Success Factors in Canadian Academic Spin-Offs

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ABSTRACT. In the last 20 years Canadian university produced some 1200 spin-off companies, out of which 5–6% are still independent and quoted in the stock exchanges. This study analysed these public companies in terms of industry, technologies, regions, universities and growth. The paper finds that the growing companies of the 2000s are most often not in biotechnology, in spite of their frequent support by venture capital. Conversely spin-off companies that grew had often obtained patents and received support from the Industrial Research Assistance Program, a support program for R&D in smaller firms, managed by the National Research Council of Canada.

JEL Classification: O31, O32

In the 1990s, academic spin-offs and university technology have become hot issues. Research conducted in universities is regarded as having major commercial value, and several economic agents are interested in sharing this value, including the universities themselves, as well as investigators, and governments. Besides, after World War II, universities have been held responsible not only for training and research, but also for economic development, through the production and transfer of this valuable technology generated within their confines. More specifically, governments want some insurance that there are economic returns for the public investment on academic research. The managerial and economic literature on the subject has become plentiful and the United States, more than Western Europe or Japan, is the main locus of this growing mass of publication (Mansfield, 1995; Etzkowitz and Leydesdorff, 1997; Branscomb *et al.*, 1999; Rosenberg, 2000; Mowery *et al.*, 2001; Goldfarb and Henrekson, 2003).

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1. The Canada-US landscape

Biotechnology and information technology are the two preferred areas of university technology commercialisation. In the 1990s and early 2000s, these two technologies represented well over 50% of the entire commercial output generated in universities, measured either by the number of patents, licenses, or academic spin-offs. In fact, life sciences (mostly represented by biotechnology) account for nearly 50% of all spin-offs, patents and licenses of American and Canadian universities (Cooper, 2001; Mowery *et al.*, 2001; AUTM, 2003). In 1996, 86% of gross income received by American and Canadian universities was for life sciences inventions (Kneller, 1999, p. 412). The numbers, however, vary from one source to another, not so much because definitions are different, but because most universities do not require academics to report on their patents, licenses, or spin-off companies, particularly when the research is financed by private industry and not by public funds.

This paper is about one specific mechanism—the most dramatic—namely the creation of spin-off companies by academics in order to commercialise technology produced in the university, whether the technology belongs to the university, to the scientist, or to private companies, but in any case invented by academic researchers. The technology may be patented or not, and it may be complemented by knowledge, and expertise embodied by university researchers, be they professors, graduate students or visiting scholars. The definitions in Table I, although slightly different, summarize the meaning we give to the concept of university spin-offs.[1] But it is clear that the central meaning of "spin-off" in this paper leans towards companies using university technology; companies simply using expertise from graduates, professors or other research personnel are not included.

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Table I
Spin-offs defined

"Start up companies were /.../ dependent upon licensing the institution's technology for initiation" (AUTM, 2000, p. 37).
"...A spin-off was defined as a company established for one or more of the following reasons: Type 1: to license the institution's technology; Type 2: to fund research at the institution in order to develop technology that will be licensed by the company; Type 3: To provide a service that was originally offered through an institution's department or unit. (Statistics Canada, 2003, p. 38).
""A firm formed specifically to commercialise university-owned and / or university researcher's technology" (Cooper, 2000, p. 3).
"...in order to be classified as a university spin-off, three criteria have to be met: (1) the company founder or founders have to come from a university (faculty, staff or student); (2) the activity of the company has to be based on technical ideas generated in the university environment; and (3) the transfer from the university to the company has to be direct and not via an intermediate employment somewhere" (McQueen and Wallmark (1982), p. 307.[3]

2. The database

The database was built on 65 publicly quoted companies that had been spun-off from Canadian universities. The identification of these companies was made through several stages. We started with the NRC database on Canadian spin-offs, containing close to 1200 companies, originally built by Denys Cooper; then other spin-offs were identified using information provided by the universities themselves. Financial information about these public companies was obtained from the companies' annual reports, the Canadian stock exchanges, the SEDAR website, the websites of the companies and other public information such as the *Canadian Biotechnology Reports* published by Contact Canada, and the biweekly *Canadian Biotechnology News*. Merged and defunct companies, or companies turned private were not included. The reference period for financial and other information was for the 2000–2003 period. Key variables in the database were the domain of activity year of incorporation, year of IPO, number of employees, revenues, venture capital support, patents, city and province of head office.

Descriptive results

Almost 60% of the public companies in our sample (38) were specialised biotechnology firms (SBFs), and the remaining 27 were active in different industries, but most of them were operating in information technology. The companies in our database had a strong intellectual property base: over 80% of them had been granted US patents; the latter ranged from 8 firms with one patent up to one company with 56 US patents. The average was nine US patents per firm. These were young firms; the median age of the public academic spin-offs was 11 years (thus, the median firm was born in 1993), and the average age was 14 years, but one company was 50 years old and thirteen firms counted 20 years or more after their incorporation.

As to regional distribution, 21 companies were located in Ontario, 15 in British Columbia, 13 in Quebec, 12 in the Prairies and four in the Atlantic Provinces. The vast majority of the firms (60%) had received venture capital and IRAP support (67%). The majority of companies were not growing during the 2000s: both the employment and the revenues of only 42% had been growing between 2000 and 2002. However, in 2002 these 65 companies had a total of 21075 employees, and their revenues were 3,6 billion Canadian dollars, thus showing a strong record of growth in previous years. In 2002, the median revenue of these spin-off companies was C$20 million and their median total employment was 115 (Table II–VI).

Cross-tabulations show that most stagnant companies in the 2000s are core biotechnology firms, and this is true both in terms of revenues and employment (Table VII, VIII).

Also, firms that are growing in terms of revenues are not the same as those growing in terms of employment. Two thirds of the firms show similar patterns of growth on both variables, but one third of the companies do not grow following equal trends on both dependent variables. This occurs because some biotechnology firms are getting revenues on past products and reducing employment, while others are stagnant in terms of revenues but can increase employment by using their reserves from recent and past financing rounds[2] (Table IX).

Finally, companies not supported by IRAP are more likely to be stagnant, but those supported by

Table II
Frequencies. Domain of activity

Domain	Frequency	Percentage
Core biotechs	38	58.5
Other	27	41.5
Total	65	100

Table III
Frequencies. Venture capital support

	Frequency	Percentage
Supported	40	61.5
Not supported	19	29.2
Missing values	6	9.2
Total	65	100

Table IV
Frequencies. IRAP support

	Frequency	Percentage
Supported	44	67.7
Not supported	21	32.3
Total	65	100

Table V
Frequencies. Growing and stagnant firms, revenues, 2000–2

	Frequency	Percentage
Growing	27	41.5
Stagnant or declining	37	56.9
Missing values	1	1.5
Total	65	100

Table VI
Frequencies. Growing and stagnant firms, by employment, 2000–2

	Frequency	Percentage
Growing	27	41.5
Stagnant or declining	31	47.7
Missing values	1	10.8
Total	65	100

Table VII
Crosstabs. Domain of activity and growth of revenues

	Core biotechnology	Other activity	Totals
Growing	12	15	37
Stagnant or declining	26	11	27
Missing values	38	26	64

Table VIII
Crosstabs. Domain of activity and growth of employment

	Core biotechnology	Other activity	Totals
Growing	15	11	26
Stagnant or declining	22	9	31
Total	37	20	57

Missing values: 8.

Table IX
Crosstabs. Growth of revenues and growth of employment

Employment Revenues	Growing	Stagnant/ declining	Total
Growing	15	9	24
Stagnant or declining	10	22	32
Totals	25	31	56

Missing values: 9.

venture capital do not seem to be facing the stormy 2000s better armed than those that were not supported by risk capital (Tables X–XII). It seems that IRAP and venture capital firms use analogous criteria, but not precisely the same, when choosing to support an academic spin-off (Table XIII). Either IRAP standards are stricter, or IRAP funding is more effective, or venture capital firms were supporting too many biotechnology firms that were not growing.

Table X
Crosstabs. IRAP support and revenue growth 2000/2

	Supported by IRAP	Not supported	Total
Growing	21	6	27
Stagnant or declining	23	14	37
Total	44	20	64

Missing values: 1.

Table XI
Crosstabs: Venture capital support and revenue growth

	Supported by venture capital	Not supported	Total
Growing	16	8	24
Stagnant or declining	24	11	35
Total	40	19	59

Missing values: 6.

Table XII
Crosstabs: Venture capital support and employment growth

	Supported by venture capital	Not supported	Total
Growing	18	6	24
Stagnant or declining	20	8	28
Total	38	14	52

Missing values: 13.

Table XIII
Crosstabs: IRAP and venture capital support

	Supported by venture capital	Not supported	Total
Supported by IRAP	30	11	41
Not supported	10	8	18
Total	40	19	59

Missing values: 6.

Explaining the growth of academic spin-offs

The growth of academic spin-offs seems related to several variables, such as their activity, their age, patents and support, particularly from IRAP. We developed four dependent variables, EMP2002 (a metric variable measuring the total number of employees that the company had by the end of 2002), REV2002 (another metric variable, total revenue at the end of 2002), CREV (a dichotomy, opposing growing and stagnant companies, in terms of revenues, between 2000 and 2002) and CREM (another dichotomy, opposing growing and stagnant companies, in terms of total employment, between 2000 and 2002). Linear regression measured the factors explaining growth in the four cases.

Total employment in 2002 was a function of four variables, explaining over 42% of its growth (Table XIV). These four variables were all significant: the area of activity, the age of the firm, the number of patents, and support by IRAP. Firms not in biotechnology, older, with more patents and supported by IRAP had a better chance to be large in terms of employment. Biotechnology firms seem to be in the worst situation. Since 2002, three of the publicly quoted SBFs have turned into oil and gas corporations, by investing their liquidities into junior hydrocarbon companies and liquidating their biotechnology assets.

Total revenues in 2002, another metric variable, had similar determinants, but age did not show up as significant (Table XV). The domain of activity, patents and IRAP support explained close to 30% of their revenues up to 2002.

Correlations are strongest, as one would expect, between the two main dependent variables, revenues and employment in year 2002, as these two variables normally grow in parallel. The independent variables show little bi-collinearity, except for age and domain, which appear to be slightly related, as core biotechnology firms are younger than spin-off companies in other areas (Table - XVI). Several of the independent variables are, as they should be statistically related to the dependent variables.

Conclusion

Canadian universities have spun-off over a 1000 firms, a 100 of which have become publicly quoted. Two-thirds of them are still quoted in the TSX, and a few are in the CDNX and in NASDAQ. Nearly half of these spin-off companies are specialised biotechnology firms, and around a quarter of them are information technology companies. However, SBFs represent the majority of publicly quoted firms, as biotechnology firms have been more able to obtain venture capital and be accepted in the stock exchanges than companies operating in other areas. In recent years, and particularly since 2000, these SBFs have experienced financing problems. Thus, in Canada there was not a single initial public offering of a dedicated biotechnology between 2001 and 2003 inclusively. Nevertheless, some of the largest and most successful publicly quoted SBFs managed to obtain financing through secondary offers in the stock exchanges, as well as private investments by financial institutions such as insurance companies, pension funds and banks.

Since the early 1980s, life sciences were the preferred area of research and technology transfer from academia to industry (Kenney, 1986). Also, in the late 1990s and early 2000, biotechnology had become the main sector of investment of Canadian venture capital. This new technology has now become a very different sector of investment, with a few winners detaching themselves

Table XIV
Regression. Explaining employment in 2002

Variables entered

Model	Variables entered	Method			
1	Age, Domain, IRAP, Patents	Enter			
Model summary					
Model	*R*	R^2	Adjusted R^2	Standard error of estimate	
1	0.649[a]	0.421	0.372	718.9203	
ANOVA[b]					
Model	Sum of squares	Df	Mean square	*F*	Sig.
1 Regression	17671424.280	4	4417856.070	8.548	0.000
Residual	24291778.393	47	516846.349		
Total	41963202.673	51			
Coefficients					
Model	Unstandardized coefficients		Standardized Coefficients	*T*	Sig.
	B	Std Error	Beta		
1 (Constant)	−502.721	490.515		−1.025	0.311
Domain	667.733	237.733	0.349	2.809	0.007
IRAP	−331.331	220.118	−0.170	−1.505	0.139
Patents	15.023	7.348	0.237	2.045	0.047
Age	28.923	12.776	0.282	2.264	0.028

[a] Predictors: (Constant), Age, Domain, IRAP, Patents.

[b] Dependent variable: Emp2002.

Table XV
Regression. Explaining revenues

Variables entered

Model	Variables entered	Method			
1	Domain, IRAP, Patents	Enter			
Model summary					
Model	*R*	R^2	Adjusted R^2	Standard error of estimate	
1	0.533a	0.284	0.249	622.8322	
ANOVA b					
Model	Sum of squares	Df	Mean square	*F*	Sig.
1 Regression	9390519.279	3	31301703.093	8.069	0.000
Residual	23663114.167	61	387919.904		
Total	33053633.446	64			
Coefficients					
Model	Unstandardized coefficients		Standardized Coefficients	*T*	Sig.
	B	Std Error			
1 (Constant)	6.342	378.926		0.017	0.987
Domain	410.583	158.047	0.284	2.598	0.012
Patents	21.502	5.964	0.397	3.605	0.001
IRAP	−320.618	168.163	−0.210	−1.907	0.061

[a]Predictors: (Constant), Age, Domain, IRAP, Patents.

[b]Dependent variable: Rev2002.

Table XVI
Correlations

	DOMAIN	IRAP	PATENT	AGE	PROVINCE	VENCAP	CREM	CREV	REV2002	EMP.2002
DOMAIN Pearson	1.000	−0.085	0.079	0.282	−0.085	−0.169	0.139	0.260	0.333	0.525
Sig. (2-tail.)	.	0.500	0.529	0.023	0.503	0.199	0.304	0.038	0.007	0.000
N	65	65	65	65	65	59	57	64	65	52
IRAP Pearson	−0.085	1.000	0.159	0.010	0.147	0.174	0.016	0.166	−0.171	−0.142
Sig. (2-tail.)	0.500	.	0.205	0.936	0.244	0.189	0.906	0.189	0.173	0.316
N	65	65	65	65	65	59	57	64	65	52
PATENT Pearson	0.079	0.159	1.000	0.224	−0.242	−0.133	0.153	0.245	0.386	0.342
Sig. (2-tail.)	0.529	0.205	.	0.072	0.052	0.317	0.257	0.051	0.001	0.013
N	65	65	65	65	65	59	57	64	65	52
AGE Pearson	0.282	0.010	0.224	1.000	0.017	−0.028	0.256	0.256	0.051	0.472
Sig. (2-tail.)	0.023	0.936	0.072	.	0.895	0.836	0.055	0.041	0.687	0.000
N	65	65	65	65	65	59	57	64	65	52
PROVINCE Pearson	−0.085	0.147	−0.242	0.017	1.000	0.101	−0.169	−0.045	−0.256	−0.043
Sig. (2-tail.)	0.503	0.244	0.052	0.895	.	0.446	0.210	0.724	0.040	0.764
N	65	65	65	65	65	59	57	64	65	52
VENCAP Pearson	−0.169	0.174	−0.133	−0.028	0.101	1.000	0.040	−0.020	−0.141	−0.126
Sig. (2-tail.)	0.199	0.189	0.317	0.836	0.446	.	0.778	0.880	0.286	0.398
N	59	59	59	59	59	59	52	59	59	47
CREM Pearson	0.139	0.016	0.153	0.256	−0.169	0.040	1.000	0.311	0.022	0.078
Sig. (2-tail.)	0.304	0.906	0.257	0.055	0.210	0.778	.	0.020	0.869	0.592
N	57	57	57	57	57	52	57	56	57	49
CREV Pearson	0.260	0.166	0.245	0.256	−0.045	−0.020	0.311	1.000	−0.028	−0.027
Sig. (2-tail.)	0.038	0.189	0.051	0.041	0.724	0.880	0.020	.	0.826	0.851
N	64	64	64	64	64	59	56	64	64	51
REV2002 Pearson	0.333	−0.171	0.386	0.051	−0.256	−0.141	0.022	−0.028	1.000	0.625
Sig. (2-tail.)	0.007	0.173	0.001	0.687	0.040	0.286	0.869	0.826	.	0.000
N	65	65	65	65	65	59	57	64	65	52
EMP.2002 Pearson	0.525	−0.142	0.342	0.472	−0.043	−0.126	0.078	−0.027	0.625	1.000
Sig. (2-tail.)	0.000	0.316	0.013	0.000	0.764	0.398	0.592	0.851	0.000	.
N	52	52	52	52	52	47	49	51	52	52

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

from their smaller competitors and attracting most private investment; conversely, newcomers are having more difficulty in moving into the late phases of clinical essays, getting private investment or simply launching their IPOs. Even among publicly quoted and well-financed firms, some seem to abandon the sector altogether. The trend towards the concentration of resources into a small number of human health SBFs had already been found in Canada (Niosi, 2000, 2003; Niosi and Banik, in press) and was later observed in the United Kingdom and the United States (Bas and Niosi, 2004). We may be witnessing a major trend towards concentration of activity into a small number of rapidly growing dedicated biotechnology firms in the three main countries of the world. Academic research and related technology transfer in these countries may enter into a new pattern, far different from the one of the 1980s and 1990s.

Our research converges with many other ones, including several studies the results of which are presented in this special issue. Spin-offs are one way of transferring technology fro university to industry, but this transfer mechanism is far from being universally successful. Its effectiveness should be more systematically compared with those of contract research and associated technology transfer to existing medium and large firms (the most frequent channel according to Hanel and St-Pierre in this issue), as well as the knowledge transfer produced by graduates moving from university industry and consultancy by faculty. In particular, spin-offs present several problems related to the narrow range of competencies that university professors and graduates possess. This narrow range of competencies is in the field of a particular branch of science and technology, while they usually lack training in such matters as finance, marketing, manufacturing, and general management. Launching a new company under such conditions may be one way of reducing the chances of the technology being successfully commercialised. Incumbent companies may be more capable of using and developing technologies received from universities.

Notes

1. Other publications use the term "start-up" (i.e. the AUTM) and spin-outs (in Britain).
2. In 2003, Canadian publicly quoted SBFs received 1,67 billion Canadian dollars in financings. These included many of the companies in our database. Privately held SBFs only received 242 M in 2003.
3. See a handful of other definitions in Pirnay *et al*., 2003.

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