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## **Presentation topic**

**“The disappearance of Canadian biotechnology firms: what are the lessons for emerging countries?”**

### **Introduction**

Canada's federal government considers biotechnology as a strategic sector (Statistics Canada, 2007). The efforts to develop the sector have placed this country among the world leaders. Indeed, the last statistics published by the OECD<sup>1</sup> (2009) show that Canada surpasses the majority of country members in terms of number of firms created as a proportion of the population. However, there are some voices warning out about the disappearance of young biotechnology firms as well as economic results well below expectations (Pisano, 2006; Niosi, 2011).

In terms of the literature review, we have noted that, after three decades, there are few authors dedicated to track the steps following the birth of biotechnology firms. By this, we mean either their disappearance or survival. To our knowledge, most of the research has been focused on the factors that determine the creation and growth of biotechnology firms.

In our thesis we decided therefore to cover that literature gap. We try to understand the disappearance of Canadian firms dedicated to biotechnology (DBFs). To accomplish that objective we built a sample of 552 firms operating in Canada in years 1996 to 2010.

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<sup>1</sup> **Organisation for Economic Co-operation and Development**

Firstly the objective is to evaluate the extent of the phenomenon and to identify the different forms in which young biotechnology firms disappear. Then, we will determine the factors that explain the disappearance of those firms. Ultimately our objective is to stress the challenges that policy makers in emerging countries, willing to develop biotechnology, have to overcome in order to conduct their countries from a position of scientific subcontractors to access the club of leading countries.

*Key words: Dedicated biotechnology firms, venture capital support, bankruptcy, Merge and acquisition, management team, strategic alliances.*

## Literature review

Certainly there is complete consensus in the literature on the fact that the early death is a fate more likely than the survival in cases of new business products and services (Mata, 1994, Baldwin et al , 2000; Song et al, 2008; OECD, 2009). However for high tech companies, especially biotechnology firms, several authors show that these businesses can expect to live longer (Carroll and Hannan, 1995; Holbrook and Clayman, 2003; Bayus and Agarwal, 2007). For example, in U.S. Carroll and Hannan (1995) had already announced that bankruptcies are rare in biotechnology sector. Disappearances of these companies are most evident in mergers and acquisitions (M&A) as well as changed names (Carroll and Hannan, 1995).

This brings us to raise another category of authors whose works challenge us to examine in depth the phenomenon of disappearance of young companies. We found also that many authors wish to distinguish between exits due to economic failure (bankruptcy) and DBFs disappeared in the context of merger and acquisition transactions (Van Praag, 2003; Carayannopoulos and Auster, 2010; Detienne, 2010, Wennberg et al, 2010; Cefis and Marsili, 2011).

These authors agree in pointing out that failures can be explained by the lack of resources and skills. However, these authors warn that exits through mergers and acquisitions are rather the result of strategic choices reflected trajectories or technology that is part of the life cycle of business as is the case in biotechnology (Danzon et al. 2007, Haeussler, 2007; Sowlay and Lloyd, 2010).

Other authors even speak of a business model based on full-fledged mergers and acquisitions. It must be considered like other classical trajectories of survival or bankruptcy (Mangematin et al. 2003; McKelvey, 2008). Detienne (2010) and Wennberg et al (2010) suggest that the non-demarcation between these two forms of extinction can be misleading when one wants to study the factors behind this phenomenon.

Therefore we had the total conviction it would be appropriate to test the following hypothese:

**H 1: The disappearance of DBFs is not necessarily an economic failure (bankruptcy).**

Regarding the factors explaining the disappearance of young firms, our review of the literature led us to distinguish between various theoretical currents on which we relied to develop a variety of research hypotheses tailored to the specific companies dedicated to biotechnology.

We have grouped the different references consulted under the banner of two major theoretical blocks. Initially, we discussed a variety of scientific and public reports which the authors believe that the question of the survival or disappearance of young companies depends largely on the external environment.

It is more precisely the theory of “The population ecology of organizations” and “institutional theory”: national public policies, regional system of innovation and geographic externalities

Subsequently we have completed our literature review with Resource-Based View (RBV) theory and other theoretical currents whose authors are convinced that company officials (management team) have more power to influence the destiny of young high-tech

companies (e.g. survival, merger and acquisition or bankruptcy). At this point, we referred to theoretical approaches of dynamic capabilities and strategic management.

### **The population ecology of organizations**

In general the authors of this theoretical suggest that the external environment imposes a selection whose victims are composed primarily of young firms (Hannan and Freeman, 1977; Carrol and Hannan, 2004). Due to their young age “liability of newness” and limited size "liability of smallness", new businesses that fail to secure resources, may be forced to disappear from the early years (Mata, 1994; Audretsch, 1995; Baldwin et al, 2000).

Proponents of The population ecology of organizations highlight also the issue of specialization in niches and density dependence as vectors in determining infant mortality.

So companies who manage to carve out a place in industries richest in terms of resources are more likely to grow and survive (Niosi, 2003; Qian and Li, 2003; Baum and Rao 2004; Hall and Bagchi-Sen, 2007). Furthermore, the development of population size and level of competitiveness lead to a situation of scarcity in which the victims are always newcomers (Hannan and Freeman, 1977). At this point we can make a parallel with the structure of Canadian biotechnology mainly characterized by weak business resources dedicated to specialties other than human health (Statistics Canada 2007). In other words, companies dedicated to human health will account for the lion's share on all levels: government subsidies and support for venture capital companies, the number of researchers, R & D, strategic alliances, patents, revenues and exports (Industry Canada, 2006, Statistics Canada, 2007). However we must specify that firms in these niches are facing a density and a more full-bodied competition due to new start-ups (Industry Canada, 2006, Statistics Canada, 2007).

To complete the idea surrounding the determinism of the external environment powered by the theory of population ecology, we felt it appropriate to integrate some papers that examined the impact of adverse economic conditions on the life cycle of new companies. In general these works reveal us that firms created during the bad economic conditions are more likely to fail (Mangematin, et al, 2003). The leaders of emerging companies have considerable difficulties to acquire needed resources during these periods and therefore they can not succeed in the selection process imposed by the external environment. Moreover we stress that in the case of high technology companies, we can see a sort of consolidation of industries. And disappearances of businesses are also manifested in the transactions of merger and acquisition during periods of financial crises (Sowlay and Lloyd, 2010).

Based on the assumptions and arguments raised by the various authors of The population ecology of organizations, it seems sensible to raise the following assumptions:

**H 2: Biotechnology Small businesses (in terms of size) are less likely to survive.**

**H 3: Start-ups (in age) dedicated to biotechnology are less likely to survive.**

**H 4: Young DBFs not dedicated to human health are more likely to fail.**

**H 5: Young DBFs established during poor economic circumstances are more likely to fail**

### **Institutional theory**

Different authors selected at this level tell us that the national public policies, regional systems of innovation and specific financial systems can play a decisive role in the creation, survival or disappearance of new high-tech firms.

Various references consulted (Kenney, 1986; Lundvall 1992, Nelson, 1993; Cooke, 2001; Niosi, 2011) indicate that public policies, "the national innovation system ", can make all the difference in the orientation of the life cycle (e.g. growth, survival or disappearance) of high-tech startups. For example the added value of public policy may occur in the establishment of an institutional framework for interaction between government, university and industry (Kenney, 1986; Etzkowitz and Leydesdorff, 2000). Similarly the

efforts of policy makers may occur in adequate funding programs (e.g. SBIR) (Audretsch et al. 2002, Industry Canada, 2006; Wessner, 2009) and a favourable regulatory framework to the innovation process (e.g. Bayh-Dole Act) (Orsi, 2002; Mowery, et al, 2001).

The influence of the institutional environment on the life cycle of biotechnology firms may also be expressed through regional innovation systems and sectoral innovation systems (Cooke, et al., 2004; Niosi et al, 2005; Malerba, 2005). The implementation of these businesses within the regions with favorable innovation systems enables leaders to enjoy a variety of information sources and the presence of various stakeholders (e.g. universities, research laboratories, venture capital companies, etc.). Moreover, these leaders can take advantage of a mass market and tax incentives (e.g. subsidies and tax credits) (Niosi and Bas, 2001; Cooke, et al. 2004; Niosi, et al. 2005).

To complete the institutional school, we discuss other theoretical currents. Roughly speaking we found that the authors highlight other theoretical concepts such as: anchor tenant, cluster and externalities arising from metropolitan area (Porter, 1990, 1998, Zucker, et al. 1998; Feldman, 2003; Agrawal and Cockburn, 2003).

It turned out that firms dedicated to high technology tend to be concentrated geographically, because of externalities and spillovers of economic, social and cognitive environment. In more explicit words, the leaders of these companies benefit from the presence of donors, universities active in R&D, externalities associated to the presence of major players as well as a positive result of the competitive spirit (Saxenian, 1994; Niosi and Bas, 2001; Acs, 2002; Agrawal and Cockburn, 2003, OECD, 2009a).

It must note also that these companies can benefit from the mobility of qualified human resources (channels transfer of explicit knowledge and especially tacit) and social capital (strong and weak ties) (Zucker et al. In 1998, Malmberg and Power, 2005). The references cited below, lead us to test the hypotheses the following research:

**H 6: DBFs established in major Canadian provinces, have a longer life expectancy.**

**H 7: DBFs located in major metropolitan areas, have a longer life expectancy.**

**H 8: DBFs with government subsidies have a longer life expectancy.**

Regarding the issue of adequate financing system, the majority of works consulted are agree on the importance of venture capital support and stock market as funding sources necessary for growth and even survival of young firms Biotechnology (Gompers and Lerner, 2001; Niosi, 2003; Aghion et al. 2007; Kenney, 2011). Given the uncertainty, information asymmetry and the high costs characterizing the activities of these firms (DiMasi et al, 2003), venture capital support is fast becoming essential for this kind business.

Beyond adequate funding, venture capital managers provide coaching and guidance in order to maximize the chances of successful commercialization of their innovations (Niosi, 2003, Baum and Silverman, 2004; Luukkone and Maunula, 2007; Kenney, 2011). Similarly venture capital managers use their own partners networking to facilitate access of young companies at national or international business networks (Hsu, 2006; Rosiello and Parris, 2009, Colombo, et al. 2010).

We must not forget that the mission of corporate venture capital is limited to a financial intermediary that supports these companies for a specified time period (Black and Gilson, 1999, Gompers and Lerner, 2001; Hall and Lerner, 2010). This brings us to highlight the role of the financial market as a source of additional funding which is to take over after the exit of venture capital companies (Black and Gilson, 1999, Hochberg et al. 2007). Apart from the output through public market, venture capital companies orchestrate mergers and acquisition transactions in order to sell their shares in the capital of young high-tech companies (Cumming, 2008).

To conclude this section we wish to emphasize that during economic crises periods, venture capital corporate are agree with new firms leaders to encourage more M&A transactions because return on investment is more attractive and realistic access to a stock

market crisis (Cumming, 2008; Sowlay and Lloyd, 2010). This brings us to raise the following assumptions:

**H 9: DBFs with venture capital support and listed on stock market have a longer life expectancy.**

**H 10: DBFs without venture capital support have a lower life expectancy.**

**H 11: DBFs with venture capital support are more likely to get public financing.**

**H 12: During economic crisis, DBFs companies receiving venture capital support are more likely to disappear in mergers and acquisitions.**

### **Resource-Based View theory**

Although the literature is very rich at this point, our choice fell on two dimensions internal to the organization that can justify the survival or failure of new biotechnology companies that are: dynamic capabilities and strategic management. Also in each of these dimensions, we have several concepts arising from the theory of internal resources, we believe relevant to the analysis of our problem. Thus we retained under the banner of strategic management of intellectual property protection, export as well as strategic alliances for the purpose of exploration and / or exploitation of innovations. In the case of dynamic capabilities, we selected the intensity of R&D activities, sources of income to own businesses (e.g. sales of licenses and products on market) and the presence of a skilled management team and diverse as survival factors.

Edith Penrose explains that differences in growth among organizations are due to their differences in internal resources, and specifically about differences in managerial competences. Based on Penrose insights, different authors have gone further, like the evolutionary approach which states that the force and competitiveness of a firm depend on the combination of the different know-how's. In the long run, the succession of those know-how's determine the trajectory of the firm (e.g. Survival of the firm, Mergers and Acquisitions, or bankruptcy), which is why this current is named evolutionary (Nelson and Winter, 1982). There is the approach of the dynamic capacities which stresses that

organizations prosperity is based mainly in the capacity of executives to put in place a strategic management able to reconfigure the internal resources and the creation of organizational capacities (Teece, 2009). Eisenhardt and Martin (2003) precise that “Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new *resource configuration as markets emerge, collide, split, evolve and die.*”

In biotechnology, the lack of know-how and of dynamic competences for business management could imply the impossibility of obtaining venture capital (Canada Industry, 2002). In the same vein, Traoré (2003) make the precision that small Canadian biotechnology firms that have been refused capital, exhibit problems in the managerial capabilities demanded by funding donors.

Zucker et al, (1998) demonstrate significant statistical relationships between the performance of young American biotechnology firms and the presence of a star scientist. However Rhyne (2009) specify that the importance of scientific research competences diminishes as the product moves on its life cycle while for competences related with manufacturing, commercialization and public relations become more important. Also, Rhyne (2009) says that business management competences and financial planning are very important in the different stages of the development of a new product. This last point is related to Patzelt (2007) which argues that executives with professional experiences in venture capital sector are in a better position to obtain financial resources out of the public market. Patzelt (2007) also mentions that executives with international experience can profit from their personal networks to establish partnerships with venture capital firms and/or other funds donors (e.g. Big pharma, research funds, angel investors). Therefore, even in uncertain environments, the prestige and quality of the executive team send a positive signal to secure different stakeholders, especially the funds donors (Lester et al., 2006).

Rothaermel and Deeds (2006) explain that executives should have a certain level of abilities and experience to manage the risks of asymmetric information and opportunism that can be developed by certain business partners. Niosi (2003) warns that the success of

strategic alliances adopted by young biotechnology firms depends on the capacity of executive to choose the right moment to do so (neither early nor late).

However, some authors state that these assets may be behind the disappearance of firms (Van Praag, 2003; Hsu et al., 2007; Cefis and Marsili, 2011). For biotechnology companies, leaders can encourage outflows through M&A transactions to maximize the chances of realization of a project (Danzon et al. 2006; Haeussler, 2007). Sides of their experienced leaders may decide to sell their businesses to get attractive offers offered by the big pharmaceutical companies especially in cases of financial distress (McKelvey, 2008; Bonardo et al ., 2009; Sowlay and Lloyd, 2010). Therefore, it seems interesting to test the research hypotheses include:

**H 13: BDFs with a qualified and experienced management team have a longer life expectancy (more chances to survive).**

**H 14: Disappearance of BDFs with a qualified and experienced management team occur primarily in M&A transactions.**

As part of the dynamic capabilities we also built two types of references: R&D activities and income from licensing and product on market.

Adopting R&D activities, young biotechnology companies can gain a distinct advantage in the marketplace by offering innovative and specific products (O'Regan et al. 2006; Cefis and Marsili, 2006; Stam and Wennberg, 2009). Young biotechnology companies can develop their absorptive capacity to benefit fully from their partnerships strategies they can reduce their vulnerability and their lack of resources (Cohen and Levinthal, 1990; Niosi, 2003; Levitte and Bagchi-Sen, 2010).

To minimize their external dependence, leaders of some young biotech companies must rely on their own sources of funding that typically appear in license sales and products on market (Mangematin et al. in 2003, Industry Canada, 2006; McKelvey, 2008). This leads us to formulate the following two assumptions:

**H 15: DBFs adopting intensive R&D strategies have a longer life expectancy.**

**H 16: DBFs with revenues of licenses and / or products on the market have a longer life**

## **expectancy**

In the case of the last internal dimension, which is strategic management, we detected a variety of choices that can explain the growth or failure of these economic entities. We have identified three strategic directions that occur frequently in the literature and that we considered relevant to study the phenomenon of the disappearance of young biotech companies.

First, we have strategies for protection of private property which may be a factor in the survival of young biotech companies to the extent they are able to preserve effort and money invested in R&D (Zucker and al. 2002; Helmers and Rogers, 2011; OECD, 2009). Patenting is a form of insurance and asset that companies managers can exploit the aim of convincing donors, especially corporate venture capital, and to draw attention of other business partners (Hall and Bagchi-Sen, 2001; Silverman and Baum, 2002; Niosi, 2003). Nevertheless we stress that this kind of strategic choice is not unanimity in the literature. Biotechnology companies that fail to develop active and complementary internal absorptive capacities risk becoming a simple licensors who can not get innovative products on the market (Gans and al. 2002; Cockburn, 2010).

Then we have internationalization strategies and export that can help young biotech companies to grow and survive. Authors who support this strategic management indicate that internationalization offers young companies the opportunity to maximize the exploitation of their technology by addressing the broader consumer markets (Qian and Li, 2003; Ganotakis and Love, 2010). Companies that manage to conquer foreign markets are more likely to gain different experiences and innovative (Sapienza et al. In 2006) and build synergistic relationships with foreign stakeholders (Ganotakis and Love, 2010). At this level, the research hypotheses that we test are:

**H 17: DBFs with quality patents at the USPTO have a longer life expectancy.**

**H 18: DBFs with quality patents at the USPTO are more likely to get venture capital support.**

**H 19: DBFs adopting internationalization and export strategies have a longer life expectancy.**

Finally, we have strategic alliances that are part of the most strategic choices cited in literature, especially in the case of companies dedicated to biotechnology.

In general, we can say that strategic alliances allow these companies to access resources such as regulatory expertise, skills in business management, funds and new technologies (Powell et al. in 1996, Stuart, 2000, Baum et al, 2000; Oliver, 2001 ; Audretsch and Feldman, 2003; Hulsink and Elfring, 2003, Lerner et al. 2003). Also the leaders of these companies can take advantage of strategic alliances to provide social capital (strong and weak ties) through which they can access to critical information and new business opportunities (Granovetter, 1985; Coleman, 1988; 1990; Hulsink and Elfring, 2003).

Moreover we want to emphasize two points which marked literature review. One side, when we talk about strategic alliances among biotechnology companies, we must distinguish between alliances dedicated to exploration and exploitation. On the other hand, strategic alliances continue to raise more and more criticism and questioning. We can mention for example that young biotechnology companies may face problems of opportunism in alliance strategies with large organizations (2004; Pisano, 2006; Levitte and Bagchi-Sen, 2010). In addition, to survive and grow, these companies must rely primarily on internal resources and capabilities. Also these companies need to develop absorptive capacity in order to benefit fully their interactions with different partners (Gans and Stern, 2003; Zheng et al. 2010).

Therefore, it would be prudent for the leaders of these organizations to choose the right time to cooperate and ensure a certain internal immunity before engaging in strategic alliances with large companies (Niosi, 2003, Gans and Stern, 2003). Otherwise, these companies may disappear following the opportunistic strategies adopted by the partners (Lindsey, 2008; Bonardo et al. 2010).

To place the question of survival and extinction of biotechnology firms within the debate about strategic alliances, we have decided to issue the following research hypotheses:

**H 20: DBFs opting for both exploitation and exploration alliance strategies have a longer life expectancy.**

**H 21: BDFs adopting early strategic alliances exploration are more likely to disappear in M&A.**

### **Sample and methodology**

This paper is part of a more ample longitudinal study about the disappearance of Canadian biotechnology firms. The study has taken almost three years, in which we have built a mega database containing more than 500 firms' names active in the period 1996-2010.

We used two related sources of information to build the mentioned database: the electronic databases (consulted online), and the documents and guides in paper format. In fact to gather information about the quantity and quality of patents held by the firms under study, we consulted the United States Patent and Trademark Office (USPTO). Nevertheless for firms with access to venture capital financing, we examined the Canadian database “Thomson Venture Capital Reporter”. This last database provides pertinent information like: amounts obtained different stage of the financing, type of investor, objective of the financing, etc. In addition to collect other relevant information about age, employment, sector of activity, management team, business partners, products in development and in market, exports, investment in R&D, and revenues, we used several databases specialized in biotechnology (e.g. Biotech Canada Statistics Canada, Industry Canada, Biotech Gate). Finally we must not forget our consultation of various editions (1996, 2000, 2005 and 2008) of the Canadian biotechnology guide in paper format with the objective to validate some of the data collected.

To test our research hypotheses, we used statistics tests like Chi-square, Pearson and Spearman correlation coefficients, multicollinearity tables, and logistic regression. The *table 1* below summarizes the different variables used to explain the disappearance and survival of biotechnology firms.

**Table 1:**

<b>Dependent variables</b>	<b>Independent variables</b>
- Life expectancy	- Sector of activity: human health, agriculture, environment, industrial
- Survival	- Management team: CEO, star scientist and sales manager
- Failure and bankruptcy	- Venture capital support: amounts invested, investor's profile and financing stage
- Mergers and acquisitions	- Stock market access
	- R&D intensity: amounts invested and number of employees
	- Patent strategy: quantity and quality
	- Strategic alliances: exploration versus exploitation
	- Revenues: licencing and product on the market
	- Internationalization and exports

**Expected results and conclusions**

We consider that our study can contribute to fill some gaps in the literature specializing in the development of biotechnology dedicated firms. To our knowledge, our doctoral thesis is among the few studies that examine in depth the different factors characterizing the disappearance of young biotechnology firms (e.g. the different disappearance paths as well as their determinants).

The building of our theoretical framework, which tries to solve an apparent contradiction (Resource-Based View Vs population ecology and institutional approaches), is in itself a very pertinent exercise because it has the virtue to propose commonalities shared by

otherwise heterogeneous concepts. Also, the present study has the added value of pointing out the impact of entrepreneurship on the disappearance of young science-based firms.

Regarding public policy, our objective is to stress the challenges that policy makers in emerging countries, willing to develop biotechnology, have to overcome in order to conduct their countries from a position of scientific subcontractors to enter the club of biotechnology leaders (e.g. efficient and effective public programs, number of approved products, revenues, strength of the financial system, stock market and venture capital).

Whether in the form of bankruptcy or in M&A, the disappearance of biotechnology firms can be also explained by limits of the Canadian institutional environment (e.g. Public policy, regional and national innovation system). For instance Canadian biotechnology firms are founded prematurely because universities, the place in which the majority of scientific discoveries occur in Canada, are evaluated according to the number of spin-offs created (Industry Canada, 2006). Also, Canada is different from other OECD countries because more of the financial resources for the biotechnology sector come from government (OECD, 2009). Most of those government funds are destined to fundamental research (Industry Canada, 2006). It is clear that a strategic change in public policy should be taken on different fronts like the following: a) chose a more prudent approach in the strategies adopted to support entrepreneurial activities and R&D activities (Lerner, 2010). b) Regulate the fragmentation of the financial market (Fazeli, 2005).

In terms of managerial implications, we are convinced that our longitudinal study will propose relevant and updated conclusions. In other words, we think the study can offer an accurate portray of the sector to the different stake holders (e.g. future directors of biotechnology firms, venture capital executives).

Inspired by the results published by Carroll and Hannan (1995), the present study reveals that the disappearance biotechnology firms in not only due to bankruptcy and failure. The analysis carried to the sample composed by 552 firm shows that M&A are the main exist path because at least one fourth of the firms have followed that way. Confronted with those facts, we think that those kind of disappearance are part of a strategic choice

adapted to constraints faced by young biotechnology firms and/or to bad conjectural economic conditions (Carayannopoulos and Auster, 2010; Danzon et al, 2007).

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