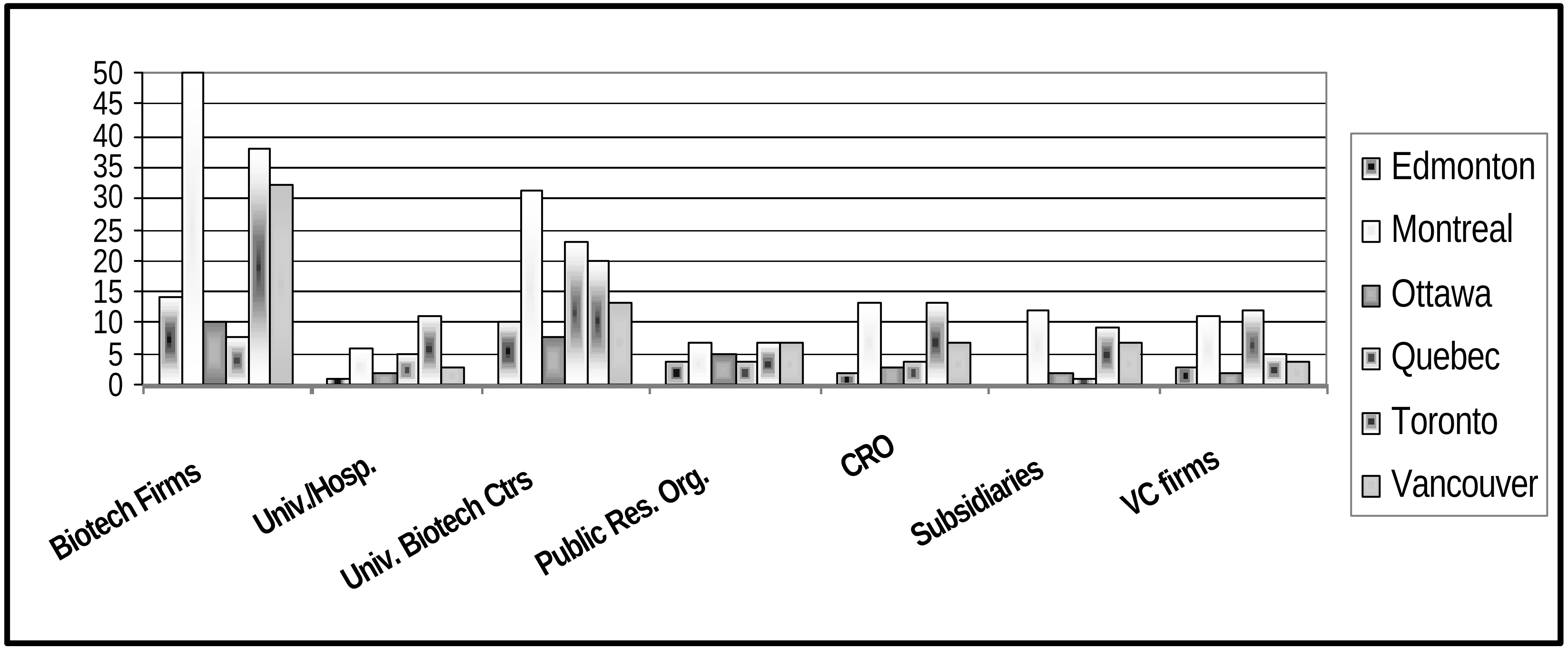
Canadian Human Health Biotechnology

Figure 2: Regional distribution of Leading Bioscientists[a]



[a]:Total number of Bio-Supertars, Bio-Stars and Bio-collaborators type 2A and percentage by region

Active organizations in Canadian Biotechnological System[a]



[a]: Total number of active organisations in the most productive Canadian biotechnology clusters
Source: Canadian Biotechnology Directory, Contact Canada, Canada Statistics & Statregis – Industry Canada.

Findings interpretation: Model I: Impact of Bioscientists with discoveries of genetic sequences (Zucker)

H_1 : ***Presence of bioscientists and discoveries of genetic sequences play a role in employment growth of Canadian SBFs***

Therefore, the equation is:

y= $a + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_6 + B_7X_7 + E$

*y(E**mployment Growth 1997-2000) =***
a+genetic sequences+ patents+ patent citations+ superstars+ stars+ collabo-rators 2A+ collaborators 2B + E

Findings analysis - Model 1: Impact of Bioscientists with discoveries of genetic sequences (Zucker)

Table 2: Correlations on Canadian SBFs Employment Growth 1997-2000

Pearson Correlation	**# Empl.Growth 1997-2000**	**Sig. (1-tailed)**
# Empl. Growth	1,000	,
# COLLAB 2B	,294	,001
# COLLAB 2A	,391	,000
# SUPERSTARS	,355	,000
# STARS	,219	,011
# PATENTS	,384	,000
# PATENTS CITATIONS	,647	,000
# GENETIC SEQUENCES		

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Findings analysis - Model 1: Impact of Bioscientists (Zucker)

Table 3: Model I Summary: Employment growth 1997-2000 of Canadian SBFs

	R	R Square	F	Sig. (One-tailed
Model				
1	,697	,477	50,205	,000[a]

[a.] Predictors: (Constant), CITATION, PATENTS

		Beta In	T	Sig.
Model				
1	COLLAB2B[a]	,208	2,879	,005
	COLLAB2A[a]	,140	1,726	,087
	STARS[a]	,153	1,977	,051
	SUPERSTARS[a]	,117	1,574	,118
	SEQUENCES[a]	,087	1,177	,242

Findings interpretation – Model 2: Impact of Bioscientists with patents

H_2 : ***Presence of bioscientists and patents and citations play a role in employment growth of Canadian SBFs***

Therefore, the equation is:

$$y = a + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_6 + E$$

y (Employment Growth 1997-2000)= a+patents+ patents citations + bio-superstars+ bio-stars+ bio-collaborators 2A+ bio-collaborators 2B + E

Findings analysis – Model 2: Impact of Bioscientists with patents

Table 7: Model Summary- Employment growth 1997-2000 of Canadian SBFs

	R	R Square	F	Sig. (One-tailed)
Model				
2	,706	,498	53,172	,000[a]

[a]. Predictors: (Constant), CITATION, STARS

Table 8: Coefficients[a] on Employment growth 1997-2000 of Canadian SBFs

		Unstandardized Coefficients	Standardized Coefficients	t	Sig.
Model		B	Beta		
2	(Constant)	10,206		4,361	,019
	CITATION	2,308	,489	6.299	,000[b]
	BIO-STARS	13,607	,328	4,222	,000[b]

Discussion & conclusions

Discoveries of genetic sequences: important measures of research successes (Zucker & al., 1994, 1995)

Findings for American SBFs:

Publications of genetic sequences - Determinants of links between intellectual capital and SBFs growth (Zucker & al., 1994, 1995)

Discussion & conclusions

Contrary to Zucker et al. - Different determinants of links between intellectual capital and SBFs growth –

Model 2 Findings:

Innovation outputs – patent citations + presence of Bio-stars represent real factors of employment growth for Canadian SBFs

Bio-Stars (- 5 patents & - 2 publ./year): Active role as economic agents in the development of SBFs

Discussion & conclusions

Type of externality in biotechnology: + than just knowledge spillovers , + and + market and non-market transactions

- 54% of Canadian bioscientists with patents or publications are linked to SBFs;
- 37% are affiliated to SBFs (direction, founders);
- 9% wear two hats (direction & university professors)

Discussion & conclusions

Result: Presence of increased research productivity and employment in firms with specific identifiable links to different types of top university scientists

The study confirms the importance of geographical proximity of star scientists for the starting and the growing of SBFs (Zucker et al.,1994, 1995)

Discussion & conclusions

Niosi (2003) found that 80% of growth of SBFs is explained by patents, venture capital, exports and alliances.

Our research: 2 other determinants of SBFs growth: Quality of patents of SBFs (measured by patent citations) and presence of stars in SBFs

A few more findings

71% of the studied population (165 SBFs) have obtained venture capital out of which:

90% of firms with affiliated or linked bio-superstars;

85% of firms with affiliated or linked bio-stars;

84% of firms with affiliated or linked bio-collaborators type 2a and

78% of firms with affiliated or linked bio-collaborators type 2b

✍ Importance of bioscientists with patents for the obtaining of venture capital

Discussion & conclusions

Furthermore,

Exploration of other SBFs growth variables in relationship with bioscientists roles =

Few more insights about the evolution pattern of canadian biotechnology firms

Discussion & conclusions

In our study, we bring light on the dynamics of collaborative relationships between university bioscientists and entrepreneurs

And also on the debate on knowledge spillovers vs knowledge market

Definitions and hypotheses

At the beginning of our study,

identification of Canadian Bioscientists with the definition brought forward by Zucker et al.

Our first defining factor: Genetic sequences for four types of bioscientists (1990-2002).

Definitions and hypotheses

1) **Superstar**: + 40 genetic sequences, + 5 patents or + 5 publications/year (In Canada, 26 such bioscientists);
2) **Star** : + 40 genetic sequences, - 5 patents or - 5 publications/year (26);
3) **Collaborator type A**: 1-39 genetic sequences, 1 patent or 1 publication/year or more (160);
4) **Collaborator type B**: 1 patent or 1 publication/year or more (No genetic sequences) (241).

Definitions and hypotheses

Another set of definitions into which patents were the primary discriminant factor

New categories:

1) **Bio-superstar**: + 5 patents and + 2 publications/year (44 of these bioscientists);
2) **Bio-star**:– 5 patents and – 2 publications /year (89);
3) **Bio-collaborator type A**: 2-4 patents (157);
4) **Bio-collaborator type B**: 1 patent (163)

Concepts of Star Scientist, interaction and system

Biotechnological System

A few more findings

- Mean Age of 165 SBFs: 8,4 years
- 568 patents and 91 SBFs have patents
- 396 patent citations
- 71 of SBFs are publicly-quoted
- 50% of SBFs are spin-offs