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What Distinguishes Innovative Firms from Other Firms:

Results from the 1999 Innovation Survey

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ABSTRACT

Using data from the 1999 Survey of Innovation, this paper evaluates the incidence of innovation for the manufacturing industries between 1997-1999. Data shows that more than 80 percent of manufacturing firms have introduced an innovation between 1997 and 1999, and that the ICT industry is the most innovative. This paper also examines the business practices followed by innovative as well as non-innovative firms. Results validate the assumption of complementarities of activities linked to innovation. Being involved in several activities to innovation drastically increases the likelihood of being a successful innovator.

INTRODUCTION

It is now well recognized that R&D expenditure is not the sole channel leading to innovation. As a result, the R&D component is not longer sufficient to distinguish potentially innovative firms from other firms. For instance, Napolinato (1991), found for Italian manufacturing firms, that R&D activities count for only 18 % of expenditure on innovative activities. He concludes that "R&D activities, being only one phase of the innovation process, cannot be an accurate indicator of a firm's commitment to technological activities".

Acquisition of technological information or machinery and equipment; adoption of new organizational routines; and hiring experienced knowledge workers are also important parts of the innovation process. Moreover, recent studies (OECD, 2000; Brouwer and Kleinknecht, 1999) assert that collaboration between firms or between firms and public organizations, such as laboratories or universities, is useful to foster innovation and to diffuse knowledge. Collaborative firms, by interactive learning, can more easily benefit from knowledge developed outside the firm and bring this knowledge into innovation.

Surveys on innovation in the Canadian manufacturing industries have been carried out in last decades to better understand the dynamics of this complex interaction of factors leading to innovation. The previous survey on innovation (1993 Survey of Innovation and Advanced Technology) was very successful in providing a broad overview of the innovative activities of Canadian firms. We learned that, even though 65 per cent of firms performed R&D, only half of them successfully brought new products or new processes to the market. The survey results also clarify the objectives and impact of innovation, as well as the obstacles to these activities.

However, many macro-economic and institutional transformations have occurred since the early 1990s. Globalization increases competition and puts more pressure on firm's efforts to improve their performance. New managerial paradigms and a widespread use of information and communication technologies (ICT) have led to new "buy or make" decisions in the firms' innovation strategy. A new innovation survey was undertaken in 1999 to shed some light on the responsiveness of firms to innovate in this new competitive environment.

In this paper, we use data from the 1999 Innovation Survey to provide new information on the innovative process and to determine the factors that distinguish innovative firms from non-innovative ones.

The second section of this paper will describe the survey and its characteristics. The third section will present some findings about the practices followed by innovative and non-innovative firms and, finally, the last section will use econometrics to underline what distinguishes a successful innovator from an unsuccessful one.

SURVEY DESCRIPTION

The Survey of Innovation 1999 was conducted by Statistics Canada. It is based on a sample of "provincial enterprises" in the Canadian manufacturing sector and selected natural resources industries. A "provincial enterprise" consists of all establishment of a given enterprise in the same industry within a province[1]. Each "provincial enterprise" had revenues of at least $250,000 and more than 19 employees.

Approximately 6000 provincial enterprises in manufacturing industries and 800 in selected natural resources industries were surveyed. The survey was completed by CEOs[2], and the response rate was over 90 per cent.

The objective of the 1999 Innovation Survey is primarily to provide new information on innovative and non-innovative firms[3]. For this purpose, a questionnaire was designed to identify innovators (product and/or process innovators) and establish a profile of the practices followed by these firms.

The questionnaire can be divided into two sections. The first section deals with general statements such as whether or not a firm is involved in a competitive environment, and which factors are important for the success of a firm. This section also deals with questions regarding research and development, intellectual property, and government support programs. All firms in the sample answered these questions.

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1 If an enterprise, for instance, owned two establishments producing the same product but in different provinces, these two establishments are considered as two different sample units (two separate "provincial enterprises"). In the same manner, if another enterprise owned two establishments producing different products in the same province, these two establishments are also considered as two different sample units.

2 CEOs with more than one "provincial enterprise" were sent more than one questionnaire.

3 For the remaining analysis, firm will refer to the sample unit "provincial enterprise".

The second section of the questionnaire is related to innovation and whether or not a firm introduced an innovation between 1997-1999, or at least tried to innovate. Only firms which answered positively to these questions (innovate or tried to innovate) were asked to answer questions related to innovation activities such as: sources of information; the relevance of activities linked to innovation; and collaborative arrangements for innovation. Other questions addressed commercialization strategies, financial outcomes, and other impacts of innovation, as well as information on impediments to innovation.

INNOVATION AND BUSINESS PRACTICES

Incidence of innovation

A very large proportion of firms surveyed introduced innovations[4] during the 1997-1999 period. As seen in Figure 1, more than 80 per cent of manufacturing firms have implemented a new, or significantly improved, product or process.

The percentage of innovative firms may seem surprisingly high[5]. A comparison can be made with the European "Second Community Innovation Survey (CIS2) 1997-1999". Results from the CIS2

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[4] Definition of innovation was based on Oslo manual (1996) and included new or significantly improved products or processes that have been implemented during the 1997-1999 period. This definition does not include changes to existing products which are purely aesthetic or which only include minor modifications.

[5] One may note that using the Oslo definition, an innovative firm is a firm which either produced an innovation (new to the market) or introduced an innovation (new to the firm but not new to the market) in its production process.

survey show that 53% of manufacturing enterprises introduced an innovation during the 1997-1999 period which is much lower when it is compared to the Canadian innovative firm's performance[6]. However, results from the CIS2 also show that large enterprises are definitely more innovative (81%) than smaller ones (respectively 59% and 44% for medium-size and small enterprises). Given that only Canadian firms with at least $250,000 of revenue and at least 20 employees were surveyed, the Canadian sample surveyed mostly large firms[7]. Therefore, it may be appropriate to be cautious when we compare the frequency of innovative firms from both surveys. As a result, the gap between European and Canadian innovative firms may be smaller than what it is suggested by raw numbers.

For the remaining 20 percent of non-innovative firms, the survey allows us to split them into two categories. The first category (7.2%) consists of firms who tried to innovate, but have either failed or have not yet completed projects leading to a new or significantly improved product or process. The second category (12.6) includes firms which did not try to innovate and, therefore, were not engaged in activities linked to innovation.

The incidence of innovation appears to be more concentrated in ICT firms (Figure 2). Machinery Manufacturing, and Petroleum & Chemical Manufacturing ranks respectively second and third. It is not surprising to find these industries at the top because of the high technological content required for doing business in these industries. However, one may be surprised by the small difference

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[6] Results come from Eurostat Statistics in Focus, Community Innovation Survey 1997/1998, Theme 9– 2/1999 (http://europa.eu.int/eurostat.html).

[7] Threshold for the Canadian survey are more than 19 employees which had a revenue of at least $250,000. For the CIS2 survey, the only cut-off point for inclusion in the target population is 20 employees. Moreover, the cut-off point for the Canadian survey has been applied for each "provincial enterprise".

between these industries and the less innovative, such as Textile, Clothing and Leather industries. It can be explained by the definition used, which included producers as well as users of innovation.

Competitive environment

Innovative and non-innovative firms agreed (see Figure 3) that the ability of customers to easily substitute products, the rapid pace of change of office technologies, and the threat of new products in the market are symptomatic of a strong competitive environment[8]. These three statements were ranked among the highest when firms were asked to depict their competitive environment.

Both innovators and non-innovators also recognize that qualified workers are difficult to hire, but report that, once hired, they do not have problems retaining them. Of innovative firms, 63 percent agreed that qualified workers are difficult to hire but only half reported that it is hard to retain them.

What distinguishes innovators from non-innovators is the perception of the rapid obsolescence of production technologies. Innovative firms are twice as likely to agree that production technologies change rapidly than non-innovative firms[9]. Disaggregating non-innovative firms between

[8] This survey uses widely ordinal questions (rate of importance from 1 to 5). All along the paper, we report frequencies of firms which ranked a given statements of importance "4" (agree) or" 5" (strongly agree).

[9] See Table A1 for a summary of significant factors that distinguish innovative firms from non-innovative firms or unsuccessful innovators. Chi-square tests (α= 0.005) have been performed.

unsuccessful innovators[10] and firms that did not try to innovate, revealed the same pattern, but the gap is wider for firms which did not try to innovate (half as likely than innovative firms to agree that production technology changes rapidly) than for unsuccessful innovators (about one third less likely than innovative firms).

Even though innovative firms agreed more frequently than non-innovators for almost each statement on the competitive environment, the difference between the response of innovators and non-innovators is quite small (and even non-significant). Therefore, firms' responses to the competitive environment questions do not help (except for the perception about the rapid change of production technologies) to distinguish innovative firms from non-innovative ones.

Firms' success factors

Innovators and non-innovators share the same view on the importance of consolidating markets (see Figure 4). Both of these groups have considered satisfying existing clients and promoting firm or product (good or service) reputation as the most important success factors.

Experienced human capital is also seen as important to firm's success. While training employees and

10 Unsuccessful innovators include firms who tried to innovate, but have either failed or have not completed projects to develop or introduce new or significantly improved products or processes. Unfortunately, it is not possible to further separate the former group from the latter as no question in the survey allows disaggregation. We called the whole group "unsuccessful innovators" because both of them have failed to introduce innovation for the 1997-99 period.

hiring experienced employees are important factors for firms' success, hiring new graduates from universities or technical schools and colleges are considered only of minor importance[11]. This finding is quite interesting. It shows that firms put more emphasis on the informal learning system (training and experience) than in the formal schooling system. Firms prefer to hire experienced workers and/or giving a specific training (based on the firm's specific needs) to their employees instead of using the more formal and general education system.

Innovators place a higher priority on developing new products and processes, and on performing R&D than non-innovators. The likelihood of reporting that developing innovations or performing R&D (as firm's success factors) is much higher for innovative firms than for other firms. These results may not be surprising as firms which are not involved in innovation activities are unlikely to report that performing R&D or innovating are of much importance to them. However, comparing only successful and unsuccessful innovators shows that successful innovators are also more likely to report that these activities (see Table 1) are important to their success than unsuccessful innovators.

As mentioned earlier, hiring new graduates from universities or colleges are considered only slightly important (as measured by their ranking). Nevertheless, innovative firms are more likely than non-innovative firms to mention them as an important success factor.

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[11] Hiring new graduate form universities and from colleges are not shown in the Figure 4 because they rank lower than tenth. They rank respectively fifteenth and twelfth out of sixteen factors for innovative firms.

Finally, even though involvement in collaboration with other firms ranked quite low (14^{th}) for all firms surveyed, the likelihood of seeing collaboration as an important success factor is much higher (twice as likely) for successful innovative firms.

Objectives of innovation

Innovators report that they innovate primarily to improve product quality, increase production capacity, and extend product range (see Figure 5). These findings are in line with firm success factors where innovators place high priority on satisfying existing clients (by improving product quality) and seeking new markets (by extending product range).

The importance of increasing speed to market is reflected in the reduction of production time, the improvement of production flexibility, and the increased speed of delivering products to market. These objectives fit into a strong competitive environment. As mentioned before, "easy substitutions of my products for the products of my competitors" and the "arrival of competing products" in the market were perceived as predominant in a competitive environment.

The relevance of these top six objectives is commonly agreed upon by successful and unsuccessful innovators as the ranking is essentially the same for the two categories of firms[12]. The sole exception is that the likelihood to report "extend product range" as an objective of innovation is much lower

[12] Firms who were not involved in activities linked to innovation were not supposed to answer this part of the survey. Therefore, for the rest of the paper, we will focus our analysis only on successful and unsuccessful innovators.

for unsuccessful innovators.

Even though the objective "To replace products being phased out" rank relatively low (8th for successful innovators), this objective is more of a concern for successful than unsuccessful innovators, as the former are twice as likely to report that this is an important objective than unsuccessful innovators.

Environmental issues were ranked far lower as an objective of innovation. For example, dealing with or responding to new government regulations was ranked lowest, followed by reducing energy consumption or environmental damage. The frequency of reporting these objectives as important does not change whether the firm is innovative or not. Therefore, questions regarding environment issues are not useful in distinguishing successful from unsuccessful innovators.

Activities linked to innovation

Figure 6 shows that firms primarily acquired embodied technology with new machinery and equipment. The striking feature of this figure is that, although there is a minor difference between successful and unsuccessful innovators engaged in the acquisition of machinery and equipment, unsuccessful innovators are much less likely than successful innovators to get involved in other complementary activities to innovate, such as: training, R&D, tooling up and industrial engineering.

Literature suggests that a firm performing R&D enhances its technological absorptive capacity.

Besides the principal task to support the future development of new products or new processes, performing R&D also permits a firm to use more efficiently embodied technology acquired externally (acquisition of machinery, equipment or other technology)[13]. As states by Casselman and Veugelers (2000): "The performance of a firm's innovation strategy that relies on successfully integrating externally acquired technology, depends [...] on the ability of the firm [by its internal research capacity] to appropriate the benefits from this innovation".

Therefore, doing R&D or buying embodied technology should also be accompanied by a qualified labour force to be fully efficient. Several authors pinpoint the importance of complementarities between employees' skills, firm's competencies and innovation[14]. As noted in the introduction, R&D activities are not sufficient to assure that a firm will be innovative, however, it is rather a complex interaction of factors or activities (where R&D activities remain important) that lead a firm to be innovative. Therefore, being involved in only one or a few activities would restrain firms' technological absorptive capacity and, as a result decreases the likelihood to innovate. This is consistent with findings from Table 2 where unsuccessful innovators are less likely than successful innovators to be engaged in several activities linked to innovation.

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[13] Cohen and Levinthal (1989) underline the dual role of R&D – creation of new knowledge, and capacity to assimilate and exploit externally available information. Ernst (1998) reviews some of the principal functions that can be performed by research. He mentions a better understanding of presently used techniques, transferring technologies from external sources into the firm, facilitating personnel acquisition, strengthening information exchange and establishing (international) research cooperation.

[14] See, for instance, Bresnahan et al. (1999) and Leiponen (2000) for papers on complementarity between skill, technology and internal organization (firm's competencies). See also Chennells & Van Reenan (1998) or Berman et al. (1993)for papers on technological change. Goldin & Katz (1996) show that complementary between skills and technological change will depend of the nature on the technology used but, at least for last decades, technological change has been biased toward skilled workers.

Collaborative and cooperative arrangements can also be seen as another innovation activity (Figure 7). For successful innovators involved in these arrangements, the top three reasons to collaborate are: accessing critical expertise; accessing R&D; and prototype development.

As noted before, innovators are more likely than unsuccessful innovators to see collaboration with other firms as an important success factor. It is not surprising, therefore, that frequency of collaboration for successful innovators (33 %) is larger than for unsuccessful innovators (16%). However, as the pool of unsuccessful innovators is quite small (7.2% of the whole population, see Figure 1) and the sub-sample of them which collaborate is even smaller (1% of the population), they cannot be split further to investigate the reasons to collaboration as the results would suffer reliability problems. Nevertheless, results showing that successful innovators are more likely than unsuccessful ones to collaborate are interesting findings.

Obstacles to innovation

The two major impediments to innovation are the inability to devote staff to projects to develop innovations on an on-going basis because of production requirements and the high costs of developing new or significantly improved products or processes (see Figure 8). Further analysis will explore whether these obstacles are more related to small firms[15]. Only these two impediments out of the fifteen are recognized by more than half of the respondents (a little less for the unsuccessful

[15] As the data related to the size of the firms have not been released, we cannot yet explore this assumption. Statistics Canada staff are currently working on linking the 1999 Survey of Innovation with other databases; and, we will, therefore, be able to test this assumption later.

innovators as they stand at 40 percent).

Except for the lack of skilled personnel and financing (respectively, 37 percent and 26 percent of innovative firms), all other impediments are judged as important by less than 20 percent of manufacturing firms. For instance, the inability to qualify for government assistance programs or to access expertise in university and government laboratories that could assist in developing or introducing innovations (reported as important by only 15%, 5% and 4% respectively) are not seen as major impediments to innovate.

Differences between successful and unsuccessful innovators are either small or not statistically significant[16]. Therefore, obstacles to innovation do not appear to be an important factor for distinguishing unsuccessful innovators from successful ones.

[16] The difference in percentage is less than 25% for all factors. Therefore, these factors are not reported in Table 1.

Government support programs for innovation

The majority of innovative firms across manufacturing industries have used government support programs and, of these, "Research and development tax credit" is by far the most popular program (see Figure 9). This finding corroborates the previous one where both successful and unsuccessful innovators indicated that the difficulty in accessing government programs was not seen as a major impediment to innovation.

However, the likelihood of using government support programs is much lower for unsuccessful innovators. Of course, as seen earlier, unsuccessful innovators are less likely to perform R&D activities, so it is not surprising that they also report less frequent use of government support programs related to R&D relative to successful innovators. It is, nevertheless, striking that only 4% of unsuccessful innovators used the government R&D grant program.

This section outlines some similarities and differences between innovative and non-innovative firms were found. One of these differences is that innovators attach more importance to collaboration than non-innovators, as they are more likely to see it as an important success factor. Indeed, looking at the frequency of collaboration, we found that successful innovators were also more likely to be involved in collaborative agreements than unsuccessful ones. In the same manner, successful innovators are more likely to indicate that performing R&D is an important success factor, and are also more involved in R&D activities and more widely use R&D government support programs –

tax credit or grants – for innovation. These results show that there is consistency between firm managers' strategies and firms' action or, in other words, what they expect to do is borne out by what they choose to do (revealed preferences) .

The characteristics studied in this section help us to draw a specific profile of business practices followed by successful innovators. However, this analysis is limited by being strictly descriptive and gives only a first idea of what distinguishes an innovative firm from a non-innovative one. To develop a more in-depth profile, it is possible to perform a multi-variate econometric analysis, where the individual effects are controlled by the presence of other variables. This is the purpose of the next section.

MODEL AND RESULTS

The main objective of this paper is to underline specific characteristics that distinguish innovative firms from non-innovative ones. The impact of different characteristics on being an innovative firm is analysed using logistic regression. The econometric model can be written as:

$$\Pr[Succes\_Innov] = \beta_0 + \beta_i X_i + \beta_S (Succes\_factors) + \\ \beta_G (Gvt\_pgms) + \beta_E (Environment) + \beta_C (Cooperation) \\ + \beta_A (Act\_multi) + \varepsilon$$

Where Succes_Innov is a binary dependent variable indicating whether or not a firm is a successful innovator. X_i is a set of industrial and regional dummies. Succes_factors refer to a set of firms' success factors. Gvt_pgms represents government support programs used by a firm. Environment refers to a set of variables indicating the competitive environment faced by a firm. Cooperation and Act_multi are binary variables indicating respectively whether or not a firm is involved in cooperation, and whether or not a firm is engaged in several activities linked to innovation (three and more). Finally ε is the error term. Alternative models can also be tested as, for instance, replacing the Act_multi binary variable by a set of variables indicating specific activities undertaken.

The rationale to include industrial dummies in the model is quite standard in the literature. Each industry will face different technological challenges and obstacles. Potential appropriability of the innovation and technological opportunities are different by industries and, therefore, the willingness to innovate or probability to successfully bring an innovation into the market will be different by industry.

Regional dummies -- Atlantic, Quebec, Ontario, Prairies, and British Columbia -- are also included in the model because the specific location of the firm may also be an important factor to succeed to innovate. Ideally, we would have liked to distinguish firms by metropolitan areas (instead of regions) as knowledge infrastructure is seen as important for innovation. It is safe to argue that each firm in a neighbourhood (or metropolitan area) will face the same environment and will be able to use the same knowledge infrastructure (as universities and labs). Using regions (as a proxi for metropolitan areas) means that we assume that each firm will be able to use the specific knowledge infrastructure of the region.

As seen in the previous section, only a few statements are viewed as important for distinguishing successful innovators from unsuccessful ones. In order to reduce potential collinearity, we will add, in the regression, only factors already identified as important in the descriptive analysis.

Table 3a and 3.b present results from the Logit model described above. Model (1) of Table 3.a deals with the dependent variable defined as successful innovators versus non-innovators (grouping unsuccessful innovators and firms that did not try to innovate together). As firms not involved in innovation activities did not answer questions regarding objectives of innovation, activities linked to innovation, or cooperation, these variables have not been used in this first regression.

Results show that firms located in Quebec or Ontario are more likely to innovate. Further analysis using metropolitan areas instead of the region dummy would tell us if this finding support the cluster assumption: Innovative firm are highly geographically agglomerated. As stated by Baptista and Swann (1998), "The importance of knowledge spillovers can make geographical proximity vital for innovative activity". The Montreal area of the province of Quebec and, Toronto as well as Ottawa areas for the province of Ontario, would serve as metropolitan agglomerations with strong knowledge infrastructures[17].

Firm managers who indicated that the arrival of new competitors or competing products are constant threats, as well as indicating that production technologies change rapidly, are more likely to manage an innovative firm. In the same manner, success factors with a positive effect on the probability to innovate are: satisfying existing clients; developing niche or export markets; providing after-hour client support services; as well as using teams which bring people together with different skills; performing R&D; collaborating with other firms; and, developing new products and processes. Finally, using government programs to support innovation also have a positive effect on the probability of being innovative.

Looking at the Odd ratio, only the perception that production technologies change rapidly will

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[17] Using the postal code of the CEO office, it will be possible to situate precisely the location of the firm (but only for enterprises with one "provincial enterprise"). However, this variable was not available for this report.

have an important effect (odd ratio of 1.87) on the probability of being an innovative firm[18]. It follows that, if the CEO reported that production technologies change rapidly, the odds of being an innovative firm will be double that of a CEO did not recognize it as being important. Unsurprisingly, agreeing that factors such as developing new products and processes and performing R&D are important for the success of the firm will increase the probability of being innovative. All other factors linked to the firm's success seems less important as the odd ratio does not surpass 1.5. Finally, using at least one government support program will also increase the probability of being an innovator.

Model (2) of Table 3.a presents results of a regression which the dependent variable is now defined as being a successful innovator (=1) or an unsuccessful one (=0). Regressors remain as before: regions, industries, a set of factors related to the CEO's perception of a competitive environment, and the firm's success.

Several factors which were significant in the last regression turned out to be non-significant in this model. Moreover, factors which remain significant usually have a lower impact (measured by odds ratio) in this model. It follows that the CEO's perception on its competitive environment and success factors is less useful to distinguish a successful innovator from an unsuccessful one. Therefore, it will be important to introduce, in the model, variables that represent firm's behaviours (revealed preferences) rather than CEO's intention to distinguish successful

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[18] Odd ratio, in this case, represent the number of times that the presence of a given variable, compared to its absence, increase the probability that the firm turn out to be innovative.

innovators from unsuccessful ones.

Table 3.b presents results of regressions where variables represent the firm's behaviours – such as being involved in cooperation (COOP) and having undertaken R&D activities during the 1997-1999 period (RD_act) – have been added in the model[19]. Model (3) also specifies different activities linked to innovation – R&D, acquisition of machinery and equipment, training, tooling-up, and industrial engineering. Model (4) regrouped these activities into a binary variable indicating whether or not a firm is engaged in several activities linked to innovation (more than three). This variable will be used to test the assumption of complementarity of activities linked to innovation.

Results from Model (3) show that several activities linked to innovation are useful to distinguish successful innovators from unsuccessful ones. Undertaking R&D activities, training and tooling-up activities improve the likelihood of being innovators. The coefficient of acquisition of machinery and equipment (M&E) is not significant. This is not surprising because, as we have already seen in the descriptive analysis, successful as well as unsuccessful innovators are massively involved in this activity. Therefore, acquisition of M&E is not a useful determinant to distinguish successful from unsuccessful innovators, but it does not mean that acquisition of M&E is not important in the innovation process. To verify if acquisition of M&E is important in the innovation process, it is possible to regroup all activities linked to innovation and test if the impact is more important than with each activity alone.

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19 To avoid collinearity, the set of factors related to the firm's success has been removed.

Results from Model (4) broadly support the assumption of complementarities of activities linked to innovation. Being involved in at least three activities considerably increased the probability of being a successful innovator (odd ratio of 4.86). To fully appropriate benefits from own R&D, training, or acquisition of technological equipment, it is preferable to join these activities together[20].

Being involved in a cooperation agreement also increases, but to a lesser extent, the probability of being a successful innovator (odd ratio less than 2 in both regressions). As we can perceive collaboration as another activity linked to innovation, it is not surprising that we obtain a positive impact of collaboration on the likelihood of being an innovator. Finally, using at least one government support program turns out to be non-significant in both model (3) and (4).

[20] Another regression has been performed in adding variables representing the number of activities undertaken by the firm. Results from this regression show that the odds of being innovator increases with the number of activities undertaken. The odds ratio of being involved in more than four activities linked to innovation is greater than 10.

CONCLUSION

A profile of business practices followed by manufacturing firms were drawn from data in the 1999 Survey of Innovation . It shows that more than 80 percent of firms have introduced an innovation between 1997 and 1999, and that the ICT industries is the most innovative.

We learned that the firm's perception of a competitive environment and most important success factors (top 4) are generally similar for innovators and non-innovators. As for the human resource issue, firms – innovative or not – prefer using the informal learning system (training and hiring experienced workers) instead of the more formal education system (hiring from university, technical school or college). These findings show that all firms, innovative or not, face the same environment and same constraints.

However, some differences between innovative and non-innovative firms were also found. A first set of regressions was used to assess if the CEO's perception of the firm's success factors and its competitive environment, has a significative impact on the probability of being an innovator. Results using econometrics or simple descriptive analyses show that only a few factors have an impact on being an innovator or not. However, the impacts are generally small showing that CEO's perceptions do not seem to be very helpful to distinguish potential innovators from non-innovators.

Nevertheless, replacing variables that imply CEO's perceptions by variables related to CEO's actions considerably increases the likelihood of being innovative. The odds of being innovative increases substantially if the firm is involved in cooperation agreements rather than acknowledging that collaboration is an important firm's success factor. As well, undertaking R&D activities is more important to distinguish successful versus unsuccessful innovators than to agree that performing R&D is an important firm's success factor.

Results also corroborate the assumption of complementarities of activities linked to innovation. Being involved in several activities to innovate drastically increases the likelihood of being a successful innovator. This result is not surprising as several studies stress the increasing complexity of technology. As noted by Rycroft and Kash (1999), the range of technologies required for innovation has also expanded as innovation has moved closer to the scientific frontier and technologies have become more complex. Nowadays, a firm must combine all kinds of activities – performing R&D; training employees; buying equipment and machinery which embody technological knowledge; as well as, collaborating among firms agreement– to improve their firm's capabilities to innovate.

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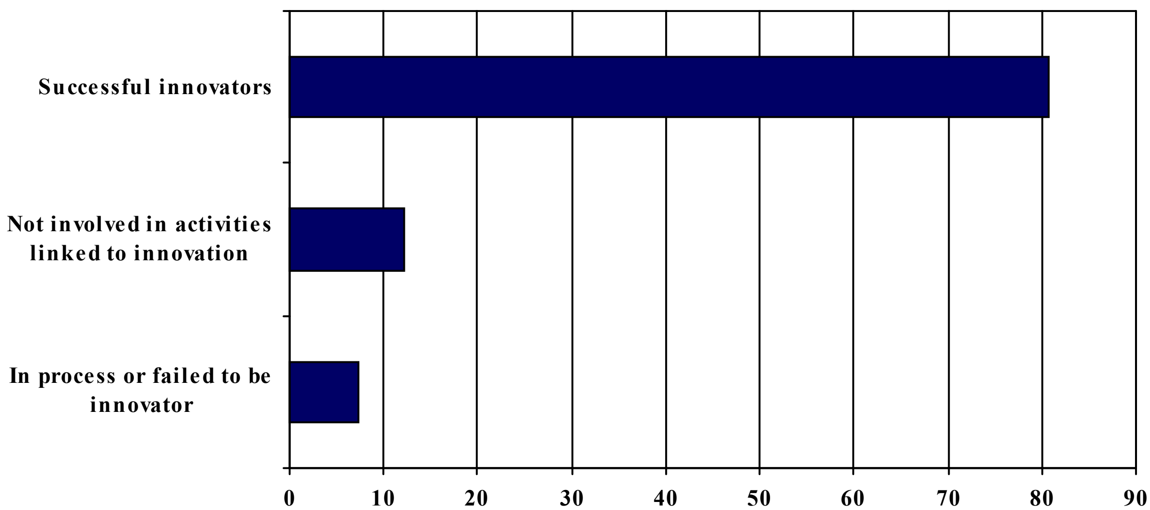
Figure 1
Sample distribution by type of firms
(%)



Note: ICT industries include Computer & Electronic Product Manufacturing (NAICS 334)and Electrical Equipment, Appliance and Component Manufacturing (NAICS 335). Other Manufacturing industries include Non-Metallic Mineral Product Manufacturing (NAICS 327), Primary Metal Manufacturing (NAICS 331), Fabricated Metal Product Manufacturing (NAICS 332), Furniture & Related Product Manufacturing (NAICS 337), and Miscellaneous Manufacturing (NAICS 339).

Figure 2
Percentage of firms introducing product and/or process innovations by industry

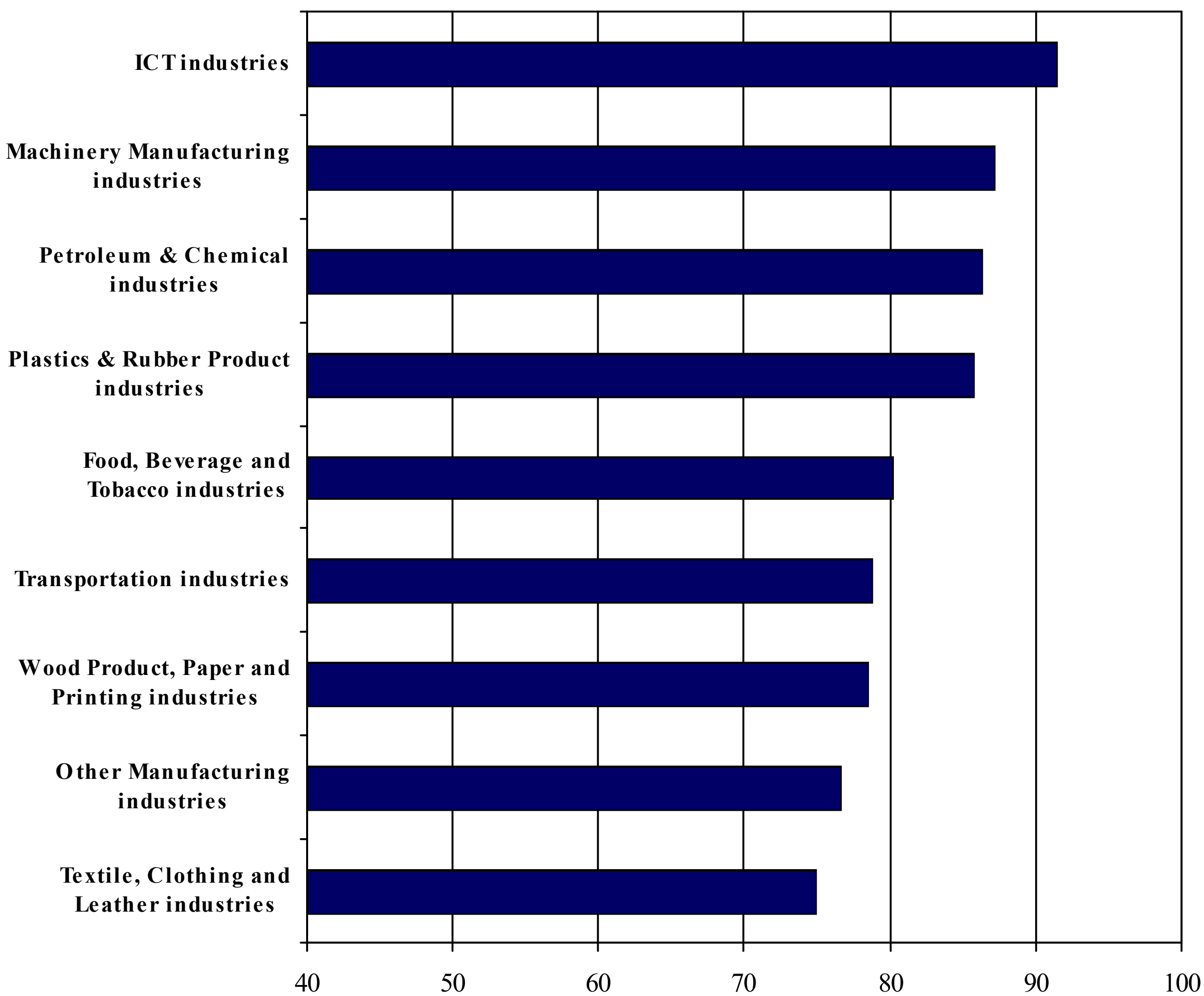
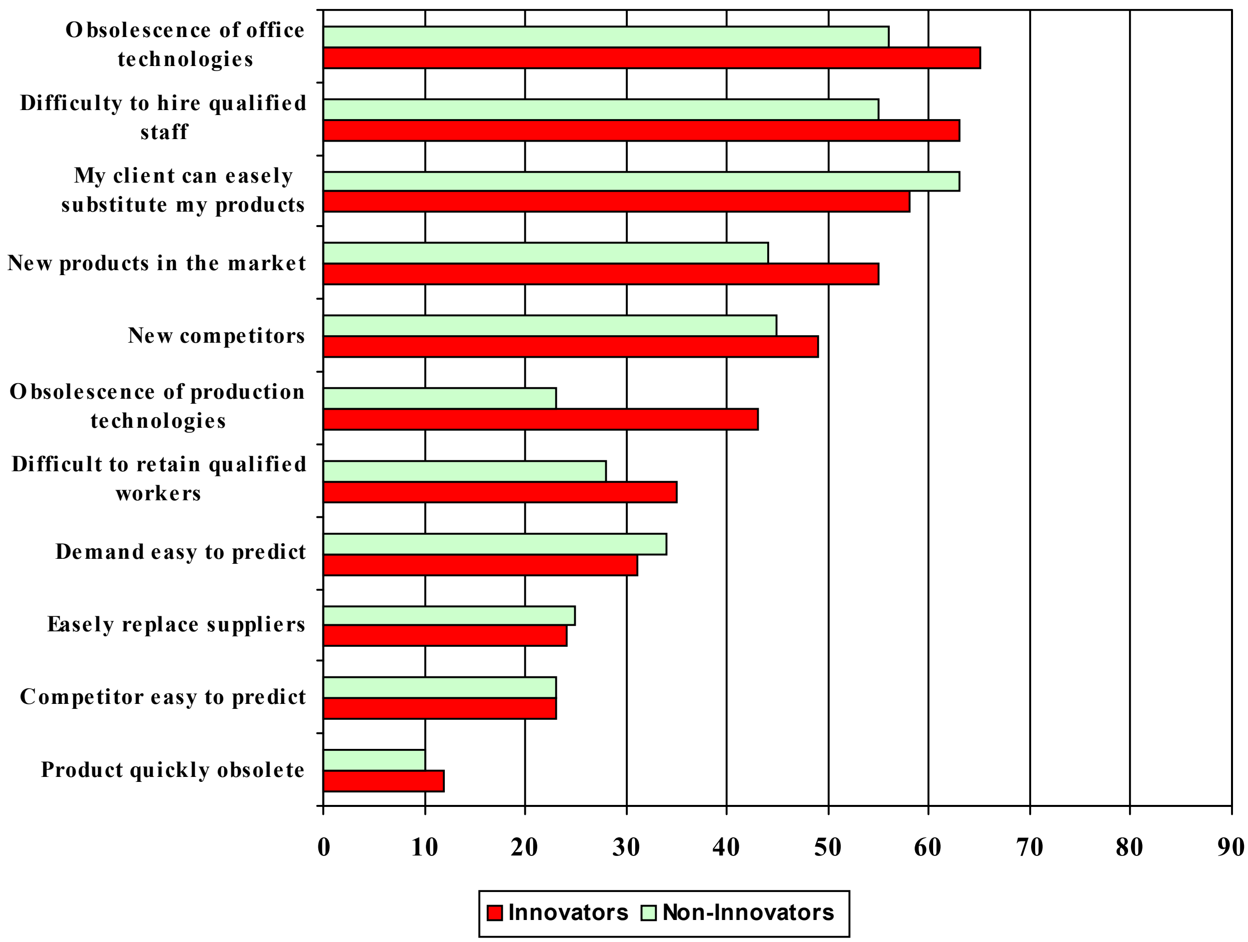
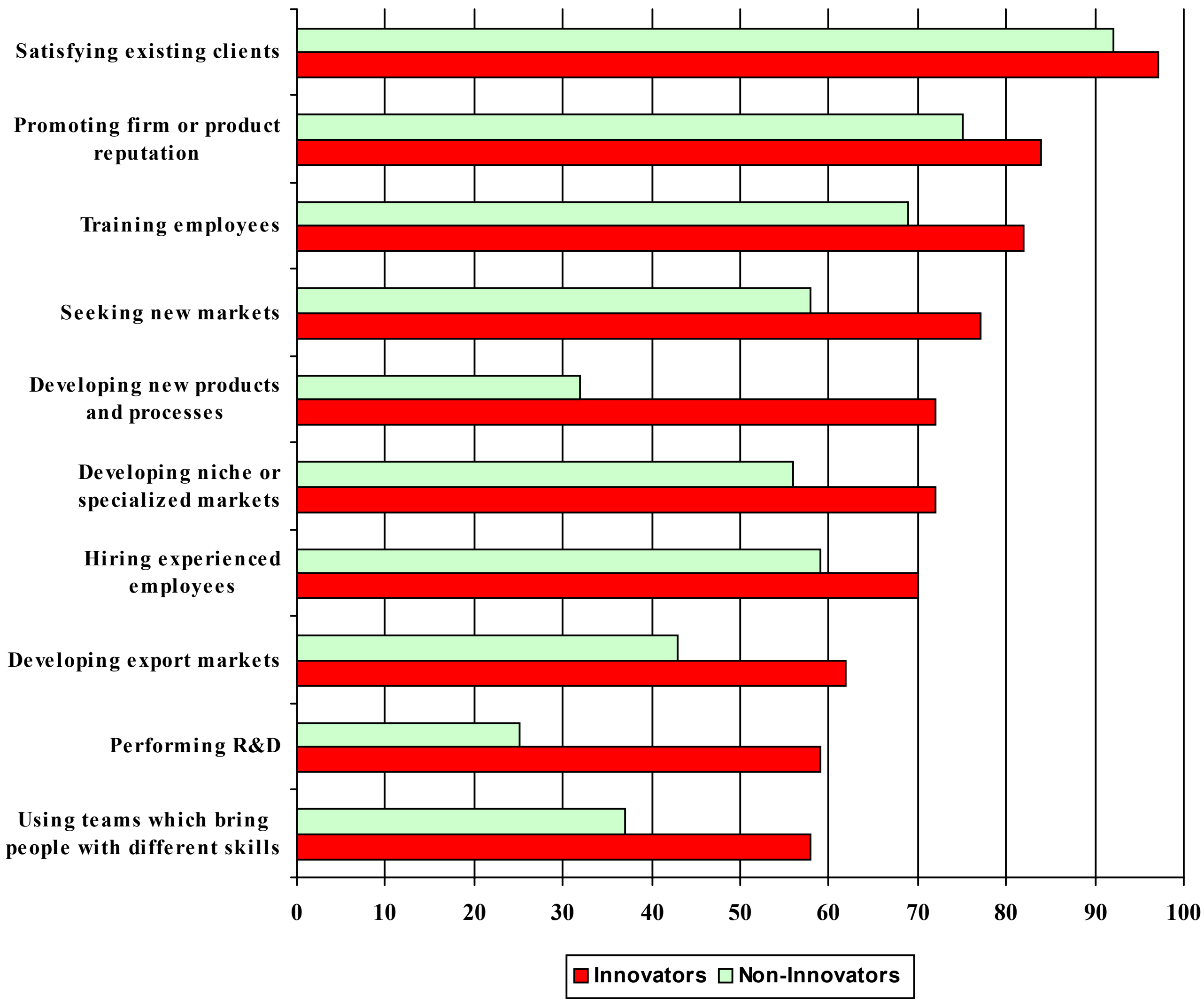


Figure 3
Percentage of firms agreeing with statements on the competitive environment



Note: Non-innovators included unsuccessful innovators and firms not involved in activities linked to innovation

Figure 4
Percentage of innovators who indicated that the following factors (Top Ten) are important for firm success



Note: Non-innovators included unsuccessful innovators and firms not involved in activities linked to innovation

Figure 5
Percentage of innovators which indicated that the following objectives are important, 1997-1999

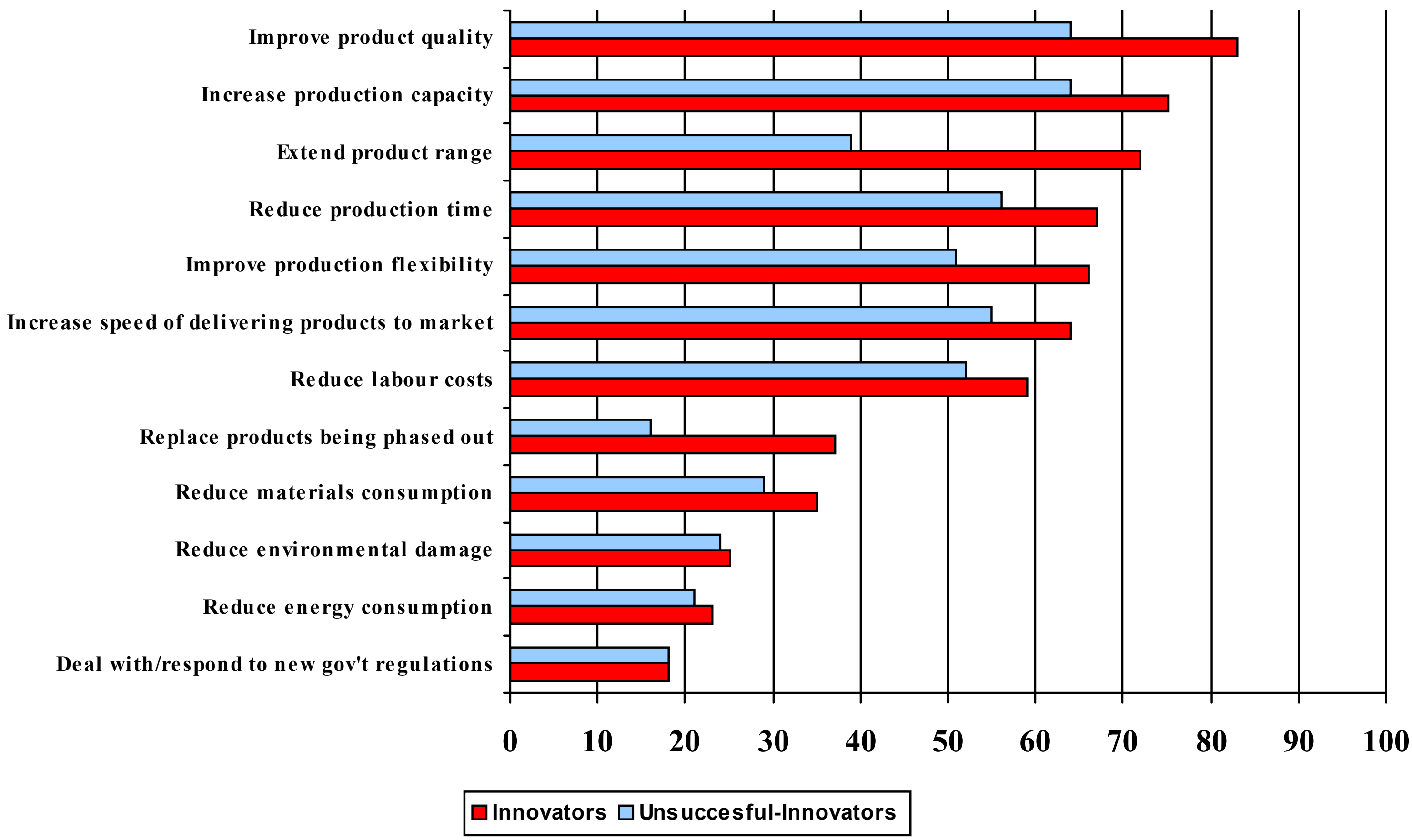


Figure 6
Types of activities linked to innovation
(% of innovative firms)

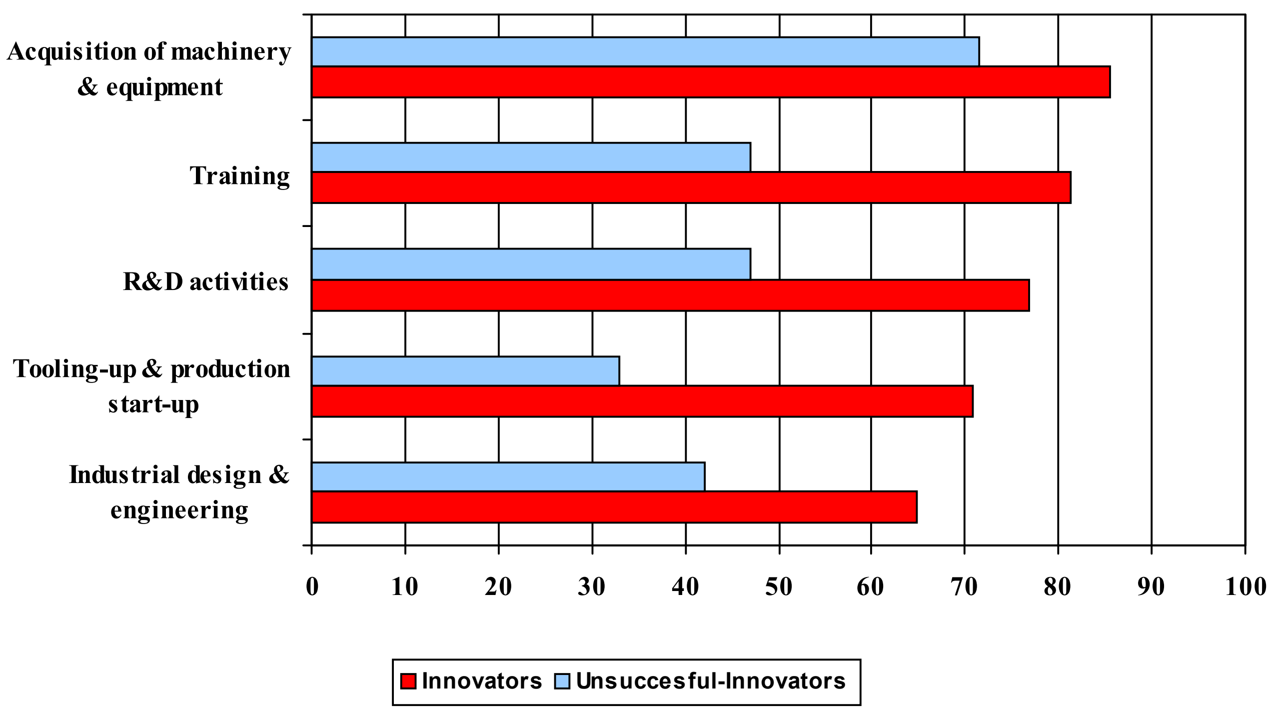


Figure 7
Percentage of cooperative firms identifying given factors as important for the involvement in cooperative arrangement
(successful innovators only)

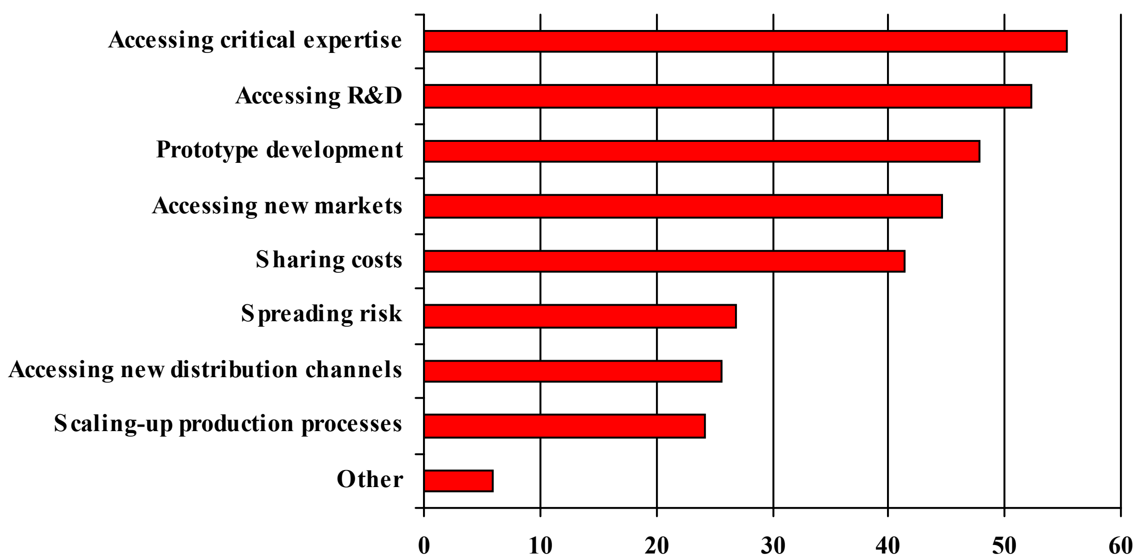


Figure 8
Factors identified as having slowed down or caused problems in developing or introducing innovations (% of firms)

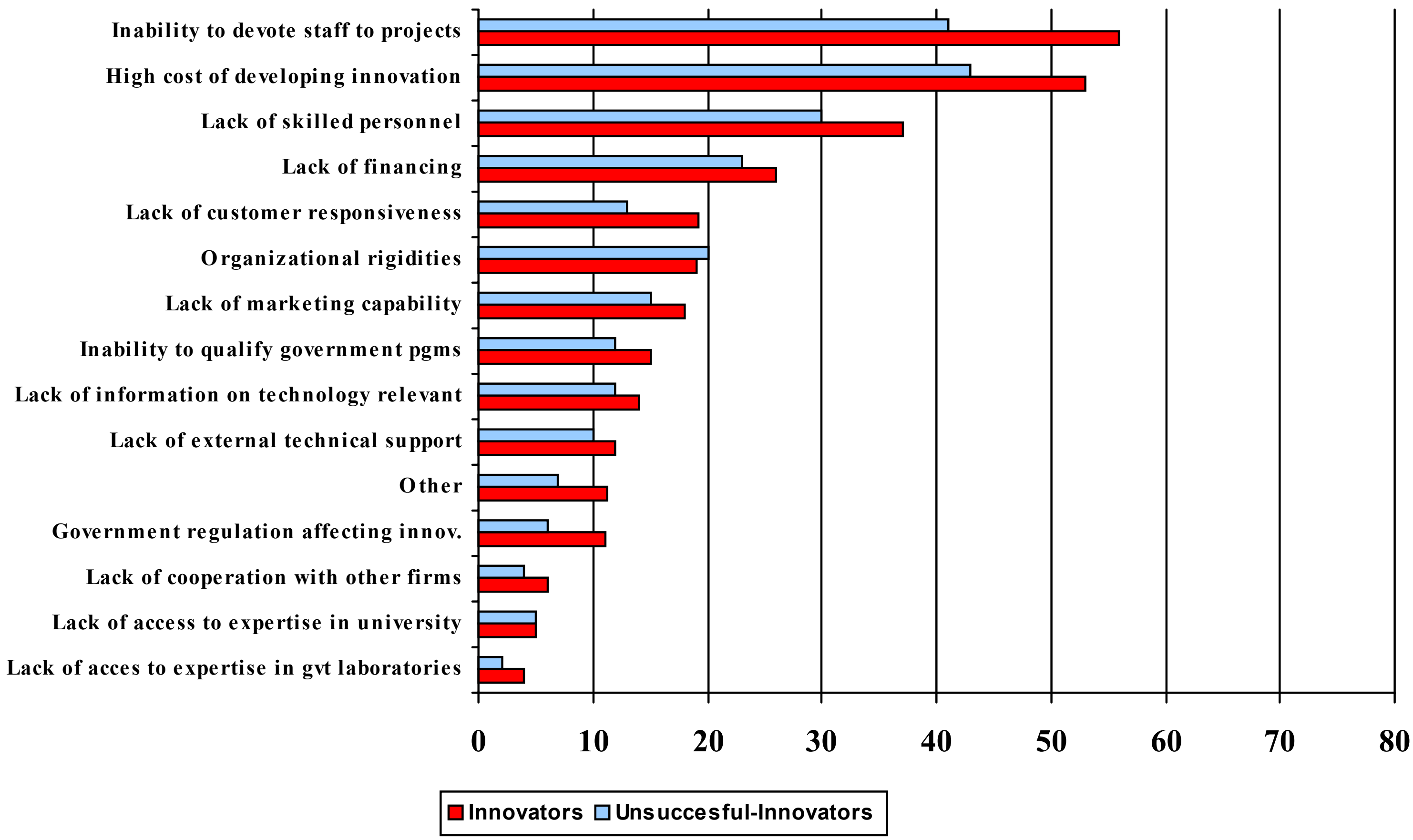
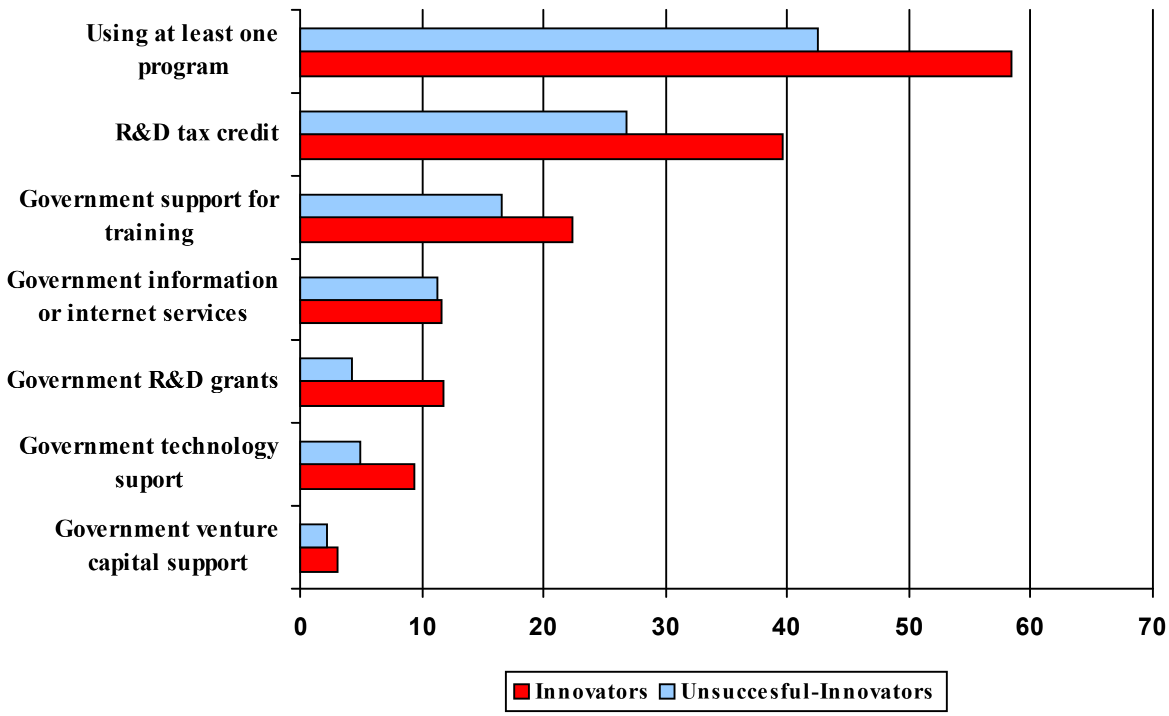


Figure 9
Percentage of firms using government support programs



Note: Data have been weighted by the inverse of the sampling rate. Data for figures and tables come from Statistics Canada, 1999 Innovation Survey. Published and unpublished data.

Table 1
Frequency to agree with the following statements, by type of firms**

	Innovator (%)	Non-innovator (%)	%Diff
Competitive environment			
Production tech. change rapidly	43	23	46%
Success factors			
Developing export markets	62	43	32%
Providing after-hour client support	42	30	30%
Hiring new graduate from university	23	11	53%
Hiring new graduate from colleges	41	24	41%
Recruiting int'l skilled people	9	6	31%
Using teams with people with different skills	58	37	35%
Performing R&D within your firm	59	25	58%
Developing new product-process	72	32	54%
Collaboration with other firms	33	15	48%
Involvement in new industry standards	34	20	41%

	Successful Innovator (%)	Unsuccessful Innovator (%)	%Diff
Competitive environment			
Production tech. change rapidly	44	31	28%
Success factors			
Hiring new graduate from universities	23	16	31%
Hiring new graduate from colleges	41	28	31%
Performing R&D within your firm	59	35	40%
Developing new product-process	72	42	41%
Collaboration with other firms	33	18	46%
Involvement in new industry standards	34	21	38%
Objectives of Innovation			
Replace product obsolete	45	25	43%
Extend product range	76	50	35%
Activities linked to innovation			
Tooling-up and Production start up	71	33	53%
Training	81	47	42%
R&D	77	47	39%
Industrial engineering	65	42	35%
Government support programs			
R&D grants	12	4	64%
Technical Support & assistance	9	5	47%
R&D tax credit	40	27	32%
Training	22	17	26%

** Factors are statistically significant (Chi-square test at .005 level). Only factors with a difference in percentage higher than 25% are reported.

Table 2
Frequency of Being Involved in Several Activities Linked to Innovation

	Involved in less than 3 activities	Involved in 3 or more activities
Innovators	19.9%	80.1%
Unsuccessful Innovators	58.5%	41.4%

Table 3.a
Determinant of Innovation: Logit Model

	(1)				(2)			
	Coefficient		**S.E.**	**Odds ratio**	**Coefficient**		**S.E.**	**Odds ratio**
Intercept	-1.152	**	(0.20)	.	0.124		(0.27)	.
Region								
Quebec	0.329	**	(0.13)	1.39	0.278	*	(0.16)	1.32
Ontario	0.425	**	(0.13)	1.53	0.676	**	(0.18)	1.97
Prairies	-0.111		(0.14)	0.90	0.047		(0.19)	1.05
BC	0.021		(0.15)	1.02	0.630	**	(0.21)	1.88
Industries								
Textile	-0.340	**	(0.13)	0.71	-0.213		(0.19)	0.81
Wood	0.124		(0.12)	1.13	-0.121		(0.17)	0.89
Chemical	0.249		(0.17)	1.28	0.159		(0.24)	1.17
Plastics	0.130		(0.17)	1.14	-0.076		(0.23)	0.93
Machinery	0.188		(0.15)	1.21	0.037		(0.21)	1.04
ICT	0.620	**	(0.20)	1.86	0.579	**	(0.29)	1.79
Transportation	-0.275	*	(0.16)	0.76	-0.319		(0.23)	0.73
Misc.	0.030		(0.11)	1.03	-0.078		(0.16)	0.93
Competitive environment								
Client can easely substitute my products	-0.121	*	(0.06)	0.89				
Arrival of new competitors	-0.177	**	(0.07)	0.84				
Arrival of new products in the market	0.191	**	(0.07)	1.21	0.147		(0.09)	1.16
Difficulty to hire qualified staff	0.040		(0.07)	1.04				
Difficult to retain qualified workers	0.043		(0.07)	1.04	0.145		(0.10)	1.16
Product quickly become obsolete	-0.071		(0.10)	0.93				
Production technologies change rapidly	0.626	**	(0.07)	1.87	0.342	**	(0.09)	1.41
Success factors								
Seekink new markets	0.205	**	(0.07)	1.23	0.368	**	(0.10)	1.45
Satisfying clients	0.366	**	(0.14)	1.44	0.311		(0.19)	1.36
Developing niche	0.177	**	(0.07)	1.19	0.110		(0.09)	1.12
Developing export markets	0.217	**	(0.07)	1.24	0.083		(0.09)	1.09
Promoting firm reputation	-0.035		(0.08)	0.97	0.088		(0.11)	1.09
Providing after-hour client support	0.177	**	(0.07)	1.19	0.142		(0.09)	1.15
Hiring new graduate from university	0.153		(0.10)	1.17	-0.112		(0.13)	0.89
Hiring new graduate from colleges	0.185	**	(0.08)	1.20	0.257	**	(0.11)	1.29
Recruiting int'l skilled people	0.115	*	(0.06)	1.11	0.064		(0.11)	1.06
Using teams with people with different skil	0.183	**	(0.07)	1.20	-0.024		(0.10)	0.98
Performing R&D within your firm	0.484	**	(0.07)	1.62	0.237	**	(0.09)	1.27
Collaboration with other firms	0.230	**	(0.08)	1.26	0.291	**	(0.12)	1.34
Developing new product-process	1.039	**	(0.07)	2.83	0.750	**	(0.10)	2.11
Involvement in new industry standards	-0.006		(0.08)	0.99	0.138		(0.11)	1.15
Government support	0.683	**	(0.06)	1.98	0.353	**	(0.09)	1.42
-2 log L	7181.48				4018.371			
Concordant	0.80				0.72			
Nb. Obs.	5453				4800			

Dependent variable for Regression (1) is defined as being innovator (=1) versus non-innovator(=0)

Dependent variable for Regression (2)-(4) is defined as being innovator (=1) versus unsuccessful-innovator(=0)

The reference categories are: Atlantic region; Food-beverage and Tobacco industry

** Significant at 5% level, * Significant at 10% level.

Table 3.b
Determinant of Innovation: Logit Model

	(3)				(4)			
	Coefficient		**S.E.**	**Odds ratio**	**Coefficient**		**S.E.**	**Odds ratio**
Intercept	0.189		(0.22)	.	0.555	**	(0.21)	.
Region								
Quebec	0.217		(0.18)	1.24	0.220		(0.18)	1.25
Ontario	0.659	**	(0.19)	1.93	0.571	**	(0.19)	1.77
Prairies	0.160		(0.20)	1.17	0.156		(0.20)	1.17
BC	0.741	**	(0.22)	2.10	0.731	**	(0.22)	2.08
Industries								
Textile	0.113		(0.19)	1.12	0.092		(0.19)	1.10
Wood	-0.179		(0.17)	0.84	-0.177		(0.17)	0.84
Chemical	0.147		(0.25)	1.16	0.155		(0.25)	1.17
Plastics	-0.192		(0.24)	0.83	-0.161		(0.23)	0.85
Machinery	0.199		(0.22)	1.22	0.019		(0.21)	1.02
ICT	0.506	*	(0.29)	1.66	0.524	*	(0.29)	1.69
Transportation	-0.695	**	(0.25)	0.50	-0.550	**	(0.23)	0.58
Misc.	-0.197		(0.16)	0.82	-0.170		(0.16)	0.84
Competitive environment								
Production technologies change rapidly	0.366	**	(0.10)	1.44	0.426	**	(0.10)	1.53
Cooperation	0.475	**	(0.12)	1.61	0.455	**	(0.12)	1.58
Undertake R&D activities					0.645	**	(0.10)	1.91
Activities linked to innovation								
R&D	0.776	**	(0.10)	2.17				
Machinery & Equipment	0.039		(0.11)	1.04				
Industrial Engineering	-0.117		(0.10)	0.89				
Tooling-up	0.985	**	(0.11)	2.68				
Training	0.868	**	(0.10)	2.38				
Multi_activities					1.433	**	(0.09)	4.19
Government support	0.141		(0.09)	1.16	0.047		(0.10)	1.05
-2 log L	3769.78				3859.630			
Concordant	79%				77%			
Nb. Obs.	4800				4800			

Note: For description of reference categories, see Note of Table 3.a