

**FIRM SIZE AND TECHNOLOGY COMMERCIALIZATION IN CANADA'S  
BIOTECHNOLOGY AND MANUFACTURING SECTORS WITH A FOCUS ON  
MEDIUM-SIZED FIRMS**

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## LEGEND

<b>CBOC</b>	Conference Board of Canada
<b>CEO</b>	Chief executive officer
<b>F</b>	Used when statistics are too unreliable to be published
<b>GDP</b>	Gross domestic product
<b>ICT</b>	Information and communications technology
<b>IP</b>	Intellectual property
<b>NAICS</b>	North American Industry Classification System
<b>OECD</b>	Organization for Economic Cooperation and Development
<b>R&amp;D</b>	Research and development
<b>SMEs</b>	Small and medium enterprises
<b>U.S.</b>	United States
<b>VC</b>	Venture capital
<b>X</b>	Used when statistics were suppressed to meet the confidentiality requirements of the Statistics Act

## ABSTRACT

Innovation and commercialization are crucial for the competitiveness and economic well-being of countries. Several recent reports (e.g., The Council of Canadian Academies, 2009; The Expert Panel on Commercialization, 2005; The Conference Board of Canada, 2008), have shown that Canada's innovation performance has been declining over the last two decades. In fact, these reports argue that Canada has been lagging behind most of its counterparts in the Organization for Economic Cooperation and Development (OECD). The claim is often made that Canada performs well in generating the knowledge needed for innovation; however, the problem lies in transforming this knowledge into commercial success. Thus, a major preoccupation is how to improve this weak commercialization performance.

Various solutions have been proposed by various organizations and agencies, and over the years the Government of Canada along with its provincial counterparts have implemented a wide range of policies, programs, and regulations to engender an improvement. Unfortunately, despite these efforts by various governments and agencies, little has changed in our commercialization performance. Thus, the search for solutions continues. Given that the commercialization process takes place mainly at the firm level, the commercialization capabilities and challenges of Canadian technology firms are analyzed in this thesis. The research focuses on two related questions: (1) does firm size influence commercialization capability and performance? And (2) are medium-sized firms better positioned to undertake technology commercialization?

This study is mainly based on the analysis of data gathered by Statistics Canada through the Survey on the Commercialization of Innovation, 2007. Data covered the biotechnology sector, the information and communication technology sector, and the manufacturing sector. The results indicate that there are substantial differences between small firms and medium-sized firms in their ability to commercialize innovations. Medium-sized firms are better positioned than smaller firms to commercialize innovations. Commercialization in this study refers to the ability of firms to transform technological knowledge into viable businesses (Iansiti & West, 1997). The results also revealed that the relationship between firm size and innovation differs

from one sector to another, and that different performance indicators could lead to different conclusions.

This study provides an empirical basis for differentiating small and medium-sized firms and for treating them differently. From a theoretical perspective, this study provides evidence that suggests that innovation research needs to be guided by a more nuanced approach leading to the consideration of three distinct size categories (small firms, medium-sized firms, and large firms), rather than the current dichotomous approach of classifying firms into either small and medium-sized (SME) or large. It also adds to the evidence on the link between technology commercialization and firm size, lending support to existing arguments, based on Canadian data, that firm size does matter when it comes to transforming technological knowledge into viable businesses. From a managerial perspective, this study presents business executives several business practices and strategies that they could implement in order to enhance their commercialization performance. The results could provide useful information for policy analysis. For instance, this study highlights the importance of considering medium-sized firms as a distinct firm-size category which could imply developing policies, programs, and initiatives targeted to medium-sized firms and designed to harness and leverage their commercialization potential – a missing piece in Canada’s innovation landscape.

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## SECTION 1 - INTRODUCTION

In technology management research, the concepts of innovation, research and development (R&D), commercialization, and invention are sometimes used interchangeably and in other instances used to refer to specific processes. In this study, the latter practice is adopted where innovation is defined as involving the generation of concepts or ideas for new or significantly improved goods, services or processes, and their introduction into the market. Invention, on the other hand, refers to the first occurrence of an idea of a new product or process; it does not become an innovation until it is commercialized, that is, introduced into the market (Fageberg, 2003). Innovation encompasses the R&D phase and the commercialization phase. The R (research) in “R&D” refers to basic research through which knowledge is generated. The D (development) refers to the applied research, where the knowledge generated through the R is used to develop the innovation (good, service or process). The last phase, commercialization, involves activities and functions allowing for the successful introduction of the innovation into the market, such as the marketing, branding, promotions, and distribution of the products.

Innovation is regarded as a crucial component of a high-performing economy, as it has positive effects on productivity, competitiveness, and economic growth, leading to a higher potential for rising wages and incomes, higher standards of living, and improving national prosperity (Phillip, 2008; Pavitt & Soete, 1982; Chih-Hai, 2006; Council of Canadian Academies, 2009; Conference Board of Canada (CBOC), 2008). At the firm level, innovation allows businesses to become more competitive by improving their business models and work organization leading to improving efficiency. Innovation is also essential to allow businesses to develop and introduce new or significantly improved products, services and technologies that better meet customers' needs.

Despite the importance of innovation, recent studies have showed that Canada is lagging behind other countries in terms of its innovation and commercialization performance, which is viewed as a reason for the decline in Canada's global competitiveness (CBOC, 2008; Industry Canada, 2005; Rao, Ahmad, Horsman & Kaptein–Russell, 2001). It is also argued that Canada performs well in terms of the generation of knowledge to develop innovations; however, the problem is in transforming this knowledge into a commercial success (CBOC, 2008; Brzustowski, 2008).

Several studies have examined the link between innovation and firm size (Herath, et al., 2008; Stock, Greis, & Fischer, 2002; Malerba & Orsenigo, 1995) but few have examined the link between commercialization and firm size. Notable exceptions in the context of Canada are Munn-Venn and Mitchell (2005) and Guthrie and Munn-Venn, (2005). These authors argue that medium-sized firms are well positioned to lead Canada's commercialization improvement because they possess many of the critical capabilities and complementary assets required for commercialization (Guthrie & Munn-Venn, 2005).

Despite the arguments supporting medium-sized firms' ability to commercialize innovations, there is a weak empirical base that explores the position of Canadian medium-sized firms and their innovation and commercialization capabilities. Munn-Venn and Mitchell (2005) noted that neither Statistics Canada nor provincial governments collect statistics on the contribution of medium-sized firms as a separate and distinct group to Canada's GDP. Moreover, medium-sized firms are often combined with small firms under the small and medium-sized enterprises (SMEs) category, which masks the specific characteristics and factors that may hinder or strengthen the innovation capabilities of these firms. Most of the existing studies, when considering the size aspect in treating firms' ability to innovate and commercialize innovations, adopt a dichotomous approach in classifying firms; they focus on comparing the group of small and medium-sized firms (SMEs) with larger ones, without exploring the differences between small and medium-sized ones. Therefore, considering medium-sized firms as a separate group when studying commercialization, instead of adopting the approach that combines small and medium-sized firms in one group, would represent a significant contribution to existing knowledge.

This study explores the commercialization capabilities of medium-sized firms in three key industries of the Canadian economy – information and communications technology (ICT), biotechnology, and traditional manufacturing. This study also compares the ability of medium-sized firms to commercialize their innovations to that of small and large firms. Thus, the two main research questions addressed in this study are:

1. Does firm size affect firms' ability to commercialize innovations?
2. Are medium-sized firms better positioned to foster Canada's commercialization performance?

This study will contribute to existing knowledge by covering the gap in the literature concerning the role of medium-sized firms in commercialization. The research findings could also influence government technology commercialization policies, in particular those relating to medium-sized firms. Currently, there are few, if any, programs specifically designed to enable medium-sized firms to enhance their commercialization capabilities and performance. The research findings may also guide managerial strategies since it will reveal managerial strategies and practices that are effective in fostering technology commercialization.

This study is structured into seven main sections. The next section highlights Canada's innovation and commercialization performance compared to its counterparts in the Organisation for Economic Co-operation and Development (OECD). Section 3 presents the definition of key concepts used in the study, a review of the relevant literature, and a summary of the relevant theoretical frameworks. Section four describes the methodology. Section five presents the results and Section 6 discusses the implications of the results, which is followed by the conclusion.

## **SECTION 2 - CANADA'S INNOVATION AND COMMERCIALIZATION PERFORMANCE**

Innovation is considered an important component of a high-performing economy (CBOC, 2008) and contributes positively to the economic growth of countries (Phillip, 2008; Pavitt & Soete, 1982; Chih-Hai, 2006). Accordingly, countries that are more innovative tend to have higher per capita incomes, productivity, and standards of living (CBOC, 2008). Canada's productivity has been declining relative to our major trading partner, The United States, over the last two decades and this has exerted a negative impact on our competitiveness (Council of Canadian Academies, 2009). In addition, Canada faces even more competitive challenges from the emergence of new economic powers including Brazil, Russia, India, and China that are making inroads into technology areas and markets where Canada was considered strong (Council of Canadian Academies, 2009). Its aging population also poses challenges, which may negatively impact its innovation capabilities through the shortage of sufficient people with the required talents and capabilities to accelerate innovation. These challenges suggest that innovation and commercialization must be improved and quickly too, if Canada is to improve its competitiveness as a nation. Clearly, innovation is crucial for Canada's global competitiveness, prosperity and sustainable development.

In the last five years alone, over half-dozen major reports from various agencies (the Government of Canada, Statistics Canada, the CBOC, the Council for Canadian Academies, and the OECD) have all concluded that Canada is lagging behind its OECD counterparts in terms of its innovation and commercialization performance. Even more concerning is the finding that no significant improvements to Canada's innovation and commercialization performance were noted for the last three decades (CBOC, 2008). Indeed, it seems that enhanced improvements have remained elusive despite the wide-ranging policies, programs and initiatives introduced over the years by various federal and provincial governments.

The importance of innovation has led to many initiatives by the Government of Canada designed to stimulate the generation and the diffusion of innovation (CBOC, 2008). In the public sector alone, there are over 100 federal programs that support innovation activities, which are managed by about 25 federal departments or agencies. These programs include direct funding, tax credits, prudent fiscal and monetary policies, lower tax rates, support for university

research, etc. (see Appendix A). According to the Council of Canadian Academies (2009), despite all the efforts that were made to create an environment that encourages business innovation, Canada is still falling behind in terms of its innovation performance.

The CBOC (2008) has used several indicators to assess Canada’s innovation performance compared to its international competitors and trading partners. These indicators include publication of scientific articles, technology exchange (measures the flow of technological know-how and technological services into and out of a country as a share of GDP), patenting, and others. According to the CBOC (2008), Canada ranks near the bottom of the list compared to other countries in terms of innovation. As shown in Table 1, Canada ranked 13 out of 17 countries and received a D grade for its innovation performance, which is the lowest grade that could be given in the study. In fact, there was a decline from a B grade on the generation of scientific articles in the 1980s and 1990s to a C grade in the 2000s. For most of the other performance indicators a D grade is obtained throughout the last three decades. The only improvements that were noted are the progression from a D grade to a C grade for two performance indicators, export market share (Aerospace), and knowledge-intensive services (see Appendix B).

**Table 1: Canada’s Innovation Performance Ranking**

Country	Grade	Country	Grade
1. USA	A	10. Finland	C
2. Switzerland	A	11. Denmark	C
3. Ireland	A	12. Belgium	C
4. Japan	B	13. Canada	D
5. Germany	B	14. Austria	D
6. UK	B	15. Australia	D
7. Sweden	B	16. Italy	D
8. Netherlands	B	17. Norway	D
9. France	C		

Source: The CBOC, 2008

As Table 2 shows, Canada has also obtained the lowest grade (a D grade) on 9 out of 12 key indicators of innovation performance, and a C grade on the other 3 indicators.

**Table 2: Canada's Innovation Performance on Science, Technology, and Market Activities**

Indicators	Grade	Indicators	Grade
Scientific articles	C	Export market share: Aerospace	C
Technology exchange	D	Export market share: Electronics	D
Patents by population	D	Export market share: Office machinery and computers	D
Share of world patents	D	Export market share: Pharmaceuticals	D
High- and medium-high technology manufacturing	D	Export market share: Instruments	D
Knowledge-intensive services	C	Top 100 Brands	D

Source: The CBOC, 2008

Further, according to Barrows (1992), compared to other developed nations in the world, Canada has one of the lowest export-to-import ratios for high-tech goods. Brzustowski (2008) noted that there is a considerable demand in Canada for research and technology; however, instead of making and exporting these technologies, Canada imports them. This may be due partially to more focus in Canada on traditional fields instead. Indeed, only 5% of Canada's GDP comes from high and medium-high technology manufacturing, and 1.3% of its GDP comes from high-tech manufacturing (CBOC, 2008).

Canada is also suffering from labour productivity problems. Canada's average productivity growth over 1985-2006 was ranked 15<sup>th</sup> out of 18 OECD countries. Since 1984, labour productivity in Canada has decreased from more than 90% of that of the United States, to around 76% in 2007 (Council of Canadian Academies, 2009). These results were attributed to the lack of investments in leading edge technologies. Investments in ICT are key drivers of productivity growth; however, Canada was lagging significantly behind not only that of the United States, but also many of other advanced countries in terms of investments in leading-edge technologies such as computers and communications technologies (Council of Canadian Academies, 2009).

Canada's small domestic market size is also often cited as one of the reasons for its declining performance. According to this view, a small domestic market tends to attract fewer competitors because of the lower potential benefits associated with undertaking the risk of innovation (Council of Canadian Academies, 2009). Weak competition tends to play a negative role in

motivating businesses to innovate and Canadian firms tend to adopt price-based strategies to deal with competition (Council of Canadian Academies, 2009). Generally, firms compete by lowering the price of their products rather than introducing new products (Statistics Canada, 2010). Focusing on the domestic market and on exploiting existing technologies rather than developing new ones suggests that Canadian firms are not motivated to innovate. Indeed, uncertainty and risks are cited as among the leading obstacles to innovation by Canadian businesses (Statistics Canada, 2010).

In order to put some context to Canada's declining innovation and commercialization performance, it is important to distinguish between the role of government and the role of private industry. Generally, governments create the conditions or the business environment through its various policies for innovation to flourish (Jukka-Pekka & Ahti, 2002). However, the primary responsibility for developing and commercializing innovations rests with private industry; essentially it is a firm-level activity (Zahra & Neilsen, 2002). Firms must make the necessary investments and implement business strategies that foster innovation. Recently, the Council of Canadian Academies (2009) concluded that Canadian businesses are less customer-focused than those in the United States and this may explain why innovation-oriented business strategies are less pronounced in Canada.

A widely held view among many industry observers is that Canada's weak innovation performance has less to do with the generation of knowledge (developing innovations) and more to do with commercializing innovations – that is taking innovations to the market (CBOC, 2008; Brzustowski, 2008). Proponents of this view argue that Canada has good universities, engineering schools, teaching hospitals, and technical institutes, which produces ample supply of scientists and engineers; however the problem is in transforming this knowledge into a commercial success. It is suggested that Canadian business managers are not as well trained as their U.S. counterparts and these latter are more likely to adopt business strategies based on innovation and are more knowledgeable of leading edge technological developments (Council of Canadian Academies, 2009).

Another weakness of the Canadian innovation system that is often cited as a reason for the dismal commercialization performance is the weak collaboration between universities and the private sector. . It is argued that Canadian universities' graduates do not have the necessary skills

and knowledge, especially in business and marketing, required by industry. Lack of adequate people with the right skills and knowledge in marketing and business is seen as a key obstacle to technology commercialization in Canada (Statistics Canada, 2010). The lack of collaboration between academia and the private sector does not only affect the skills of Canadian universities' graduates, but also lead to the loss of knowledge generated by academia on universities' shelves without transforming it into innovations to be introduced into the market. Establishing strong collaboration between academia and the private sector improve the potential for commercializing the knowledge generated by these institutions, thus improving Canada's commercialization performance.

The preceding analysis highlights Canada's dismal innovation performance and some of the key reasons advanced by various industry observers, policy makers, and industry executives in various government-initiated reports or those undertaken by other agencies. Before concluding this section, it is noted that each of the reports cited (e.g., CBOC, Council of Canadian Academies, Expert Panel on Commercialization) has proposed solutions to improve the situation. A summary of the main solutions proposed is presented in Appendix C. It is observed that most of the prescribed solutions require governments to take some action to either modify or cancel existing policies and programs or to introduce new ones. For instance, the recommendations converge around common themes such as investments in fields in which Canada excels, the need and access to financing, encouraging competition by removing trade and investments barriers, encouraging partnerships and collaboration between academia, research institutions, government, and businesses, development of talents and human capital, improving tax regimes, and encouraging the growth of SMEs. As noted earlier, all these recommendations are covered by many existing Government programs, in which substantial investments were made.

Unfortunately, very little is prescribed for industry to act upon. This situation suggests that a micro-analysis focusing on technology commercialization at the firm-level could yield insights that may lead firms to take actions to improve their commercialization track record. This thesis explores this particular line of investigation with the goal of identifying possible firm-level actions that may lead to enhancing our poor commercialization performance.

## SECTION 3 - LITERATURE REVIEW

This section provides a brief discussion of the key concepts used in this study as well as the relevant literature on innovation, commercialization and firm size.

### 3.1 Innovation

An invention is the first occurrence of an idea for a new product or process; an invention does not become an innovation until it is first commercialized (Fageberg, 2003). Innovation is defined as the implementation of a new or significantly improved product, service, process, or a new organizational method in business practices, workplace organization or external relations (OECD, 2005).

There are many ways to categorize innovations. According to Schumpeter, there are five types of innovations; new products, new methods of production, new sources of supply, exploitation of new markets and new ways to organize business (Fageberg, 2003). Innovation can also be classified as incremental, marginal, radical, sustaining, or disruptive depending on the extent of changes embedded in the innovation or the impact of the changes it produces or learning required to use it. Innovations are also classified as first in the world, first in Canada, or first in the industry, or first in the company.

According to the Council of Canadian Academies (2009), there are many ways to assess innovation performance. There are observable aspects of innovation that are usually used in the assessment of this performance, which include the inputs (investment in machinery, financing, employing highly skilled people, establishing partnerships, etc.), the outputs (i.e. the percentage of sales contributed by a certain innovation during a certain period of time), and the outcomes (i.e. higher market share). Each of these aspects, although it may reflect certain information regarding the innovation process, it does not allow to capture the whole process.

Strategies adopted by firms are what determine their behaviour towards the inputs allocated to their innovation process. For instance, to a large extent, a business strategy determines the investments allocated to conduct R&D activities, to train employees, and to acquire new machinery. Therefore, the business strategies that Canadian businesses adopt are what shape Canada's innovation performance (Council of Canadian Academies, 2009). Thus, at a broad level, there are many factors that influence the adoption of innovation as a business strategy by

firms. These factors include structural characteristics (sector of activity), the intensity of competition, the climate for new ventures (universities to supply research, new ventures financing, etc.), public policies (taxes, regulations, etc.), and business ambition (extent of entrepreneurship and drive to expand to new markets, etc.) (Council of Canadian Academies, 2009). For instance, competition can be viewed by firms as one of the main incentives to innovate, because of the benefits innovation can provide in terms of greater market shares, and the threats that it allows to avert. Another example of an important aspect that influences the innovation system at a national level is the climate for new ventures, because of their role in introducing new ideas to market, and creating new competition. This climate affects the contribution of venture capitalists to new ventures, which can represent a valuable support to these firms due to the market knowledge, experience and networks they have.

### **3.2 Commercialization**

The commercialization of an innovation can be defined as the process by which firms transform knowledge, discoveries, and inventions into new or significantly improved products and services that satisfy customers' needs (Zahra & Nielsen, 2002). A much broader conceptualization is offered by Iansiti and West (1997) and Bagchi-Sen (2006) who view commercialization as the process of transforming technological opportunities into viable businesses. Another way to define commercialization is the one adopted in the *People and Excellence: The Heart of Successful Commercialization* report released by Industry Canada (2006) (Appendix D). In this report, the commercialization is defined as being "a complex, integrated system anchored in the world of business. It has many components that come together in different ways. Each commercialization situation is different and based on a distinct mix of factors" (Volume 2, page 10). These factors include supply and demand issues, business operation factors, marketplace framework issues, etc. The commercialization process involves many activities and functions that allow introducing these products into the market and increasing customers' demand for these products, such as the marketing and distribution of the products. Marketing innovations involves product design or packaging, product placement, product promotion or pricing (OECD, 2005). This process requires many competences and institutional preconditions (Iansiti & West, 1997; Bagchi-Sen, 2006). There are many alternatives that can be adopted to commercialize innovation such as licensing, R&D contracting, partnering, alliances, and joint ventures (Arora & Grambardella, 1990; Kollmer & Dowling, 2004).

### **3.3 Sectoral Differences**

Given that this study is focused on specific economic sectors, this section aims to present notions and concepts allowing the explanation of the differences between different sectoral systems. According to Malerba (2005), a sector is a set of activities sharing some basic knowledge, and unified by some related product groups. A sectoral system is “a set of products and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products” (Malerba, 2002, p.1). There are three main building blocks of a sectoral system: knowledge and technologies, actors and networks, and institutions (Malerba, 2005).

Each sectoral system has its own knowledge base, technologies, and inputs that vary across sectors, and that affect the innovative activities and behaviours of agents within sectors. Knowledge domains comprise technological and scientific fields at the base of innovative activities in a specific sectoral system (Malerba, 2002). A technological regime is the knowledge environment in which firms operate. The cumulativeness of knowledge in a sectoral system refers to the generation of new knowledge based on existing knowledge, which can be attributed to three sources: the learning processes allowing to improve the current knowledge based on existing knowledge, organizational capabilities that improve over time, and feedbacks from the market where innovative success lead to increasing investments in R&D and therefore the probability to innovate again (Malerba, 2002).

Actors or agents are firms and non-firms organizations, such as innovations’ producers, input suppliers, customers, universities, scientists, government agencies, financial institutions, etc. Agents have their specific learning processes, behaviours, competences, objectives and goals. Agents interact together in a sectoral system through processes of communication, cooperation, competition, and exchange. “The types and structures of relationships and networks differ from sectoral system to sectoral system, as a consequence of the features of the knowledge base, the relevant learning processes, the basic technologies, the characteristics of demand, the key links and the dynamic complementarities” (Malerba, 2002, p.10). Institutions, which include laws, regulations, norms, standards and routines, are what shape agents’ interactions and relationships.

The boundaries of a sectoral system, which include interdependencies and complementarities between related industries, are not fixed. The level of aggregation adopted when considering a

sectoral system depends on the goals and the objectives of research. Also in a specific sectoral system, there are different levels for the analysis of agents, from considering a firm as a unit of analysis, to considering firm's sub-units or departments as the analysis unit. In this study, the unit of analysis is the firm. The analysis covers the biotechnology sector and the manufacturing sector, where the knowledge and technologies, actors and networks, and institutions characterizing these sectors comprise differences distinguishing the two sectors when comparing the behaviours of firms and their innovation strategies in these sectors. For instance, in the biotechnology sector, the nature of the knowledge required to innovate allows firms to control only a subset of the search space, and increase the dependency of firms on strong scientific capabilities, and on the ability of firms to interact with scientific institutions to explore the search space (Malerba, 2005). In the computer industry, given the high number of components involved and the necessity of compatibility between different components (both hardware and software requirements), institutions, such as standards and IP laws, play a central role in the innovation process of firms. The complexity of computer and electronic products increases the necessity for involvement in cooperative agreements in order to procure components necessary to build innovative products.

### **3.4 Firm Size**

One of the main variables in this study is the size of firms. The most widely used variable for firm size is the number of employees, although other variables such as sales and assets are sometimes used. In this study, firm size is defined by the number of employees within the firm. The data collected through the *Survey on the Commercialization of Innovation* (2007), which were used in this study, were provided by Statistics Canada broken down into three categories: small firms counting between 20 and 50 employees, medium-sized firms counting between 50 and 249 employees, and large firms, counting 250 employees and over. These three distinct categories will be used in identifying firm size throughout the analysis of the data; unlike most of the existing literature where a dichotomous approach is adopted, combining small and medium-sized firms under the SME category and comparing them to larger firms. The classification of firm size reflects the unique nature of Canada as a small, open economy where the majority of firms are small. In fact, small firms represent approximately 98% of Canadian businesses. Medium-sized firms represent approximately 1.9%, and large firms count for approximately 0.3% of Canadian businesses (Statistics Canada, Business Register, 2007). Despite the fact that

the majority of Canadian businesses are small, large firms play a key role in the Canadian economy given their significant contribution to income generation and wealth creation. The strong ability and innovativeness of many large Canadian firms at the international level, such as Bombardier and RIM, supports the importance of larger firms in the Canadian economy. Large firms also nurture smaller firms that service and support them. Medium-sized firms have the potential to grow and become large firms.

### **3.5 Firm Size and Innovation**

The relationship between firm size and innovation has received a good deal of attention in management literature (Herath, et al., 2008; Stock, Greis, & Fischer, 2002; Malerba & Orsenigo, 1995). However, there was no common conclusion derived from different studies. This general topic can be traced back at least as far as Schumpeter in 1942, who first emphasized the relationship between firm size and technical change (Kaplinsky, 1983). The objective of the following literature review is to examine the relationship between the size of a firm and its innovation and commercialization capabilities.

Malerba and Orsenigo (1995) examined the relationship between firm size and innovation performance while taking into consideration the technological aspects of the industries in which innovations are measured. These authors observed that in mechanical industries, an industrial structure consisting of small firms is more conducive to technological performance than that in which innovators are of larger firms, whereas in the traditional industries, the opposite is true (Malerba & Orsenigo, 1995).

According to Herath, Cranfield, Henson, and Sparling (2008), the size of a firm is an important driver of the intensity of firms' innovation. Stock, Greis, and Fischer (2002) argue that, because sustained innovations require more resources, larger firms are in a better position to generate such innovations. In addition, they argue that larger firms are better able to generate returns from their innovation and are less vulnerable to periods of lower innovative performance. According to Herath, et al. (2008) larger firms are better able to spread R&D investments over more projects, which allow them to reduce the capital requirements per each innovation unit they produce and their need for external funding. As well, large firms are better able to finance their own projects; which is often not the case for small firms, who seek external funding to conduct their projects. Other studies argue that larger firms have the financial and technical

capabilities allowing them to acquire external capabilities (Rothwell, 1989; Luukkonen & Palmberg, 2007), and small firms are at a disadvantage because of the lack of the required complementary assets to take their technologies to market, as well as the lack of manufacturing capabilities (Shane & Stuart, 2002). Based on these findings, it seems that small firms are less capable of performing all the activities from research to commercialization.

A different perspective is offered by Chaney, Devinney, and Winer (1991). Chaney et al. (1991) argue that smaller firms are more motivated to innovate than larger firms, as this is more valuable for them. Whereas larger firms need innovation to stay on top of the market; smaller ones need innovation to survive. According to Bommer and Jalajas (2002), the climate inside small and medium-sized firms is crucial for their success in innovation. The work climate is defined as the way employees perceive and cognitively interpret the work environment in which they work (Bommer & Jalajas, 2002). When there are mechanisms in place that reflect the support and the encouragement of management for the creativity of employees, and when employees are offered more complex tasks to perform and are less controlled, a firm can be in a better position to innovate, and employees perform better (Bommer & Jalajas, 2002). Also the higher motivation of employees in smaller firms has a positive impact on the innovation performance of these firms. This motivation is associated with the fact that their compensation is more linked to their performance and their contributions are more visible, as well the potential to obtain feedback from their principals regarding their performance is also higher, which is crucial to improve their motivation (Lerner, 2010).

Other factors that have a positive influence on small firms' innovation is their flexibility, especially when dealing with changing conditions, and the ability of small firms to avoid "bureaucratic inertia" found in large firms and which leads to more difficult communication and coordination of R&D (Stock, Greis, & Fischer, 2002). Lerner (2010) argues that small firms are better able to observe where technologies could be applied to meet customers' needs, and to introduce these technologies to the market faster. Baldwin (2000) argues that SMEs are more flexible, and able to provide more rapid responses with a customer-oriented focus. Based on this, smaller firms seem to be better able to deal with the customer-orientation problem than larger firm. According to McNamara and Baden-Fuller (2005), small firms generate significantly higher returns in exploration activities as opposed to exploitation activities, compared to their larger counterparts.

Hitt, Hoskisson, and Ireland (1990), argue that there is an inverse U-shaped relationship between firm size and innovation - the positive relationship between firm size and innovation continues until it reaches a certain point, after which the relationship becomes negative. Based on this, one could expect that after a certain size, the larger the size of a firm gets, the lower its innovation performance becomes. This argument leads to thinking about the case of medium-sized firms, and whether it is the optimal form of firm size, at which the innovation and commercialization performance of firms can be maximized.

Yet, another perspective between firm size and innovation is proposed by Kamien and Schwarz (1982) following a broad review of literature. They argue that the relationship is inconclusive and that the advantage of being better able to innovate is not associated with smaller or with larger firms (Rothwell, 1989). They suggest that each firm size tends to possess some characteristics associated with it that can positively or negatively affect its innovation performance relative to other size categories. For instance, Rothwell (1989) suggests that management structures of small firms represent, generally, a positive effect on their innovative performance compared to larger firms. Smaller firms have a better tendency to undertake risky innovation projects, whereas the bureaucratic inertia in larger firms could represent an obstacle for undertaking such projects. Similarly, it was found that investments in R&D tend to increase with the size of a firm up to a certain level after which, spending starts to decline. Also it was found that middle size firms allocate the most effort relative to their size.

In the context of Canada, Munn-Venn and Mitchell (2005) found that medium-sized firms have better capabilities than small firms and they tend to participate in the increasingly global system of production and distribution. Small firms in Canada were found to be predominantly engaged in serving their local clients, which affects their ability to become global players (Guthrie & Munn-Venn, 2005). Compared to medium-sized firms, small ones lack marketing talents (Dale, 2004), and negotiation and managerial expertise to commercialize their products (Industry Canada, 2006). And because of the resource constraints, small-firms have a little margin for error or risk-taking, which can, in a way, limit their innovativeness. On the other hand, large firms, because of their size, they experience more difficulties in communication and in coordination of R&D, have less flexibility and are slower than medium-sized firms when reacting to changing conditions.

Compared to small firms, medium-sized firms are able to commercialize products more quickly because they are global players, export-focused, innovative, profitable, and can take products to market quickly (Munn-Venn & Mitchell, 2005). Because they can insert themselves in the global supply chain, medium-sized firms are likely to experience superior performance (Guthrie & Munn-Venn, 2005). Another advantage for medium-sized firms is that they have higher growth rates and perform more R&D. Further, the SME Financing Data Initiative (2003) report also highlights the inability of most small firms to make the transition into medium-sized firms, and the difficulties they face in this transition.

The arguments presented above by various studies regarding the link between firm size and innovation and commercialization are to a large extent rooted in the resource based theory of the firm. The resource-based theory focuses on the resources, capabilities, competences and the complementary assets of firms. According to this theory, the capabilities of firms in manufacturing (Ettlie, 1997), marketing (Cooper, 1993; Dutta et al. 1999), and management (Zahra & Neilsen, 2002) are crucial for firms to be successful in commercializing their products. These capabilities are advantageous for firms because they allow them to be quicker in bringing their products to the market (Shane & Stuart, 2002). Resources are defined as “everything that the organization has available to aid work in a domain targeted for innovation” (Amabile et al 1996, p. 1156). In the context of this study, this theory allows us to explore whether medium-sized firms possess the required capabilities and resources to successfully innovate and commercialize their innovations compared to other firms.

Some studies argue that larger firms have the financial and technical capabilities allowing them to acquire external capabilities (Luukkonen & Palmberg, 2007), and small firms are at a disadvantage because of the lack of the required complementary assets to take their technologies to market, as well as the lack of manufacturing capabilities (Shane & Stuart, 2002); therefore small firms are less capable of performing all the activities from research to commercialization. On the other hand, medium-sized firms are found to possess many of the critical capabilities and complementary assets required for commercialization, which small firms do not possess (Guthrie & Munn-Venn, 2005). Therefore, medium-sized firms could be viewed as more capable of performing the commercialization process than smaller firms.

A related view is the ability of firms to become part of a network and to benefit from that network. Networks provide firms “access to knowledge and information about trends present in the environment. [...] and the potential for providing resources required in order for organizations to innovate” (Vincent, 2005, P.154). Firms that take advantage of the existing capabilities within its network could improve their innovation performance (Powell, 1996) because networks facilitate collaboration, market access, and knowledge spillovers among firms and between industry, academia, and public research agencies (Audretsch & Feldman, 1996). Thus, linkages between firms in networks could have a positive influence on the commercialization of innovations. According to Polt, Vonortas, and Fisher (2008), the involvement of customers and commercial partners in the development of innovations could have a positive effect on developing technologies. According to Tether (2000), firms that introduce high-level innovations are much more likely to be involved in cooperative arrangements with their suppliers and/or customers. In alliances established between small and large firms, usually large firms benefit from the technical and scientific capabilities of smaller firms, whereas smaller firms benefit from the access to markets that large firms offer them (Doz, 1988; Xia & Roper, 2008). Janne, and Frenz (2007) found that larger firms have a higher propensity to engage in horizontal and vertical cooperation than smaller firms.

Intellectual property protection was listed as an issue to be addressed as part of the efforts to improve Canada’s commercialization performance, especially that high-growth sectors rely on IP rights to secure financing and develop their products (Council of Canadian Academies, 2009). Laws and regulations are crucial in determining the extent to which the intellectual property (IP) rights of firms are protected. Collaboration between government, academia and the private sector is also identified as being crucial to improve Canada’s commercialization performance (Council of Canadian Academies, 2009; Guthrie & Munn-Venn, 2005). Establishing strong intellectual property laws is crucial in order to facilitate such collaboration and to encourage firms’ investments in innovation, thus improving the conditions for technology transfer (OECD, 2010). If laws do not emphasize and enforce IP rights’ protection, firms will hesitate to share their knowledge with their partners because they will be concerned about their assets being stolen, and therefore will prefer to commercialize their innovation themselves (Gans et al. 2002); however, if firms do not have the necessary resources to commercialize their inventions, knowledge will be lost as it will not be shared with other organizations. When existing laws and

regulations are strong enough to protect IP rights, firms will consider different options when commercializing their innovations, whether they perform the commercialisation activities themselves or establish partnerships with other firms to commercialize their innovations. There are many IP rights instruments, including patents. According to Traoré and Rose (2005), small and medium-sized firms conduct cutting-edge research leading to the development of knowledge with quality and novelty, which allows them to obtain patents should they seek to patent their innovations. However, given the limited resources of small firms, they tend to prefer secrecy over patenting to protect their innovations. Traoré and Rose (2005) also argue that medium-sized firms usually choose to develop their inventions into new products, instead of transferring their knowledge through IP instruments to other organizations; which proves that medium-sized firms have the necessary capabilities to commercialize their innovations. When it comes to larger firms, given the ample resources that they possess and their strong and experienced legal departments, they can adopt a more aggressive patenting strategy to generate revenues from their inventions (Traoré & Rose, 2005).

In summary, the theoretical arguments seem to suggest that large firms are better positioned than small firms to innovate and commercialize innovations because of the resources they possess and their higher propensity to be involved in cooperative arrangements. However large firms could suffer from organizational inertia, they are less able to adapt to changing conditions, and given their complexity, communication within these firms are usually more difficult than in smaller ones (Vincent, 2005). As well, large firms typically exploit their existing technologies (Anderson & Tushman, 1990) instead of developing a pipeline of new products. On the other hand, small firms can react quicker to changing conditions than larger firms because their structure and decision-making processes are less complex (Lerner, 2010).

Despite these theoretical arguments on both sides of the debate, existing evidence of the link between firm size and innovation and commercialization is equivocal at best. Indeed, such evidence in Canada is very thin. This study will explore the relationship between firm size and innovations' commercialization in Canadian firms.

## SECTION 4 - METHODOLOGY

This study is based on quantitative data collected through the Survey on the Commercialization of Innovation, 2007, which was conducted as a joint project by Statistics Canada and Industry Canada. In order to gather data regarding the commercialization activities and performance of Canadian firms, and to explore the relationship between firm-size and commercialization abilities, the researcher has initially designed her own survey instrument. After finding out that Statistics Canada has executed a similar survey on the commercialization of innovation that is more comprehensive, and with a high response rate (70% response rate), the decision was made to use the data collected through the Survey on the Commercialization of Innovation (2007) to conduct this study. Given that most business surveys executed by Statistics Canada are mandatory, a high response rate is expected, thus leading to more reliable results. However, the inability to obtain raw data prevented using more advanced statistical techniques such as regression analyses. The study was based on tabular and graphical analyses of the data.

Data were collected using a paper mail-out, mail-back questionnaire. According to Oppenheim (1992), and Sapsford (1999), questionnaires offer an objective means of collecting information about people's knowledge, beliefs, attitudes, and behaviours. And mail surveys could represent an advantage because they allow people more time to think before answering the questions, compared to telephone and face-to-face interviews (Dillman, 1991).

The Survey on Commercialization aims to better understand the commercialization activities performed by Canadian firms and the factors that influence their commercialization performance. The purpose of this survey is “to establish statistical indicators on commercial performance in the marketing of innovative products” (Statistics Canada, 2007). Product innovation was defined on the questionnaire as being “the introduction of a new or significantly improved good or service. The innovation may be either technical or non-technical. The innovation (new or improved product) must be new to your enterprise”. The survey covered the innovation and commercialization activities and performance of participants for the period 2004-2007.

The questionnaire included 32 questions; out of which 31 questions related to the commercialization and/or innovation activities or performance of firms, and the last question covered the time it took the respondent to complete answering the questionnaire. The

questionnaire contained questions of different formats. For instance, there were dichotomous questions, with yes or no answer choices. There were also fixed choice questions where the respondent had to choose an answer from a list of choices, and which generally included an open 'other' category, which could be seen as a useful contingency measure in case respondents want to provide an answer that is different than the choices already provided (Murray, 1999). Also, there were checklist questions where the respondent is asked to tick all the choices that apply to their firm. Some other questions required inputting a number to answer the question (i.e. number of years, number of innovations, percentages, dollar values, etc.). There were no leading or repetitive questions, and the way the questionnaire is structured allows for a logical and smooth flow of questions from one topic to another. Questions relating to the same topic/theme are grouped under the same section, and in general questions are simply worded, and when needed, definitions of what is meant by certain expressions/terms is provided with the question or at the beginning of the section in which the term is used.

The subjects covered by the questionnaire include the commercialization activities carried out by firms, the objectives of the commercialization process, the time it takes to reach these objectives, the importance assigned to the commercialization strategies, the financial activities related to commercialization, development costs, cooperative agreements established to commercialize innovations, intellectual property, and entrepreneur profile.

This survey targeted a sample of 2300 firms from the biotechnology and manufacturing sectors, including the ICT manufacturing sector. The response rate was 70%, which corresponds to 1610 firms. The sample was drawn from units that have introduced innovation(s) to the market or that have conducted R&D activities in 2005. The Business Register and the Survey of Innovation 2005 were used in the sampling process. According to Statistics Canada (2007), "quality assurance measures were implemented at each step of the data collection and processing cycle to monitor the quality of the data. These measures included the use of error detection programs and systematic edits and verification".

The survey covered all North American Industry Classification System (NAICS) at 3 digits of the manufacturing (from 311 to 339) and the biotechnology sectors. In the manufacturing industries, data were structured to cover the ICT manufacturing, and other manufacturing fields, which allows comparing these two groups. *ICT manufacturing* category included Computer and

Peripheral Equipment Manufacturing, Telephone Apparatus Manufacturing, Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing, Audio and Video Equipment Manufacturing, Semiconductor and Other Electronic Component Manufacturing, Manufacturing and Reproducing Magnetic and Optical Media, and Other Communications Equipment Manufacturing. The *other manufacturing* category covered a significant number of industries (see Appendix E), such as: food manufacturing, beverage and tobacco product manufacturing, textile mills, clothing manufacturing, plastics and rubber products manufacturing, chemical manufacturing, machinery manufacturing, transportation equipment manufacturing, furniture and related product manufacturing, and many other manufacturing industries.

Tables of data were provided by Statistics Canada as summaries, which were broken down into three size categories - small firms that have between 20 and 49 employees, medium-sized firms having between 50 and 249 employees, and large firms with 250 employees or more. Unexpectedly, researcher was not able to obtain raw data because of policy restrictions; only summary tables and some customized tables combining data obtained for a combination of questions were provided by Statistics Canada. Given the limited financial resources available to acquire the cross-tabulated data, only 16 custom tables were obtained. Each table combined the results of two questions, for one industry (either the ICT manufacturing, or the other manufacturing industries). So in total there were 8 combinations of questions for the ICT manufacturing industry, and another 8 for the other manufacturing industries that were covered. For each indicator, the standard error, and the reliability measures were provided. Data with a reliability indicator of F were too unreliable to be published, and therefore were not included in the analysis. The inability to obtain the raw data reduced significantly the ability to conduct further analyses beyond the tables provided. This could have led to a deeper analysis and richer findings of the commercialization landscape in Canada.

In order to analyze the data, estimates in each of the tables obtained are compared for different size categories and different industries covered by the questions. A report listing all the tables with the presentation and interpretation of the data was made. Then, these contents are grouped under five themes that are relevant to this study. These themes are generated based on the original structuring and the titles of the different sections of the questionnaire. These themes are: generation and commercialization of innovations, commercialization strategies,

commercialization financing, cooperative agreements on commercialization, and intellectual property. Under each of these themes, the tables and the presentation and interpretation of the data relevant to each theme are presented. The implications of the findings are discussed in Section 6 of the thesis.

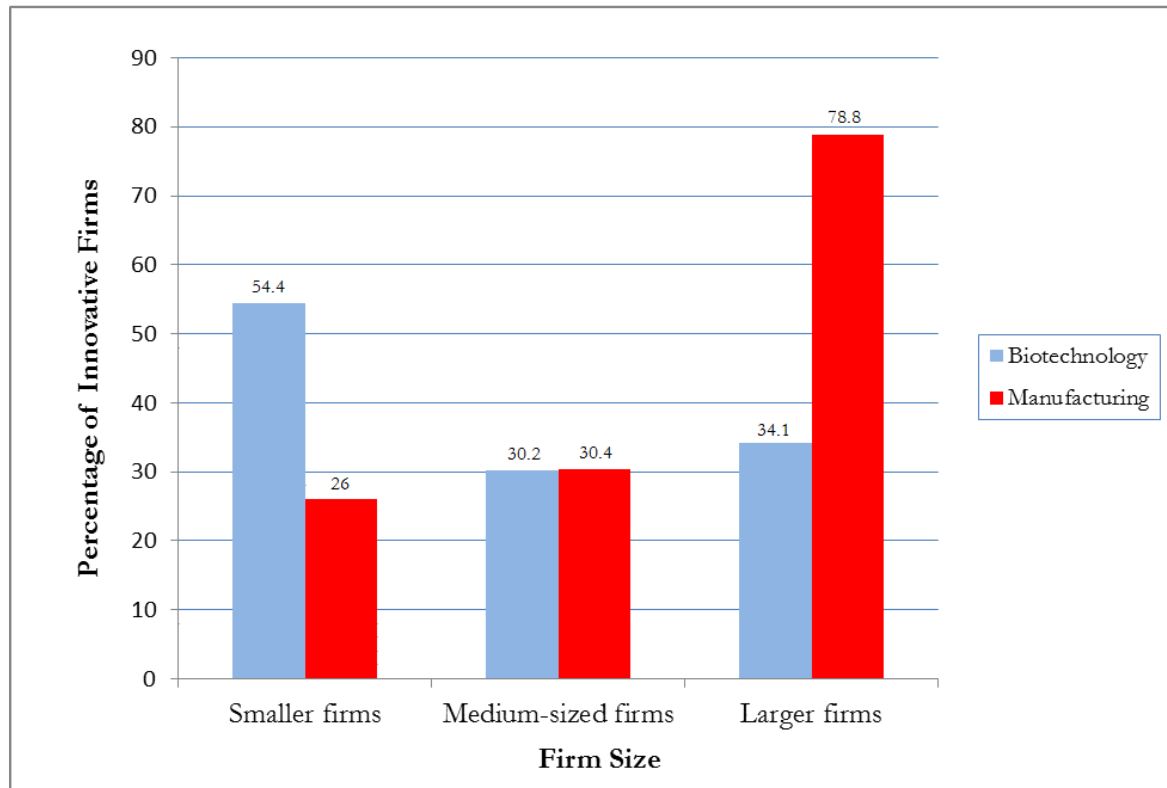
## SECTION 5 - ANALYSIS

### **5.1 Generation and Commercialization of Innovations**

*Innovators versus non-innovators:* Based on the data collected through the Survey on the Commercialization of Innovation, 2007, the percentage of biotechnology firms that introduced innovations to the market is the highest in the small firms' category (54.4%), followed by large firms (34.1%), then by medium-sized firms (30.2%) (Figure 1). In the manufacturing sector, the percentage of innovators (those that introduced innovations to the market between 2004 and 2007) compared to non-innovators is the highest in the large firms' category (78.8%), followed by medium-sized firms (30.4%), and then by small firms (26%). Based on this data, it looks that the effect of firm size on the ability of firms to introduce innovations to the market differs from one industry to another. In the manufacturing sector, data suggest that the larger the firm, the better the propensity to commercialize innovations. In the biotechnology sector, the relationship between firm size and innovation is different and does not follow a linear pattern.

*Industry difference:* Data also indicate that the percentage of small firms that are innovators is higher in the biotechnology sector, than the manufacturing sector (biotechnology: 54.4% and manufacturing: 26%). Whereas the percentage of medium-sized firms that are innovators in both sectors is very similar (biotechnology: 30.2% and manufacturing: 30.4%). And the percentage of large firms that are innovators in the manufacturing sector (78.8%) is substantially higher than those in the biotechnology sector (34.1%) (Figure 1). The analysis of the data suggests that larger firms are better able to innovate in the manufacturing sector, whereas smaller firms innovate more in the biotechnology sector than in the manufacturing sector. Medium-sized firms' ability to commercialize innovations seems to be the same in both sectors.

**Figure 1: Percentage of enterprises that introduced a new or significantly improved good or service to the market between 2004 and 2007, by firm size**



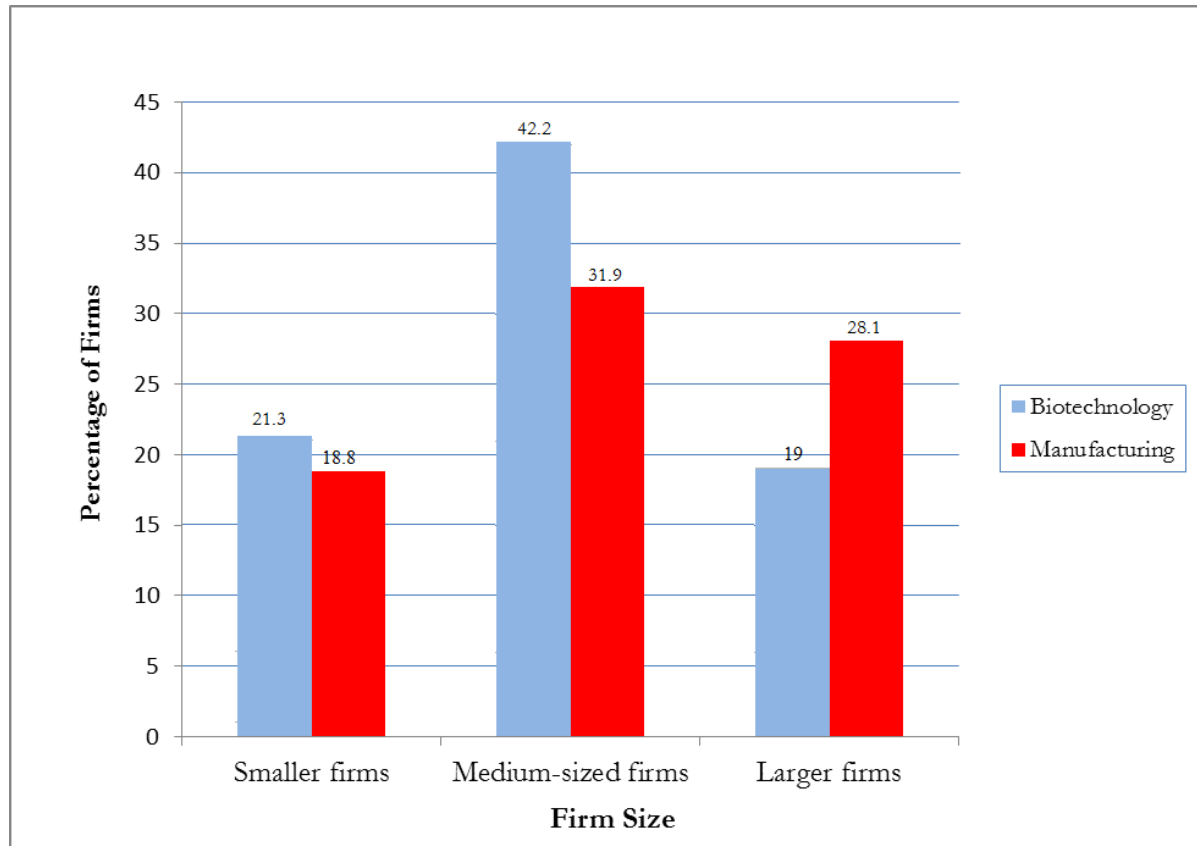
The data suggest that there should be a differentiation between small firms and medium-sized firms when comparing the characteristics affecting their ability to introduce innovations to the market (Figure 1). While the percentage of small biotechnology firms that were able to introduce new innovations to the market is the highest compared to firms from other size categories, medium-sized biotechnology firms' category had the lowest percentage of firms that were able to introduce innovations to the market. Therefore, the relationship in this case between firm size and innovation cannot be explained by simply arguing that there is a positive or a negative relationship between firm size and the ability of firms to introduce innovations; but it is more about the specific characteristics of each size category. Most of the existing literature targeting the relationship between firm size and innovation often combine small and medium-sized firms under the small and medium size enterprises (SMEs) category, which masks the specific characteristics allowing both medium-sized as well as small firms to innovate and commercialize innovations. Therefore, there is some evidence for considering medium-sized firms as a separate category in innovation and commercialization research.

The percentage of small biotechnology firms that were able to introduce innovations to the market is greater than that of firms from other size categories (Figure 1); this could be supported by the commitment and the need to generate innovations that small firms should have in order to survive; whereas larger firms need to innovate only to stay on the top of the market (Chaney, Devinney, and Winer; 1991). This could serve as an explanation of why the percentage of innovative small firms is greater than that of large firms. Traore (2004) also found that the flexibility that smaller firms have is an important factor that can offset the cost spreading advantage of large biotechnology firms, which could contribute to their innovation performance.

On the other hand, in the manufacturing sector, the percentage of large firms that are innovators is significantly greater than the percentage of innovators from other size categories (see Figure 1). This finding could be explained by the greater financial and technical capabilities that large firms have, compared to firms from other size categories (Herath, Cranfield, Henson, & Sparling, 2008). Whereas smaller firms are at a disadvantage because of the lack of the required complementary assets to take their technologies to market, as well as the lack of manufacturing capabilities (Shane & Stuart, 2002).

*Number of innovations:* When it comes to the number of innovations that innovators have introduced to the market, the percentage of medium-sized firms from the biotechnology sector (42.2%) and from the manufacturing sector (31.9%) that were able to introduce a high number of innovations (8 or more), is the highest compared to small firms (21.3% in the biotechnology sector and 18.8% in the manufacturing sector), and large firms (19% in the biotechnology sector and 28.1% in the manufacturing sector) (see Figure 2). This highlights the capability of innovative medium-sized firms to introduce a higher number of innovations compared to smaller and larger firms in both the manufacturing and biotechnology sectors.

**Figure 2: Percentage of firms that introduced 8 or more new or significantly improved good or service to the market between 2004 and 2007, by firm size**

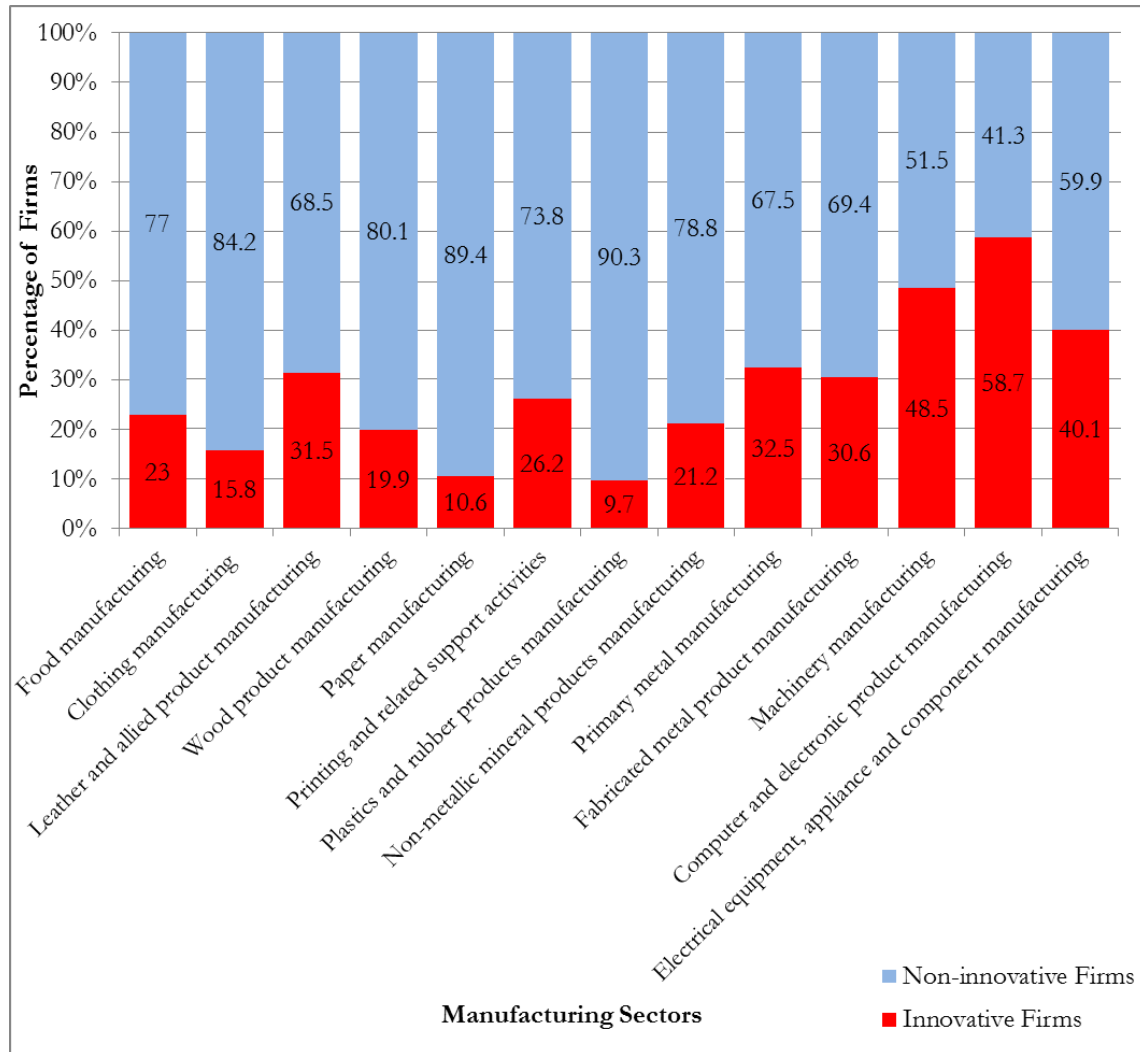


Despite the lower percentage of medium-sized innovators compared to large firms in the manufacturing sector, and to large and small firms in the biotechnology sector (Figure 1), the ability of medium-sized innovators to introduce higher numbers of innovations exceeds that of firms from other size categories in both the biotechnology and the manufacturing sectors (Figure 2). So if the evaluation of the innovative capacities of firms is based on the output of their innovation process in terms of the number of innovations they introduce to the market, successful (innovators) medium-sized firms show a better ability to innovate than other firms. This aspect can support the argument stating that the transition of medium-sized firms from not being innovators (not introducing any innovations to the market) to being able to innovate could lead to improving Canada's innovation performance, given the high number of innovations that innovative medium-sized firms are able to bring to the market, compared to small and large firms in both the biotechnology and manufacturing sectors. King, Covin, and Hegarty (2003), argue that when it comes to the frequency of innovations introduced to the market, and firm size, small firms adopt strategic controls, which is associated with increased

R&D spending and more frequent product introductions, whereas large firms adopt financial controls which are associated with risk aversion and decreased R&D spending. But the data indicate that the percentage of medium-sized firms that introduced 8 or more innovations is higher than that of small or large firms (Figure 2), followed by small then by large firms in the biotechnology sector, and by large firms then small firms in the manufacturing sector. Therefore, this supports the importance of considering medium-sized firms as a separate category when studying innovation. Small firms are different than medium-sized firms, and combining them under one category could lead to biased findings.

Within the manufacturing sector, firms from the computer and electronic products manufacturing industry show a higher ability to generate innovations (58.7% innovators and 41.3% non-innovators) compared to firms from other sectors. Whereas other traditional fields, such as the plastics and rubber product manufacturing industry (9.7% innovators and 90.3% non-innovators), show a lower percentage of innovators compared to non-innovators firms (see Figure 3). The computer and electronics product manufacturing industry is part of the ICT sector. And as Butje (2005) explains, the ICT market changes faster than any other market sector and ICT products become out of date by the introduction of newer technologies at a faster rate than in any other industry. This could explain why computer and electronic product manufacturing firms are more motivated to introduce innovations to the market compared to firms from other industries, in order to survive in the changing environment in which they operate.

**Figure 3: Percentage of firms that introduced a new or significantly improved good or service to the market (innovative firms), and those that did not introduce any innovations to the market (non-innovative firms), between 2004 and 2007, by manufacturing industries**



*Time-to-Market:* Compared to other size categories, medium-sized firms from the biotechnology sector show a strong ability to introduce innovations to the market in a significantly shorter period of time. On average, the time it takes medium-sized firms to introduce innovations to the market is 8.6 months, compared to 17.4 months for large firms, and 17.5 months for small firms.

**Table 3: Time it takes to introduce the most significant and recent product innovations to the market, in the biotechnology sector, by firm size**

<b>Firm Size</b>	<b>Average months</b>	<b>Standard Error</b>
Smaller Firms	17.5	5.3
Medium-sized Firms	8.6	13.5
Larger Firms	17.4	12.3
<b>All sizes</b>	<b>16.5</b>	4.9

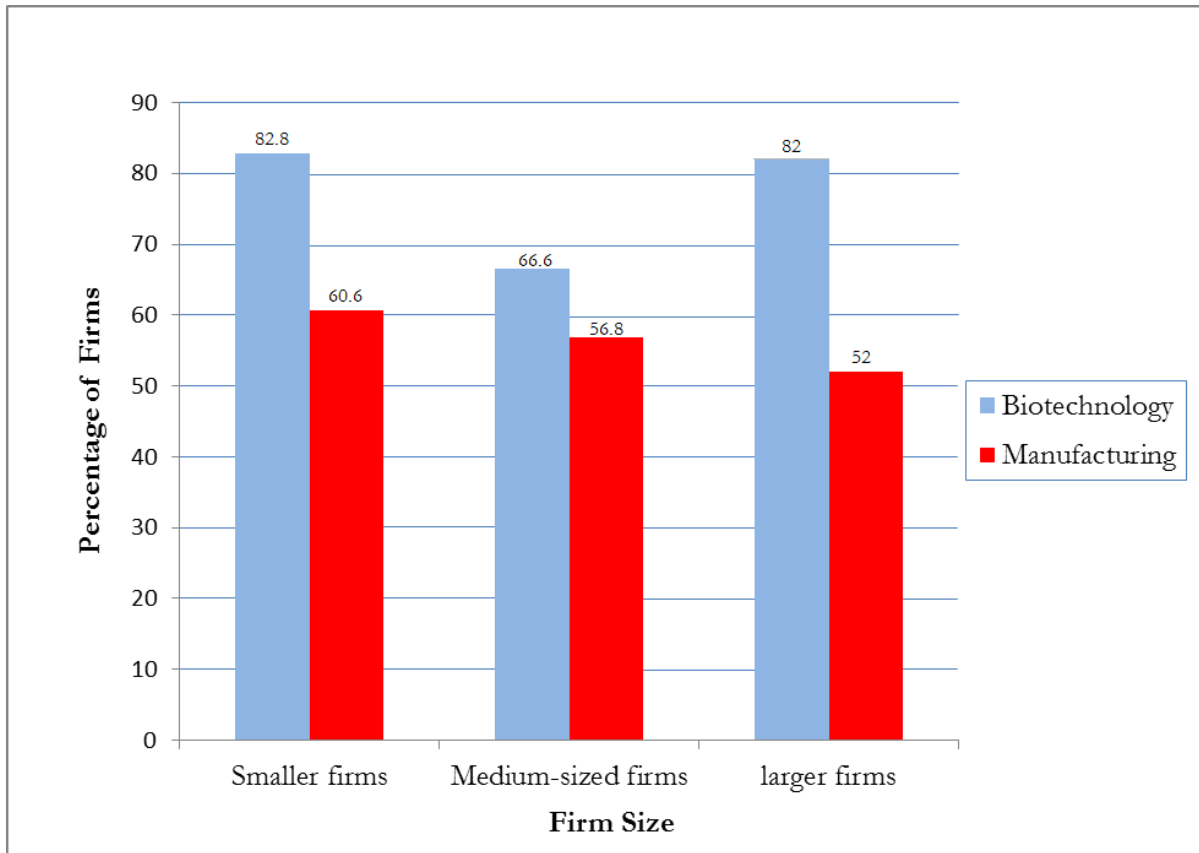
Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

An observation that outlines the innovativeness of medium-sized firms from the biotechnology sector is their ability to introduce innovations to the market in a significantly shorter period of time compared to firms from other size categories (see Table 3). This finding confirms Munn-Venn and Mitchell's (2005) argument stating that medium-sized firms are able to commercialize their products more quickly. They explain that this is the case because they are global players, export-focused, and innovative (Munn-Venn & Mitchell, 2005).

*“New to the market” innovations:* Another aspect that was covered by the Survey on the Commercialization of Innovation (2007) is the type of innovations that the participating firms have introduced to the market. Based on the data available (Figure 4) the following observations were derived:

1. The percentages of biotechnology firms from all size categories that introduced innovations that they considered new to the market are greater than those of firms from the manufacturing industry (see Figure 4).
2. The percentage of small (82.8%) and large (82%) biotechnology firms that introduced innovations that are new to the market is greater than that of medium-sized firms (66.6%).
3. In the manufacturing sector, the percentage of medium-sized firms (56.8%) that introduced innovations that they considered new to the market is greater than that of larger firms (52%), but falls short compared to smaller firms (60.6%).

**Figure 4: Percentage of enterprises that indicated that their most significant and recent product innovation was new to the market, by firm size**



Previous studies that targeted the relationship between firm size and the newness of innovations introduced into the market did not derive a common conclusion regarding this subject. For instance, in a study that was conducted by the Organization for Economic Cooperation and Development (OECD) in 2009, it was found that generally, small and medium-sized enterprises (SMEs) are less likely to introduce “novel” innovations and that large firms tend to introduce more “novel” innovations than SMEs. Novel innovations in the previously mentioned study point to innovations that are new to the market or that are new to the world. On the other hand, Janne and Frenz (2007, p. 16) argue that “there is no association between enterprise size and new-to-market innovators”. Based on the Survey on the Commercialization of Innovations, in the manufacturing industry, data illustrate an inverse relationship between the percentage of firms that indicated that their innovations were new to the market and firm size. In the biotechnology industry, small firms are also more likely to introduce innovations that are new to the market, followed by larger firms (with a tiny difference) and then by medium-sized firms (see Figure 4). So in both industries (biotechnology and manufacturing), small firms are more likely

to generate new to the market innovations. The differences between the different studies in terms of the conclusions regarding the relationship between firm size and the ability to introduce new-to-market innovations could be explained by the difference between the industries that each study target. For instance, Janne and Frenz (2007) based their conclusions on the analysis of data that covers all manufacturing and most private service sectors. Whereas, the data collected in this survey cover the biotechnology and manufacturing industries. This also could be explained by the focus of larger firms on exploiting their existing innovations, whereas smaller firms tend to focus more on exploration activities.

*Regular clients:* The Survey on the Commercialization of Innovation (2007) contained a question regarding the regular clients of the participating firms. In the biotechnology sector, other enterprises are identified as being regular clients by 51.1% of small firms, followed by distributors and wholesalers for 50% of small biotechnology firms, and individual consumers for 40% of small biotechnology firms. For medium-sized biotechnology firms, distributors and wholesalers are identified as being regular clients by 47.4% of firms, followed by retail for 36.7% of firms, and other enterprises for 33.4% of firms. For large biotechnology firms, distributors and wholesalers are identified as being regular clients by most of the firms (81%), followed by individual consumers (60%) and retail for 40% of large biotechnology firms.

In the manufacturing sector, other enterprises are identified as being regular clients by 62.3% of small firms, followed by distributors and wholesalers for 49.1% of small firms. For medium-sized manufacturing firms, other enterprises are identified as being regular clients by 54.6% of firms, followed by distributors and wholesalers for 42.7% of firms, and retail for 32% of firms. For large manufacturing firms, other enterprises are identified as being regular clients by 66.6% of firms, followed by distributors and wholesalers by 36.2%, and retail by 33.8% of large manufacturing firms.

To summarize, small firms from both sectors rely mainly on other enterprises, followed by distributors and wholesalers, as regular customers for their innovations. Medium-sized biotechnology firms indicated mostly distributors and wholesalers as their regular customers. Whereas medium-sized manufacturing firms indicated mostly that their regular customers are other enterprises, followed by distributors and wholesalers. Large biotechnology firms identified their regular customers as being mostly distributors and wholesalers, followed by individual

consumers. Mostly, large manufacturing firms identified their regular clients as being other enterprises, followed less significantly by distributors and wholesalers, and by retail (Table 4).

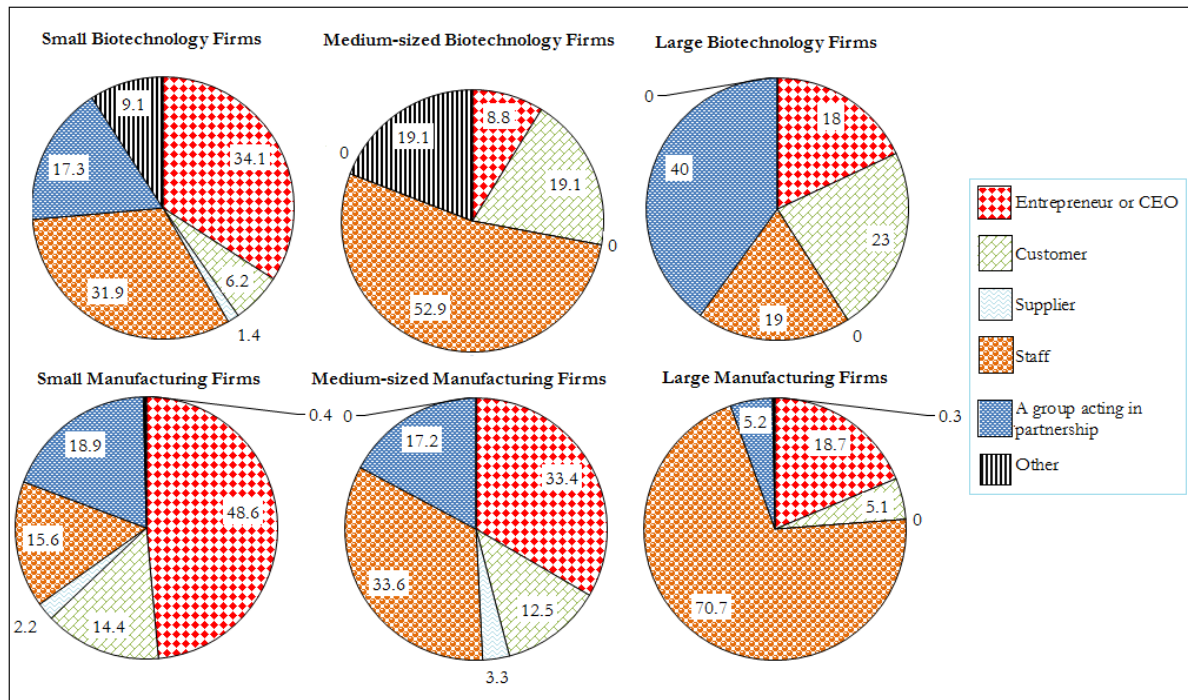
**Table 4: Regular clients for each size category, in the biotechnology and manufacturing sectors**

	<b>Regular Clients</b>	<b>Biotechnology Firms</b>	<b>Manufacturing Firms</b>
<b>Smaller Firms</b>	Other enterprises	51.1	62.3
	Distributors or wholesalers	50.0	49.1
	Retail	11.0	24.0
	Individual consumers	40.0	20.7
	Other	16.0	4.4
<b>Medium-sized Firms</b>	Other enterprises	33.4	54.6
	Distributors or wholesalers	47.4	42.7
	Retail	36.7	32.0
	Individual consumers	0.0	9.7
	Other	0.0	9.1
<b>Larger Firms</b>	Other enterprises	23.0	66.6
	Distributors or wholesalers	81.0	36.2
	Retail	40.0	33.8
	Individual consumers	60.0	5.3
	Other	23.0	5.4

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

*Idea generation:* In both the biotechnology and manufacturing sectors, most of the ideas or concepts for innovations in small firms are primarily generated by these firms' CEOs/entrepreneurs. In medium-sized biotechnology and manufacturing firms, innovation ideas or concepts are mainly generated by the staff and CEOs. In large biotechnology and manufacturing firms, innovation ideas or concepts are mainly generated by the staff (see Figure 5).

**Figure 5: Person or group responsible for the idea or concept for the most significant and recent product innovation, for each size category, in the biotechnology and manufacturing sectors**



The analysis shows that in small firms the experience and the qualifications of the CEO or entrepreneur are central to the generation of these firms’ innovations. An important factor to consider under such conditions (where CEO or entrepreneur generates most of the ideas and concepts for innovation) is the lower motivation and willingness of employees to contribute to the generation of ideas or to questioning or challenging these ideas. Employees’ involvement in the generation of innovation ideas and concepts could be of a great importance for improving the quality of these ideas. When the entrepreneur or CEO is the main source of ideas or concepts used to generate innovations, it would be expected that the involvement of employees will be very limited, and the likelihood of them providing feedback to propose improvements or corrections will not be as high as if a colleague was the source of the idea. This could be seen as a factor inhibiting the quality of innovations’ ideas and concepts.

On the other hand, medium-sized and large firms from both the biotechnology and manufacturing industries tend to involve their staff in the generation of these ideas/concepts; which highlights the importance of having the appropriate climate and conditions for the staff to innovate. Sauer mann (2008, p. 75) argue that “the motives of R&D employees, and the way

in which those motives are managed, can play an important role in affecting innovative processes and performance”. Therefore, these firms should attribute a great importance to establishing a culture where employees have challenging work and responsibilities. Having a good system of remuneration could also play an important role in improving the performance of the employees, and therefore the performance of the firm, given that these employees are the main source of the ideas and concepts of innovations. And in order to achieve a superior innovative performance, these firms should ensure to have a “mix of individuals with different motives, who are exposed to a range of incentives and broader research and professional environments that will vary across the demands of different tasks” (Sauer mann, 2008, p. 78).

To summarize this section, the data demonstrate that there should be a differentiation between small and medium-sized firms as the difference between these two firm-size categories could be even more significant than the difference between small and large firms (see Figure 1). Medium-sized innovators are found to be able to introduce higher numbers of innovations compared to smaller and larger firms. In the biotechnology sector, medium-sized firms are found to be better able to introduce innovations to the market in shorter periods of time.

## **5.2 Commercialization Strategies**

The Survey on the Commercialization of Innovation (2007) covered the commercialization strategies adopted by firms. The questions covered the commercialization activities carried out by firms, both in Canada and abroad, the extent to which firms have reached their commercialization objectives, the strategies they have used to commercialize innovations and the importance they attribute to each of these commercialization strategies, and the costs they have incurred in advertising, promoting and distributing innovations, relatively to development costs.

*Commercialization activities:* The data indicate that the percentage of medium-sized biotechnology firms that carried out many commercialization activities in Canada, such as promoting their products through advertising (72.1%), establishing product research agreements (42.2%), providing training on how to market the product (80.9%), and conducting research and development activities (91.2%) is higher than those of smaller and larger firms from the same

industry. However, they (medium-sized biotechnology firms) lag behind other firms in terms of conducting market research in Canada. Also, a higher percentage of medium-sized biotechnology firms (compared to larger and smaller firms) carried out many commercialization activities abroad; such as, promoting their products through advertising (52.9%), product positioning (61.7%), conducting market research (52.9%), providing training on how to market the product (52.9%), conducting campaigns to recruit personnel specialized in commercialization (23.1%), and providing customer specific services (46.2%) (Figures 6 and 7).

Both small and medium-sized biotechnology firms showed a higher tendency than larger firms to provide customer-specific services both in Canada and abroad. The Council of Canadian Academies argues that Canadian businesses are less customer-oriented than firms in other countries, such as the United States. This lack of customer orientation could be seen as one of the factors explaining the commercialization problem of Canadian innovations. Baldwin (2000) argues that SMEs outperform larger firms in terms of their customer-oriented focus, which is supported by the higher percentages of smaller and medium-sized firms compared to larger firms in terms of providing customer-specific services (Figures 6 and 7).

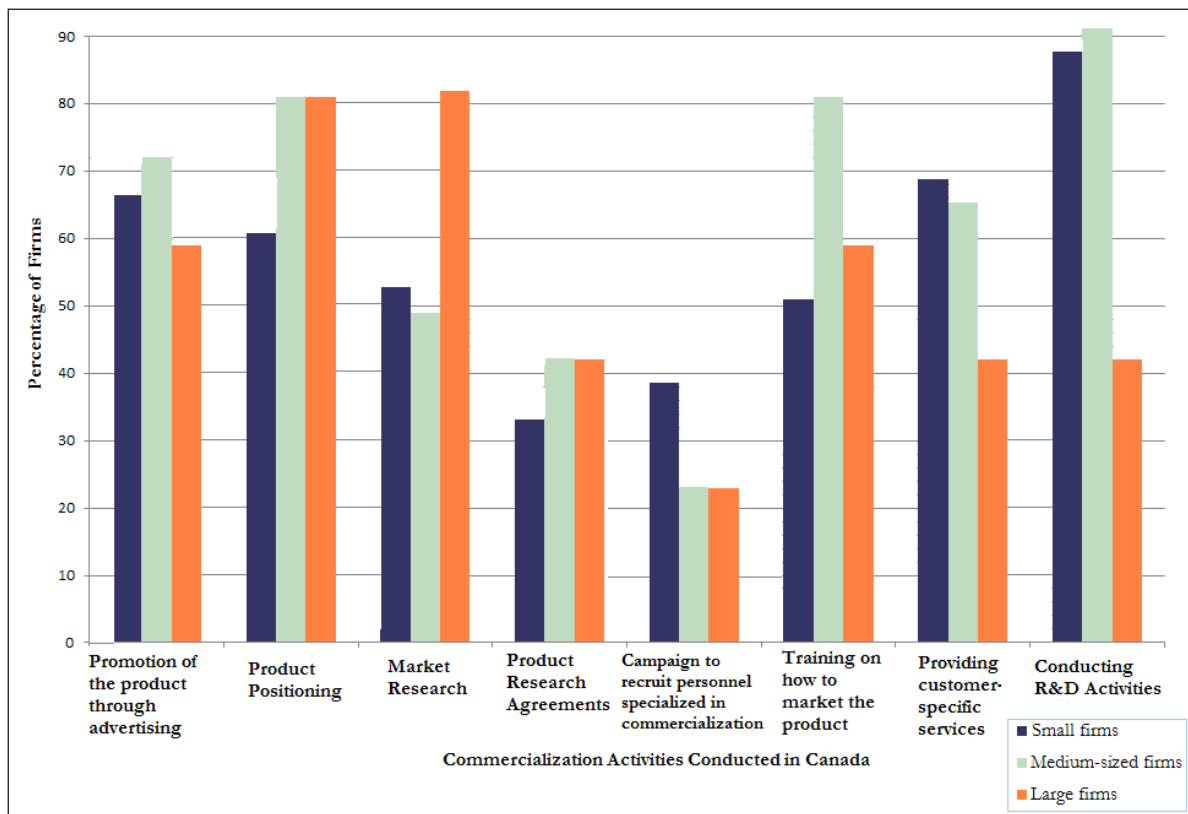
The strategies adopted by medium-sized biotechnology firms in performing commercialization activities outline the importance of the human resources aspect in the commercialization process; therefore, they generally tend to provide training to their employees on how to market their innovations more than smaller and larger firms (Figures 6 and 7). In many studies (Statistics Canada, 2010; Expert Panel on Commercialization's report, 2006; Guthrie & Munn-Venn, 2005), skills development was identified as being a crucial element to improve Canada's innovation and commercialization performance. And by outperforming smaller and larger firms in providing training to their employees on how to market innovations, medium-sized biotechnology firms show a better propensity and commitment to invest in developing their employees' marketing skills, thus improving the conditions needed to succeed in commercializing innovations.

Based on the data related to the commercialization strategies adopted by firms, many observations were derived. Medium-sized firms from different industries show a stronger ability to conduct many commercialization activities compared to smaller and larger firms. The data demonstrate that medium-sized firms have the necessary capabilities to conduct commercialization activities both abroad and in Canada (see Figures 6, 7, 8 and 9). Medium-

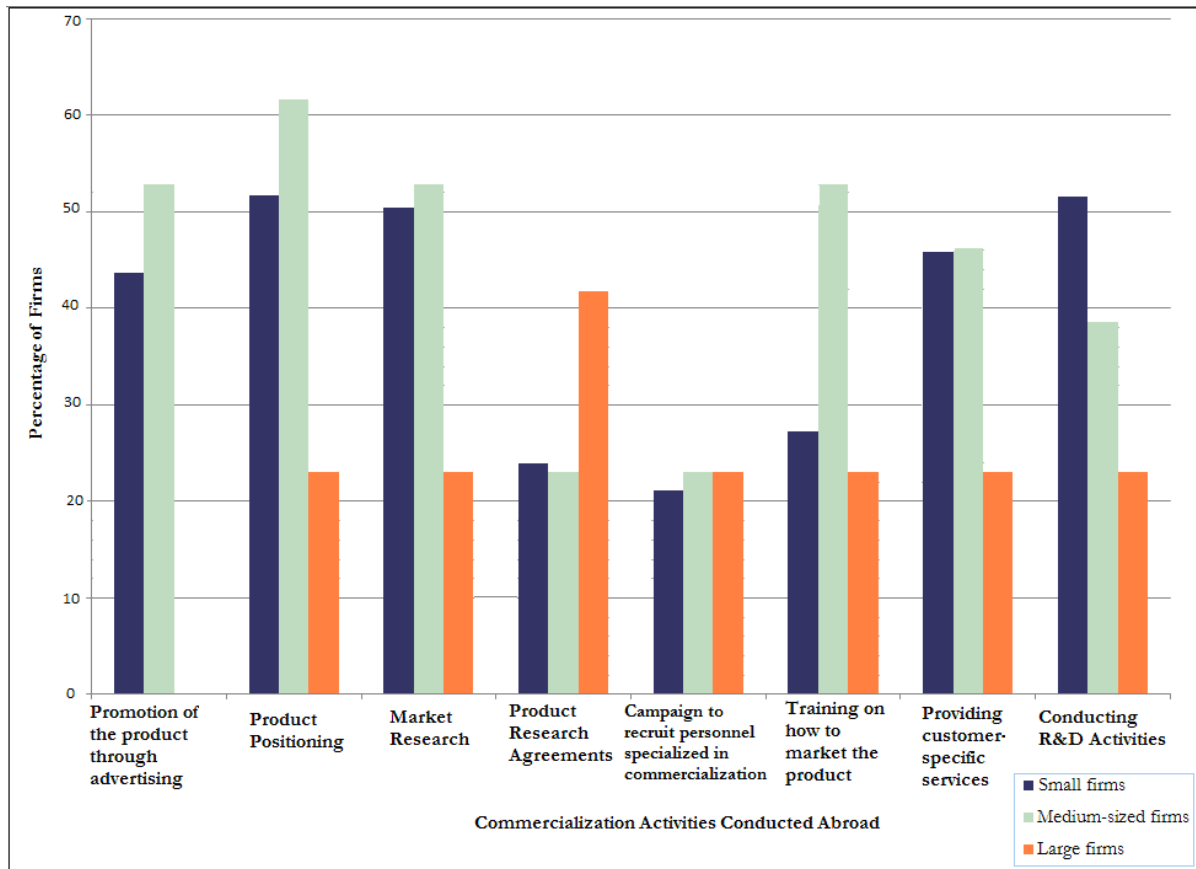
sized firms have surpassed smaller and larger firms when it comes to the percentage of firms that conducted many commercialization activities, such as, promoting their products through advertising, among others. Conducting these activities outlines the commitment that these firms have and the resources that they devote to commercialize their innovations.

Another observation relates to the ability of medium-sized enterprises to surpass smaller and larger firms in terms of the percentage of firms that conducted activities that are absolutely essential to developing an integrated business. Medium-sized firms outperformed smaller and larger firms in conducting activities from different phases of the innovation process, from conducting research and development activities, to promoting their products through advertising or via a website, and positioning their products. According to Kohli and Leuthesser (1993), product positioning refers to the act of designing the image of the product offered by the firm in order for the client to appreciate it and know what it stands for compared to its competitors.

**Figure 6: Percentage of biotechnology enterprises that carried out commercialization activities in Canada for their most significant and recent innovations**

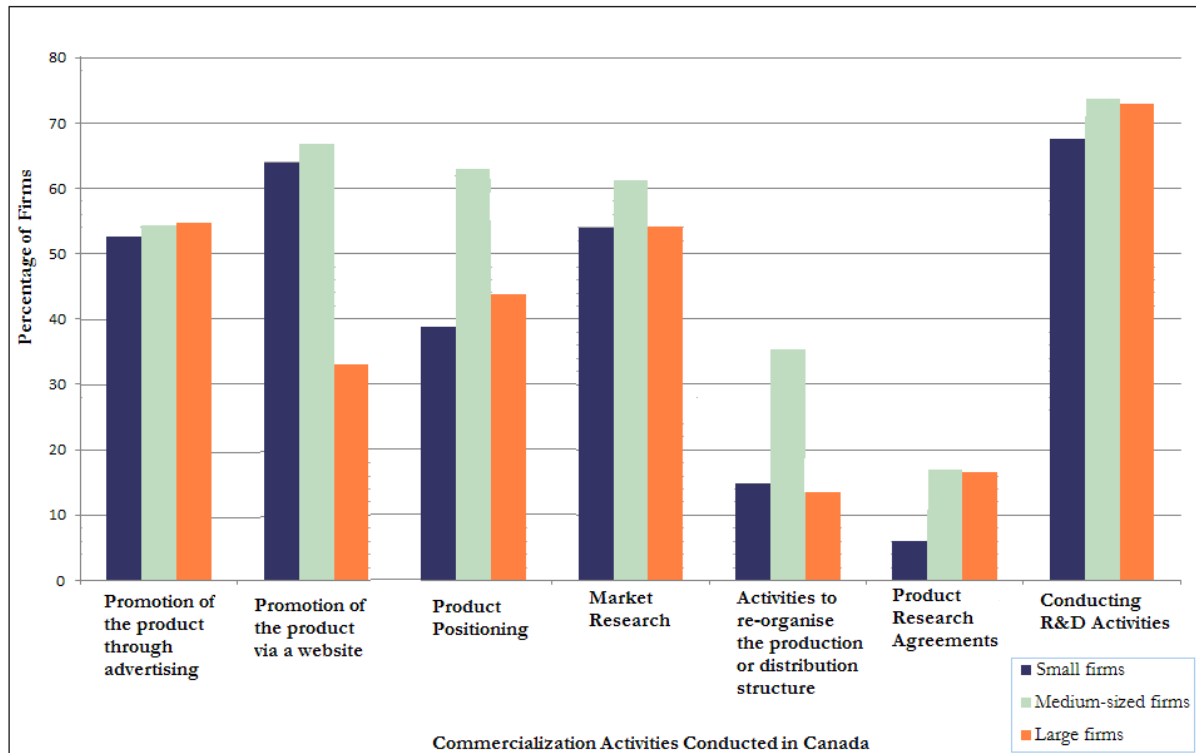


**Figure 7: Percentage of biotechnology enterprises that carried out commercialization activities abroad for their most significant and recent innovations**

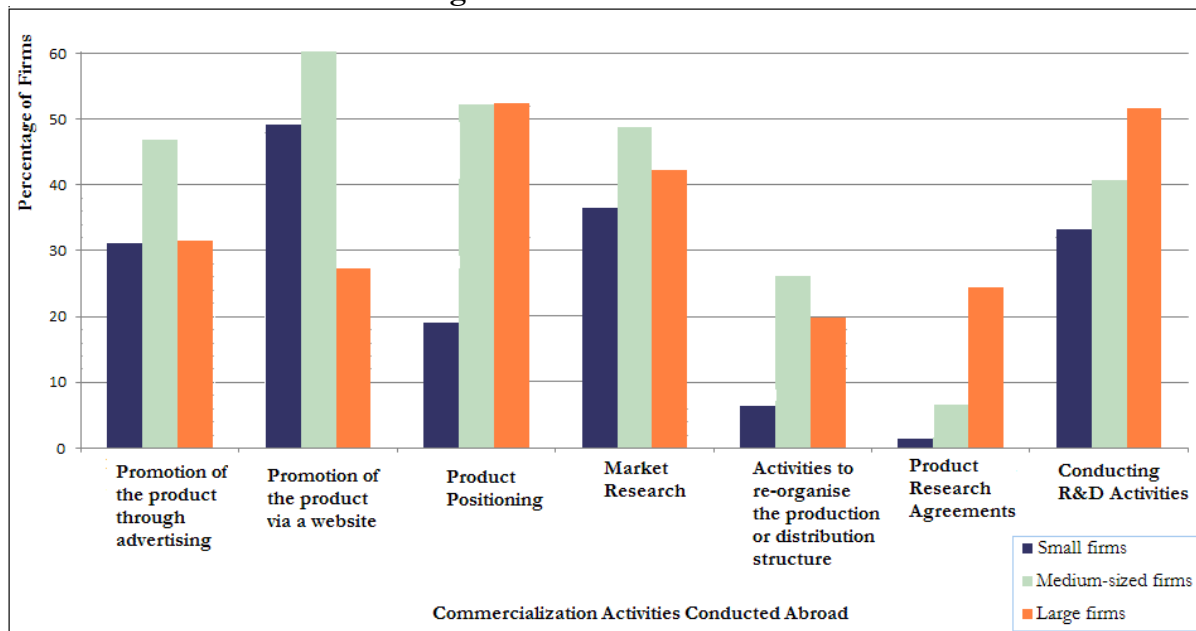


Medium-sized firms from the manufacturing industry showed a higher tendency than smaller and larger firms to conduct many commercialization activities in Canada such as, promoting the product via a website, product positioning, conducting market research, establishing product research agreements, and conducting research and development activities. As well, they have outperformed larger and smaller firms in conducting the following commercialization activities abroad: promoting their products through advertising, promoting their product through a website, conducting market research, and performing activities to reorganize their production or distribution structure. The percentage of medium-sized manufacturing firms that promoted their products in Canada through advertising, or that carried out product positioning activities abroad is higher than that of small firms, and very close (slightly lower) to the percentage of larger firms that conducted these activities (see Figures 8 and 9).

**Figure 8: Percentage of manufacturing enterprises that carried out commercialization activities in Canada for their most significant and recent innovations**



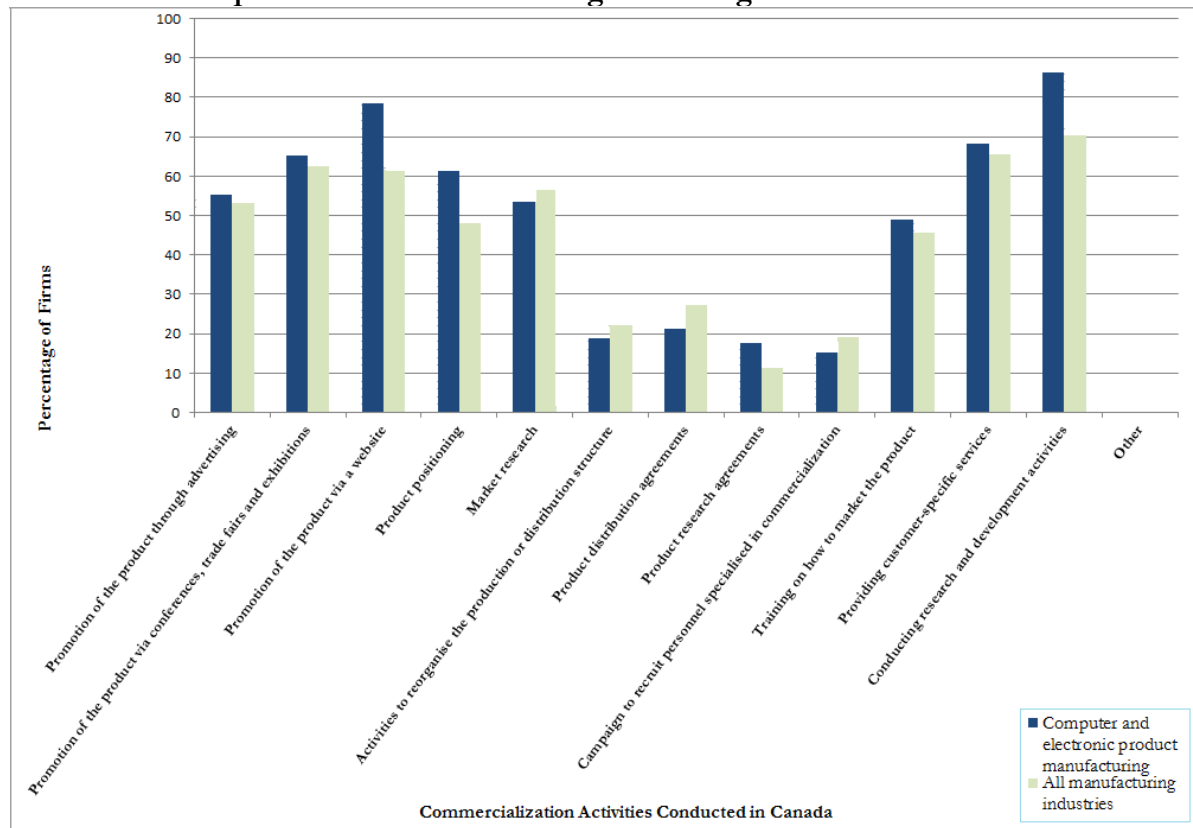
**Figure 9: Percentage of manufacturing enterprises that carried out commercialization activities abroad for their most significant and recent innovations**



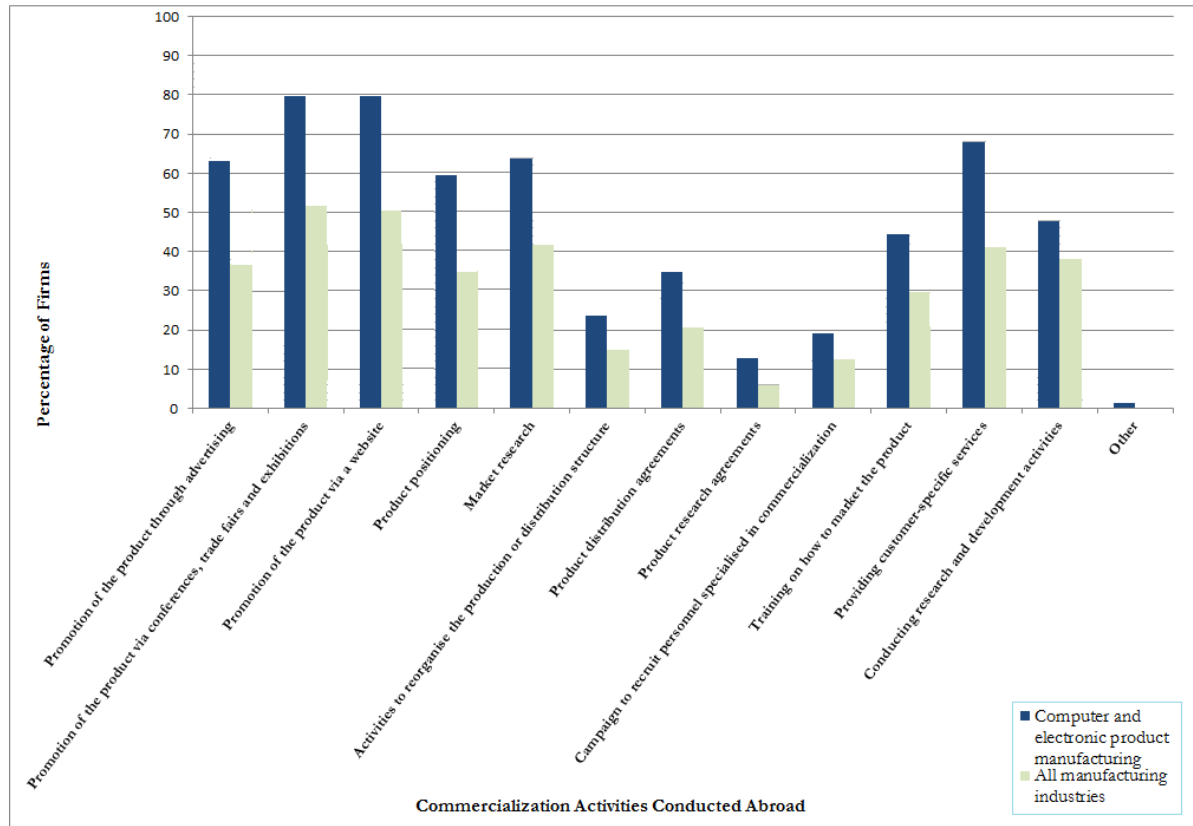
In the manufacturing industry, computer and electronic product manufacturing firms showed a higher tendency than the average of the respondents from the manufacturing firms to perform

most of the commercialization activities indicated in the survey (except for performing the following activities in Canada: conducting market research, performing activities to reorganise the production or distribution structure, establishing product distribution agreements, and conducting a campaign to recruit personnel specialised in commercialization) (Figures 10 and 11). The higher tendency of computer and electronic product manufacturing firms to perform commercialization activities compared to other manufacturing industries is an indication of their commitment to devote the necessary resources to conduct these activities. This also indicates the higher ability of computer and electronic product manufacturing firms to insert themselves into the global system of production and distribution, compared to firms from other industries. In order to be able to compete at the international arena, being able to perform well at the global level and not being limited to the domestic market are key. Computer and electronic product manufacturing firms also show a higher tendency than firms from other industries in terms of conducting activities that cover the innovation process from research and development to commercialization.

**Figure 10: Percentage of computer and electronic product manufacturing firms that carried out commercialization activities in Canada for their most significant and recent innovations compared to the manufacturing sector in general**



**Figure 11: Percentage of computer and electronic product manufacturing firms that carried out commercialization activities abroad for their most significant and recent innovations compared to the manufacturing sector in general**

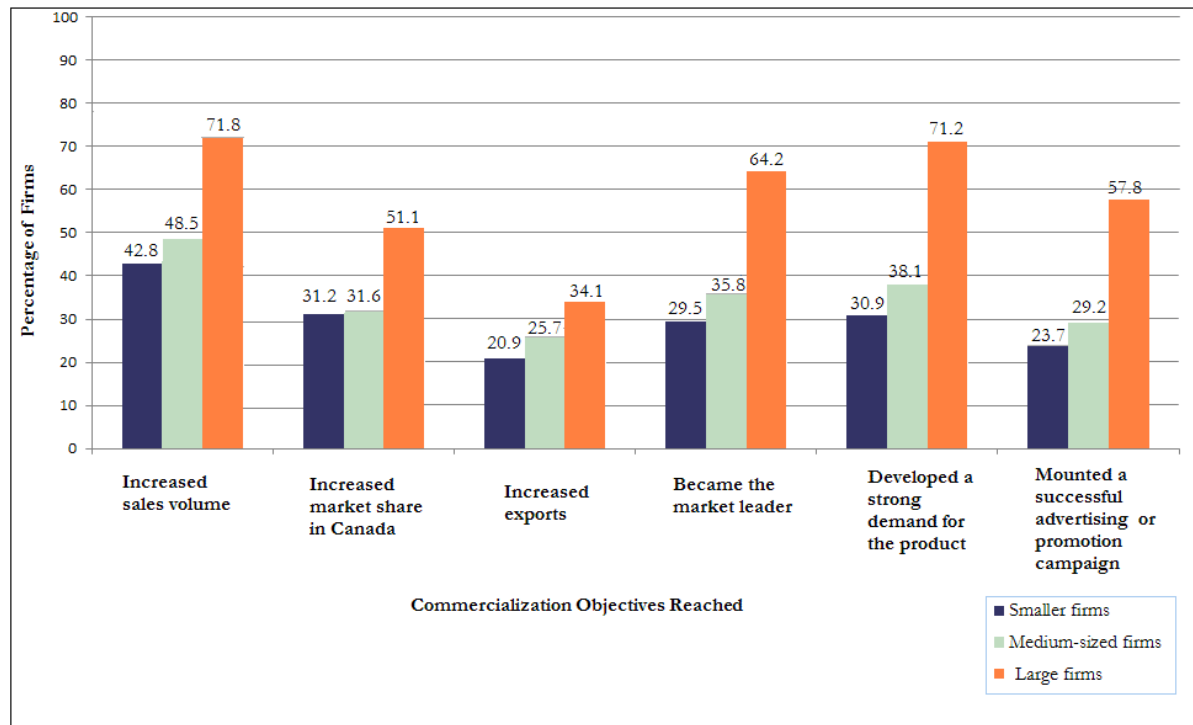


*Commercialization objectives:* Respondents were asked to indicate the extent to which they have reached their commercialization objectives for their most recent and significant product innovation(s). A list of commercialization objectives was presented, including investment costs recovery, sales volume increase, Canadian market share increase, exports increase, among others.

In the manufacturing sector, the percentage of enterprises that reached their commercialization objectives tends to increase with the increase of the size of firms for the following commercialization objectives: increase in sales volume, increase of market share in Canada, increase in exports, becoming market leader, developing a strong demand for products, and mounting a successful advertising or promotion campaign. A positive linear relationship between firm size and reaching commercialization objectives is revealed; the percentage of large manufacturing firms that succeeded in reaching their commercialization objectives exceeded that

of medium-sized firms, and the percentage of medium-sized firms exceeded that of smaller firms (Figure 12).

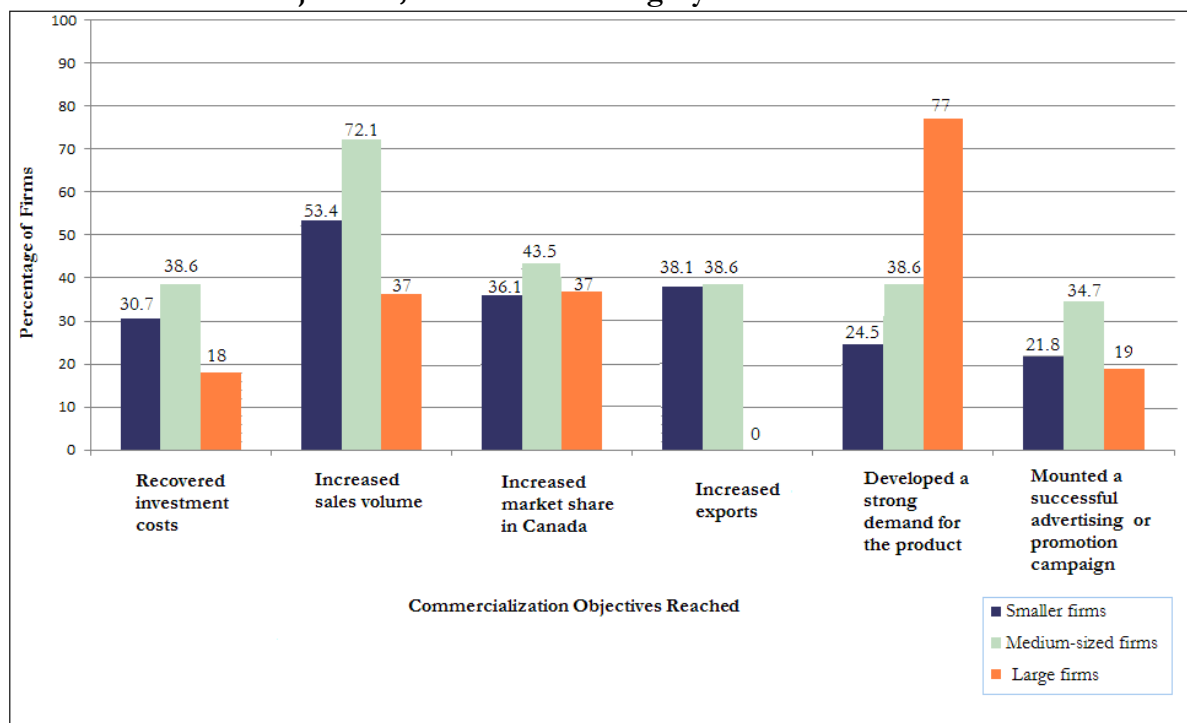
**Figure 12: Percentage of manufacturing enterprises that reached or exceeded their commercialization objectives, for each size category**



Based on the data, it becomes evident that conducting more commercialization activities does not necessarily result in achieving commercialization objectives. For instance, in the manufacturing industry, although medium-sized firms outperformed their smaller and larger counterparts in conducting many commercialization activities, they lagged behind larger firms in reaching their commercialization objectives. In the manufacturing industry, the ability of firms to reach their commercialization objectives seemed to increase with the increase of the size of firms for many commercialization objectives such as increasing sales volumes, increasing market share in Canada, increasing the exports, becoming a market leader, developing a strong demand for products, and mounting a successful advertising or promotion campaign. This could be explained by many factors, especially by the resource advantages that large firms have compared to smaller ones, such as capital, distribution channels and sales force strength (Roberts, 1980). So in general, large firms could be viewed as having greater marketing, sales, distribution, financial, and/or managerial resources than small firms (Alvarez & Barney, 2001), which can contribute to explaining their success in reaching their commercialization objectives.

Data also demonstrate that the picture is different in the biotechnology sector, and that there is no specific relationship between firm size and reaching commercialization objectives that could be identified. Overall, medium-sized biotechnology firms did better than firms from other size-categories in terms of many success criteria related to their ability to reach their commercialization objectives, such as, investment costs recovery, sales volume increase, Canadian market share increase, exports increase, and mounting a successful advertising and promotion campaign (see Figure 13).

**Figure 13: Percentage of biotechnology enterprises that reached or exceeded their commercialization objectives, for each size category**



Medium-sized biotechnology firms generally outperformed their smaller and larger counterparts in terms of the percentage of firms that conducted many of the commercialization activities listed in the survey (Figures 6 and 7). As well, it is evident that the efforts and commitment that these firms devoted to commercialize their innovations translated into a success, compared to small and large firms, in reaching their commercialization objectives. So in the biotechnology industry, the commercialization systems of medium-sized firms succeeded in reaching their commercialization objectives through the commercialization activities that they perform (Figure 13). These objectives include investment costs recovery, sales volume increase, Canadian market

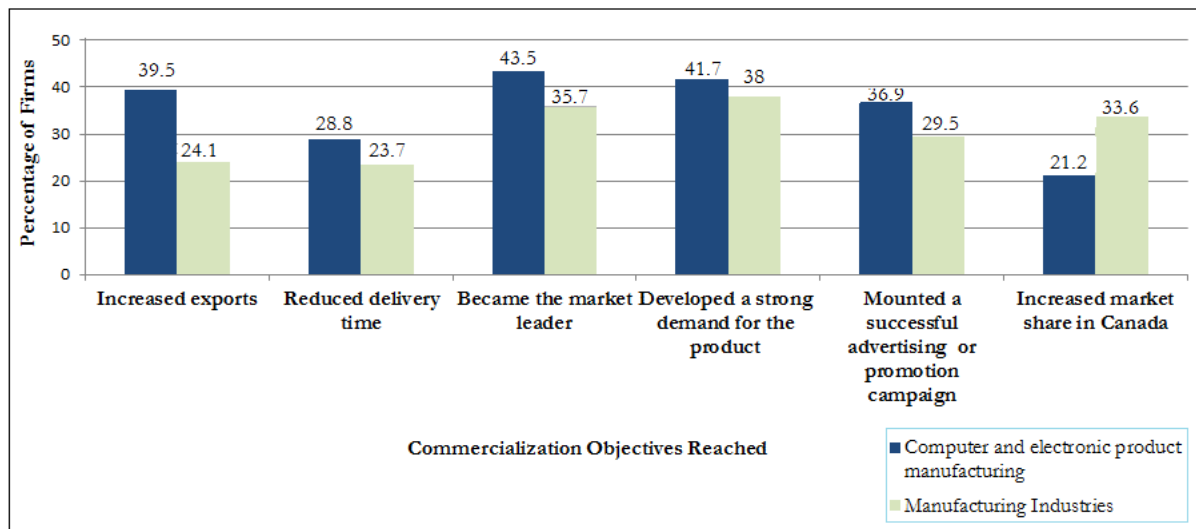
share increase, exports increase, and mounting successful advertising and promotion campaigns (see Figure 13).

Within the manufacturing sector, the percentage of firms from the computer and electronic manufacturing industry that succeeded in increasing their exports, reducing delivery time, becoming a market leader, developing a strong demand for the product, and mounting a successful advertising campaign, exceeded the percentage of manufacturing firms that reached these objectives (see Figure 14). When it comes to other commercialization objectives, such as increasing products' market share in Canada, computer and electronic product manufacturing firms did not perform well in reaching these objectives.

In general, computer and electronic product manufacturing firms did better than firms from other manufacturing industries in reaching most of their commercialization objectives (see Figure 14). Therefore, even though no specific conclusions could be made at this point regarding any specific size category's commercialization performance, but the electronic and computer manufacturing industry demonstrates a strong ability to reach most of the commercialization objectives listed on the questionnaire. It is important to note that the computer and electronic manufacturing industry does not perform well compared to the biotechnology industry and to other manufacturing industries in terms of increasing their sales volumes and their market share. Further, the data show that there are many commercialization activities that if conducted both abroad or in Canada could improve the ability of ICT firms to reach their commercialization objectives (Tables 5 and 6). These activities include conducting market research, product positioning, promoting products through advertising, and promoting products via a website. As the computer and electronic product manufacturing firms (which are part of the ICT sector) lag behind firms from other manufacturing industries in terms of conducting market research in Canada, which is one of the important activities associated with the ability of ICT firms to reach their commercialization objectives, this could represent one of the reasons affecting ICT firms' performance in meeting these objectives. Despite that computer and electronic product manufacturing firms lag behind firms from the manufacturing industry in general in performing market research in Canada, they outperform them in conducting market research abroad (Figures 10 and 11), which could be due to their strong focus on foreign markets, more than the relatively small Canadian domestic market.

In general, firms from the computer and electronic product manufacturing industry showed a higher tendency than firms from other manufacturing industries to perform most of the commercialization activities (Figures 10 and 11) that were found to be positively associated with the success of firms in reaching their commercialization objectives in the ICT sector, such as advertising, promoting products via a website, and product positioning (Tables 5 and 6).

**Figure 14: Percentage of computer and electronic product manufacturing enterprises that reached or exceeded their commercialization objectives, compared to the manufacturing sector in general**



As for conducting commercialization activities in Canada, the data show that most of the firms that succeeded in reaching their commercialization objectives, promoted their innovation(s) through a website. Promoting the product through advertising, product positioning and conducting market research also tend to positively impact the ability of ICT firms to reach their commercialization objectives. For instance, 76% of ICT firms that succeeded in increasing their market share and 67.5% of ICT firms that were able to reduce their production costs performed product positioning as part of their commercialization strategy (see Table 5).

Advertising via a website is an important commercialization activity for ICT firms to reach their commercialization objectives. This could be explained by the powerful effect that electronic advertising could have on strengthening firms' brand names, and increasing sales volumes (Mylonakis, Evripiotis, Orfanos, & Tsatsanis, 2008). Data support this, especially in the ICT sector, as most of the firms that indicated that they succeeded in reaching their commercialization objectives, promoted their products through a website (see Tables 5 and 6).

Product positioning is also a crucial part of marketing products. Product positioning is all about the image of a product that gets into the mind of prospective customers, which contributes to differentiating it from competitors' products. Data confirm the importance of performing product positioning as part of the commercialization efforts to reach the commercialization objectives (see Tables 5 and 6). Being able to positively shape the image of a product offered by a firm, and to differentiate it from its competitors in customers' perception is expected to enable firms to improve its commercialization performance, by, for instance, the positive effect it has on convincing potential customers to purchase the product.

The percentage of firms that have carried out a campaign to recruit personnel specialized in commercialization is lower compared to the percentage of firms that have performed most of the other commercialization activities listed on the questionnaire (Tables 5 and 6, and Figures 6 and 7). For firms that have reached their commercialization objectives, and those who did not reach their commercialization objectives, the percentage of firms that conducted a campaign to recruit personnel specialized in commercialization is significantly low (Appendix F). These low percentages do not seem to be associated with the success nor the failure to achieve commercialization objectives. Firms' willingness to conduct such campaigns could be negatively affected by the lack of skills, which has been identified as a main obstacle to innovation by Canadian businesses (Statistics Canada, 2010); therefore the majority of these firms do not bother to conduct such campaigns. It is important to note that, despite the low percentage of firms that have conducted campaigns to recruit personnel specialized in commercialization, medium-sized biotechnology firms have showed a higher tendency compared to smaller and larger biotechnology firms to provide training to their employees on how to market their products, both in Canada and abroad. In the manufacturing sector, there is a positive linear relationship between the propensity of firms to provide training to their employees on how to market their products, both in Canada and abroad, and firm size; large firms tend to provide more training to their employees on how to market their products, than medium-sized firms, and those latter tend to train their employees on how to market their products more than smaller firms (Appendix G). In the manufacturing sector, computer and electronic product manufacturing firms tend to train their employees on how to market their products more than firms from other manufacturing industries (Figures 10 and 11). Providing such training allows firms to face the lack of skills obstacle by developing their employees' skills to market innovations.

**Table 5: Percentage of ICT enterprises that experienced success with their most significant and recent innovations by commercialization activities carried out in Canada**

		<b>Commercialisation activities that were carried out in Canada</b>					
		<b>Promotion of the product through advertising</b>	<b>Promotion of the product via a website</b>	<b>Product positioning</b>	<b>Market research</b>	<b>Product distribution agreements</b>	<b>Campaign to recruit personnel specialised in commercialisation</b>
<b>Commercialization Objectives that are Fully Reached or Exceeded</b>	Investment Costs Recovery	52.1	80.7	56.9	52.9	5.8	12.6
	Sales Volume Increase	55.7	84	55.6	49.6	21.4	21.6
	Market Share increase	54.2	85.8	76	50.4	9.6	26.7
	Production Costs Reduction	49.1	92.1	67.5	63.1	29.2	29

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

Also when it comes to performing commercialization activities abroad, promoting innovations via a website seems to have a significant positive impact compared to other commercialization activities on the ability of ICT firms to reach their commercialization objectives. Conducting market research abroad also has a positive impact on the ability of ICT firms to reach their commercialization objectives, even more than when it is conducted in Canada. Product positioning abroad and promoting the product abroad through advertising are also commercialization activities that are positively associated with the ability of ICT firms to reach their commercialization objectives. Conducting market research abroad is more significantly associated with the ability of firms to reach their commercialization objectives than when it is performed in Canada. Also promoting innovation(s) through advertising abroad is more significantly associated with reaching many commercialization objectives of ICT firms, such as increasing sales volumes, increasing market share, and reducing production costs (see Table 6).

**Table 6: Percentage of ICT enterprises that experienced success with their most significant and recent innovations by commercialization activities carried out abroad**

		Commercialisation activities that were carried out abroad					
		Promotion of the product through advertising	Promotion of the product via a website	Product positioning	Market research	Product distribution agreements	Campaign to recruit personnel specialised in commercialisation
Commercialization Objectives that are Fully Reached or Exceeded	Investment Costs Recovery	49.3	83.2	53.1	64.9	24.6	18
	Sales Volume Increase	63.9	82.3	59.1	65.6	36.3	29
	Market Share increase	57.8	85.8	56.9	51.7	26.4	19.4
	Production Costs Reduction	61.6	88.8	68.7	81.4	48.6	29.6

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

In the manufacturing industry, promoting innovations via a website in Canada seems to have a positive effect on reaching the commercialization objectives of manufacturing firms, but this effect is less significant than the effect it has on the ability of ICT firms to reach their commercialization objectives. The same observation applies for the effect of conducting product positioning activities in Canada; there is a positive effect on the ability of manufacturing firms to reach their commercialization objectives, but this effect is less pronounced in this sector compared to the ICT industry. Promoting innovations through advertising in Canada, and conducting market research in Canada are also two commercialization activities that positively impact the ability of manufacturing firms to reach their commercialization objectives (see Table 7). Promoting the product through advertising in Canada has a greater positive effect on the ability of firms to reach their commercialization objectives, such as recovering investment costs, increasing sales volumes, increasing market share, and reducing production costs (see Tables 7 and 8).

**Table 7: Percentage of manufacturing enterprises that experienced success with their most significant and recent innovations by commercialization activities carried out in Canada**

		<b>Commercialisation activities that were carried out in Canada</b>					
		<b>Promotion of the product through advertising</b>	<b>Promotion of the product via a website</b>	<b>Product positioning</b>	<b>Market research</b>	<b>Product distribution agreements</b>	<b>Campaign to recruit personnel specialised in commercialisation</b>
<b>Commercialization Objectives that are Fully Reached or Exceeded</b>	Investment Costs Recovery	52.5	64	41.5	53.9	20.1	21.5
	Sales Volume Increase	60.1	65.4	42.8	55.1	29.1	22.8
	Market Share increase	61	64.7	43.2	58.1	25.2	21.3
	Production Costs Reduction	49.2	62.4	50.2	61	25.9	21.2

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

Promoting products via a website abroad seems to have the greatest positive impact, compared to other commercialization activities performed abroad, on the ability of manufacturing enterprises to achieve their commercialization objectives (see Table 7). Promoting products via a website both in Canada and abroad is significantly associated with increasing manufacturing firms' sales volumes (see Tables 7 and 8). Conducting market research in Canada has more impact on achieving the commercialization objectives of manufacturing firms, than conducting it abroad (see Tables 7 and 8). To summarize, data suggest that conducting the following commercialization activities abroad is more beneficial for firms from the ICT sector than for manufacturing firms, to achieve their commercialization objectives: promoting through advertising, promoting via a website, product positioning and conducting market research.

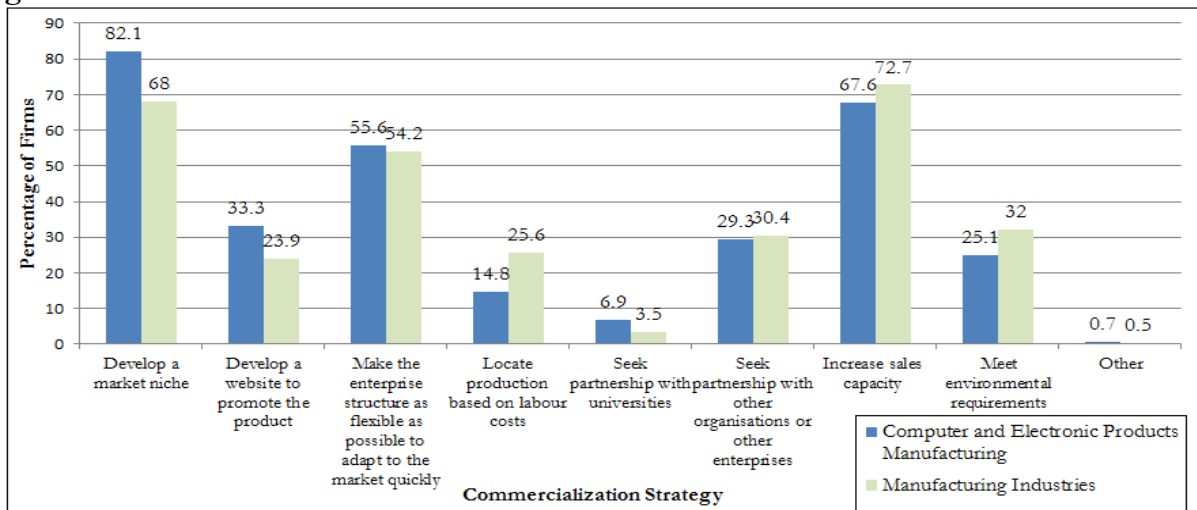
**Table 8: Percentage of manufacturing enterprises that experienced success with their most significant and recent innovations by commercialization activities carried out abroad**

		Commercialisation activities that were carried out abroad					
		Promotion of the product through advertising	Promotion of the product via a website	Product positioning	Market research	Product distribution agreements	Campaign to recruit personnel specialised in commercialisation
Commercialization Objectives that are Fully Reached or Exceeded	Investment Costs Recovery	33.5	51.6	31	42.7	18.2	9.4
	Sales Volume Increase	39.3	61.4	33.7	47.2	25	17
	Market Share Increase	32.3	56.4	24	45.8	22.1	13.2
	Production Costs Reduction	35.5	53	40.6	49.3	23.2	13.4

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

*Commercialization strategies' importance:* The commercialization strategies that computer and electronic products manufacturing firms considered mostly as essential or of a great importance to reach their commercialization objectives are developing a market niche, making the enterprise structure as flexible as possible to adapt to the market quickly, and increasing sales capacity (see Figure 15). These commercialization strategies are also those to which manufacturing firms have attributed essential to great importance to attain commercialization objectives.

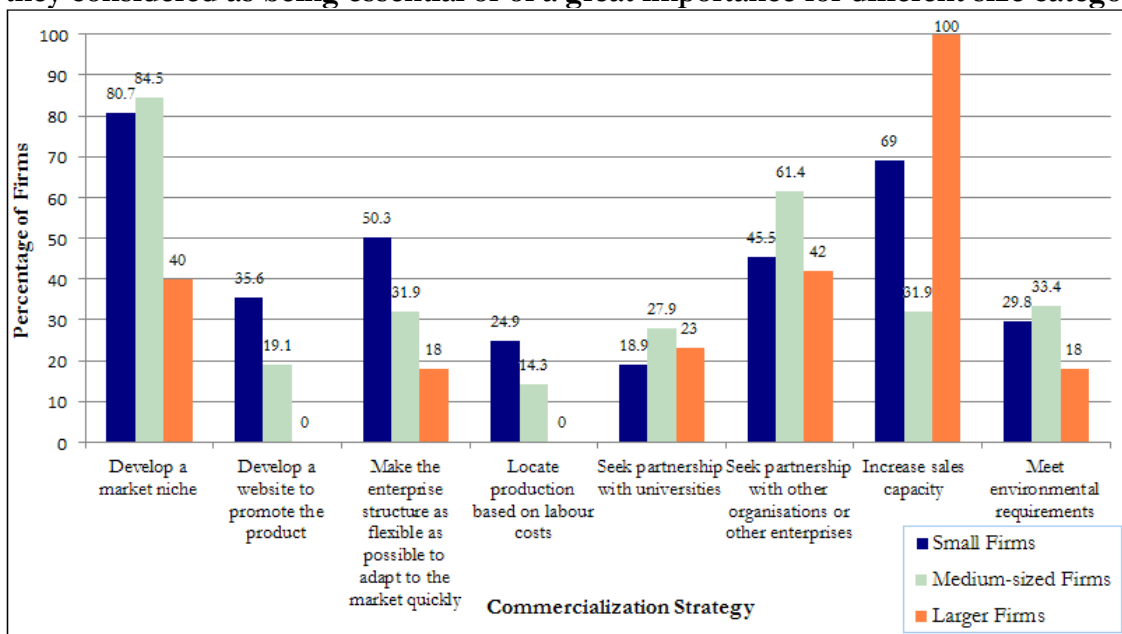
**Figure 15: Percentage of computer and electronic product manufacturing firms by the commercialization strategies that they considered essential or of a great importance to their innovations' commercialization success compared to the manufacturing sector in general**



Promoting products via a website in Canada and abroad was found to be positively associated with the ability of ICT and manufacturing firms to reach their commercialization objectives (Tables 5, 6, 7 and 8). Computer and electronic product manufacturing firms showed a higher tendency compared to firms from other manufacturing industries to consider developing a website to promote their products as essential or of a great importance (Figure 15). In the manufacturing sector, larger firms showed a higher tendency compared to small and medium-sized firms to consider developing a website to promote their products as essential or of a great importance (Figure 17). This could be seen as having a positive impact on these firms' (on computer and electronic product manufacturing firms compared to other manufacturing firms, and on larger firms in the manufacturing sector) ability to reach their commercialization objectives.

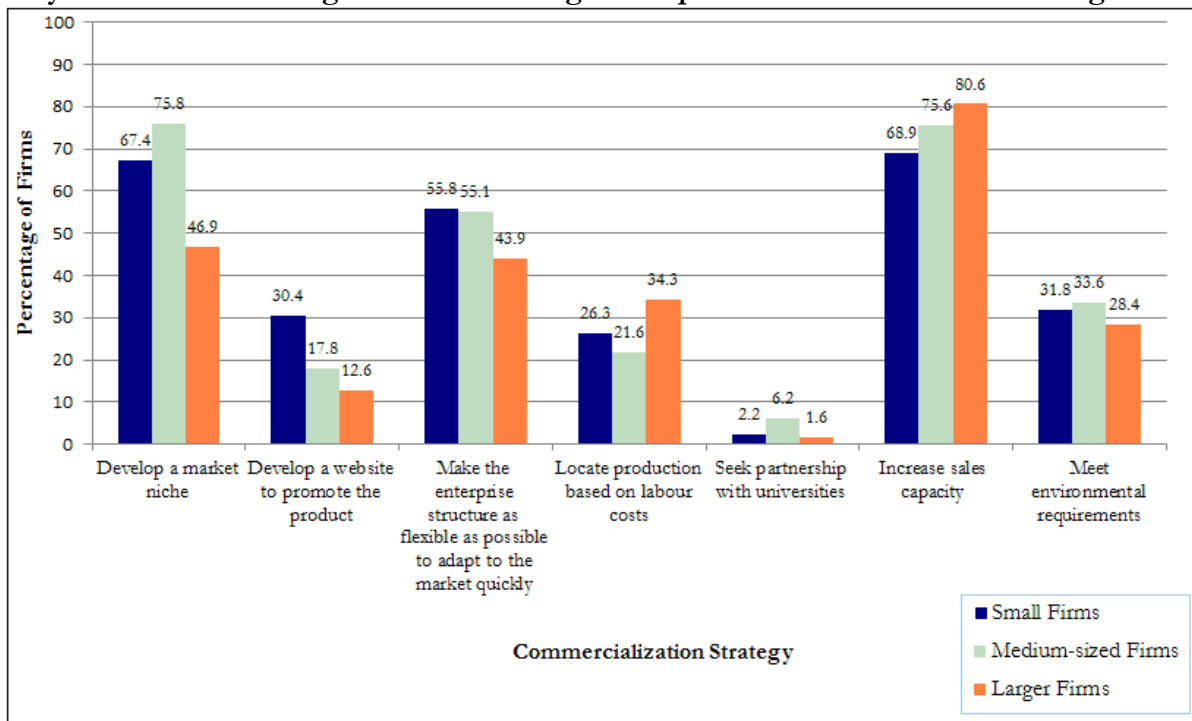
In the biotechnology sector, large firms consider seeking partnerships with other organizations/enterprises as essential, and attribute a great importance to increasing their sales capacity and developing market niche as commercialization strategies. Medium-sized firms, attribute great importance to developing a market niche, and to seeking partnerships with other organizations/enterprises. Small firms attribute great to essential importance to developing a market niche, increasing their sales capacity, and making the enterprise structure as flexible as possible to adapt to the market quickly (see Figure 16).

**Figure 16: Percentage of biotechnology firms by the commercialization strategies that they considered as being essential or of a great importance for different size categories**



As in the biotechnology sector, small firms from the manufacturing sector also considered increasing their sales capacity, developing a market niche, and making the enterprise structure as flexible as possible to adapt to the market quickly, strategies that are essential or of a great importance. Medium-sized manufacturing firms, considered essential or of a great importance developing a market niche, increasing their sales capacity and making the enterprise structure as flexible as possible to adapt to the market quickly, which are the same commercialization objectives identified as being essential or of a great importance by the majority of firms from the computer and electronic product manufacturing sector (see Figures 15 and 17). And large manufacturing firms attributed a great to essential importance to increasing their sales capacity (see Figure 17).

**Figure 17: Percentage of manufacturing firms by the commercialization strategies that they considered as being essential or of a great importance for different size categories**



Manufacturing firms in general, including the computer and electronic product manufacturing firms, as well as firms from all size categories from the biotechnology industry tended to indicate developing a market niche as essential or of a great importance as a commercialization strategy (Figures 15, 16 and 17). Also increasing sales capacity was one of the commercialization strategies that were considered as essential or of a great importance by biotechnology firms from different size categories, as well as by a significant percentage of manufacturing firms. In the

computer and electronic product manufacturing sector, developing a market niche, making the enterprise structure as flexible as possible to adapt to the market quickly, and increasing sales capacity are commercialization strategies that were considered as essential or of a great importance to a significant percentage of firms. Butje (2005) argues that the ICT market changes faster than any other market sector, and that, ICT products become out of date by the introduction of newer technologies at a faster rate than in any other industry; ICT innovations have shorter product life cycles relatively to other market sectors. Therefore, it becomes crucial for ICT firms to have a flexible structure to be able to adapt to market changes, and to be able to respond to customers' changing needs. And according to the 2008 International Council for Small Business - World Conference, because small and medium-sized firms are smaller, dynamic and more versatile in nature than their larger counterparts, they are more able to leverage their flexibility to adapt to market changes.

*Commercialization strategies' importance to firms that have reached their commercialization objectives:* Developing a market niche is a commercialization strategy that was identified by most of ICT enterprises that fully reached or exceeded their commercialization objectives, to be essential or of a great importance in order to reach their objectives. Also making the enterprise structure as flexible as possible to adapt to the market quickly is a strategy that they have identified as essential or of a great importance to succeed in reaching their commercialization objectives, but less significantly than developing a market niche (Table 9).

**Table 9: Percentage of ICT enterprises that fully reached or exceeded their commercialization objectives by commercialization strategies that they indicated as being essential or of a great importance to reach their commercialization objectives**

		<b>Strategies used to commercialise the most significant and recent product innovation</b>				
		<b>Develop a market niche</b>	<b>Develop a website to promote the product</b>	<b>Make the enterprise structure as flexible as possible to adapt to the market quickly</b>	<b>Seek partnership with universities</b>	<b>Seek partnership with other organizations or other enterprises</b>
<b>Commercialization Objectives that are Fully Reached or Exceeded</b>	Investment Costs Recovery	84.8	35.2	66.3	0	31.7
	Sales Volume Increase	84.6	39.6	59.3	0	45.4
	Market Share increase	89.6	37.6	55.7	0	38.2
	Production Costs Reduction	94.7	51.6	65.6	0	41.2

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

Also in the manufacturing sector, developing a market niche is a strategy that was identified by a significant percentage of manufacturing firms that fully reached or exceeded their commercialization objectives, to be essential or of a great importance in order to reach their commercialization objectives (see Table 10). Same as in the ICT industry, also in the manufacturing industry a significant percentage of firms identified making the enterprise structure as flexible as possible to adapt to the market quickly as a strategy that is essential or of a great importance to reach their commercialization objectives. However, the percentage of firms that indicated these two strategies as being essential or of a great importance to reach their commercialization objectives is more significant in the ICT sector than in the manufacturing sector.

**Table 10: Percentage of manufacturing enterprises that fully reached or exceeded their commercialization objectives by commercialization strategies that they indicated as being essential or of a great importance to reach their commercialization objectives**

		Strategies used to commercialise the most significant and recent product innovation(s)				
		Develop a market niche	Develop a website to promote the product	Make the enterprise structure as flexible as possible to adapt to the market quickly	Seek partnership with universities	Seek partnership with other organizations or other enterprises
Commercialization Objectives that are Fully Reached or Exceeded	Investment Costs Recovery	62.7	22.9	54	3.7	24
	Sales Volume Increase	61.5	25.7	53.9	3.6	30.7
	Market Share increase	59.4	30	55.5	4.5	27.3
	Production Costs Reduction	59.1	20.8	56	5.7	28

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

The analysis shows that, in general, a small percentage of firms (manufacturing, biotechnology, and computer and electronic product manufacturing firms) have indicated seeking partnerships with universities as being a commercialization activity that they perform, relatively to other

commercialization activities performed by these firms (Figures 15, 16 and 17). Also, most successful firms indicate “Seeking partnership with universities” as a strategy of little importance (Tables 9 and 10). This points to the importance of exploring the relationship between universities and firms and how to shift the association of such partnerships (between industry and academia) from being negative to being a positive one. The weakness of such relationships requires more exploration, as it could be a reason that can partly explain why our commercialization efforts are failing. Here we are probably looking at one side of the picture, which relates to the ability of firms to commercialize their own innovations. On the other hand, there is another important aspect to consider which are the potential innovations wasted on universities’ shelves without being transformed into commercial success. By seeking partnerships with universities, firms could benefit from the knowledge generated by these universities. At the national level, when establishing partnerships between firms and universities, instead of wasting the knowledge, that has a commercial potential, generated by universities, universities could become ideas’ factories that nurture firms’ innovation pipeline to be thereafter developed into a commercial success by these firms, thus leading to improving Canada’s innovations’ commercialization performance.

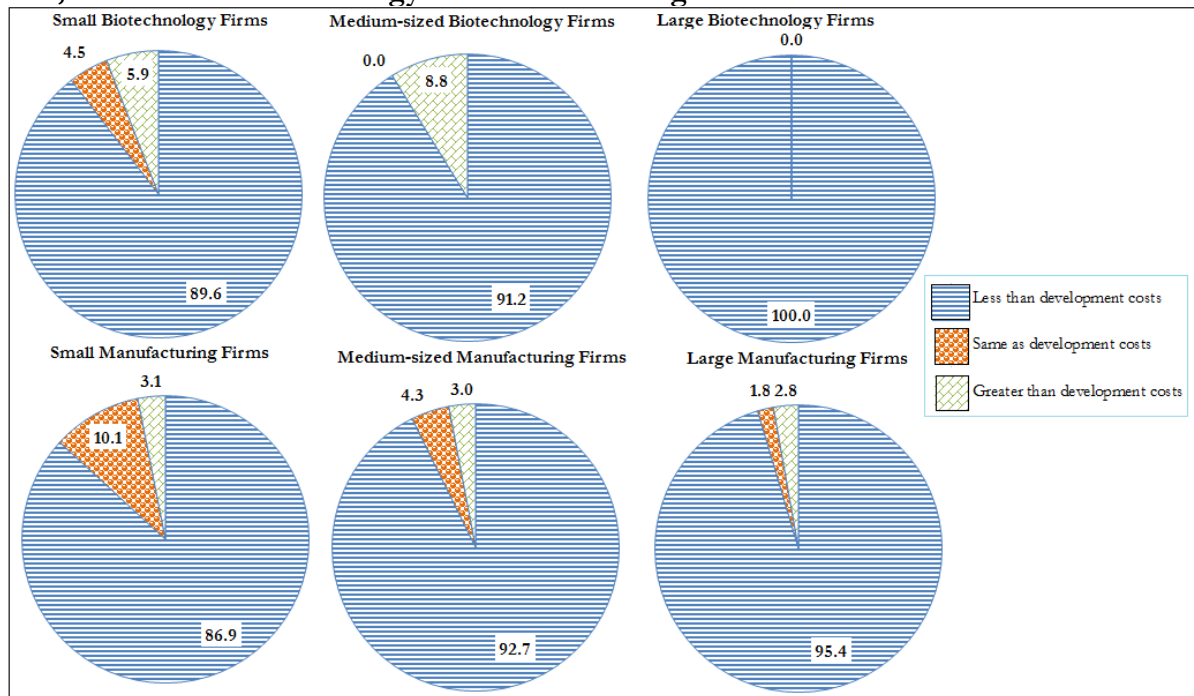
Medium-sized firms outperformed smaller and larger firms, both in the manufacturing and biotechnology sectors, in terms of seeking partnerships with universities as part of their commercialization activities (Figures 16 and 17). This aspect could be seen as supporting the argument stating that universities could represent ideas’ factories for firms, which thereafter work on taking such knowledge to be then commercialized. This could be an indication that medium-sized firms are better positioned than firms from other size categories to be involved in such partnerships, to develop universities’ knowledge into a commercial application.

*Advertising, promotion and distribution costs compared to development costs:* The Survey on the Commercialization of Innovation (2007) included a question regarding the costs associated with the advertising, promotion and distribution costs of firms’ most recent and significant product innovation. Participants were asked whether these costs are less, equal, or greater than development costs.

The analysis shows that, in general, most of the firms from the biotechnology and manufacturing industries have incurred less advertising, promotion and distribution costs compared to development costs. However, the percentage of medium-sized biotechnology firms

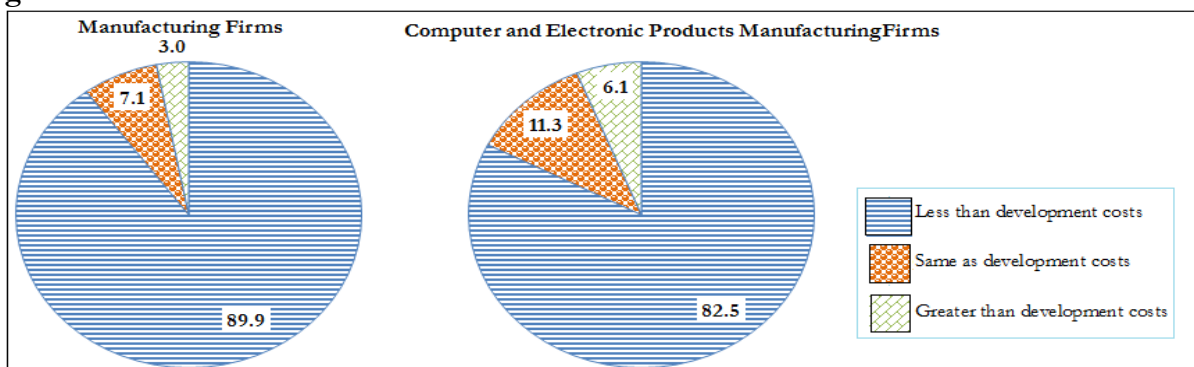
that spent more on advertising, promotion and distribution than the development costs is the highest compared to large and small firms (see Figure 18).

**Figure 18: Advertising, promotion and distribution costs relative to the total development costs for the most significant and recent product innovation(s), by firm size, in both the biotechnology and manufacturing sectors**



In the manufacturing sector, 17.4% (11.3% + 6.1%) of firms from the computer and electronic product manufacturing industry have spent on their advertising, promotion and distribution an amount that is equal or higher than the development costs. This was the highest number compared to firms from other industries in terms of their advertising, promotion and distribution costs compared to their development costs (see Figure 19).

**Figure 19: Advertising, promotion and distribution costs relative to total development costs for the most significant and recent product innovation(s), by firm size, in both the computer and electronic product manufacturing sector and the manufacturing sector in general**



In terms of the costs incurred in commercializing innovations, generally, the data indicate that manufacturing and biotechnology firms spent more on developing their innovations than on their commercialization (Figure 18). The computer and electronic products manufacturing sector was an exception where 17.4% of firms have spent on their advertising, promotion and distribution an amount that is equal or higher than the development costs (Figure 19). This represented the highest percentage compared to firms from other industries. When it comes to firm size, the percentage of medium-sized biotechnology firms that spent a greater amount on commercializing innovation, than on developing it, is greater than that of small or large firms. In the manufacturing industry, the percentage of medium-sized firms that spent on commercializing their innovations an amount that is equal or greater than the development costs, is greater than that of larger firms, but lower than that of smaller firms (Figure 18). So, compared to larger firms, small and medium-sized firms' investments in commercialization represent a more significant portion compared to their development costs; this could be the case because larger firms tend to have more established marketing and distribution systems, thus requiring less marketing resources than their development costs compared to their SMEs counterparts (which might allocate huge investments in establishing such systems), and this could also be related to the more significant pipeline of innovations, and the more exploitation activities larger firms perform compared to small and medium-sized firms, thus requiring greater development costs.

These numbers show that medium-sized biotechnology firms, small manufacturing firms, and firms from the computer and electronic product manufacturing industry invest more in advertising, promoting and distributing their innovations, relatively to development costs, compared to other firms. This could serve as an evidence of the commitment of these firms to innovate and commercialize their innovations. In terms of the number of innovations that they are able to introduce, and in terms of achieving their commercialization objectives, medium-sized firms performed well compared to their small and large counterparts. This leads to thinking about the role that these firms can play in leading Canada's commercialization improvement should they be provided the required support.

To summarize this section, the analysis shows that medium-sized firms outperformed smaller and larger firms in conducting many commercialization activities in Canada and abroad, which prove their strong ability to insert themselves into the global markets. In the manufacturing

sector, there is a positive relationship between firm-size and the ability of firms to reach their commercialization objectives. In the biotechnology sector, medium-sized firms tend to outperform smaller and larger firms in reaching many commercialization objectives. Promoting innovations via website or through advertising, product positioning and conducting market research tend to positively impact the ability of firms to reach their commercialization objectives, but less significantly when conducted abroad by manufacturing firms. Despite the significant investments made by the Canadian Governments to leverage the cooperation between industry and academia, seeking partnerships with universities was identified as being essential or of a great importance as a strategy by a relatively small percentage of firms; which suggests further exploration in future studies as to why this might be the case.

### **5.3 Commercialization Financing**

*Sources of commercialization financing:* In the biotechnology sector, in general large firms rely mainly on their internal resources to commercialize innovations (81% of large biotechnology firms used this source of funding to commercialize 75 to 100% of their innovations, and 19% used it to commercialize 50 to 74% of their innovations). Also 19% of large firms obtained funding from banking institutions to commercialize 50 to 74% of their innovations and 23% of these firms relied on public offering to commercialize 1 to 24% of their innovations. Large biotechnology firms indicated that they did not use venture capital investments, co-operation arrangements, private placements, subsidiaries or affiliates, and federal and provincial governments to fund their commercialization activities (Table 11).

**Table 11: Sources of funding for the commercialization of the most significant and recent product innovation of large biotechnology firms**

	Percentage of Innovations				
	0	1 to 24	25 to 49	50 to 74	75 to 100
<b>Internal sources</b>	0	0	0	19	81
<b>Venture capital</b>	100	0	0	0	0
<b>Co-operation arrangements</b>	100	0	0	0	0
<b>Public offering</b>	77	23	0	0	0
<b>Private placement or other firms</b>	100	0	0	0	0
<b>Subsidiary or affiliate</b>	100	0	0	0	0
<b>Federal government</b>	100	0	0	0	0
<b>Provincial government</b>	100	0	0	0	0
<b>Banking institutions</b>	81	0	0	19	0
<b>Other</b>	100	0	0	0	0

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

Medium-sized biotechnology firms made use of more sources of funding to commercialize their innovations, than large firms. In the biotechnology industry, 76.9% and 14.3% of medium-sized firms relied mainly on their internal resources and venture capital investments respectively, to commercialize 75 to 100% of their innovations. On the other hand, 8.8% and 14.3% of medium-sized biotechnology firms relied on private placements or on other firms to fund commercializing 50 to 74% and 1 to 24% of their innovations, respectively. Also, 8.8% of these firms relied on the Federal Government to commercialize 1 to 24% of their innovations. And another 8.8% rely on public offerings to commercialize 25 to 49% of their innovations. Medium-sized biotechnology firms indicated that they do not use co-operation arrangements, subsidiaries or affiliates, provincial governments, and banking institutions as sources of funding to commercialize their innovations (Table 12).

**Table 12: Sources of funding for the commercialization of the most significant and recent product innovation of medium-sized biotechnology firms**

	Percentage of Innovations				
	0	1 to 24	25 to 49	50 to 74	75 to 100
<b>Internal sources</b>	23.1	0	0	0	76.9
<b>Venture capital</b>	85.7	0	0	0	14.3
<b>Co-operation arrangements</b>	100	0	0	0	0
<b>Public offering</b>	91.2	0	8.8	0	0
<b>Private placement or other firms</b>	76.9	14.3	0	8.8	0
<b>Subsidiary or affiliate</b>	100	0	0	0	0
<b>Federal government</b>	91.2	8.8	0	0	0
<b>Provincial government</b>	100	0	0	0	0
<b>Banking institutions</b>	100	0	0	0	0
<b>Other</b>	100	0	0	0	0

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

When it comes to small biotechnology firms, they use many more sources to fund their innovations' commercialization than large and medium-sized firms. 50.5% and 24.4% of small biotech firms used their internal resources to commercialize 75 to 100% and 50 to 74% of their innovations, respectively. They rely on obtaining funding from banking institutions more than medium-sized firms (7.9% and 3.5% of small biotechnology firms to commercialize 1 to 24% and 50 to 74% of their innovations, respectively). Also 10.2% of these firms relied on provincial governments and 16.6% on the Federal Government to commercialize 1 to 24% of their

innovations. Another 10.8% and 4.5% of small biotechnology firms relied on the Federal Government to fund 25 to 49% and 50 to 74% of their innovations, respectively. Small biotechnology firms used also venture capital investments (less than medium-sized firms), cooperation arrangements and subsidiary or affiliate (more than medium-sized and large firms), and private placement or other firms as sources to fund the commercialization of their innovations (Table 13).

**Table 13: Sources of funding for the commercialization of the most significant and recent product innovation of small biotechnology firms**

	Percentage of Innovations				
	0	1 to 24	25 to 49	50 to 74	75 to 100
<b>Internal sources</b>	13.1	4.1	7.9	24.4	50.5
<b>Venture capital</b>	91.2	3.5	2.9	2.4	0
<b>Co-operation arrangements</b>	90.2	5.6	1.2	3	0
<b>Public offering</b>	100	0	0	0	0
<b>Private placement or other firms</b>	87.1	4.1	0	3.2	5.5
<b>Subsidiary or affiliate</b>	88.9	0	1.8	1.5	7.8
<b>Federal government</b>	68.1	16.6	10.8	4.5	0
<b>Provincial government</b>	89.8	10.2	0	0	0
<b>Banking institutions</b>	88.6	7.9	0	3.5	0
<b>Other</b>	100	0	0	0	0

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

The unreliability of the data regarding the sources of funding for the commercialization of large manufacturing firms' innovations, in general, prevents deriving specific conclusions regarding these sources. Overall, the data show that these firms rely on internal sources to commercialize over 50% of their innovations, and much less significantly on banking institutions (Table 14).

**Table 14: Sources of funding for the commercialization of the most significant and recent product innovation(s) of large manufacturing firms**

	Percentage of Innovations				
	0	1 to 24	25 to 49	50 to 74	75 to 100
<b>Internal sources</b>	3.6	1.3	0.7	F	F
<b>Venture capital</b>	99	1	0	0	0
<b>Co-operation arrangements</b>	100	0	0	0	0
<b>Public offering</b>	95.3	1	0	0	3.6
<b>Private placement or other firms</b>	99.4	0.6	0	0	0
<b>Subsidiary or affiliate</b>	99.2	0.8	0	0	0
<b>Federal government</b>	F	F	0.5	0	0
<b>Provincial government</b>	F	F	0	0	0
<b>Banking institutions</b>	97.2	0.3	0.7	1.7	0
<b>Other</b>	99.8	0	0	0	0.2

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

Medium-sized manufacturing firms used mainly their internal sources to commercialize most of their significant and recent innovations (73.9% of these firms used their internal sources to commercialize 75 to 100% of their innovations, 6.3% used it to commercialize 50 to 74% of their innovations, and 6.2% used it to commercialize 25 to 49% of their innovations). Also, 14.5% of medium-sized manufacturing firms relied on banking institutions to commercialize their innovations, 10.2% and 8.2% of these firms relied on the Federal Government and on provincial governments respectively to commercialize their innovations. 5% of medium-sized manufacturing firms used venture capital investments to commercialize innovation. Medium-sized manufacturing firms (5%) tend to also use private placements or other firms more than large (0.6%) or small firms (0.3%) as a source to fund commercializing their innovations (Table 15).

**Table 15: Sources of funding for the commercialization of the most significant and recent product innovation(s) of medium-sized manufacturing firms**

	Percentage of Innovations				
	0	1 to 24	25 to 49	50 to 74	75 to 100
<b>Internal sources</b>	13.3	0.2	6.2	6.3	73.9
<b>Venture capital</b>	95	0.3	0	1.2	3.5
<b>Co-operation arrangements</b>	99.1	0.2	0	0.8	0
<b>Public offering</b>	99.5	0	0	0.1	0.3
<b>Private placement or other firms</b>	95	0.2	3.9	0.4	0.5
<b>Subsidiary or affiliate</b>	99	0.9	0	0	0.1
<b>Federal government</b>	89.7	8.6	1.3	0.2	0.1
<b>Provincial government</b>	91.8	7	0.2	1	0
<b>Banking institutions</b>	85.5	1.5	0.2	4.8	8
<b>Other</b>	99.9	0	0	0	0.1

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

Small manufacturing firms rely mainly on their internal sources (75.2% of firms use their internal sources to commercialize 75 to 100% of their innovations). 19% of small manufacturing firms use banking institutions to obtain funding to commercialize their innovations, 11.2% of which they rely on this source of funding to commercialize 75 to 100% of their most recent and significant innovations. Only 1% of these firms relied on venture capital investments to commercialize their innovations. Federal and provincial governments are also two sources of funding of the commercialization activities of small manufacturing firms. 14.6% and 8.2% of

these firms rely on the Federal Government and provincial governments, respectively, to commercialize their innovations (Table 16).

**Table 16: Sources of funding for the commercialization of the most significant and recent product innovation(s) of small manufacturing firms**

	Percentage of Innovations				
	0	1 to 24	25 to 49	50 to 74	75 to 100
<b>Internal sources</b>	11.7	2.9	5.5	4.7	75.2
<b>Venture capital</b>	99	0	0	0.5	0.5
<b>Co-operation arrangements</b>	98	0.3	0.1	1.7	0
<b>Public offering</b>	100	0	0	0	0
<b>Private placement or other firms</b>	99.7	0.1	0.1	0	0.1
<b>Subsidiary or affiliate</b>	99.2	0	0	0.8	0
<b>Federal government</b>	85.4	9.4	4.4	0.8	0
<b>Provincial government</b>	91.9	5.3	2.7	0.2	0
<b>Banking institutions</b>	81	3	1	3.8	11.2
<b>Other</b>	98.6	0.1	0.6	0	0.7

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

Computer and electronic products manufacturing firms rely on their internal sources to commercialize their most recent and significant innovations more than other manufacturing firms (90.8% of computer and electronic manufacturing firms compared to 88.5% of all manufacturing firms). Also, venture capital investments were significantly more used by computer and electronic products manufacturing firms than by other manufacturing firms (8.7% of computer and electronic products manufacturing firms compared to 2.4% of all manufacturing firms). Also, computer and electronic manufacturing firms rely more, on private placements or other firms, on co-operation arrangements and on Federal Government, than all manufacturing firms, as a source to commercialize their innovations. Manufacturing firms in general used more the provincial governments as a source of funding to commercialize their innovations, than the computer and electronic products manufacturing firms. All manufacturing firms (15.5%) also tend to use banking institutions as a source of funding to commercialize their innovations significantly more than the computer and electronic products manufacturing firms (9.9%).

**Table 17: Sources of funding for the commercialization of the most significant and recent product innovation(s) of computer and electronic products manufacturing firms compared to the manufacturing sector in general**

	<b>All Manufacturing Firms</b>		<b>Computer and Electronic Products Manufacturing</b>	
	<b>Percentage of Innovations</b>			
	<b>1 to 49</b>	<b>50 to 100</b>	<b>1 to 49</b>	<b>50 to 100</b>
<b>Internal sources</b>	6.9	81.6	4	86.8
<b>Venture capital</b>	0.2	2.2	3.2	5.5
<b>Co-operation arrangements</b>	0.2	1.2	1.1	0.8
<b>Public offering</b>	0.1	0.6	0	0.7
<b>Private placement or other firms</b>	1.7	0.3	2.7	2.8
<b>Subsidiary or affiliate</b>	0.4	0.5	2.2	0.3
<b>Federal government</b>	13.3	0.5	15.4	0.4
<b>Provincial government</b>	9.1	0.5	7.1	0
<b>Banking institutions</b>	2.8	12.7	3.7	6.2
<b>Other</b>	0.4	0.4	0.7	0.3

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

In general, data pertaining to the financing aspects related to the commercialization of innovations indicate that large firms tend to use their internal sources more than smaller ones to fund their commercialization activities. Similar findings were reached in a study that was conducted by Gracia, and Arias (2000), where they found that larger companies show a higher index of self-finance than smaller firms. As well, the data show that small and medium-sized firms also rely mainly on their internal sources to fund their commercialization activities, but to a lesser extent than larger ones. Coase (1937) argues that small firms rely mainly on their retained earnings, because of the transaction and contracting costs that obtaining external financing require.

As well, smaller firms tend to use more sources to fund commercializing their innovations, more than larger ones. An explanation of these findings could be that larger firms have greater financial resources that they could devote to conducting their commercialization activities, whereas, smaller firms they also use their internal sources to finance their commercialization activities, but because these resources are limited compared to larger firms, they have to reach to more funding sources in order to secure the necessary funds to commercialize their innovations.

In the manufacturing sector, small firms used funds from banking institutions to commercialize their innovations more than medium-sized and large firms, respectively. This could be because the higher need of these resources for smaller firms compared to larger ones; larger firms have more internal resources that they can use to conduct their commercialization activities. Also, as Coase (1937) argues, small firms are likely to borrow short-term bank debts in order to avoid diseconomies of scale and the costs of financial distress.

It is important to note that accessing financial resources through banking institutions does not only depend on the need of firms to these resources, but also on different other factors that could affect banking institutions' decision regarding lending these resources to firms. Gracia and Arias (2000) argue that smaller firms are disadvantaged when it comes to their ability to obtain external funds, compared to their larger counterparts. They accord this aspect to the poor financial information that smaller firms tend to produce, which consequently prevents lenders from knowing the real value of the projects proposed by these firms, or how the funds will be used. Mittelstädt and Cerri (2008) presented some barriers faced by smaller firms when attempting to obtain financing from banks. They argue that due to the lack of collateral, and due to their higher risk, small and medium-sized firms could be offered financing at a higher lending rates than larger ones. Another explanation as to why small firms may use less funding from banking institutions than larger ones, is because their owners prefer to limit intrusion into their business, therefore, they tend to first use personal savings and resources generated internally before thinking about external funding.

Data also indicate that large manufacturing firms and large biotechnology firms rely more than small or medium-sized firms on public offering as a source to fund their commercialization activities. This could be explained by the fact that they usually have a better reputation and public information, which could lead them to issue cost-efficient public debt (Diamond, 1991). Also 8.8% of medium-sized biotechnology firms and 0.5% of medium-sized manufacturing firms, compared to 0% of small firms in both sectors indicated public offering as a source of funding to commercialize their innovations. This could be explained by the higher financial capabilities and better reputation that medium-sized firms have compared to smaller ones, which are crucial for public offerings.

When firms attribute a great importance to maintaining privacy, or don't have a strong reputation or financial status, they could choose to obtain funding for their commercialization

activities through private placements. Private placements involve the issuance of a block of shares to a relatively small group of investors (Wruck & Wu, 2009). According to Wruck (1989), these investors are usually “willing and able to monitor management, ensure that corporate resources are used more efficiently, and increase the probability of value-increasing takeovers” (Balachandran et al., 2008, p. 4). The data show that medium-sized firms tend in general to adopt this source of funding to commercialize innovations more than small and large firms. Also, firms from the computer and electronic product manufacturing tend to rely more on private placements than other manufacturing firms, as a source of funding to commercialize their innovations. These firms will benefit from the knowledge and abilities that these investors will bring by managing them, while maintaining their privacy. This is also an indication that these firms are seen as promising by investors, which is why they have decided to invest in.

In general, small and medium-sized enterprises rely significantly on federal and provincial governments to fund their commercialization activities, except for medium-sized biotechnology firms which indicated that they do not rely on provincial government to obtain these funds. However, in general, the percentage of small firms that indicated the federal and provincial governments as sources of funding is higher than that of medium-sized firms, especially in the biotechnology sector. This shows the importance of the support that federal and provincial governments offer to small and medium-sized firms in order to commercialize their innovations. However, it seems that there is a difference in the significance of this support between small and medium-sized firms. Also, computer and electronic product manufacturing firms rely more on the Federal Government, than other manufacturing firms, as a source of funding to commercialize their most recent and significant innovations. This could be explained by the strategic importance that the Government attribute to this sector, which is part of the ICT sector, to the Canadian economy. These firms also show a higher tendency to perform commercialization activities compared to firms from other manufacturing industries, both in Canada and abroad (Figures 10 and 11) which requires more resources to conduct these activities, thus increasing the requirement to obtain government support.

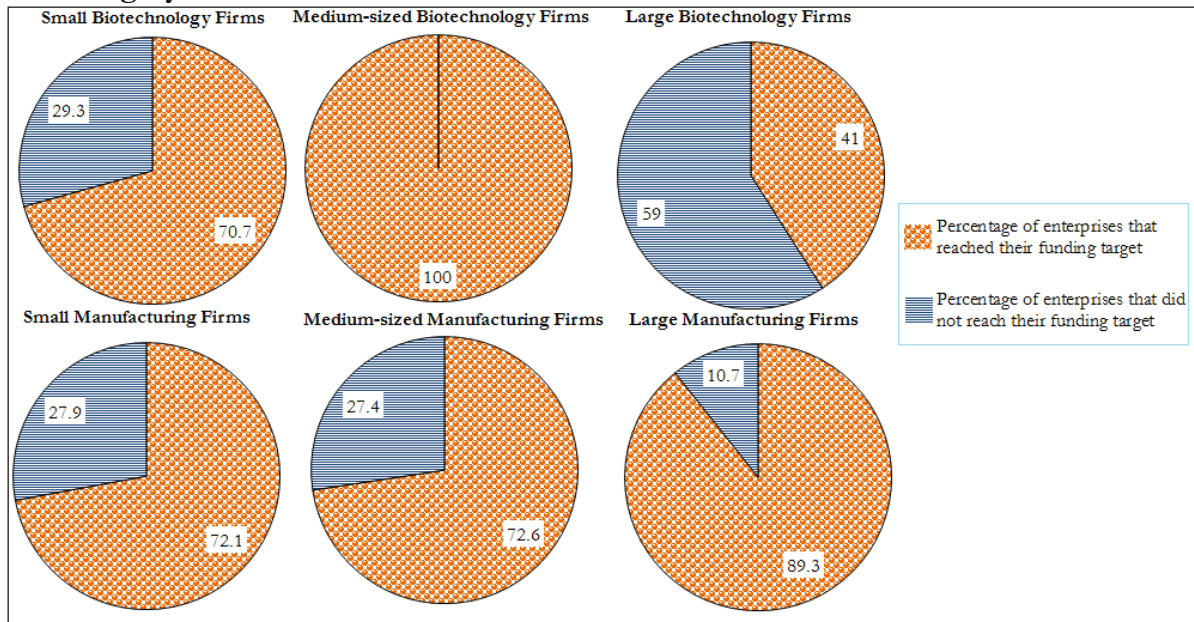
Medium-sized firms showed a higher tendency to fund their commercialization activities through venture capital (VC) investments, compared to smaller and larger firms. Also, venture capital investments were significantly more used by firms from the computer and electronic products manufacturing firms than by other manufacturing firms to fund innovations?

commercialization activities. Venture capital could be defined as “a private equity provided by specialized firms acting as intermediaries between primary sources of finance [...] and private companies whose shares are not freely traded in any public stock market. Because of the high risk involved, venture capital funds take a hands-on approach to the management and governance of the financed firms” (OECD, 2009, p. 44). In a report that was generated by the SME Financing Data Initiative (2004) it was argued that venture capitalists generally invest in firms with high-return potential. Samila and Sorenson (2010) also presented venture capitalists, as active professionals that are able to screen inventions and ideas and identify those that have the greatest market potential to invest in. In the report that was published by the SME Financing Data Initiative (2004), information technology firms, and life sciences firms (to a lesser extent) were presented as industries that attract venture capital investments the most. A report that was produced by OECD (2009) also supported this finding, as it explained that, in Canada, high technology firms attract over 75% of venture capital investments. Based on this and on the data gathered through the Survey, it could be concluded that medium-sized firms from both sectors, and ICT firms, including the computer and electronic product manufacturing firms, represent firms that could be seen as of high return potential, given that they attract venture capitalists more than other firms categories covered by the survey. On the other hand, Hogan and Hutson (2005) argued that one of the main aspects affecting the adoption of venture capital as a source of funding is the willingness of founders to relinquish control. This could explain why small firms, tend not to use this source of funding, because their owners generally prefer to limit intrusion into their business. Another factor to consider is that firms that are able to attract VC investments, which are medium-sized firms, and ICT firms in this case, not only take advantage of the capital they get access to, but also benefit from the connections that venture capitalists allow them to establish with business-minded individuals, and from the advice they offer to these firms (Samila & Sorenson, 2010).

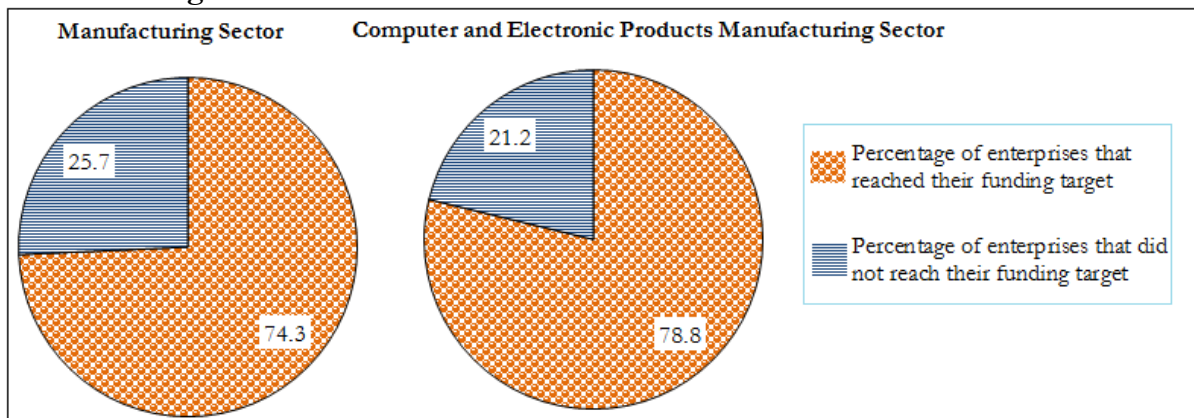
*Reaching funding target:* Firms were asked whether they have reached their funding target for the commercialization of their most significant and recent product innovations. In the biotechnology sector, all medium-sized firms indicated that they have reached their funding target compared to 70.7% of small firms and only 41% of large firms (see Figure 20). In the manufacturing sector, the percentage of large firms (89.3%) that indicated that they have reached their funding target for the commercialization of their most recent and significant

innovations is higher than that of medium-sized firms (72.6%) and small firms (72.1%). However, in general, the computer and electronic product manufacturing industry showed a stronger ability than other manufacturing industries, to reach their funding target for their most significant and recent innovations (see Figure 21).

**Figure 20: Percentage of enterprises that reached their funding target for the commercialization of their most significant and recent product innovations, for each size category**



**Figure 21: Percentage of enterprises that reached their funding target for the commercialization of their most significant and recent product innovations, in the manufacturing sector (the average), and in the computer and electronic products manufacturing sector**



There is a positive relation between reaching the funding target to commercialize innovations and the ability of firms to reach their commercialization objectives. This relation is found to be more significant in the manufacturing industry than in the information and communication technology industry. Of the ICT firms that reached their funding target to commercialize their most recent and significant innovations, 78.7% recovered their investment costs, 76.8% increased their sales volume, 75.1% increased their market share, and 68.8% reduced their production cost. On the other hand, in the manufacturing sector, of the firms that reached their funding target to commercialize their most recent and significant innovations, 79.6% recovered their investment costs, 79.9% increased their sales volume, 79% increased their market share, and 81.2% reduced their production costs (see Table 18).

In the manufacturing industry, the percentage of large firms that indicated that they have reached their funding target is higher than that of small and medium-sized firms. This number translated into a better ability of large manufacturing firms, compared to small and medium-sized ones, to reach their commercialization objectives. Also in the biotechnology sector, the ability of medium-sized to surpass small and large ones in reaching their funding target was associated with a higher ability of medium-sized firms to reach their commercialization objectives. Also, within the manufacturing sector, the percentage of firms from the computer and electronic products manufacturing industry that indicated that they have reached their funding target is higher than the average of the manufacturing sector as a whole. Data also indicate that these firms (computer and electronic products manufacturing firms) did better than firms from other manufacturing industries in terms of reaching many commercialization objectives, such as increasing their exports, reducing delivery time, becoming a market leader, developing a strong demand for the product, and mounting a successful advertising campaign. Therefore, it could be concluded that supporting firms to attain their commercialization funding target could be of a great importance to help firms succeed in achieving their commercialization objectives. There are many ways to improve firms' ability to reach their funding target. For instance, government by providing tax incentives, and lending institutions by improving conditions for firms to obtain financing can play a positive role in allowing firms to reach their commercialization funding target.

**Table 18: Percentage of enterprises that reached or exceeded their commercialization objectives with their most significant and recent innovations by whether or not they reached their funding target**

		ICT Firms		Manufacturing Firms	
		Firms reached commercialization funding target?			
		Yes	No	Yes	No
<b>Commercialization Objectives reached or exceeded</b>	<b>Investment Costs Recovered?</b>	78.7	21.3	79.6	20.4
	<b>Sales Volume Increased?</b>	76.8	23.2	79.9	20.1
	<b>Market Share increased?</b>	75.1	24.9	79	21
	<b>Production Costs Reduced?</b>	68.8	31.2	81.2	18.8

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

To conclude this section, medium-sized firms showed a higher tendency to fund their commercialization activities through venture capital (VC) investments and through private placements, compared to smaller and larger firms, which supports their strong market potential as investors choose to invest in them. These firms do not only take advantage of the capital they get access to, they also benefit from the connections that venture capitalists allow them to establish with business-minded individuals, and from the knowledge and advice they offer to these firms. Data also indicate that there is a positive relation between reaching the funding target to commercialize innovations and the ability of firms to reach their commercialization objectives, which highlights the importance of commercialization financing as an aspect to target to improve commercialization financing .

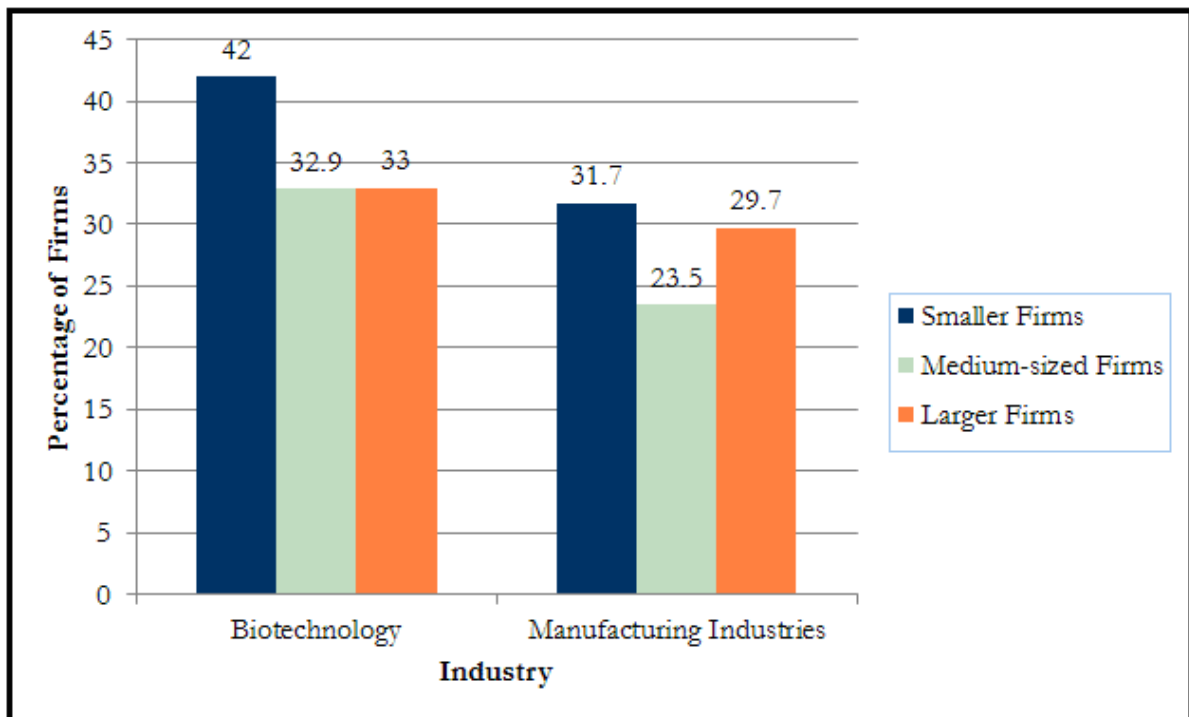
#### **5.4 Cooperative Agreements on Commercialization**

The Survey on the Commercialization of Innovation (2007), included a section covering the involvement of participating firms in cooperative agreements to commercialize innovations. In

this survey, a cooperative agreement on commercialization was defined as involving “the active and joint participation of the enterprise and other firms or organizations in projects to develop or pursue work on the marketing, distribution or promotion of their most significant and recent product innovation. Sub-contracting is not considered a cooperation agreement”.

In both the biotechnology and the manufacturing sectors, small firms tend to participate more than large and medium-sized firms in cooperative agreements to commercialize their innovations. In the biotechnology sector, the percentage of medium-sized firms and the percentage of large firms that participated in such cooperative agreements are very close (32.9% for medium-sized firms and 33% for large firms). Whereas in the Manufacturing sector, the percentage of large firms (29.7%) that established cooperative agreements on commercialization is higher than that of medium-sized firms (23.5%) (see Figure 22).

**Figure 22: Percentage of enterprises that participated in one or more cooperative agreement(s) to market, distribute or promote their most significant and recent product innovations, by firm size**



Previous research has found that firms that introduce innovations that are ‘new to the market’ are much more likely to participate in cooperative arrangements for innovation (Tether 2000). According to the Survey on the Commercialization of Innovation (2007) data (Figure 4), small firms surpassed other firm size categories in both the biotechnology and the manufacturing

sectors in terms of the percentage of firms that indicated that their most recent and significant innovation was new to the market. As well, small firms in both the biotechnology and the manufacturing sectors were found to participate more than larger firms in cooperative agreements to commercialize their innovations; which supports Tether’s findings. On the other hand, one could argue that larger firms are better positioned to participate in cooperative agreements, should they decide to, because they have more resources and capabilities to negotiate and support collaborative relationships (Janne & Frenz, 2007).

In general, the percentage of firms from the computer and electronic product manufacturing sector that are involved in cooperative agreements to commercialize their innovations is higher than that of firms from the biotechnology or the manufacturing industries (see Table 19). 29.6% of computer and electronic product manufacturing firms indicated that they have participated in one or more cooperative agreement(s) to commercialize innovations, compared to 27.9% of biotechnology firms, and 28.5% of manufacturing firms.

**Table 19: Percentage of enterprises that participated in one or more cooperative agreement(s) to market, distribute or promote their most significant and recent product innovations, in the biotechnology, manufacturing, and computer and electronic product manufacturing industries**

	<b>Biotechnology</b>	<b>Manufacturing</b>	<b>Computer and Electronic Products Manufacturing</b>
<b>Percentage of enterprises that participated in one or more cooperative agreement</b>	27.9	28.5	29.6

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

*Reasons to establish cooperative agreements on commercialization:* Firms were asked in the survey to indicate the importance of various reasons in their decision to establish cooperative agreements to commercialize their most recent and significant innovations. The reasons listed on the survey are: accessing skilled or specialized worker, accessing financing, accessing partner’s intellectual property, accessing partner’s expertise, accessing a new market, and accessing an established distribution network. The reliability of the data gathered through this question was not strong enough to allow deriving strong conclusions regarding the different firm size categories covered by the study.

Respondents mostly indicated accessing partner’s expertise, accessing new markets, and accessing an established distribution network as being reasons of a great importance or essential for establishing cooperative agreements for commercializing innovations, especially biotechnology and computer and electronic product manufacturing firms. The percentage of small biotechnology firms that indicated these reasons as essential or of a great importance is greater than the average of the biotechnology sector as a whole. The percentage of medium-sized manufacturing firms that indicated access to skilled or specialized workers and access to partner’s expertise as reasons of a great importance or essential to establish collaborative agreements on commercialization, is greater than the average of firms from the manufacturing industry (Table 20).

**Table 20: Percentage of enterprises that indicated these reasons for establishing cooperative agreements for the marketing, distribution or promotion of the most significant and recent product innovations as essential or of a great importance**

	Biotechnology		Manufacturing				
	Small firms	All Sizes	Small firms	Medium-sized firms	Large Firms	All Sizes	Computer and Electronic Products Manufacturing
Access to skilled or specialized workers	54.6	56	44.3	46.4	F	45.4	46.4
Access to financing	32.7	34	17.8	F	4.7	20.7	13.7
Access to partner's intellectual property	29.3	31.1	25.4	F	F	32.4	24.1
Access to partner's expertise	77.5	75	43.7	55	F	49.6	78.4
Access to a new market	71.6	65.9	55.8	F	F	68.8	82.1
Access to an established distribution network	76.7	73.8	72.1	F	F	69.8	78.5

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

McCutchen and Swamidass (2004, p. 207) propose that in the biotechnology industry, “licensors are strongly motivated to enter strategic alliances in this industry to gain market access”, and that this argument applies to all size categories, but it is stronger among larger licensors. Strategic alliances could be defined as being cooperative agreements between firms, by which they combine their complementary resources, in order to create more value than what each firm can create independently (Das & Teng, 1996; St John & Harrison, 1999). Despite the unreliability of many figures associated with the data concerning this aspect, it is evident that access to a new market, and access to an established distribution network, are two reasons that were identified as

essential or of a great importance to establish cooperative agreements by a significant percentage of biotechnology firms (Table 20) (access to a new market: 71.6% of small biotechnology firms, and 65.9% of biotechnology firms from all size-categories - Access to an established distribution network: 76.7% of small biotechnology firms and 73.8% of biotechnology firms from all size-categories). However, these figures show that smaller firms tend to identify these reasons for cooperation as essential or of a great importance, more than larger firms. Bosse and Alvarez (2010, p. 367) argue that small biotechnology firms “often form strategic alliances with large firms in order to access financial capital and penetrate markets they need to commercialize their new technologies”. They (Bosse and Alvarez, 2010) also argue that large biotechnology firms participate in cooperative agreements to access small firms’ technical capabilities and specific scientific capabilities, whereas small firms participate to get access to markets.

Both in the ICT and in the manufacturing sectors, the percentage of firms that indicated accessing skilled workers and accessing new markets as reasons of a great importance or essential to establish cooperative agreements on commercialization is higher within firms that succeeded in increasing their sales volumes, than within firms that failed to attain this objective. In the ICT sector, the percentage of firms that indicated accessing skilled workers, and accessing financing as reasons of a great importance or essential to establish cooperative agreements on commercialization is also higher within firms that succeeded in increasing their market share, than within firms that failed to attain this objective. In the manufacturing sector, access to a new market is indicated as a reason of a great importance or essential to establish cooperative agreements on commercialization more by firms that succeeded in reaching their commercialization objectives, than by firms that failed to attain these objectives. Same for accessing financing, except that the percentage of manufacturing firms that failed in increasing their sales volume that indicated this reason as of a great importance or as essential to establishing cooperative agreements on commercialization is higher than that of firms that reached this objective (sales volume increase) (Table 21).

**Table 21: Percentage of enterprises that reached their commercialization objectives, for their most significant and recent innovations by the reasons they indicated as essential or of a great importance to participate in cooperative agreements for the marketing, distribution or promotion of innovations**

			ICT			Manufacturing		
			Access to Skilled Workers	Access to Financing	Access to a New Market	Access to Skilled Workers	Access to Financing	Access to a New Market
<b>Commercialization Objectives Reached</b>	<b>Investment Costs Recovered?</b>	Yes	16	3.5	25.4	12.3	8.5	20.5
		No	19.1	7.6	30.8	12.5	4	18.5
	<b>Sales Volume Increased?</b>	Yes	27.4	5.5	39.9	13.9	3.5	22
		No	11.5	6.7	23.2	12.6	9.2	18.2
	<b>Market Share increased?</b>	Yes	27	8.5	26.1	9.1	4.6	20.1
		No	20.5	7.4	28.3	18.2	2.9	18.2
	<b>Production Costs Reduced?</b>	Yes	17.7	3.7	30.2	16.2	10.5	22.4
		No	19.3	13.2	31.2	14.1	2.9	15.6

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

Firms that attributed a great importance to accessing new markets as a reason for establishing cooperative agreements showed a higher ability to succeed in increasing their sales volumes. This could be explained by the fact that firms, in order to increase their sales, could rely on many strategies, including accessing new markets where their products could be sold. More successful manufacturing firms, in general, than the unsuccessful ones, indicated access to new markets and access to financing as reasons that are essential or of a great importance to participate in cooperative agreements on commercialization.

*Customers' involvement:* Firms were asked whether they have developed their most significant and recent product innovation(s) for a major customer. The percentage of manufacturing firms in general, from all size-categories, that indicated that they have developed their most significant and recent product innovation for a major customer, is higher than the percentage of biotechnology firms, and computer and electronic product manufacturing firms who developed their most significant and recent product innovation to a major customer. The percentage of computer and electronic product manufacturing firms (32.9%) that developed their innovation(s) for a major customer is significantly higher than that of biotechnology firms

(21.6%), and lower but close to the percentage of manufacturing firms (34.1) that developed their product innovation for a major customer. This could be seen as an indication of the higher customer-orientation required for these firms (manufacturing firms, including computer and electronic product manufacturing firms, compared to biotechnology firms) in order to be able to respond to their customers specific needs. In terms of firm size, the percentage of medium-sized firms that developed their most significant and recent product innovation for a major customer is higher than their smaller and larger counterparts (Table 22).

**Table 22: Percentage of enterprises that developed their most significant and recent product innovations for a major customer**

	<b>Biotechnology</b>	<b>Manufacturing Industries</b>	<b>Computer and Electronic Products Manufacturing</b>
<b>Smaller Firms</b>	20.7	33.9	N/A
<b>Medium-sized Firms</b>	27.9	36.9	N/A
<b>Large Firms</b>	23	26	N/A
<b>All sizes</b>	<b>21.6</b>	<b>34.1</b>	<b>32.9</b>

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

In one of the questions of the Survey, firms were asked about the level of involvement of their customers in the development of their most significant and recent product innovation(s). Analyzing the data gathered from the answers to this question could have been valuable to identify the effects that such involvement has on the innovation performance of these firms. However, unreliable data were not included in the analysis. Polt, Vonortas, and Fisher (2008) discussed in their paper the involvement of customers as well as other partners in the development of technologies and the positive effect that this could have. In his study, Lau (2011) also found that product innovation is positively correlated with the involvement of customers in its development, which could lead to a better product performance. The unreliability of the data gathered prevents from exploring the differences between firms from different size categories and different industries in involving their customers in the development of their innovations.

### ***5.5 Intellectual Property***

In the ‘*Intellectual Property*’ section of the Survey, firms were asked about the instruments they used to protect the intellectual property rights for their innovations, whether they have

transferred intellectual property rights to another organization using a formal method, and the number of intellectual property rights licensed and obtained by their firms.

*Instruments used to protect IP rights:* The data indicate that the majority of biotechnology firms (82.5%) tend to use trade secrets as a way to protect their intellectual property (IP) rights, with 100% of large biotechnology firms, and 82.1% of small biotechnology firms using this IP instrument to protect their IP rights of their most significant and recent product innovations. Data related to the use of other IP instruments by biotechnology firms were too unreliable to be used in the analysis (Table 23).

**Table 23: Percentage of biotechnology firms that protected the intellectual property rights of their most significant and recent product innovations using trade secrets**

	<b>Percentage of Firms that Used Trade Secrets to Protect their IP</b>
<b>Smaller Firms</b>	82.1
<b>Medium-sized Firms</b>	F
<b>Large Firms</b>	100
<b>All sizes</b>	82.5

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

Data relating to the intellectual property (IP) section of the survey indicate that trade secrets are used by most biotechnology firms to protect their IP rights. No data were provided relating to the use of IP instruments in the manufacturing sector. Despite that the statistics concerning IP instruments other than trade secrets are too unreliable, which prevents from making the comparison, previous studies have treated this topic, which allows deriving some conclusions. For instance, in a study that was conducted by Leiponen and Byma (2009), most of small firms they examined find informal means of protection such as speed to market and secrecy as being more important than patenting. Traoré and Rose (2005) also argued that smaller firms tend to prefer secrecy over patenting as a way to protect their innovations, given their limited resources. Our data do not allow comparing between the use of different IP instruments, but it is evident that, given the high percentage of biotechnology firms (both small and large) that rely on trade secrets to protect their IP rights, that it is a very important IP instrument for biotechnology firms.

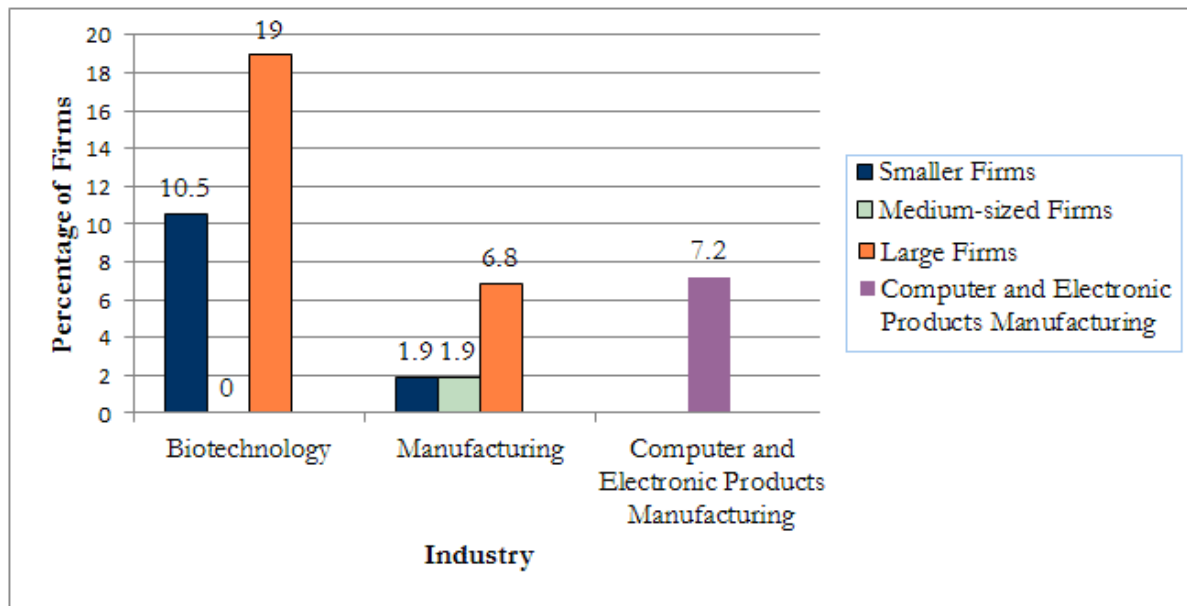
When it comes to medium-sized firms, there are no reliable data to rely on in analyzing their use of different IP instruments. Previous studies (Gans et al., 2002; Gans & Stern, 2003) argue that

patents are very beneficial for venture capital-financed firms. Given that medium-sized firms are more likely to be financed by venture capital investors than other firms, one could argue that patenting is very important for these firms.

A significant part of the survey's data pertaining to patenting came too unreliable to be published. However, existing studies, such as the one conducted by Traoré and Rose (2005, p. 10) explain that “large firms, because they have more resources, can channel more of these resources to support their inventive activity and adopt a more aggressive patenting strategy in order to reap more revenues from their inventions”. Large firms rely on their legal departments, which tend to have a lot of experience and expertise in filing patent applications (Traoré & Rose, 2005). This explanation could be used to explain why larger firms are more likely to transfer IP rights to other organizations than small and medium-sized firms (Figure 23). It is important to note that, in this study (Traoré & Rose, 2005), small and medium-sized firms were found to conduct cutting-edge research, leading to developing knowledge with quality and novelty. Therefore, should they seek to patent their innovations, the quality and novelty of their research allow them to obtain patents.

*Transfer of IP rights:* Biotechnology firms are more likely to transfer IP rights to other organizations using a formal method, such as licensing agreements and technology transfer agreements, than manufacturing firms. Within the manufacturing industry, computer and electronic products manufacturing firms are also more likely to use these formal methods to transfer IP rights to other organizations more than firms from other manufacturing sectors. When it comes to firm size, large firms (19% of large biotechnology firms and 6.8% of large manufacturing firms) tend to use these IP rights transfer methods more than small firms (10.5% of small biotechnology firms and 1.9% of small manufacturing firms). Medium-sized firms (0% of medium-sized biotechnology firms and 1.9% of medium-sized manufacturing firms) are more likely to use these IP rights transfer methods less than firms from other size categories (Figure 23).

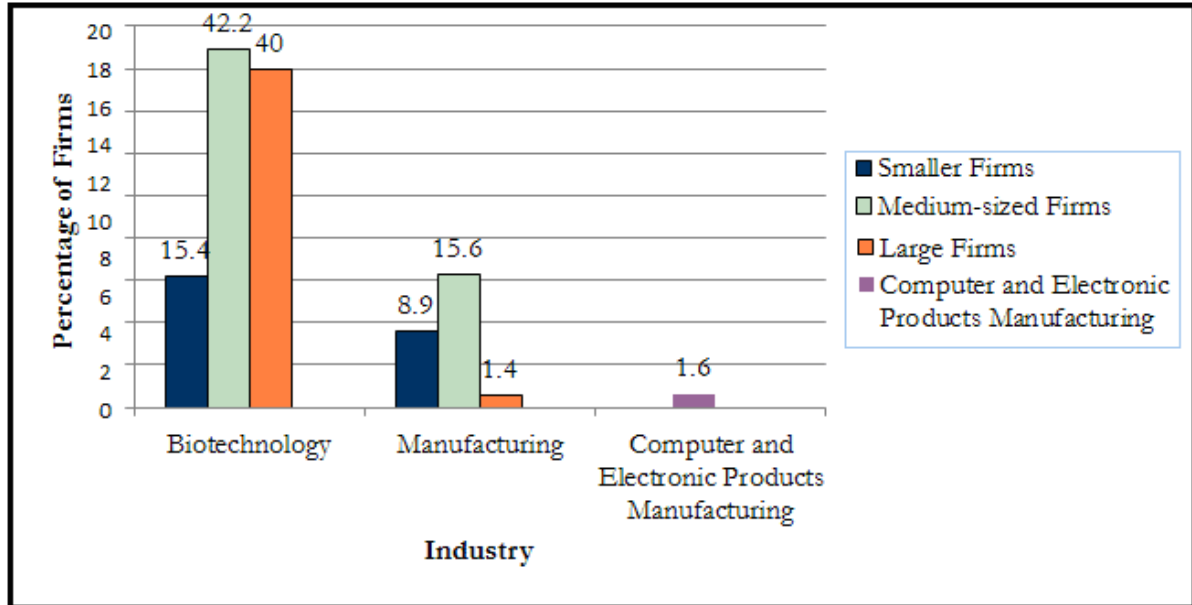
**Figure 23: Percentage of enterprises that transferred intellectual property rights to another organization using a formal method (licensing agreement, technology transfer agreement) for a new or significantly improved good or service in 2006, by firm size**



Leiponen and Byma (2009) argue in their study that complex products, such as computer and electronic products, usually require many different components in their construction, thus requiring accessing technologies from other organizations; which explains why patenting is more important in industries generating these products than in industries generating discrete products. This could explain what the data have indicated, in terms of the higher tendency of computer and electronic product manufacturing firms to transfer IP rights to other organizations, compared to firms from other traditional manufacturing sectors (Figure 23).

*Acquiring IP rights:* Biotechnology firms (19.8%) are more likely to acquire IP rights for their innovations, than manufacturing (10.5%) and computer and electronic products manufacturing firms (9.4%). In both the biotechnology and the manufacturing sectors, medium-sized firms are more likely to acquire IP rights for their innovations than firms from other size categories (42.2% of medium-sized biotechnology firms, and 15.6% of medium-sized manufacturing firms). In the biotechnology sector, small firms are less likely to acquire IP rights for their innovations (15.4% of small biotechnology firms compared to 40% of large biotechnology firms). In the manufacturing sector, large firms are less likely to acquire IP rights for their innovations compared to firms from other size categories (1.4% of large firms, compared 8.9% of small firms) (Figure 24).

**Figure 24: Percentage of enterprises that acquired intellectual property rights for a new or significantly improved good or service, by firm size**



A very important aspect that this data reveal is the higher tendency of medium-sized firms to acquire intellectual property rights for their innovations, and their lower tendency to transfer IP rights to other organizations, compared to small and large firms. This outlines their ability to develop their products into innovations, and to develop other organizations R&D products into innovations, as well. Traoré and Rose (2005) have argued in their paper that medium-sized firms usually choose to develop their inventions into new products, instead of transferring their knowledge through IP instruments to other organizations to generate innovations. Such an observation could very well support the argument stating that these firms (medium-sized firms) are very well positioned to lead Canada's commercialization improvement. This also leads to arguing that, the cooperation between smaller firms that may not have the sufficient resources to develop their R&D outputs into innovations, or academic institutions and universities, and medium-sized firms could be of a great importance to generate innovations contributing to improving Canada's innovation and commercialization performance. To decrease the loss of such research efforts, these organizations should acknowledge the importance of establishing cooperative agreements to turn knowledge into innovations, and Governments should encourage such collaborations. An important factor that can facilitate such cooperation, and encourage firms to invest in innovation is establishing strong intellectual property laws enforcing the protection of firms' intellectual properties, thus enabling the potential for technology transfer (OECD, 2010).

In the biotechnology sector, firms are more likely to obtain IP rights through patents (70.9%) than through other IP instruments, such as licensing agreement (41.8%), and technology transfer agreements (13.4%). 100% of medium-sized biotechnology firms have indicated that they have obtained licenses from other firms or organizations, whereas 0% of these firms acquired IP rights through technology transfer agreements. Small firms are also more likely to use licensing agreements (27%) more than technology transfer agreements for their innovations.

**Table 24: Percentage of biotechnology firms that indicated the type of IP rights obtained, in 2007, for their most significant and recent product innovation(s), by firm size**

	<b>Patent</b>	<b>Licensing agreement</b>	<b>Technology transfer agreement</b>
<b>Smaller Firms</b>	F	27	20.6
<b>Medium-sized Firms</b>	F	100	0
<b>Large Firms</b>	X	X	X
<b>All sizes</b>	70.9	41.8	13.4

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

The data indicate that most of small manufacturing firms (93.4%) relied on licensing agreements to acquire IP rights, whereas 8.9% of medium-sized manufacturing firms, 16.8% of large manufacturing firms and 11.3% of computer and electronic product manufacturing firms used technology transfer agreements to acquire IP rights for their most recent and significant product innovations. The unreliability of most of the figures (see Table 25), limits the ability to compare the use of different IP instruments to acquire IP rights, between firms from different size categories, and from different industries.

**Table 25: Percentage of manufacturing and computer and electronic products manufacturing enterprises that indicated the type of intellectual property (IP) rights obtained, in 2007, for their most significant and recent product innovations, by firm size**

<b>Industry</b>	<b>Firm Size</b>	<b>Licensing agreement</b>	<b>Technology transfer agreement</b>	<b>Other</b>
<b>Manufacturing</b>	<b>Smaller Firms</b>	93.4	F	F
	<b>Medium-sized Firms</b>	F	8.9	F
	<b>Larger Firms</b>	F	16.8	0
	<b>All sizes</b>	F	F	F
<b>Computer and Electronic Products Manufacturing</b>	<b>All sizes</b>	F	11.3	7.1

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

To summarize, the data demonstrate that medium-sized firms have a higher tendency to acquire intellectual property rights for their innovations and a lower tendency to transfer IP rights to other organizations, compared to their smaller and larger counterparts, which outlines their ability to develop their products and other organizations' R&D products into innovations.

## SECTION 6 - DISCUSSION AND IMPLICATIONS

*Distinction between small and medium-sized firms:* Data suggest that there should be a differentiation between small firms and medium-sized firms when comparing their characteristics affecting their ability to introduce innovations to the market. The commercialization abilities in terms of introducing innovations to the market differ between small and medium-sized firms, specifically in the biotechnology sector; there is no linear relationship between firm size and the ability of firms to introduce innovations to the market. Therefore, it is illogical to combine small and medium-sized firms in one size category when studying their commercialization abilities; this will mask the specific characteristics allowing both medium-sized and small firms to commercialize innovations. This study proposes considering small and medium-sized firms as two distinct size categories in innovation and commercialization research.

*Firms-size and ability to commercialize innovations – sectoral differences:* The effect of firm size on the ability of firms to introduce innovations to the market differs from one industry to another. In the manufacturing sector, the ability to introduce innovations to the market increases with the increase of firm size; whereas in the biotechnology sector, this relationship does not follow a linear pattern. In terms of industry differences, larger firms are better able to innovate and to reach their commercialization objectives in the manufacturing sector, whereas smaller firms innovate more in the biotechnology sector than in the manufacturing sector. Sectoral differences between the biotechnology and manufacturing industries could explain the differences in the innovation processes, and agents' decisions and behaviors in terms of their innovation strategies and investments, thus impacting the innovative performance of firms. The nature of innovations and technologies and the required knowledge base to develop innovations differ across these sectors, which influence the type and the structures of relationships and networks established between firms. Institutions, which include laws, regulations, and standards, also comprise differences across these sectors, thus affecting firms' innovation strategies, and their involvement in networks to develop innovations.

*Medium-sized firms' commercialization capabilities:* Medium-sized firms' ability to introduce innovations to the market seems to be the same in the manufacturing and in the biotechnology sectors (Figure 1). Medium-sized firms tend to outperform smaller and larger firms in the biotechnology sector, and smaller firms in the manufacturing sector, in reaching their

commercialization objectives. Innovative medium-sized firms are better able to introduce higher numbers of innovations compared to smaller and larger firms in both the manufacturing and the biotechnology sectors; which highlights the importance of the transition of medium-sized firms from not being innovators (not introducing any innovations to the market) to being able to innovate, in order to contribute positively to the improvement of Canada's innovation performance. Another observation that outlines the innovativeness of medium-sized firms in the biotechnology sector is their ability to introduce innovations to the market in a significantly shorter period of time compared to firms from other size categories (see Table 3). Also, medium-sized firms show a stronger ability to conduct many commercialization activities both abroad and in Canada compared to smaller and larger firms; which is an indication of their ability to insert themselves into the global markets (see Figures 6, 7, 8 and 9).

A very important aspect that the data revealed is the higher tendency of medium-sized firms to acquire intellectual property rights for their innovations, and the lower tendency to transfer IP rights to other organizations, compared to small and large firms. This outlines their ability to develop their products and other organizations' R&D products into innovations. Therefore, universities or smaller firms who might not have sufficient resources to develop their R&D outputs into innovations, could benefit from cooperating with medium-sized firms to transform this knowledge into innovations; this could be of a great value to improving Canada's innovation and commercialization performance. Firms should acknowledge the importance of establishing cooperative agreements to turn knowledge into innovations, and governments should encourage such collaborations. An important factor that can facilitate such cooperation, and encourage firms to share knowledge is establishing strong IP laws enforcing the protection of firms' intellectual properties, thus enabling the potential for technology transfer (OECD, 2010).

All these observations support medium-sized firms' ability to commercialize innovations and to be at the forefront of improving Canada's innovations' commercialization performance.

*Computer and electronic product manufacturing firms:* Compared to other manufacturing firms, firms from the computer and electronic product manufacturing industry show a higher ability to generate innovations, to perform commercialization activities both in Canada and abroad, and to reach their commercialization objectives. This aspect is crucial for these firms to be able to survive in their fast changing markets, where their products become out of date and are cranked

out by the introduction of newer technologies at a faster rate than in other industries (Butje, 2005). This also outlines the higher ability of these firms to insert themselves into the global system of production and distribution, compared to firms from other industries, which is crucial in order to be able to compete at the international arena. Computer and electronic products manufacturing firms also showed a higher tendency to transfer IP rights to other organizations, compared to firms from other traditional manufacturing sectors (Figure 23). These firms, given that the products they generate are complex, thus requiring more components in their construction, require accessing technologies from other firms more than firms from other industries.

*Sources of innovations' ideas:* Data reveal that, in small firms, entrepreneurs or CEOs generate most of the ideas or concepts of firms' innovations (see Figure 5). Therefore, the experience and the qualifications of the CEO or entrepreneur are central to the generation of these firms' innovations. However, it is important to note that, under such conditions, the motivation and the willingness of employees to contribute to the generation of ideas or to questioning or challenging the ideas generated by their superiors will be hindered. Therefore, it is important in these firms to establish the appropriate climate to motivate and welcome the input and involvement of employees in the ideas' generation process. Also in firms where employees were found to have more involvement in the generation of innovations' ideas (medium-sized and larger firms), it is important to offer these employees the appropriate climate and conditions motivating them to contribute to the generation of ideas, and to acknowledge their contributions.

*Customer orientation:* Both small and medium-sized biotechnology firms showed a higher tendency than larger firms to provide customer-specific services, both in Canada and abroad. And the percentage of medium-sized firms that developed their most significant and recent product innovation(s) for a major customer is higher than that of larger firms. These firms (medium-sized firms) are better positioned to deal with the lack of customer orientation problem that Canadian businesses, in general, suffer from.

*Skills development:* The lack of skills is one of the obstacles to innovation in Canada (Statistics Canada, 2010). Medium-sized biotechnology firms provide training to their employees on how to market their innovations more than smaller and larger firms (Figures 6 and 7). Therefore,

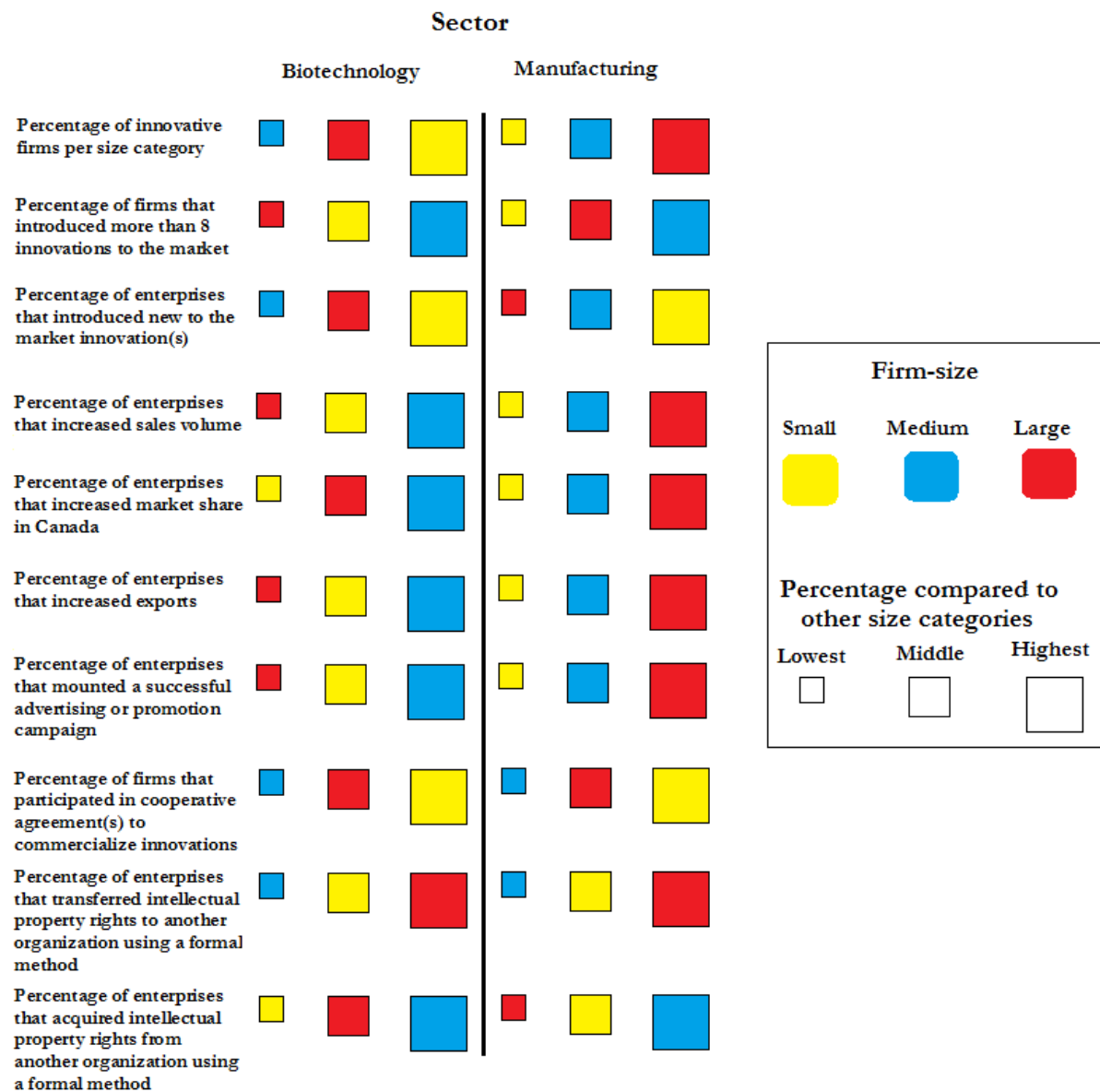
these firms show a better propensity and commitment to invest in developing their employees marketing skills, thus improving the conditions needed to succeed in commercializing innovations.

*Partnerships with universities:* An important observation of this study is that firms in general, including successful ones (those that reached their commercialization objectives) indicated “*Seeking partnership with universities*” as a strategy of little importance. This could be seen as a negative factor affecting the overall commercialization performance in the Canadian economy. Missing the opportunity of establishing partnerships with universities involve losing the knowledge they generate, with all the investments made to produce this knowledge, without transforming it into innovations. By not establishing such partnerships, firms lose the benefit of exploiting this knowledge. This study proposes encouraging such partnerships, where universities could become ideas’ factories that nurture firms’ (particularly medium-sized firms) innovation pipeline to be thereafter developed into commercial products by these firms, thus leading to improving Canada’s innovation and commercialization performance. Medium-sized firms outperformed smaller and larger firms, both in the manufacturing and the biotechnology sectors, in terms of seeking partnerships with universities as part of their commercialization activities (Figures 16 and 17). This aspect could be seen as supporting the argument stating that universities could represent ideas factories for these firms, which thereafter work on taking such knowledge to be then commercialized. And this could also be an indication that medium-sized firms are better positioned than firms from other size categories to commercialize university-generated knowledge and transform it into innovations.

*Commercialization financing:* Medium-sized firms tend in general to use private placements and venture capital (VC) investments as sources of funding to commercialize innovations more than smaller and larger firms. Also, firms from the computer and electronic product manufacturing industry tend to rely more than firms from other manufacturing industries on private placements and VC investments to fund their commercialization activities. Therefore, these firms will benefit, not only from the capital they get access to, but also from the knowledge and abilities that these investors will bring by managing them. As well, these firms (that fund their commercialization activities through private placements and VC investments) are seen as promising by these investors who screen inventions and ideas and identify those that have the greatest market potential to invest in.

*Reaching funding target:* There is a positive relation between reaching the funding target to commercialize innovations and the ability of firms to reach their commercialization objectives. Therefore, supporting firms to attain their commercialization funding target could be of a great importance to help firms succeed in achieving their commercialization objectives. There are many ways to improve firms' ability to reach their funding target, such as tax incentives programs offered by the Government, and improving lending conditions, especially for small and medium-sized firms, by financial institutions.

**Figure 25: Summarizing Figure – Firm Size and Commercialization Capabilities of Firms from the Biotechnology and Manufacturing Sectors**



## SECTION 7 - CONCLUSION

Based on the analysis of the data gathered through the Survey on the Commercialization of Innovation (2007), it becomes evident that there is a difference between the performance of medium-sized firms and smaller firms when it comes to their abilities to conduct commercialization activities and to meet their commercialization objectives (Figure 25). Therefore, there should be a differentiation between small and medium-sized firms in innovation and commercialization research, rather than combining them under the SMEs category. When a relationship is revealed between firm size and innovation or commercialization capabilities, this relationship is not always linear; which means that the differences based on some indicators between smaller and medium-sized firms, could be even more pronounced than the differences between smaller and larger firms. It is also important to note that the relationship between firm size and the ability of firms to innovate and commercialize innovations differs from one sector of activity to another. For instance, in the biotechnology sector, the percentage of smaller firms that introduced innovations to the market exceeded that of larger and medium-sized firms, respectively; whereas in the manufacturing sector, the percentage of larger firms that introduced innovations to the market exceeded that of medium-sized and smaller firms, respectively. Using different indicators could also lead to different conclusions regarding the relationship between firm size and innovation and commercialization performance.

In the case of Canadian medium-sized firms, there are many indications highlighting their strong ability to commercialize innovations compared to smaller and larger firms, such as:

- Medium-sized firms from the biotechnology sector show a strong ability to introduce innovations to the market in a significantly shorter period of time than smaller and larger biotechnology firms.
- Medium-sized firms from both the biotechnology and manufacturing sectors could be seen as representing a higher return potential than smaller and larger firms, given that they attract more venture capital investments.
- Medium-sized firms show a higher tendency to acquire IP rights for their innovations, and a lower tendency to transfer IP rights to other organizations, compared to smaller and larger firms. This highlights their ability to develop their products and other

organizations' R&D outputs into innovations. This aspect also leads to arguing that the cooperation between medium-sized firms and smaller firms, which may not have sufficient resources to develop their R&D outputs into innovations, or academic institutions and universities, could be of a great importance to generate and commercialize innovations contributing to improving Canada's innovation and commercialization performance.

- Medium-sized firms from both the biotechnology and the manufacturing sectors have surpassed larger and smaller firms in terms of the percentage of firms that conducted many commercialization activities both in Canada and abroad. This outlines the commitment that these firms have and the resources they devote to conducting their commercialization activities, and their ability to insert themselves into the global market.
- In the biotechnology sector, the percentage of medium-sized firms that spent on commercializing their innovations an amount that is greater than the development costs, is greater than that of smaller and larger biotechnology firms.
- The ability of medium-sized innovators to introduce higher numbers of innovations exceeds the ability of firms from other size categories in both the biotechnology and the manufacturing sectors. Therefore, the transition of medium-sized firms from being non-innovators (not introducing any innovations to the market) to being able to innovate, could lead to a significant improvement in Canada's innovation performance, given the high number of innovations that innovative medium-sized firms are able to bring to the market.

There are many important aspects and propositions presented in the literature reviewed that are worth emphasizing. As presented earlier in this study, the Council of Canadian Academies, the Panel of Experts on Commercialization, and the CBOC have generated reports offering many propositions to improve Canada's weak innovation and commercialization performance. These propositions converge around common themes, such as: focusing investments in fields in which Canada excels, the need and access for financing, encouraging competition by removing trade and investments barriers, encouraging partnerships and collaboration between academia, research institutions, government, and businesses, development of talents and human capital,

improving tax regimes, and encouraging the growth of SMEs. All these aspects are crucial to improving Canada's innovation and commercialization performance. Such propositions could positively contribute to overcoming many of the obstacles associated with Canada's innovation and commercialization problems such as: the lack of motivation of firms to innovate (given the weak competition mainly attributed to the size of the Canadian market and to the existing trade and investments barriers), the lack of human resources qualified to promote products, and the weak collaboration between academia, research institutions, government, and businesses. In addition to these factors, there are other aspects that should be targeted in order to contribute to improving Canada's innovation and commercialization performance, which include encouraging firms to adopt more customer oriented and innovation-oriented strategies, and strategies involving a greater risk-taking and promoting a culture of innovation. Firms should also be more encouraged to hire and develop highly qualified people with sophisticated technical and business skills and experiences. Another proposition to target the labour productivity problems experienced in Canadian businesses is to invest more in leading edge technologies, which could help improve Canada's productivity growth. And given the low export-to-import ratios for high-technology goods in Canada, Canadian high-tech firms should become motivated to innovate even more, not only to offer their products to the Canadian market, but also to adopt export-oriented strategies. For instance, Government initiatives could involve becoming a main client that procures Canadian-made high-technologies, providing incentives to Canadian businesses to adopt Canadian high-tech innovations, and offering incentives and support to high-tech firms to export their innovations.

Given the significant number of government programs and initiatives aiming to improve Canada's innovation performance, and the results related to Canada's innovation and commercialization performance presented in many recent studies that revealed that Canada is lagging behind its counterparts, future studies could target reviewing and evaluating these programs. This could allow exploring what changes should be made to these programs and to their application to better contribute to improving Canadian firms' innovation and commercialization performance, and if there are other areas/factors that should be considered by government's initiatives, in addition to the ones already considered.

## APPENDICES

## **Appendix A: Government of Canada's Programs Supporting Innovation and Commercialization**

The following Government of Canada programs provide *research grants and funding* opportunities to firms:

- Canadian Institutes of Health Research
- Genome Canada
- National Research Council (NRC) – Industrial Research Assistance Program (IRAP)
- Industry Canada – Sources of Financing
- Industry Canada – Government Services and Programs – Financing
- Industry Canada – Federal Government Assistance Programs (by research area)
- Business Gateway Finance Section
- Farm Credit Canada
- Business Development Bank of Canada
- Networks of Centers of Excellence

The following federal departments and agencies provide *research assistance* programs:

1. National Research Council (NRC)
  - Biotechnology Research Institute
  - Industrial Research Assistance Programs (IRAP)
  - Federal Partners in Technology Transfer
  - Canadian Technology Network
2. Agriculture and Agri-Food Canada
  - Research-Centres
3. Other Federal Agencies
  - Canadian Institutes of Health Research
  - Natural Sciences and Engineering Research Council of Canada
  - Genome Canada

The federal and provincial governments also provide *tax incentive programs* to encourage R&D in the areas of science and technology. Government of Canada's largest tax incentive and funding program supporting business activity is the Scientific Research and Experimental Development (SR&ED), with a total tax expenditure of \$2.5 billion in 2005. Along with similar provincial tax incentive programs, Canada's tax treatment of R&D expenses is rated one of the best in the world. The following lists the federal and provincial tax incentive programs:

1. Federal – Canada Customs and Revenue Agency
  - Science Research and Experimental Development (SR&ED)
2. Provincial and Territorial Programs
  - Alberta Tax Incentives
  - BC Scientific Research and Experimental Development Tax Credit

- Manitoba Tax Incentives
- New Brunswick 10 percent Tax Credit
- Newfoundland Tax Incentives
- Northwest Territories – Resources, Wildlife and Economic Development
- Nova Scotia Research and Development Tax Credit
- Ontario R&D Tax Credits
- Quebec Corporations – Tax Related forms
- Saskatchewan Tax Credits
- Yukon Investment Tax Credit

The following federal departments and agencies provide other *information products* supporting commercialization activities:

1. Industry Canada
  - Life Sciences Gateway
  - Canadian Intellectual Property Office
2. National Research Council
  - Agri-Food, Agriculture, and Environment
  - Competitive Intelligence Pathfinder
3. Health Canada
  - Novel Foods
  - Medical Devices
  - Drug Products
  - Biologic and Genetics
  - Cosmetic Products
4. Agriculture and Agri-Food Canada
  - Research and Innovation
5. Canadian Food Inspection Agency
  - Biotechnology
6. Natural Resources Canada
  - Science and Technology
  - Sustainable Development
7. Department of Fisheries and Oceans
  - Scientific Excellence
  - Aquaculture Collaborative Development Program
  - Ocean and Aquaculture Science Branch
8. Environment Canada
  - Science and Technology
9. International Trade Canada
  - Market Reports and Services Abroad – By Sector
  - Science and Technology Program
10. Other Federal Agencies and Programs
  - Canadian Institutes of Health Research
  - Genome Canada

## Appendix B: Canada's Innovation Historical Record

Figure 26: Canada's Innovation Historical Record for the Last Three Decades

REPORT CARD			
Innovation in Canada			
	1980s	1990s	2000s
Overall	D	D	D
Scientific articles	B	B	C
Technology exchange	D	D	D
Patents by population	D	D	D
Share of world patents	D	D	D
High- and medium-high-technology manufacturing	D	D	D
Knowledge-intensive services	D	D	C
Export market share: Aerospace	D	C	C
Export market share: Electronics	D	D	D
Export market share: Office machinery and computers	D	D	D
Export market share: Pharmaceuticals	D	D	D
Export market share: Instruments	D	D	D
Top 100 brands	D	D	D

Source: The Conference Board of Canada.

Source: The CBOC, 2008

**Appendix C: Recommendations to Improve Canada's Innovation Performance**

**Table 26: Summary of Recommendations to Improve Canada's Weak Innovation Performance**

**The Council of Canadian Academies (2009)**

1. Enhance competition
2. Foster the supply of finance for new ventures
3. Encourage the transformation of university and government research into innovation
4. Reform regulations that may be inhibiting ICT investment in certain service sectors
5. Continue to improve the design of tax incentives, and
6. Design ways to encourage innovation-based business strategies in sectors where Canada has demonstrated strengths or significant opportunities

**The Panel of Experts on Commercialization (2005)**

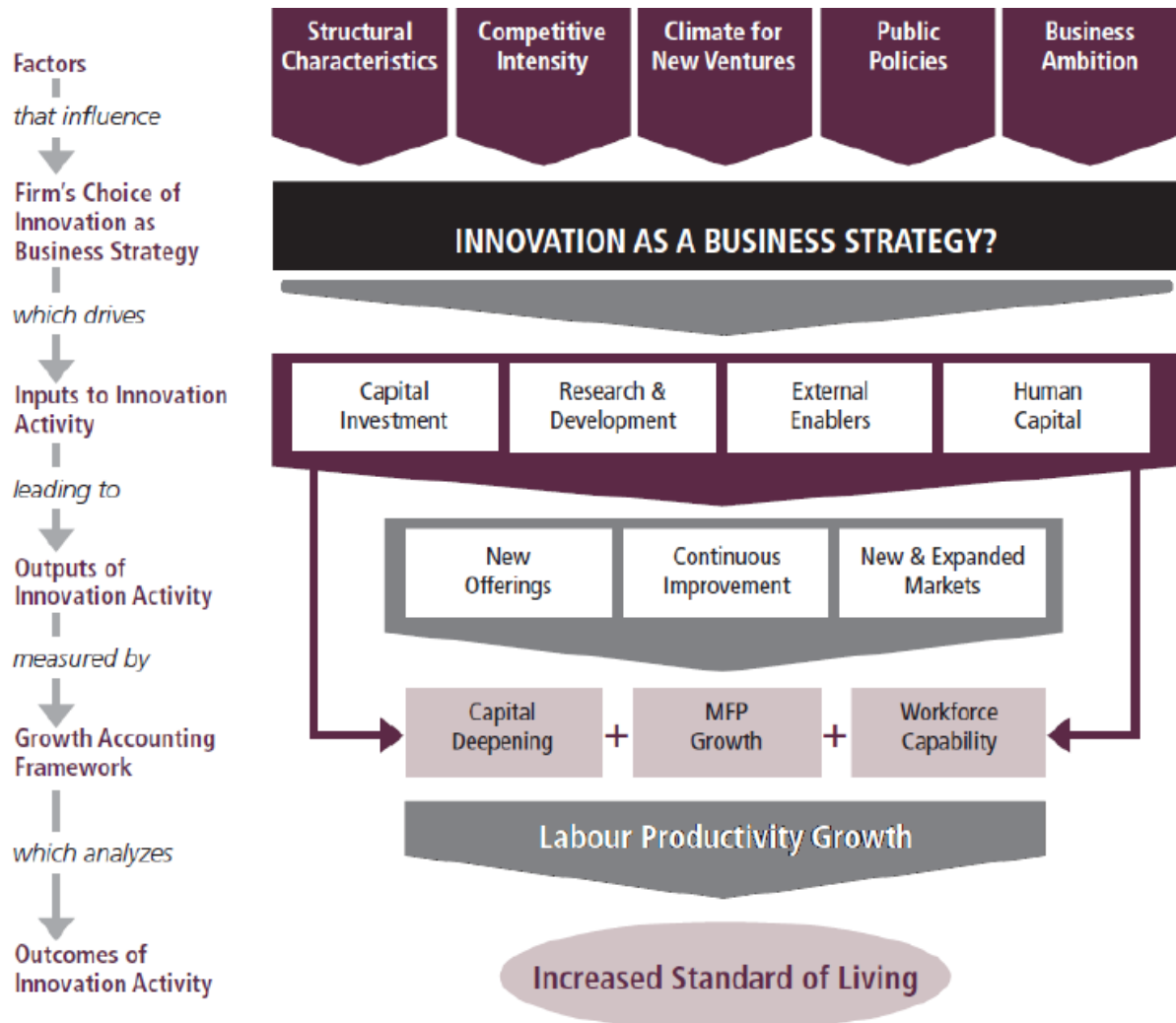
1. Spur employer hiring of recent graduates with commercialization talents
2. Increase business demand for talent through development of a new Canada commercialization fellowships program
3. Encourage and celebrate young Canadians who aim for success in business, science and technology
4. Develop and retain talent for success in a global marketplace
5. Create a commercialization superfund to address key commercialization challenges
6. Expand federal programs that support seed and start-up firms in proving their business ideas
7. Increase the commercialization involvement of small and medium-sized enterprises through a Canadian SME partnerships initiative
8. Improve access to early-stage angel financing and expertise
9. Remove barriers to foreign venture capital investment
10. Improvements to Canada's tax regime
11. Increasing competitive intensity within the Canadian marketplace

**The Conference Board of Canada (Guthrie & Munn-Venn, 2005). The priorities are:**

1. Picking Our Paths to Prosperity: Establish priority areas in which Canada will be global best.
2. Skilled People: Building Global: Best Teams for Global-Best Commerce - Increase corporate investment in strategic training and recruitment.
3. Research and Linkage: Bolstering Private Sector Activity - Increase corporate collaboration and investment in research, development, and innovation.
4. Investment and Risk Capital: Bagging the Big Bucks - Increase international and domestic risk capital investment in Canada and focus on bigger deals.
5. Knowledge-Based Clusters and Supply Chains: Cultivating Our Companies as World-Class Investors - Expand innovation in industrial supply chains.
6. National Programs and Capacities: Driving the Strategy through Evidence - Institute an independent national advisory program on innovation-based commerce.

***Appendix D: Logic Map of the Business Innovation Process***

**Figure 27: Logic Map of the Business Innovation Process**



Source: Report in Focus – Innovation and Business Strategy: Why Canada Falls Short (Council of Canadian Academies, 2009)

**Appendix E: All Manufacturing Industries Covered by the Survey on the Commercialization of Innovation, 2007**

**Table 27: Manufacturing Industries Covered by the Survey on the Commercialization of Innovation (2007)**

<b>Industry</b>	<b>NAICS Code</b>
Food manufacturing	311
Beverage and tobacco product manufacturing	312
Textile mills	313
Textile product mills	314
Clothing manufacturing	315
Leather and allied product manufacturing	316
Wood product manufacturing	321
Paper manufacturing	322
Printing and related support activities	323
Petroleum and coal products manufacturing	324
Chemical manufacturing	325
Plastics and rubber products manufacturing	326
Non-metallic mineral products manufacturing	327
Primary metal manufacturing	331
Fabricated metal product manufacturing	332
Machinery manufacturing	333
Computer and electronic product manufacturing	334
Electrical equipment, appliance and component manufacturing	335
Transportation equipment manufacturing	336
Furniture and related product manufacturing	337
Miscellaneous manufacturing	339

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

**Appendix F: Commercialization Objectives of ICT Firms that Carried out a Campaign to Recruit Personnel Specialized in Commercialization**

Table 28: Percentage of firms that carried out a campaign to recruit personnel specialised in commercialization, both in Canada and abroad, by the commercialization objectives that they have reached, and those that they have not reached.

			Percentage of Manufacturing Firms		Percentage of ICT Firms	
			In Canada	Abroad	In Canada	Abroad
<b>Commercialization Objectives</b>	Investment Costs Recovered?	Objective Fully Reached or Exceeded	21.5	9.4	12.6	18.0
		Objective Not Reached	17.7	12.8	24.4	31.5
	Sales Volume Increased?	Objective Fully Reached or Exceeded	22.8	17.0	21.6	29.0
		Objective Not Reached	17.3	7.5	21.3	25.2
	Market Share increased?	Objective Fully Reached or Exceeded	21.3	13.2	26.7	19.4
		Objective Not Reached	18.2	14.6	21.3	34.6
	Production Costs Reduced?	Objective Fully Reached or Exceeded	21.2	13.4	29.0	29.6
		Objective Not Reached	19.5	7.9	9.1	22.7

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

**Appendix G: Percentage of Firms that Provided Training to their Employees on How to Market their Products**

**Table 29: Percentage of firms that provided training to their employees on how to market their products, both in Canada and abroad.**

	Percentage of Manufacturing Firms		Percentage of Biotechnology Firms	
	In Canada	Abroad	In Canada	Abroad
Smaller Firms	39.8	14.0	50.9	27.3
Medium-sized Firms	51.1	43.2	80.9	52.9
Larger Firms	57.0	60.7	59.0	23.0

Source: Statistics Canada, Survey on the Commercialization of Innovation, 2007

## BIBLIOGRAPHY

1. Acs, Z., & Audretsch, D. (Eds.). (1990). *Innovation and small firms*. Cambridge, MA: MIT Press.
2. Alvarez, S. A., & Barney, J. B. (2001). How entrepreneurial firms can benefit from alliances with large partners. *Academy of Management Executive*, 15(1), 139-148.
3. Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of Management Journal*, 39(5).
4. Anderson, P., & Tushman, M. L. 1990. Technological discontinuities and dominant designs: A cyclical model of technological change. *Administrative Science Quarterly*, 35: 604-633
5. Arora, A., & Gambardella, A. (1990). Complementarity and external linkages: The strategies of the large firms in biotechnology. *Journal of Industrial Economics*, (4), 361-379.
6. Audretsch, D. B., & Feldman, M. P. (1996). R&D spillovers and the geography of innovation and production. *American Economic Review*, 86(630), 630-640
7. Bagchi-Sen, S. (2006). Strategic considerations for innovation and commercialization in the U.S. biotechnology sector. *European Planning Studies*, 15, 754-765.
8. Balachandran, B., Faff, R., Theobald, M., and Velayutham, E. (2009). Seasoned Equity Offerings, Quality Signalling, and Private Benefits of Control.
9. Baldwin, J.R. (2000). *Innovation and Training in New Firms*. Ottawa, Canada: Statistics Canada.
10. Barrows, D. (1992). Canada's global competitiveness. *Meeting the Global Challenge*, 31-46.
11. Bommer, M., & Jalajas, D. (2002). The innovation work environment of high-tech SMEs in the USA and Canada. *R&D Management*, 32(5), 379-386.
12. Bosse, D. A., & Alvarez, S. A. (2010). Bargaining power in alliance governance negotiations: Evidence from the biotechnology industry. *Technovation*, 30(5-6), 367-375. doi:10.1016/j.technovation.2010.01.003.
13. Bowling, A. (1997). *Research Methods in Health*.
14. Bramanti, A., & Ratti, R. (1997). The multi-faced dimensions of local development. In R. Ratti, A. Bramanti & R. Gordon (Eds.), *The dynamics of innovative regions. The GREMI approach*. London: Ashgate.
15. Brzustowski, T. (2008). *The way ahead – meeting Canada's productivity challenge*.
16. Butje, M. (2005). *Product marketing for technology companies*, Elsevier Ltd.
17. Chaney, P. K., Devinney, T. M., & Winer, R. S. (1991). The impact of new product introductions on the market value of firms. *Journal of Business*, 64(4)

18. Chih-Hai, Y. (2006). Is innovation the story of Taiwan's economic growth?, *Journal of Asian Economics*, 17(5), 867-878.
19. Coase, R. H. (1937). The nature of the firm. *Economica*, 4, 386-405.
20. Cooper, R. (1993). Winning at new products: Accelerating the process from idea to launch.
21. Council of Canadian Academies, (April 2009) Report in Focus - Innovation and Business Strategy: Why Canada Falls Short.
22. Dale, J. (February 2004). Commercialization of Ottawa high tech clusters from research to markets or is that from markets to research. *Ottawa Business Journal*.
23. Das, T. K., & Teng, B. (1996). Risk types and inter-firm alliance structures. *Journal of Management Studies*, 33(6), 827-843.
24. Diamond, D. W. (1991). Monitoring and reputation: The choice between bank loans and directly placed debt. *Journal of Political Economy*, 99, 689-721.
25. Dillman, D. A. (1991). The design and administration of mail surveys. *Annual Review of Sociology*, 17, 225-249.
26. Doz, Y. L. (1988). Technology partnerships between larger and smaller firms: Some critical issues. *International Studies of Management and Organisation*, 17(4).
27. Dutta, S., Narasimhan, O., & Rajiv, S. (1999). Success in high-technology markets: Is marketing capability critical? *Marketing Science*, 18(4), 547.
28. Ettlie, J. (1997). Integrated design and new product. *Management Science*, 41, 1224-1237.
29. Fageberg, J. (2003). Innovation: A guide to the literature. Centre for Technology, Innovation and Culture. University of Oslo.
30. Gans, J. S., Hsu, D. H., & Stern, S. (2002). When does start-up innovation spur the gale of creative destruction? *Rand Journal of Economics*, 33(4), 571-586.
31. Gans, J. S., & Stern, S. (2003). The product market and the market for "ideas": Commercialization strategies for technology entrepreneurs. *Research Policy*, 32(2), 333-350.
32. Godin, B. (2006). The linear model of innovation: The historical construction of an analytical framework. *Science, Technology & Human Values*, 31, 639-667.
33. Gracia, J. L., & Arias, C. A. (2000). An empirical approach to the financial behaviour of small and medium sized companies. *Small Business Economics*, 14, 55-63.
34. Gredel, D., Kramer, M., & Bend, B. (2011), Patent-based investment funds as innovation intermediaries for SMEs: In-depth analysis of reciprocal interactions, motives and fallacies. *Technovation*, doi:10.1016/j.technovation.2011.09.008
35. Guthrie, B., & Munn-Venn, T. (2005). Six quick hits for Canadian commercialization.
36. Hamel, G. (1998). Strategic flexibility: Managing in turbulent environments.

37. Hanel, P. (2008). The use of intellectual property rights and innovation by manufacturing firms in Canada. *Economics of Innovation and New Technology*, 17(4), 285-309.
38. Herath, D., Cranfield, J., Henson, S., & Sparling, D. (2008). Firm, market, and regulatory factors influencing innovation and commercialization in Canada's functional food and nutraceutical sector. *Agribusiness*, 24(2), 207-230.
39. Hitt, M. A., Hoskisson, R. E., & Ireland, R. D. (1990). Acquisitive growth and commitment to innovation in M-form firms. *Strategic Management Journal*, 11, 29-47.
40. Hogan, T., & Hutson, E. (2005). What factors determine the use of venture capital? Evidence from the Irish software sector. *Venture Capital*, 7(3), 259-283.
41. Iansiti, M., & West, J. (1997). Turning great research into great products. *Harvard Business Review*, 75, 69-79.
42. Industry Canada. (2005). Intellectual property and innovation in the Knowledge-Based economy.
43. Industry Canada. (2006). People and excellence: The heart of successful Commercialization.
44. International council for small business world conference. (2008). Innovate or Evaporate: Lessons from Japanese SME's, Halifax, Nova Scotia, Canada.
45. Janne, O. E., & Frenz, M. (2007). Patents and collaborations for innovation: An analysis of the fourth UK community innovation survey. DRUID Summer Conference 2007 on Appropriability, Proximity, Routines and Innovation, Copenhagen, Denmark.
46. Jukka-Pekka, S., & Ahti, S. (2002). Rationales for Government Interventions in the Commercialization of New Technologies. *Technology Analysis and Strategic Management*, 14(2): 183-200
47. Kamien, M. I., & Schwarz, N. L. (1982). Market structure and innovation.
48. Kaplinsky, R. (1983). Firm size and technical change in a dynamic context. *The Journal of Industrial Economics*, 32, 39-59.
49. King, D. R., Covin, J. G., & Hegarty, W. H. (2003). Complementary resources and the exploitation of technological innovations. *Journal of Management*, 29(4), 589-606.
50. Kohli, C. S., & Leuthesser, L. (1993). Product positioning: a comparison of perceptual mapping techniques. *Journal of Product & Brand Management*, 2(4).
51. Kollmer, H., & Dowling, M. (2004). Licensing as a commercialization strategy for new technology-based firms. *Research Policy*, 33(8), 1141-1151.
52. Lau, A. K. W. (2011). Supplier and customer involvement on new product performance. *Industrial Management & Data Systems*, 111(6), 910-942.
53. Leiponen, A., & Byma, J. (2009). If you cannot block, you better run: Small firms, cooperative innovation, and appropriation strategies. *Research Policy*, 38(9), 1478-1488.
54. Lerner, J. (2010). Innovation, entrepreneurship and financial market cycles. OECD Directorate for Science, Technology and Industry. Science, Technology and Industry Working Papers, 2010(3), 1-55.

55. Luukkonen, T., & Palmberg, C. (2007). Living up to the expectations set by ICT? The case of biotechnology commercialization in Finland. *Technology Analysis & Strategic Management*, 19(3), 329-349.
56. Malerba, F., & Orsenigo, L. (1995). Schumpeterian patterns of innovation. *Cambridge Journal of Economics*, 19, 47-65.
57. Malerba, F. (2002). Sectoral systems of innovation and production. *Research Policy*. 31, 247-264.
58. Malerba, F. (2005). Sectoral systems of innovation: a framework for linking innovation to the knowledge base, structure and dynamics of sectors. *Economics of Innovation and New Technology*. 14, 63-82.
59. Marinova, & Phillimore. (2003). Models of innovation. In L. V. Shavinina (Ed.), *The international handbook on innovation* (pp. 44-53), Pergamon.
60. McCutchen Jr, W. W., & Swamidass, P. M. (2004). Motivations for strategic alliances in the pharmaceutical/biotech industry: Some new findings. *Journal of High Technology Management Research*, 15(2), 197-214.
61. Mc Namara, P. & Baden-Fuller, C. (2005) 'Financial Feedback, Shareholder Wealth, and the Exploration-Exploitation Dilemma' Economic and Social Research Council, *Evolution of Business Knowledge Working Paper Series 23 :1-40*.
62. Mittelstädt, A. & Cerri, F. (2008), "Fostering Entrepreneurship for Innovation", OECD Science, Technology and Industry Working Papers, OECD publishing.
63. Moorsel, D. V., Cranfield, J. A. L., & Sparling, D. (2007). Factors affecting biotechnology innovation in Canada: Analysis of the 2001 biotechnology use and development survey. *International Journal of Biotechnology*, 9(1), 39-59.
64. Munn-Venn, T., & Mitchell, P. (2005). Don't overlook the "MEs" medium-sized firms show the way to global success.
65. Murray, R. (1999). Fundamental issues in questionnaire design. *Accident & Emergency Nursing*, 7, 148-153.
66. Mylonakis, J., Evripiotis, M., Orfanos, V., & Tsatsanis, D. (2008). Methods and techniques for effective electronic advertising. *Franklin Business & Law Review*, 2008(4), 87-96.
67. Traoré, N., & Rose, A. (2005). Commercialization of innovation by Canadian biotech firms: Pathways from ideas to market. *Statistics Canada*.
68. OECD. (2005). OSLO manual: Guidelines for collecting and interpreting innovation data.
69. OECD. (2009). Measuring entrepreneurship: A collection of indicators. *OECD Science, Technology and Industry Scoreboard*,
70. OECD. (2010). Ministerial report on the OECD innovation strategy, innovation to strengthen growth and address global and social challenges, key findings. *OECD*.

71. Oppenheim, A. N. (Ed.). (1992). *Questionnaire design, interviewing and attitude measurement*. London: Continuum.
72. Pavitt, K., & Soete, L. L. G. (1982). International differences in economic growth and the international location of innovation. *Emerging Technologies: Consequences for Economic Growth, Structural Change, and Employment*, 105-133.
73. Phillip, L. (2008). The role of creative innovation in economic growth: Some international comparisons. *Journal of Asian Economics*, 19(4), 334-347.
74. Polt, W., Vonortas, N. & Fisher, R. (2008). *Innovation impact: An analysis of the impact of publicly funded FP5 and FP6 projects on innovation*. Retrieved April, 2011, from [http://dimetic.dime-eu.org/dimetic\\_files/Innovation\\_Impact\\_Final\\_Report\\_published%204.pdf](http://dimetic.dime-eu.org/dimetic_files/Innovation_Impact_Final_Report_published%204.pdf)
75. Powell, W. W. (1996). Inter-organizational collaboration in the biotechnology industry. *Journal of Institutional and Theoretical Economics*, 120(1), 197-215.
76. Rao, S., Ahmad, A., Horsman, W., & Kaptein-Russell, P. (2001). Importance de l'Innovation pour la productivité, direction générale de l'analyse de la politique micro-économique.
77. Roberts, E. B. (1980). New ventures for corporate growth. *Harvard Business Review*, 58(4), 134-142.
78. Rothwell, R. (1989). Small firms, innovation and industrial change. *Small Business Economics*, 1, 51-64.
79. Samila, S., & Sorenson, O. (2010). Venture capital as a catalyst to commercialization. *Research Policy*, 39(10), 1348-1360.
80. Sapsford, R. (1999). Selecting, designing, and developing your questionnaire. In *Survey research*. London: Sage.
81. Sauermann, H., Incentives as drivers of innovative processes and performance. Duke University. *Business Administration*.
82. Shane, S., & Stuart, T. E. (2002). Organizational endowments and the performance of university start-ups. *Management Science*, 48, 154-170.
83. SME Financing Data Initiative. (2004). *Canadian venture capital activity: An analysis of trends and gaps (1996–2002)*.
84. SME Financing Data Initiative. (2003). *SME financing in Canada, 2003 — SME marketplace*.
85. St. John, C. H., & Harrison, J. S. (1999). Manufacturing-based relatedness, synergy, and coordination. *Strategic Management Journal*, 20(2), 129-145.
86. Statistics Canada. (2010). *Highlights of the survey of innovation and business strategy (SIBS 2009)*. Retrieved 02/10, 2011, from [http://www.ic.gc.ca/eic/site/eas-aes.nsf/eng/h\\_ra02118.html](http://www.ic.gc.ca/eic/site/eas-aes.nsf/eng/h_ra02118.html)
87. Statistics Canada. (2007). *North American industry classification system (NAICS) 2007 - Canada*. Retrieved 09, 2011, from <http://www.statcan.gc.ca/subjects-sujets/standard-norme/naics-scian/2007/introduction-eng.htm>

88. Statistics Canada, (2007), Report on Interviews on the Commercialization of Innovation, Catalogue no. 88F0006XIE, no. 004, 25 pages
89. Statistics Canada. (December 2007). Business register.
90. Stock, G. N., Greis, N. P., & Fischer, W. A. (2002). Firm size and dynamic technological innovation. *Technovation*, 22(9), 537-549.
91. Submission to the expert review panel on research and development, Canada's fifteen leading universities. (2011). Retrieved 08/25, 2011, from [http://rd-review.ca/eic/site/033.nsf/vwapj/sub198.pdf/\\$file/sub198.pdf](http://rd-review.ca/eic/site/033.nsf/vwapj/sub198.pdf/$file/sub198.pdf)
92. Tether, B. (2000). Who co-operates for innovation within the supply-chain, an analysis of the United Kingdom's innovation survey. CRIC Discussion Paper no 35.
93. The Conference Board of Canada. (2008). Innovation, how Canada performs: A report card on Canada.
94. The Conference Board of Canada. (2010). Innovation, how Canada performs: A report card on Canada, High- and Medium-High-Technology Manufacturing. Retrieved 12/02, 2011, from <http://www.conferenceboard.ca/HCP/Details/innovation/High-medium-high-technology-manufacturing.aspx>
95. Traoré, N. (2004). Canadian biotechnology firms' creative capacity: On the role of absorptive capacity, relational capital, learning, and firm characteristics. *International Journal of Biotechnology*, 6(1), 1-19.
96. Traoré, N., & Rose, A. (2005). Commercialisation of innovation by Canadian biotech firms: Pathways from ideas to market. Statistics Canada.
97. Utterback, J. M. (1971). The process of technological innovation within the firm. *Academy of Management Journal*, 14, 75-88.
98. Vermeulen, P. (2005). Uncovering barriers to complex incremental product innovation in small and medium-sized financial services firms. *Journal of Small Business Management*, 43(4), 432-452.
99. Vincent, L. H. (2005). Marketing strategy formulation in the commercialization of new technologies. Georgia Institute of Technology.
100. Wruck, K. H., & Wu, Y. (2009). Relationships, corporate governance, and performance: Evidence from private placements of common stock. *Journal of Corporate Finance*, 15(1), 30-47.
101. Wruck, K. H. (1989). Equity ownership concentration and firm value. *Journal of Financial Economics*, 23(1), 3-28.
102. Xia, T., & Roper, S. (2008). From capability to connectivity—Absorptive capacity and exploratory alliances in biopharmaceutical firms: A US–Europe comparison. *Technovation*, 28(11), 776-785.
103. Zahra, S. A., & Nielsen, A. P. (2002). Sources of capabilities, integration, and technology commercialization. *Strategic Management Journal*, 23, 377-398.