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Current Intellectual Protection practices by Manufacturing firms in Canada

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INTRODUCTION

The OECD estimates that between 1970 and 1995 more than half of the total growth in output of the developed world resulted from innovation, and the proportion is increasing as the economy becomes ever more knowledge intensive (European Commission, 2001). Protection of intellectual property is the oldest and one of the principal instruments of innovation policy. The objective of this study is to determine how the utilisation of intellectual property rights (IPRs) by Canadian manufacturing firms is related to their characteristics, activities, competitive strategies and the industry sector in which they operate. One of the related questions, that are also addressed, is the extent to which Canadian firms patent in Canada and abroad and especially in the United States.

Patents and other IPRs were once believed to provide an effective protection of inventions and innovations against imitation and thereby provide strong incentives for innovative activity. A path breaking study of appropriation of benefits from innovation in US manufacturing industries by Levin at al.(1987) has shown that in fact industry experts rarely consider patents and other IPRs to be effective means of protecting intellectual property. Other strategies, such as being first in the market, are often a more effective means to appropriate benefits from innovation. Since the protection of intellectual property is one of the cornerstones of innovation policy in all industrial countries, questions regarding the use of intellectual property and their effectiveness are now routinely included in innovation surveys conducted by statistical agencies.

The concept of innovation used in these surveys covers a broad range of innovations, from the introduction of major, original, path-breaking new products or production processes to incremental improvements and introduction of new products and processes new to the firm but already in existence in Canada and/or abroad. These surveys are based on a common methodology[1] and typically ask firms : "Did your firm offer new or significantly improved products (goods or services) or did your firm introduce a new or significantly improved production/manufacturing process? "

This broad definition of innovation not subject to strict objective criteria and relying on self-evaluation of surveyed firms may lead to inflated statistics of innovation incidence and originality. On the other hand it has the advantage of recognising that even though R&D activity is among the most important "inputs" in the innovation process, it is not the necessary, nor the sufficient condition for innovation to take place. Thus for example, almost one third of manufacturing firms that introduced in Canada an innovation in the 1997-1999 period did so without conducting any form of R&D. On the other hand, over 7 percent of firms that conducted R&D did not introduce any innovation. The realisation that innovation is far from being synonymous with R&D is one of the reasons behind the recent interest in innovation surveys as a means to a better understanding of how firms innovate, the information sources and strategies they use and the impact innovation has on their activities.

The principle source of information used in the present study is the most recent Statistics Canada Survey of Innovation 1999 which included several questions on the protection of intellectual property. Complementary information comes from an earlier Statistics

Canada 1993 Survey of Innovation and Advanced Technology. Since the two surveys were addressed to different target populations and were different in several other important respects, we present a brief methodological overview in note #11 to help the reader to interpret correctly the findings of both surveys.

Elements of the Conceptual Framework Used in the Present Study

The economic theory of innovation and intellectual property and earlier empirical studies. suggest a conceptual framework that is used for the descriptive analysis of the 1999 Innovation Survey. The following notes resume the principal relationships that will be examined.

- *The relationship between the use of IPRs and the innovation status* The use of patents and other statutory instruments of IPP by manufacturing firms is closely but not exclusively related to their innovation status. Innovating firms create new knowledge and intellectual property and in order to appropriate the benefits from innovation, they are more likely to protect it by various intellectual property rights and other strategies than firms that do not innovate. The overwhelming majority (about 80%) of CEOs and head-office officials surveyed in 1999 declared that their firms had introduced an innovation in the preceding three years. The present study contrasts the use of IPRs by firms that introduced an innovation in the 1997-1999 period, with those that attempted but did not succeed and those that were not involved in innovation.

- *The type of innovation* Patents usually protect more efficiently product inventions than process inventions. New or improved production processes are often better protected by trade secrets. Firms typically use a combination of IPRs. Their composition varies with the stage of the innovation process and the combination of protectable elements of the innovation (Cohen, Nelson and Walsh, 2000). To illustrate the ways Canadian manufacturing firms protect their intellectual property, the use of IPRs is broken down by the type and originality of innovation.

- *The originality of innovation*. The value of intellectual property is to an important extent function of its originality. By definition, patents are granted only to inventors of original, world-first inventions. Firms that introduce a world-first innovation are therefore more likely to use a patent than firms that realised a Canadian-first or those that imitated a new process or product already in existence elsewhere in Canada. Firms that introduce the two less original types of innovation may, however, acquire or licence patents or other IPRs as part of a technology transfer and therefore also report using intellectual property rights. The type of innovation and its originality are therefore potentially important determinants of the use of IPRs. The results of the survey are presented so as to contrast them by the type and the originality of innovation.

- *The use of IPRs and the size of firm* The need of protection of intellectual property varies according to the size of firm for at least two reasons. One is related to the

innovative activity, the other to financial constraints. Small firms are less likely to innovate than large ones. When they innovate, small firms introduce less frequently than larger firms the original innovations which contain most intellectual property worth of protecting. It is therefore likely that the use of intellectual property protection (IPP) is positively related to the size of firm. The cost aspects of IPP are also biased in favour of large firms. The cost of protection- including the cost of learning and the administrative costs involved in obtaining and maintaining statutory IPRs - presents in relative terms a larger burden to small and medium size enterprises (SME) than to the large ones. SME face another disadvantage when it comes to enforcement of their IPRs. Since a patent is no more than a 'licence to litigate,' the cost of monitoring whether infringement takes place and the prospective cost of litigation can be too high for the SME in terms of both time and money (European Commission, 2001). For all these reasons, it is expected that the use of IPRs is closely related to the size of firm. This pattern has been found in Canadian manufacturing in the 1989-91, it is also reported in Europe (European Commission, 2001). To find out whether the use of IPRs remains closely related to the size of firm in the most recent 1997-1999 period, we present the use of IPRs broken-down by the size of firm.

- *The use of IPRs varies from one industry to another* Firms operating in different manufacturing industries create different types of innovation and rely on a different mix of IPRs. These differences are related on the one hand to industry differences in technological opportunity, on the other hand, to industry differences in the use of statutory IPRs. (1) Technological opportunity, a term designating the potential contribution of advances in science and technology to innovation, varies from industry to industry and so do the competitive conditions. These differences explain to a large extent the significant inter-industry differences in innovation performance which impact on the use of IPRs. (2) The second source of industry differences in the use of IPRs is directly related to the particular intellectual property right.

  Levin at al.(1987) found that in chemical and pharmaceutical industries patents are considered more effective means of appropriation of innovation benefits and are used more frequently than in other industries. According to Cohen at al.(2000) the reasons for patenting differ between industries that usually introduce a "discrete" product (a new substance introduced by a chemical or pharmaceutical firm) and those introducing a "complex " product innovations (electronic or telecommunication products typically comprising a large number of patentable elements). Their study also shows that the reasons to patent in general and to protect discrete or complex innovations in particular, are also driven by other motivations than to prevent copying (negotiations and cross-licensing, licensing revenue, to prevent suits, enhance reputation etc.).

- *Technology sectors* A comprehensive study of innovation in the UK by Robson at. al. (1988) found that different groups of industries play different roles in the innovation process. Based on observed patterns of innovation sources and use in manufacturing industries, the authors introduced a three technology sector taxonomy (core, secondary and 'other' sectors). The core sector (Chemical, electronics, machinery

and instruments) includes industries at the forefront of technological change whose product innovations are used in the secondary and 'other' sector and in the rest of the economy. The secondary sector (metal industries, metal products, rubber and plastics, non-metallic minerals, transport equipment) is a user of product innovations from the core sector and at the same time source of innovations used in the 'other' sector and the rest of the economy. Consumer product industries and some bulk material industries that use innovations introduced by the two upstream sectors are included in the 'other' sector (food, beverage and tobacco, textiles, clothing, leather and footwear , as well as wood and paper industries belong to this sector). The usefulness of Robson's taxonomy to synthesise the inter-industry patterns of innovation and the use of IPRs is demonstrated in Baldwin and Hanel, (2001). It is used in the present study to point out the main differences in the use of IPRs among the three technology sectors.

- *Firms often use a combination of several IPRs* Trade secret may supplement a patent or it may be used as a substitute for patent protection. Inventors choose to use trade secret when they believe that patent protection is too costly relative to the value of their invention, or that it will give them a reward substantially less than the benefit of their invention (as reflected, in part, in the length of time before any else will invent it), either because the invention is not patentable or because the length (or other conditions) of patent protection is insufficient (Friedman, Landes and Posner, 1991). Trade marks are often used along trade secrets and/or patents and industrial designs. Trade marks are used to a certain extent by all industries but more intensively by those producing consumer products such as leather and clothing articles, or beverages and drugs.

  Other IPRs such as copyrights are used frequently in those industries concerned with protection of printed material, recordings and software.

The structure of this chapter

The chapter follows with an overview of principal results of other major surveys that looked at the use of intellectual property rights in Canada. The most complete of these is the previous Statistics Canada (1993) Survey of Innovation and Advanced Technology which included an extensive section on intellectual property. Since the 1993 survey included questions not included in the 1999 Survey, the relevant results are reported with some detail here. The second part of the chapter presents a descriptive statistical analysis of the principal findings of the 1999 Survey. It is based on the conceptual framework introduced above. In order not to overburden the text, a series of tables is relegated into Appendix. The use of IPRs is to a great extent correlated with basic economic characteristics of firms, their activities and the industry environment in which the firm operates. To draw in a concise way as much information as possible from the rich survey data, a series of multivariate models that identify the determinants of the use of IPRs and their statistical association with the occurrence of innovation is presented in the third part of the chapter, followed by conclusions and policy suggestions.

I. REVIEW OF PRINCIPAL FINDINGS OF PREVIOUS SURVEYS

To put the latest 1999 Statistics Canada Survey of Innovation in a proper perspective we overview in some detail findings of other major Canadian surveys of intellectual property use conducted in the last twenty years.

The Economic Council of Canada survey (De Melto, McMullen and Wills, 1980) looked into innovation and patenting in five Canadian manufacturing industries and concluded that most of the major 283 innovations introduced in Canada in the preceding twenty years were not patented. The ECC Survey included only innovations considered "major" by the firms that introduced them. Over the twenty year period covered by the ECC survey only 32% of reported major innovations were patented. The study covered five industries and revealed important inter-industry differences in the propensity to patent. These were related to structural characteristics of industries. The survey reported that: (1) The propensity to patent innovations was monotonically increasing with the size of the innovating firm. (2) Foreign controlled firms (and even more so those under the US control) patented significantly more (39%) than their domestically controlled counterparts (23%). (3) Innovations based on imported technology were more often patented in Canada than innovations based on technology developed in house. (4) There was a clear positive association between the cost of an innovation and patenting; the more costly innovations were more likely to be patented.

The long term coverage of the survey shows that except in the telecommunication industry, the rate of patenting declined over time, especially in the last half of the seventies. This tendency of firms to rely progressively less on the patent system to protect their major innovations was noted also in the US and motivated the influential study of by Levin at al.(1987).

A report commissioned by Industry, Science and Technology Canada, Consumer and corporate affairs Canada and the Science Council of Canada (Industry, Science and Technology Canada, 1989) examined attitudes, practices and interests of Canadian industry with respect to IPR.[2] The authors found that even though the majority of respondents were satisfied with Canadian IPRs, there was an important variance by industry sector and size of firm. Smaller firms[3] and firms in the "new economy" sectors such as software development and biotechnology expressed the most dissatisfaction with the Canadian IPRs.[4]

The second major finding of the study was the high reported degree of infringement and counterfeiting. Between 32% and 40% of firms in the four groups indicated that their IPRs had been violated in the four years preceding the study. A large proportion of firms complained that litigation was too expensive, especially for the smaller firms and the penalties insufficient to prevent infringement. A significant number of firms stated that they had insufficient knowledge or expertise with respect to IPRs. Finally, with the exception of copyright users, firms from all other sectors expressed that they had difficulties in terms of time and cost involved in registering and obtaining IPRs.

The 1993 Survey of Innovation and Advanced Technology

The study based on the 1993 Survey found that there are substantial differences in the use of trademarks, patents, trade secrets, industrial designs and copyrights between those who had just innovated in the three preceding years and those who had not. Trade marks were the most popular form of protection, followed by patents and trade secrets, industrial designs and copyrights (Baldwin, 1997).[5] The survey found that firms with gross business income over $250 000 and employing more than 20 persons used the IPRs as presented in Table I-1.

Table I-1 Use of intellectual property by innovators and all manufacturing firms, 1989-1991 (% of firms*)

	Intellectual Property Right							
	Patents	**Trade marks**	**Copyright**	**Trade Secrets**	**Integrated circuit design**	**Industr. design**	**Plant breeder's right**	**Others**
Innovator	24.66	31.31	9.44	17.99	1.99	13.48	0.451	1.02
All	16.32	22.96	6.35	11.7	1.14	9.05	0.51	0.82

Source : Statistics Canada, Survey of Innovation and Advanced Technology, 1993 /Special tabulation

Note : *The present special tabulation is representative of firms included in the business register In contrast to this tabulation of IPR use by the group called « larger » firms, Baldwin's (1997) results are representative of firms of all sizes, i.e. his sample includes also the smallest firms therefore the results in his paper are different.

Baldwin's study corroborated earlier findings by showing that:

1. The use of IPRs increases with the size of firm. Like in the 1960-1980 period surveyed by DeMelto at. al. (1980), the larger the firm size category, the larger the percentage of firms using IPRs. Almost two thirds of firms employing more than 500 persons used at least one statutory form IPR in the 1997-1999 period. The ratio was less than one in five among the smallest firms.

2. The use of intellectual protection varies significantly between industries. The interindustry differences in the use of IPRs are at least in part determined by the technology sector ((Robson, Townsend, & Pavitt, 1988)[6], the nature of the products, their stage in the life cycle and competitive conditions. Thus patenting is most widespread in core sector industries feeding innovations to the rest of the economy, specifically in the chemical and machinery industry. In contrast food and beverage, wood, clothing and textile firms rarely patent their products, but they frequently protect them by trade marks and/or trade secrets.

3. Product innovations (with or without a change in production process) were more than twice as likely as pure process innovations to be patented. Process innovations lend themselves better to protection through secrecy.

4. Large firms are more likely than the small ones to introduce a world first innovation. Some 15% of innovations of large firms are the world-firsts. The firms that introduced world-first innovations made in general much greater use of any IPRs than the less original ones. About 80% of world- first innovators protect

themselves with at least one form of statutory protection either in Canada or abroad.

5. Foreign owned firms irrespective of their size, industry or type of innovation had more often recourse to intellectual protection instruments than Canadian-owned firms.

Effectiveness of Intellectual Property Protection

The results of the 1993 innovation survey (Baldwin, 1997) shows that the US findings by Levin at al. (1987) suggesting that firms tend to value alternate strategies more highly than the statutory forms of intellectual property protection also apply for Canada. Moreover, the population of manufacturing firms as a whole ranks such strategies as patent protection as being less than "effective".[7] However, these rankings depend very much on the characteristics of a firm. If a firm is innovative, large, foreign-owned, and operates in one of those industries that tend to produce more innovations, the score given to the statutory forms of protection like patents increases greatly. On average, users of patents find them effective; so too do large foreign firms.

The intellectual protection section of the questionnaire of the 1993 Survey asked the firm intellectual property experts to rank the seven forms of intellectual property protection on a scale of 1 to 5, where 1 is "not very effective", 2 is "somewhat effective", 3 is "effective", 4 is "very effective", and 5 is "extremely effective". The average scores given to copyrights, patents, industrial designs, trade secrets, trade marks, integrated circuit designs, and plant breeders' rights are given in the column 1 of Table I-2. None of the statutory instruments of IPR was considered to provide an effective protection. It is therefore not surprising that many firms use alternative strategies to appropriate benefits from their innovations. "Complexity of product design" and even more "Being first in the market" receive the highest average scores--2.6 and 3.2.respectively (see the last three lines in Table I-2). They are judged to be more effective to appropriate benefits from innovation than relying on statutory IPRs.

When the sample was restricted to include just those firms using the forms of intellectual property protection in question (specific users), scores increased notably (column 2). This difference, between those who used the particular form of protection in question and those who did not, can be found in almost all the categories. Innovators who used intellectual property protection ranked this protection well above those who do not. This shows that the low average scores that the population of manufacturing firms gave to the effectiveness of intellectual property rights was due to the large number of non-users who did not regard them as effective.

Invariably, users of intellectual property were more positive in their view of the effectiveness of the various forms of protection. These consistent differences suggest that intellectual property use--like any other strategy--involves acquired skills that only develop with practice. As firms innovate, they learn which strategies best protect their knowledge assets. The study also suggests that these skills, in that they are associated

with size, are part of the growth experience, and tend to increase as a firm successfully masters a range of strategies and grows.

Table I-2 Effectiveness of Intellectual Property Protection

Intellectual Property Rights and other strategies	Average score*		
	All Firms	Users of Specific Statutory Right	Non-Users of Specific Statutory Right
	1	2	3
Statutory			
Copyrights	1.6	2.8	1.4
Patents	1.9	3.0	1.5
Industrial designs	1.6	2.5	1.4
Trade secrets	2.1	3.2	1.6
Trade marks	2.0	3.1	1.5
Integrated circuit designs	1.3	3.2	1.2
Plant breeders' rights	1.2	2.3	1.2
Other	1.4	3.3	1.3
Other Strategies:			
Complexity of product design	2.6		
Being first in market	3.2		
Other	2.3		

Source: Baldwin (1997).
Note : *Scored by firm's IP experts as 1: not at all effective; 2: somewhat effective; 3: effective; 4: very effective; 5: extremely effective

II. USE OF INTELLECTUAL PROPERTY RIGHTS AND INNOVATION-RESULTS OF THE 1999 SURVEY

The most recent survey of innovation in Canadian manufacturing was conducted by Statistics Canada in 1999. It asked the CEOs or their representatives two questions on the use of intellectual property rights. The objective of this section is to provide a descriptive analysis of the principal results of the survey with respect to the use of IPRs.

In response to the first question: "*….which of the following methods have been used by your firm to protect its intellectual property (Patents, Trademarks, Copyrights, Confidentiality agreements, Trade secrets and Other)*[8] *during the past three years, 1997 to 1999"* about two thirds of manufacturing firms (66.1%) responded that they used at least one of the intellectual property rights listed above. The question was addressed to all firms since even those that were not involved in innovation or did not succeed to introduce an innovation in the three year period could well have used IPR to protect innovations introduced earlier or other intangible assets not directly related to a recent innovation. Thus the first interesting information is the overall pattern of the IPR use by firms broken down according to their innovator status into three groups:

(1) firms that innovated successfully (i.e. firms that introduced a significantly improved or new product and/ or significantly improved or new production /manufacturing process,
(2) those that attempted to innovate but were not successful or have not completed the innovation and
(3) those that were not involved in innovation in the 1997-1999 period.[9]

Use of IPRs by all manufacturing firms

As indicated in the last column of Table II-1, successful innovators[10] used IPRs more often than the unsuccessful ones and these still more frequently than firms that did not attempt to innovate in the three ear period. Even though firms have a choice of several statutory instruments of IPR, the most frequently reported way to protect firm's knowledge assets are confidentiality agreements. These agreements with employees of the firm and its business partners are reported by almost half of all manufacturing firms (43.2 percent).

In comparison with the earlier 1989-1991 period, successful innovators appear to use now all IPRs more frequently. For example according to the 1999 Survey, 29.6 percent of successful innovators reported using patents. About one quarter of innovators (24.7 percent) used patents according to the 1993 Survey (cf. Table I-1). However, part of this apparent difference in intellectual property use reflects methodological differences between the two surveys. [11]

The statutory instruments of IPR protection require administrative procedures of various complexity and involve monetary costs. They are therefore used less frequently than trade secrets and confidentiality agreements. The choice of a particular instrument of IPR depends on the type and originality of innovation, the characteristics of the firm and the industry. Trademarks are the most frequently reported statutory instrument of IPR, used by more than a third of all manufacturing enterprises.

Table II-1. Use of intellectual property by innovation status
(% of all manufacturing firms)

Status	Share of population	Patents	Trade-marks	Copyright	Trade secrets	Confiden-tiality	Others	Any IPR
Innovation	80.7	29.3	39.8	13.6	28.4	48.4	2.7	72.6
Unsuccessful	7.2	14.1	25.3	6.4	14.4	32.6	1.8	49.7
Not involved	12.1	8.3	19.1	4.5	7.5	16.9	2.3	35.9
All	100.0	25.7	36.0	12.0	24.7	43.2	2.5	66.1

Source : Preliminary results of Statistics Canada Innovation Survey, 1999
Note: The statistics from the 1999 Survey presented in this and all other tables and figures are weighted by the gross business income and are representative of the population of Canadian manufacturing "provincial enterprises".

Only some products and processes satisfy patenting criteria of novelty, usefulness and non–obvious improvement. About one quarter of all manufacturing firms used patents to protect their inventions. When a firm patents its invention, it reveals the substance of the invention in exchange of a statutory temporary monopoly protection. Since, as indicated above, the efficacy of patent protection is far from being perfect, some inventions,

particularly new and improved production processes are often better protected by secrecy.[12] Trade secrets were used about as frequently as patents (24.7%). Copyrights are mainly used to protect works of art and software as well as other types of expression possibly relevant for any firm. The use of copyrights is therefore distributed rather unevenly among industries. On average only 12 percent of all manufacturing firms reported to use copyrights.

Use of IPRs by innovating firms

About 80% of firms innovated in the last three years. Firms that were involved in an innovation process protected their IP more frequently than the overall population of manufacturing enterprises; almost three quarters (72.6%) of successful innovating enterprises reported having used at least one of the IPR instruments. About one half of those firms that attempted unsuccessfully to introduce an innovation in the three year period under study reported to have used IPR. The lowest proportion (35.9%) of users of any IPR is found among firms that were not involved in innovation over the 1997-1999 period (see the last column of Table II-1). A roughly similar pattern is observed for each particular IPR.

The use of IPRs according to the type of innovation

As indicated in the introduction, the choice of the IPR instrument depends on the type of invention and innovation. Patents are considered to be more suitable for protection of product inventions and innovations and secrecy is found to be a more effective way of appropriating innovation benefits from process inventions and innovations. One should not, however, read too much into the difference between product and process innovations in the 1999 Survey because two thirds (66.8%) of all firms reported introducing a combination of one or more product and process innovations. Firms that introduced a combination of innovations used IPRs more frequently than creators of a product- or process-only innovations. The most pronounced difference between product and process innovators is with regard to patent protection. Product innovators are three times as likely to protect their new or improved products by patents as process innovators.

Our results do not support an earlier finding by Baldwin (1997) and other studies that process innovations are more likely to be protected by trade secrets than product innovations. The results of the present survey show that if there is any difference between the two groups, trade secrets are used more frequently by firms introducing pure product innovation rather than the other way round. The most frequent users of trade secrets are firms that introduced a combination of both types of innovation.

Table II-2. Use of IPR by type of innovation **(% of innovating firms)**

	TYPE OF INNOVATION			
IPR	**Both**	**Product**	**Process**	**All**
% of all innovations	67.0	17.6	15.4	100.0
Patents	32.7	34.1	11.1	29.6
Trademarks	43.4	44.7	18.6	39.8
Copyrights	15.0	14.8	6.7	13.7
Secrets	32.1	24.4	17.5	28.5
Confidentiality	52.6	46.6	36.3	49.0
Others	2.9	2.2	2.8	2.7

At least one	77.0	75.1	52.7	72.9

Source : Author's tabulation from results of Statistics Canada Innovation Survey, 1999

Use of IPRs by originality of innovation

The definition of innovation includes contributions of very different importance and originality. Firms were asked to classify their most important innovation into three categories according to their originality : the world-first, the Canada-first and the innovation previously existing elsewhere in Canada but new to the firm. Majority of innovators (88.3%) described their most important innovation so we have information on novelty of innovation for this sub-population of innovators. A small proportion of firms (about 3%) responded that they were not able (or perhaps not willing) to classify their innovation.

A minority (14.5%) of innovators that provided information on the novelty of their most important innovation introduced a world-first innovation. The proportion of those firms that were first to introduce an innovation from abroad to Canada is almost twice as important (24.5%). The largest proportion of firms (61%) introduced improved or new products and/or processes that were already in use elsewhere in Canada ("firm-first" - see the first line in Table II-3).

As expected, firms that introduced a world-first innovation use all instruments of IPR more frequently than those that introduced an innovation to Canada. Firms that introduced an innovation already used elsewhere in Canada obviously did not have to fear imitation and they use all ways of protecting IPRs less than the first two groups. The utilisation of each intellectual property right within each "originality" class is shown in the lower section of Table II-3. Even though this pattern applies to all IPR instruments, it is most pronounced for patents. Almost two thirds of firms that introduced in the three years a world-first innovation used patents.[13] About forty percent of firms that introduced innovations from abroad to Canada employed patents. In contrast, only one out of five firms that introduced a new product or process already known elsewhere in Canada used patents. In this case it is likely the reporting firm licensed the use of patents as a part of technology transfer. Unfortunately, the survey question did not ask the respondents whether they used a particular intellectual property right to protect their most profitable innovation; the information on the "IPR use" is describing the firm's "general" behaviour with respect to IPRs. The cross-tabulation then reveals the use of IPRs by innovators classified according to the originality of their most profitable innovation.

The novelty-related differences in the use of other instruments than patents are less pronounced but the pattern is similar. Less original innovators have less intellectual property to protect and therefore use all instruments of IPR protection less often than the world-first innovators. This confirms Baldwin's (1997) results for Canada and it is conform to what is expected.

Table II-3. Use of Intellectual Property Rights by Originality of Innovation
(% of innovating firms)

	Originality (% of innovating firms that classified their innovation in one of the three categories)		
	World-first	**Canada-first**	**Firm-first**
% of all innovations	14.5	24.5	61.0
Use of IP	(% of firms that introduced W-1st, C-1st or F-1st innovation		
Patents	62.8	40.7	20.8
Trademarks	57.9	49.1	32.9
Copyright	26.7	18.7	9.6
Trade secret	44.3	37.5	23.3
Confidentiality	72.1	60.1	42.7
Other	2.9	2.6	3.1
Any of the above	93.3	83.9	66.8

Source : Author's tabulation from Statistics Canada, Survey of Innovation,1999
Notes : 1) 88.3% of innovators answered the question on the novelty of their most important innovation. The Table above presents the distribution of innovators that responded the question on novelty and were able to classify their innovation in one of the three categories.
2) The classification of the innovation in a particular class is exclusive and not cumulative, i.e. if an innovation is classified as a world-first, it is not classified at the same time as a Canada-first and as a Firm-first, etc.

Do Large Firms Use IPRs More Frequently Than the Small Ones?

Indeed they do for two reasons. Small firms are less likely to innovate than large ones and when they do, they are less likely to introduce the most original innovations which are most frequently protected by IPRs. The cost of IP protection presents also a larger burden to small and medium size enterprises (SME) than to large ones. Small firms are therefore less likely to use IPRs than the large firms. The data from the 1999 Survey confirm this pattern for Canada.

The data tabulated in Table II-4 show that the use of IPR is positively correlated with the size of firm. The use of at least one IPR is increasing monotonically with the size of the firm from 65.2% in the smallest firm category to 87.3% in the largest one. This pattern is replicated for each of the instruments of IPR and with some minor exceptions also for each innovation type (product-process and both). Larger firms are more likely to use each instrument of IPR than the smaller ones and innovating firms use them always proportionally more often than the population of all manufacturing firms within each size category. The use of IPRs by unsuccessful innovators and by non-innovating firms and by all manufacturing firms follows within each size category a similar pattern (see Table A-1 in Appendix II).

Table II-4 Use of IPR by type of innovators and by firms' employment size
(% of innovating firms)

IPR \ Size	20- 49	50-99	100-499	500 +
Patents	21.2	25.7	36.8	50.6
Trademarks	32.8	35.5	47.8	52.4
Copyrights	9.9	11.4	17.1	24.2
Secrets	25.2	26.5	31.2	39.8
Confidentiality	39.5	44.3	58.3	67.0
At least one	65.2	69.2	80.4	87.3

Source : Author's tabulation from results of Statistics Canada Innovation Survey, 1999

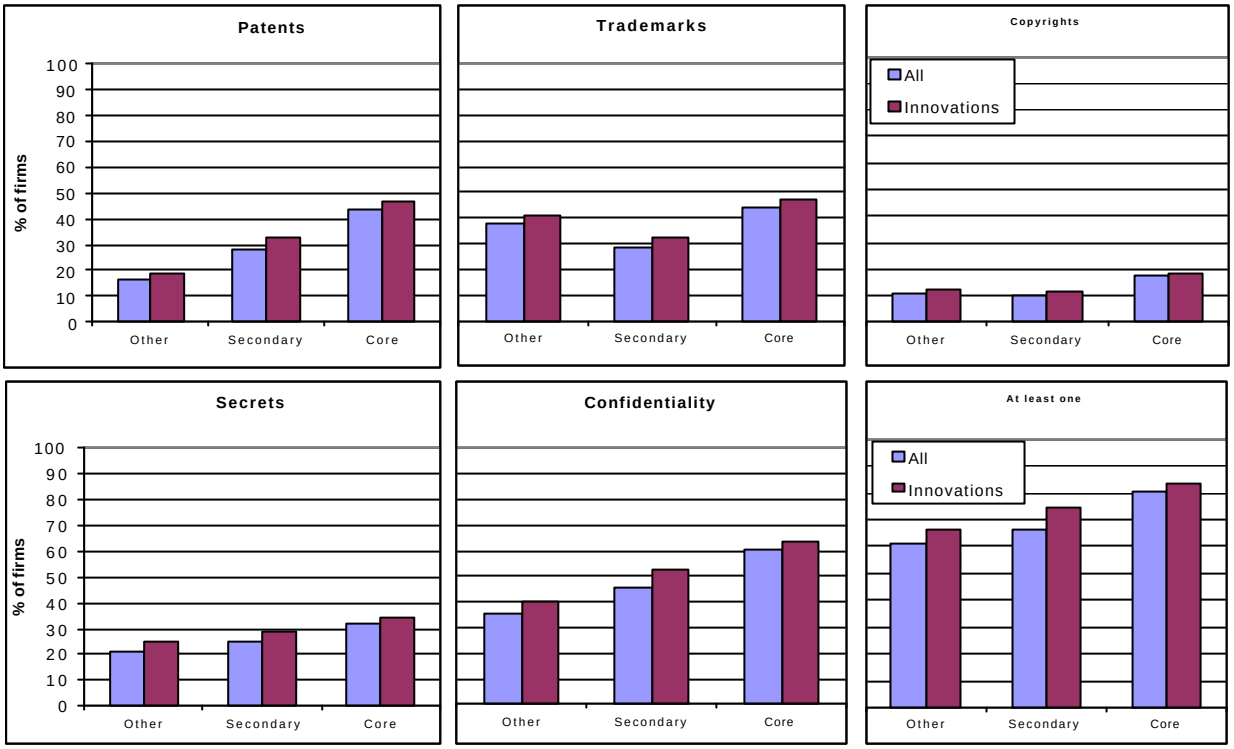
Sectoral differences

As expected, firms in the core sector with high technological opportunity feeding innovations to other manufacturing firms and, for that matter, to the rest of economy, have in general more stakes in knowledge assets than firms in technologically less progressive industries. When firms are regrouped according to Robson's *at al*. taxonomy[14] in three technology sectors: Core, Secondary and 'Other', the frequency of all IPRs use is unequivocally descending from the former to the latter group except for trademarks which are used least frequently in the secondary sector (Figure II-1). Again, successful innovators are using each IPRs more frequently than the non-successful ones and these still more frequently than the non-innovators (see Table A-2 in Appendix II).

Technological competition is most severe in industries belonging to the core sector. The core-sector firms, especially those that introduced world-first innovations, seek patent protection more often than firms in the secondary and those more than in the other sector. They also use more often all other statutory instruments of IPR protection than firms in the technologically less competitive secondary and other sector.

Within each technology sector the use of any instrument of IPRs is increasing with the size of firm and the more original innovators use them more frequently (see Table A-3 in Appendix II). Large firms presumably generate a sufficient volume of innovation sales to justify allocation of adequate resources to development of specific competencies in the field of intellectual property protection and to their defence by litigation. All firms employing more than 500 persons that introduced a world–first innovation used at least one of the instruments of IPRs. More than 80% of them used patents, compared to only about 55% of small firms (employing 20 to100) that did so.

Figure II-1 Use of IPRs by innovation Status and by Sector



Source：Author's tabulation from Statistics Canada, Survey of Innovation,1999

Interindustry differences in the use of IP by innovating firms

Even though the IPR strategies of firms belonging to the same technology sector are fairly similar, there still exist significant inter-industry differences within each sector. These differences are mainly due to inter-industry differences in perceived effectiveness of various IPRs (Cohen, Nelson and Walsh, 2000). The description of the inter-industry pattern would be too fastidious, we report only some highlights from the Table A-4 in Appendix II. As in other countries, the pharmaceutical firms in Canada protect their intellectual property most intensively. Almost nineteen out of twenty (94.2%) pharmaceutical firms used at least one of the IPRs, most frequently the confidentiality agreements, trademarks and patents.

The use of patents varies significantly from one industry to another. The top users of patents are somewhat surprisingly not pharmaceutical and chemical industries where patents are perceived as being the most effective means of appropriation (Levin at al., 1987 and Cohen at al., 2000) and which indeed were the most frequent users of patents in Canada according to the 1993 Survey (Baldwin,1997). According to the 1999 Survey, the highest proportion of innovating firms using patents is found in agricultural, construction

and mining machinery and equipment (72.3% of innovating firms using any IPR) and electrical equipment, appliances and component manufacturing (66.1%), followed by pharmaceutical firms (59.4%).

In the computer and peripheral equipment industry almost all innovating IPR users (94.9%) protect their intellectual property by confidentiality agreements but only less than half of them use patents and /or trade secrets. Among the reasons for the relatively low use of patents may be that Canadian firms in this field are not in the forefront of technological change (Trajtenberg, 2000) and introduce mostly less original innovations that are less likely to use IPRs than world first innovations. Additional and perhaps more plausible explanation is that the rate of technological change in computer and peripheral equipment manufacturing is so fast that the conventional statutory IPRs are considered relatively less efficient than alternative strategies (Levin at al.,1987).[15] The recent US survey of the effectiveness of IPRs in computer industry ranks patents well behind the effectiveness of being first in the market (Cohen at al., 2000). [16] Since software is often an integral part of computer and peripheral equipment and software can be protected by copyright, computer industry is the most frequent user of copyright (47.7% of innovating IPR users).

The top users of trade secrets are producers of semiconductors and other electronic equipment manufacturers, followed by petroleum, chemical, and pharmaceutical firms in the core sector and producers of beverage and tobacco.

On the low end of the spectrum are firms belonging to the 'other' sector, most notably those transforming and fabricating wood products. This industry produces mainly standard industrial materials and components for further transformation in downstream industries and services (construction) which are relying more on price competition than on product differentiation and technological characteristics. Less than half of firms use any IPR. When they do, they rely on trademarks, trade secrets and to a lesser extent on patents.

Research and development activity and use of IPRs

Innovative ideas and solutions come from various sources, both from within the firm and from outside. Even though R&D is not always the most important source of innovative ideas, the majority of those innovative firms that protected their intellectual property acknowledged that R&D played an important role in their innovation process. An overview of all firms (innovators and non-innovators) shows that indeed firms carrying out R&D[17] use all IP instruments more often than firms that did not carry out R&D. To illustrate this, we show the relationship between the use of IPRs for the sub-population of innovating firms, separately for those that carry out R&D and those that do not (cf. Figure II-4). This pattern remains true for each firm size category and each technology sector. Thus it appears that firms that pursue active innovative strategies based on R&D have the need to protect their intellectual property and developed the competency to do so. This is particularly notable for firms that collaborate often with universities and colleges. These firms use IPRs, especially patents, more often than other firms.[18]

R&D activity is, however, not a necessary condition for innovation. Less than two thirds (about 59%) of all manufacturing firms carried out R&D activities. Almost two thirds of firms that did not carry out R&D nevertheless innovated successfully.[19] As innovation surveys show, R&D is only one of the important sources of innovative ideas and technical solutions. Firms use frequently ideas from the management and production department, from customers, suppliers, affiliated firms and competitors and, from institutions of technological infrastructure.

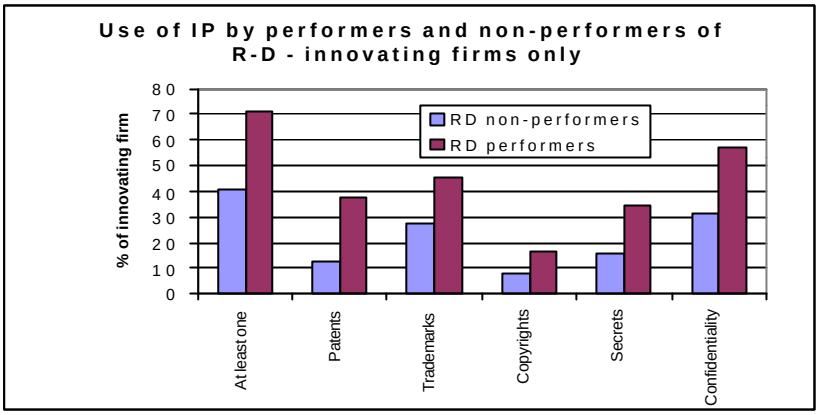
Table II-5 Relationship between Innovation and R&D

	R&D		
	No	**Yes**	
Innovation			**Total**
No	**14.8** *(76.9)* (36.6)	**4.5%** *(23.1)* (7.5)	**19.3** *(100.0)*
Yes	**25.7%** *(31.8)* (63.4))	**55%** (68.16) (92.5)	**80.7** *(100.0)*
Total	**40.6** (100.0)	**59.4** (100.0)	**100.0**

Source : Author's tabulation from Statistics Canada, Survey of Innovation,1999
Note: The Chi2 tests rejects the hypothesis of independence between R&D and the use of all IPRs beyond the 0.001 level of significance.

Firms that did not carry out R&D activities had much less use for all forms of intellectual property protection than those that did. This suggests that innovators that did not carry out R&D introduced mostly incremental, imitative innovations with lower intellectual property value. This is illustrated in Figure II-4, where the use of IPRs is contrasted for firms that perform R&D and those that do not. Since the most original innovations depend on R&D more than the imitative ones, the difference in use of IPRs between performers and non-performers of R&D is most notable -three to one -for the use of patents.

Figure II-4 Use of IPRs by performers and non-performers of R&D



Source: Author's tabulation from Statistics Canada, Survey of Innovation, 1999

The extent of patenting

The temporary monopoly protection granted by a patent may encourage firms to apply for as many patents as possible. Accelerating pace of technological change and innovation as well as the recent introduction in Canada of the 'first-to–file' patent system has increased the propensity to file patent applications (Rafiquzzaman and Whewell, 1998). Firms adopt various strategies with respect to patenting and the number of patentable innovations varies significantly from firm to firm. Given the high degree of economic integration between Canada and the United States, many firms patent their inventions in both countries. Some apply for patents in the US only and a small minority files patent applications in other foreign countries.

In addition to the question regarding the use of IPRs firms were also asked to provide information on (1) the extent and geographical pattern of patent applications and (2) on the number of patent applications filed in Canada and in the US.

Extent and geographical pattern of patenting

As far as the extent of patenting is concerned, almost one out of five manufacturing firms (19%) applied for at least one patent in the 1997-1999 period (see the first column of Table II-6). As can be expected, the proportion of firms that applied for patents is larger in the group of innovating manufacturers (22.4 percent). [20] The rest of the table presents the geographical pattern of patenting. It shows convincingly that even though two thirds of Canadian firms apply for patents both in Canada an the US, the majority (85%) files patents in Canada, and about 20% of firms in Canada only. Only about 10% of firms that applied for a patent did not bother to file an application in Canada and applied for patents only in the US. One would expect that these are mainly US affiliates.[21] A small group of firms (5%) applied in other countries than Canada or US.

The percentage of all manufacturing firms and of successful innovators that applied for patents in Canada and elsewhere (see the last two lines of Table II-6) seem to be

implausibly similar. A comparison on an industry by industry basis shows, however, that these average percentages for the total manufacturing sector are hiding often significant inter-industry differences which tend to cancel out. The similarity of the results in the two lines is also due to the high proportion of manufacturing firms that innovate rather than to an error.[22]

Table II-6 Applications for Patents in Canada and the United States, 1997 - 1999

		Of These, % That Applied For Patents In:					
	Applied for at Least One Patent	Canada	United States	Both Canada and US	Canada Only	United States Only	Neither Canada nor US
Manufacturing Industries	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**	**Percent**
All firms	19.0	85.1	75.6	65.8	19.3	9.8	5.1
Innovators	22.4	85.2	75.4	65.8	19.5	9.6	5.1

Source: Preliminary results Statistics Canada, Survey of Innovation, 1999

How many patent applications are filed?

Firms were asked to indicate not only whether they applied for a patent in Canada and/or in the US but to indicate the number of applications in each country. There are significant interindustry differences in the propensity to patent. The largest proportion of firms that applied for at least one patent over the 1997-1999 period is found in Agricultural, Construction and Mining Machinery industry (54.1%). This pre-eminence of patenting by the natural resource-oriented equipment producers appears to be an extension of Canada's comparative advantage in this field. In the second place are firms in Communication equipment (48.2%) industry, followed by Semiconductor & Other Electronic Equipment industries (about 40%). The pharmaceutical firms, which in other countries usually lead the patenting ranking, are behind; only 30% applied for a patent. This suggest that much of pharmaceutical research in Canada does not introduce original products and processes. The lowest proportion of firms that applied for at least one patent is in clothing and wood product industries. The ranking of industries is similar to that revealed by the responses to question on the use of patents. Details on industry distribution of patent applications are presented in Table A-6 in Appendix II.

Most firms applied for one patent only (respectively 41.6% in Canada and 34.4% in the US) (see Table II-7). These proportions were again rather similar for innovating firms (respectively 40.3% in Canada and 32.9% in the US). The percentage of firms that applied for more than one patent declines rapidly with the number of applications. Those, mainly larger, firms that patent most frequently, apply for patents more in the US than in Canada. For instance, a larger proportion of firms that applied for more that ten patents did so in the US (13.4%) than in Canada (9.6%).

Further analysis of the propensity to patent in Canada and in the United States shows that firms that were found in the preceding sections of the paper to be more likely to use patents (large firms performing R&D, active in the core sector and having introduced original innovations) also tend to apply for more than one patent. Instead of presenting

here detailed tables and figures which are available on request, we present only the main conclusions.

The number of patent application filed by firms is increasing from the 'other' sector to the secondary and to the core sector.

1. The frequency distribution of the number of patent applications in Canada and in the US by firm size shows that in each size category firms that patent rarely (say less than three patents) tend to patent more often in Canada than in the US. However, firms that apply for a larger number of patents do so more frequently in the US than in Canada. This trend is most notable for the largest firms that apply for large number of patents. Forty percent of these firms applied for more than 10 patents in the US and only 31 percent in Canada.

2. The preference for patent applications in the US is most notable among firms that apply for large number of patents in the technologically most progressive core sector. The observed pattern suggests that the leading edge firms that patent most frequently –apply for patents in both countries but in the US more often than in Canada. The tendency of the most active patentees in the core sector to file more often in the United States than in Canada may reflect the more extensive protection of new technologies and more inventor friendly treatment there (see the chapter by Maskus in this volume).

The geographical pattern of patent filing is further explored in three multivariate probability models in the next section of the chapter.

Table II-7 Number of Application for Patents in Canada and the United States, 1997 - 1999

		Of These, Number of Patents Applied For:						
		1	2	3	4	5 to 9	10 or more patents	Unknown
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
All Manufacturing Firms								
Applied for at least one patent	19.0							
Of these, % that applied for patents in:								
Canada	85.1	41.6	17.7	11.3	4.2	9.4	9.6	6.2
United States	75.6	34.4	15.7	13.4	3.7	11.8	13.4	7.6
Innovators in Manufacturing								
Applied for at least one patent	22.4							
Of these, % that applied for patents in:								
Canada	85.2	40.3	18.1	11.8	4.4	9.6	9.6	6..3
United States	75.4	32.9	16.1	13.7	3.9	12.0	13.7	7.7

Source: Preliminary results Statistics Canada, Survey of Innovation, 1999

The relationship between the protection of intellectual property and profitability of innovation

Firms use intellectual property rights presumably to appropriate benefits from innovation. If this hypothesis is true then innovators who protect their intellectual property are expected to be more profitable than those that do not. This hypothesis can be tested using the survey information on the impact of innovation and on the use of IPRs. Respondents scored on the scale from 1 to 5 their strong disagreement (1) or strong agreement (5) with a series of statements regarding the impact of new or improved products or production processes they introduced during the 1997-1999 period . Respondents could select among other impacts two outcomes concerning innovations' impact on profits. The first states that the innovation allowed the firm to maintain its profit margin, the second that innovation. increased profitability of the firm. Responses scored 1 and 2 were considered as an indication that the innovation activity did not contribute to profitability, scores 4 and 5 as evidence of a positive contribution to profitability.

Both answers were tabulated in a series of two-way contingency tables classifying firms by the impact of innovation on profitability and as users and non-users of each IPR. The chi2 statistics rejects for every intellectual property right the test of homogeneity, i.e. the hypothesis that either impact of innovation on profitability is independent of the use of the particular IPR. The statistical tests show that the users of IPR reported more often than the non- users that their innovation allowed them to maintain or to increase profitability.[23] This positive relationship is not very strong, but it is statistically very significant. It holds for all innovating firms but there are some sectoral differences. The positive relationship between the use of patents and profitability obtains for the core and secondary sector but not for the 'other' sector. By the way of contrast, firms that found innovation profitable in the 'other' sector are more frequently using trade secrets and confidentiality agreements. Trade mark users report maintained or increased profitability more frequently than non-users in all three sectors (for details see Table A-7 in Appendix II).

Overall, these results provide a statistically significant evidence that innovators who protected their intellectual property found their innovations contributing to profitability of their firm.

III. PROBABILITY MODELS OF INNOVATION AND INTELLECTUAL PROPERTY USE

The statistical description presented in the previous sections is of limited use when we are interested in taking into account the possible interactions between the characteristics, strategies and activities of firms and their use of IPRs. This task is better fulfilled by multivariate probability regression models. These models relate the probability that a particular event takes place- say the probability that a firm uses a patent - to a series of explanatory variables.

We first present briefly the theoretical formulation of such models. This is followed by the specification of the dependent and explanatory variables used for estimation of several multivariate logit models. In the first set of models we estimate the probability that a firm uses a particular IPR. The second set explores the variables that are associated

with the probability that a firm innovates. These models also show whether the use of IPRs affects the probability that a firm innovates. Since these two sets of decisions are not entirely independent, a single equation approach may lead to biased results. We therefore used both a single equation and a simultaneous two equation method of estimation. The latter takes into account the possibly interdependent nature of the decision to innovate and leads to unbiased estimates. Finally, we present three models that seek to determine which firm and industry characteristics are likely to be associated with a particular geographical pattern of patenting.

The logit model

Firms innovate in the expectation that the new or improved product or process will increase their profits. Even though a successful completion of the innovation process is a necessary condition, it is not sufficient to ensure that the firm will benefit from it.. To reap the expected benefits from innovation, the firm has to be able to appropriate them, i.e. to prevent its competitors to imitate the innovation. To appropriate benefits from innovation, firms may use various IPRs. Thus the decision to innovate may be related to the decision how to best appropriate its expected benefits. Even though these two decisions may not be taken at the same time, they are probably not independent.

The expected post-innovation return[24] to innovation activity r_i^* for firm i is taken to be a function of a set of firm specific and industry specific k exogenous variables x_i. This may be formally written as:

$$r_i^* = bx_i + u_i \qquad (1)$$

Even though r_i^* is not directly observable, we know whether the firm i innovated or not. We assume that when the expected return from innovation is positive, firms successfully innovate (I=1). The observable binary variable I_i takes a value of one when the firm is an innovator and zero otherwise. Thus we can write

$$I_i = 1 \quad \text{if } r_i^* > 0 \qquad (2)$$
$$I_i = 0 \quad \text{otherwise}$$

The formal reasoning regarding the use of an appropriability strategy is similar. When we observe that a firm has used a set of IPR instruments we can conclude that it is because the firm expected that their use will have a positive effect on its profitability. In this case

$$IPR_i = 1 \quad \text{if } r_i^* > 0 \qquad (3)$$
$$IPR_i = 0 \quad \text{otherwise}$$

Thus we have two sets of relationships, one for the innovation I_i and the second for the use of IPR_i.

$$E(r_i^* | x_i) \text{ gives us } Prob(I_i=1) = F(b'x_i) \qquad (4)$$

$E(r_i^*|z_i)$ gives us $Prob(IPR_i=1) = G(c'z_i)$ (5)

Where F and G are the cumulative distributions of a logistic variable.

According to economic theory, the profitability of an innovation is function of the size of firm, its activities and strategies, the competitive environment, technological opportunities and demand conditions it faces. Most of these variables are expected also to influence the choice of appropriation strategy, i.e. the use of IPRs and ways to protect firm's intellectual property.

Dependent Variables

(i) Innovation variables

Innovation is measured in three different ways for the purpose of this analysis. First, the incidence of innovation is captured by a dichotomous variable that measures whether or not a firm has introduced an innovation of any type within three years prior to the survey date of 1999. The binary variable takes a value of one for innovative firms, and zero for non-innovative firms. Second, a set of binary variables is constructed to capture novelty effects—world-first innovators versus all other innovating and non-innovating firms; and Canada-first innovators versus other innovating and non-innovating firms and firm-first innovators versus non-innovators and other innovators. The novelty of an innovation is likely to affect the use of intellectual property.

Third, the type of innovation introduced by a firm is captured by a set of three binary variables. The first variable identifies cases when a firm produces only product innovations. It takes a value of one if this is the case, and zero otherwise. The second binary variable identifies process-only innovators, while the third contrasts firms that introduced both product and process innovations against the rest.

(ii) Appropriability and Intellectual Property Rights

To protect their innovations from being copied by competitors, innovators use IPRs and other strategies.

A set of binary variables have been constructed to estimate the determinants of use of IPRs and their effects on innovation. The variables are based on whether or not a firm uses patents, uses trade secrets, or uses any other intellectual property right (trade marks, copyrights or confidentiality agreements) to protect its innovations. Each variable takes a value of one if the particular property right is used and a value of zero if it is not.

The IPR variables appear among explanatory variables in the innovation equation and innovation variables are among explanatory variables in the IPR equations.

Explanatory Variables

Innovation is highly firm specific. Some of the differences in innovative capabilities will be related to differences in industry environment. But within industries there are considerable differences in the innovative tendencies of firms. Therefore, innovation is assumed to be a function of both firm-specific and industry-specific variables. Firm-specific variables include characteristics of the firm—such as firm size, and country of ownership (unfortunately no information on ownership of firms is available in the 1999 Survey) —firm activity variables—such as R&D and use of IPRs and – firm perceptions- with regard to competitive environment and success factors (strategies). Industry-specific variables include proxies for technological opportunity and industry dummy variables

Firm Characteristics

Size

The contingency tables in the first part of this study show a clear relationship between innovation and size of the firm on the one hand and the size of the firm and the propensity to use various IPR instruments on the other. A measure of firm size is included to test whether there are inherent advantages associated with size that are independent of other variables. The large size will matter if the Schumpetarian hypothesis that large firms have inherent scale advantages is true. Large firms, it is often argued, tend to be more innovative than their smaller counterparts. Reasons for this include scale advantages of large firms; a greater likelihood to engage in risky projects; and economies of scope (Cohen and Klepper, 1996). Larger firms have easier access to financing, can spread the fixed costs of innovation over a larger volume of sales and may benefit from economies of scope and complementary relations between R&D and other manufacturing activities. Other views, however, exist to suggest that as firms grow large, their R&D becomes less efficient. Levin and Reiss (1989) reviewed the empirical evidence on the relationship between innovation and firm size and found it inconclusive.[25] Economies of scale and scope may exist, but may be exhausted at only medium-size firms.

Size is measured by the total number of employees in a firm. Firms are classified as belonging to one of four size categories—20 to 49employees, 50 to 99 employees, 100 to 499 employees, and 500 or more employees. Based on this, four binary variables have been constructed to capture size effects.

Firm's perceptions

Competitive Conditions

In contrast to earlier studies which considered market structure of an industry as one of the major exogenous determinants of innovation, more recent theoretical ((Dasgupta P. and Stiglitz J., 1980), 1980) and empirical work by Levin Reiss(1984, 1988) and (Cohen & Levinthal , 1989) suggests that it is more likely to be an endogenous outcome of dynamic growth of innovating firms.

The concept we want to measure is the degree of competition faced by a firm. The firm's representatives were asked to score their agreement with several statements describing the degree of competition faced by the firm. The competition variables take a value of one when the responded agrees or strongly agrees with the statements identifying high degree of competition (variable COMPET) [26] as been important or very important.[27] Another proxy variable for competitive challenge is identified as a threat of rapidly changing production or office technology, TECHCH. Otherwise the variables take value of zero. Firms in rapidly moving fields often face difficulties hiring and retaining qualified staff and workers. The variable STAFF takes value one when a firm indicates that this problem is important or very important and zero otherwise.

Competitive strategies-success factors

In response to questions on success factors firm representatives revealed what they considered to be successful competitive strategies. Responses to questions related to firm's success were used to construct three variables. The first NEWMT captures responses that give a high score to the importance of new markets and new products for the success of the firm.[28] The next, EXPMT identifies firms that draw their success from export markets. A more general strategy is associated with promotion of the firm or the product reputation. This variable REPUT identifies firms adopting a strategy that may be associated with the use of Trademarks.

Firm Activities

Research and Development

Even though firms not involved in R&D activities introduced 32 percent of innovations, every study of innovation confirms that R&D is the principal input for innovative activity. Firms that have established an effective R&D program are more likely to innovate for several reasons. First, R&D directly produces new products and processes. Second, firms that perform R&D are also more receptive to the technological advances made by others and able to absorb and adapt spillovers to their advantage (Cohen and Levinthal, 1989). A binary variable takes a value of one if the firm carries out R&D and zero otherwise.

The way firms organise their R&D activities - establishing a separate R&D unit and/or contracting R&D is likely to influence their innovation performance and need for protection of intellectual property. The presence or absence of a particular organisation form is again identified by a set of binary variables.

Government support programs

Government programs in support of innovation and R&D activities subsidise their cost, either directly by grants or indirectly by tax credits. Other government assistance programs such as information and internet services are also designed to enhance private innovation activities. We create a series of binary variables which identify the cases when a firm uses a particular government assistance program by a value of one, otherwise the variable takes value zero.

Industry Effects

Technological opportunities differ across industries when the scientific environment provides more fertile ground for advances in some industries than others.[29] Progress in science reduces the cost of technological advance generated per unit of R&D expenditures. The classification of a firm in one of the three technology sectors (Core, Secondary and 'Other') provides a proxy for technological opportunity.

Industry specific effects

Industries vary widely not only with respect to technological opportunity and their position in technology life cycle but also with respect to the degree of exposure to external competition, availability and cost of factors such as specialised manpower, natural resources etc. Thus relying on a simple three technology typology (core, secondary and 'other') may not capture those other industry specific conditions that may have a bearing on innovation and use of intellectual property protection. A set of industry dummy variables identifies the 24 major manufacturing industry groups.

Province-specific effects

Innovation is a social activity. As such it depends not only on incentives, motivations, resources and the thriving private sector but also on the institutional environment in which enterprises operate. The recognition of the importance of the complex relationships between the private sector and its institutional environment led to the concepts of national and regional system of innovation.[30] Many aspects of education and science, technology, industrial and fiscal policies are provincial responsibility and are likely to affect innovation performance of resident firms. For example, owing to provincial R&D tax credit programs the real cost of conducting R&D varies from one province to another (Warda, 1997) To explore whether the province of residence of a firm affects its innovation performance and the use of intellectual property protection a set of dummy variables identifies the province of residence of the firm.

The list of variables is presented in Table III-1.

Table III-1. Summary of Dependent and Explanatory Variables

VARIABLES		Values
DEPENDENT VARIABLES		
INNO	Firm introduced successfully an innovation	Yes=1, No=0
W-FIRST, C-FIRST AND F-FIRST	World-1st, Canada-1st and firm-1st innovation	Yes=1, No=0
PRODUCT-PROCESS AND BOTH	Product , process or both	
Use of Intellectual Property Rights		
PATENTS	Firm used patents	Yes=1, No=0
TRADEM	Firm used trademarks	Yes=1, No=0
COPYRIGHT	Firm used copyright	Yes=1, No=0
SECRET	Firm used trade secret	Yes=1, No=0
CONFIDENTIALITY	Firm used confidentiality agreement	Yes=1, No=0
EXPLANATORY VARIABLES		
1. FIRM CHARACTERISTICS		
Size	Employment Size	
SIZE-A	- 20 to 49 employees	Yes=1, No=0
SIZE-B	- 50 to 99 employees	Yes=1, No=0
SIZE-C	- 100 to 499 employees	Yes=1, No=0
SIZE-D	more than 500 employees	Yes=1, No=0
2. FIRMS PERCEPTION OF COMPETITIVE CONDITIONS		
COMPET	High competition in the product market	Yes=1, No=0
TECHCH	Production and office technology change rapidly	Yes=1, No=0
STAFF	Difficulties hire and/or retain qualified staff	Yes=1, No=0
3. SUCCESS STRATEGIES		
NEWMT	Seeking new and/or developing special. markets	Yes=1, No=0
EXPMT	Developing export markets	Yes=1, No=0
REPUT	Promoting firm or product reputation	Yes=1, No=0
4. FIRM ACTIVITIES		
R&D activity		
PERFORMS R&D	Performs R&D activity	Yes=1, No=0
SEPARATE UNIT	-"- in a separate R&D unit	Yes=1, No=0
CONTRACTS OUT	Contracts out R&D	Yes=1, No=0
4. GOVERNMENT SUPPORT		
GVT-SUB	Uses government R&D subsidies	Yes=1, No=0
GVT-TXC	Uses government R&D tax credits:	Yes=1, No=0
GVT-INT	Use govt. information and internet services:	Yes=1, No=0
4. INDUSTRY CHARACTERISTICS		
Technology sector		
CORE	Firm belongs to 'Core' sector	Yes=1, No=0
SECONDARY	Firm belongs to 'Secondary' sector	Yes=1, No=0
OTHER	Firm belongs to 'Other' sector	Yes=1, No=0
5. PROVINCE		
ALTA	Firm located in Alberta	Yes=1, No=0
ONT	Firm located in Ontario	Yes=1, No=0
QC	Firm located in Québec	Yes=1, No=0

Econometric issues

1. In order to be representative of the "provincial enterprise" which is the statistical unit selected by Statistics Canada for the Innovation Survey 1999, the regressions are weighted by the Gross Business Income of each firm.
2. All explanatory variables are binary, taking the value 1 or 0. In the case a variable classifies firms into several subcategories (e.g. firms are classified in one of several size categories) one of the dummy variables is left out and serves as the default category. The estimated regression coefficients (after an appropriate transformation) show the marginal effect of a given explanatory variable on the probability of the event with respect to the reference case given by the default category.
3. The regression equations presented in all tables usually exclude those explanatory variables which were statistically not significant in previous runs.
4. As is often the case, the results of logit and probit regression model estimates are practically identical. Since there are no theoretical nor econometric reasons to prefer one method over the other and logit results are easier to interpret, we opted for logit regressions.
5. According to economic theory, firms decision to innovate depends on its capability to appropriate benefits from the innovation. Thus a priori it is likely that the decision to use a particular IPR and the decision to innovate are not mutually independent. In this case estimating, say, the patent function and the innovation function separately by a single equation approach would lead to a simultaneous equation bias. The remedy is to formulate a system of simultaneous equations and estimate it by the two stage estimation method (Maddala, 1993). The information on the use of IPRs is, however, rather general. It is not specific to firms' innovation activity, and even less to its most important innovation. Thus it is not certain that both decisions were really interdependent and the two stage approach is called for. To be on the safe side, we estimate in addition to single equation models also a simultaneous two equation model using a two stage logit procedure.
6. Since neither SAS nor STATA softwares at our disposal provide an integrated two-stage logit procedure, we estimated the second stage equations of the simultaneous model by using as instruments the predicted value (linear) of each endogenous variable (patent and innovation respectively). These were obtained by regressing the interdependent endogenous variables in the first stage equation on all independent variables. The drawback of this procedure is that the covariances estimated as in a single equation procedure are likely to underestimate the correct asymptotic covariances. To compensate for this possible underestimation, the standard errors are computed by the "robust" procedure that gives more conservative estimates of standard errors than the normal method.

Interpretation of the results

Models predicting the use of IPRs

The estimated regression coefficients of five logit models predicting the probability that a firm uses a particular means of IPR are presented in Table III-2. The signs of regression coefficients show whether the answer "yes" to a particular question (the variable takes value 1) increases (+) or decreases (-) the probability that a firm uses the particular IPR. The probabilities are estimated with respect to a firm with 100 to 499 employees operating in the secondary sector and that introduced a firm-first process innovation.[31]

The first important result is that the models confirm in the multivariate context the finding from tabulations regarding the positive association between the size of firm and the probability that the firm uses most of IPRs to protect its knowledge assets. Small firms are less likely and the largest firms are more likely to use any and all IPR instruments than the medium size firms. The relationship is statistically significant for the use of all IPRs except for trade secrets and it is most notable for patents. In contrast, small firms do not use trade secrets less frequently than the medium size firms. This finding seems to corroborate the hypothesis that for the small and medium size firms the cost considerations may discourage the use of other IPRs than trade secrets.

Firms carrying out R&D and especially those doing so in a separate R&D unit and or contracting R&D out are also more likely than firms not involved in R&D to use all and any IPR . Innovating firms, especially those that introduced the original world-first innovations, and to a slightly lesser extent also those introducing new technology for the first time in Canada, are likely users of intellectual property rights. However, the world first innovators rely less on trade secrets and more on patents, copy and confidentiality agreements. The probability that a firm uses IPRs increases notably when the firm introduces product innovations or both product and process innovations rather than process innovations. Again these characteristics of innovations are more closely associated with the use of patents than of other IPRS.

Firms that base their competitive strategy on the development of new markets are likely to protect their intellectual property using trademarks, trade secrets and confidentiality agreements. Curiously, they are unlikely to use patents for this purpose. Equally surprising is the absence of statistical association between the export strategy and the use of any IPRs. As expected, the regression results confirm that trademarks are a means to enhance a firm's reputation.

Firms that reported receiving a government subsidy for their R&D project are more likely to use patents, trademarks and/or confidentiality agreements than firms that received the more generally available government tax credit. Both groups are likely to use those IPRs more frequently than firms that did not receive any form of government assistance. Paradoxically firms that reported using government information services through internet or otherwise are more likely than other firms to use trade secrets, confidentiality agreements and copyrights.

The results suggest that there are some notable differences associated with the province where the firm operates. Firms located in Ontario and in Alberta are more likely to use the majority of intellectual property rights than firms in other provinces. Firms from Quebec are more likely than firms in other provinces to protect their products by trademarks but less likely to use copyrights, trade secrets and confidentiality agreements. One hypothetical explanation could be that the use of French or the loyalty of employees to their firms may provide an efficient protection against imitation and make it unnecessary to resort to these IPRs. An alternate explanation could be that the particular pattern of IPR use in Quebec is determined by the composition of its industrial production.

Firms in the core sector are more likely to use all IPRS except trade secrets than firms in the secondary sector. Patents are used less frequently in the 'other' sector than in both upstream core and secondary sectors. In keeping with their consumer product orientation, firms in the 'other' sector are more likely than those in the secondary one to use trademarks and copyrights.

The industry dummy variables identifying major manufacturing industry groups were found to be redundant (F-test) and were therefore not included in the regressions.

One way to judge how well our probability models perform is to let them predict which firms are expected to use a particular IPR and compare this prediction with the observed use of intellectual property rights. The row next to the last in Table III-2 denoted "% concordant" shows the percentage of firms in the sample that were correctly classified by the logit regression function as users or non-users of the particular IPR. It ranges from the low 66.8% for the use of trade marks to 87.6% regarding the use of copyright.

The results suggest that when it comes to the use of IPRs, there are two groups of firms. The first group of firms are those for which the use patents and trademarks, seems to be an integral part of a successful innovating strategy, which consists of performing regularly R&D financed in part by government subsidies and grants and resulting in introduction of world first innovations. The larger the firm, the more likely it is that it uses patents. The probability of using patents is about two times higher when the firm operates in the high-tech core sector than in the low tech 'other' sector. Firms located in Quebec are less likely to use patents than those from Ontario and Alberta.

The second group of firms is likely to rely primarily on trade secrets. It consists of firms that introduce mainly Canadian-first innovations, and are less oriented to product innovation than firms in the first group. Even though they are as likely to perform R&D as firms in the first group, they are rely less on government financing of R&D but more on government information services. Firms in this group belong to all firm size categories but those in the largest one are somewhat more likely to use trade secrets than the medium size and small firms. They are found in all three sectors and in all provinces outside Quebec. Firms from Quebec are less likely to use trade secrets than those in the rest of Canada.

The innovation models

Protection of new products and processes from imitation is believed to be one of the principal incentives for innovation. Firm's decision to innovate depends of course on a host of other variables, some related to its characteristics, activities and strategies, others determined by the competitive pressures, technological opportunities and government policies. All or some of these factors might also determine which type of innovation a particular firm is likely to introduce.

Four logit regressions are presented. The first predicts the probability that a firm is an innovator, i.e. that it introduced an innovation in the 1997-1999 period. The next three models predict, respectively, the probability of introduction of a World-first, Canada-first or Firm-first innovation.

The first model predicts the occurrence of a successful innovation (I=1) as opposed to cases when a firm did not complete an innovation in the 1997-1999 period or was not involved in innovative process (I=0). The probabilities are estimated with respect to a firm operating in the secondary sector.

The preliminary results (not presented here) suggested that the probability of successful innovation is not correlated with the size of firm. The size of firm is, however, the principal determinant of a firm's decision to conduct R&D or not and how to organise it. Thus the size of firm influences the innovation activity indirectly through R&D and the modalities of its organisation. The innovation function therefore includes two R&D variables, one takes value one when the firm performs R&D, the second identifies the firms that conduct R&D in a separate division. Since none of the firm size variables was statistically significant in the presence of R&D variables, they were excluded from the final model presented in the first column of Table III-3. Several variables reflecting firm's perceptions of its competitive environment and its success factors or strategies were excluded for the same reason.

The results suggest that firms operating in the core sector (and to a much lesser degree also those in the other sector) are more likely to innovate than those in the secondary one. The probability that a firm is an innovator is greatly increased when it conducts R&D activity. It matters little, however, whether R&D activities are conducted in a separate division or in other departments of the firm. Nor does it matter whether R&D is contracted out or not. The latter variable was therefore excluded. Firms receiving government assistance programs, especially R&D grants and to a lesser degree also R&D tax credits are more likely to innovate than those that do not use them. This positive correlation between the use of government support programs and innovation is not necessarily an indication of a beneficial effect of those programs. It may simply show that innovating firms are better aware of and organised to solicit successfully governmental aid.

Firms that are developing new markets for their products both in Canada and abroad are more likely to innovate than others. These firms share the same concern over the rapid

change of production and office technologies and they experience problems hiring and retaining qualified staff and workers.

Last, but not least, as predicted by economic theory of innovation, the firms that are protecting their intellectual property with patents, trademarks and most notably with trade secrets are more likely to innovate than firms that do not. In this respect the use of trade secrets increases the probability of innovation more than the use of patents. Results of other experimental estimations not presented here show also a statistically significant positive association between the use of "any" statutory instrument of IPR and the probability of introduction of an innovation.

When the program compares the predicted probability of a firm being an innovator with the observed response, the predicted outcome is correct for 82.4% of firms.

Originality of innovation

The next three models predict the probability that a firm introduces a world first, Canada first or firm-first innovation. Each of these three models is formulated so as to estimate the probability that a firm introduces the particular type of innovation against all other possible outcomes.[32]

Results of the three regressions estimating the probability of the world-first, Canada-first and firm-first innovation are presented in this order in column 2 to 5 in Table III-3. Again, most variables that were not statistically significant were excluded. We concentrate our interpretation on the three IPRs variables included in each regression.

To be patentable, an invention must be an original contribution to the state of technology.[33] Therefore it can be expected that the use of patents is a better predictor of the probability that the firm introduces a world-first innovation than a Canada-first or firm-first innovation. This is indeed what that data show.

Firms using trade secrets are more likely introduce the world-first or Canada-first innovations than those already in existence elsewhere in Canada (firm-first). The latter is associated to a similar degree with the use of patents and trade marks but not with trade secrets. Firms introducing new technology to Canada are also using trademarks.

A simultaneous model estimated by a two stage method

As we mentioned earlier, the decisions to innovate and to protect intellectual property that the innovation entails may well not be independent. If this is the case, the single equation estimation method used up to now may lead to a simultaneous equation bias. To obtain consistent estimates of regression coefficients we used a two stage estimation method (Maddala, 1983). The results of estimation of one such model including two equations, one predicting the probability that a firms uses patents and the other that it introduces an innovation are presented in Table III-4.[34] For the sake of comparison, we present along each estimated structural equation (patents and innovation) a single equation estimate of the same equation.

After obtaining the predicted values of each interdependent endogenous variable (*PR-INNOVATION* and *PR-PATENTS*) in the first stage by regressing each variable on all explanatory variables of the system, the predicted values of *PR-INNOVATION* and *PR-PATENTS* are included in the second stage structural equations.

The comparison of regression coefficients of each structural equation with its single equation equivalent in Table III-4 shows that most regressions coefficients estimated by the 2-stage method are not very different from those obtained by a single equation approach. In the patent equation the regression coefficient of the predicted value of innovation is almost identical to the corresponding coefficient in the single equation. The most important difference between the single and the 2-stage version of the patent equation regards the variables of government support programs. The large and statistically significant regression coefficient of *R&D-SUBSIDY* variable obtained in the single equation all but disappears and becomes statistically insignificant in the 2-stage estimation. The regression coefficient of the *R&D-TAX CREDIT* is also smaller and statistically less significant in the 2-stage estimation.

The two methods of estimation of the innovation equation show that the regression coefficient of the *PR-PATENTS* variable obtained in the 2-stage structural equation is significantly smaller than its equivalent obtained in the single equation estimate. In contrast with the patent equation, the regression coefficients of *R&D-SUBSIDY and R&D-TAX CREDIT* variables estimated by the 2-stage method in the innovation equation are not significantly different from estimates obtained by the single equation method.

Thus when the possible interdependence of the decisions to innovate and to use patents is taken in consideration, the positive correlation between the probability that an innovating firm uses patents remains unchanged. On the other hand, the use of patents has less effect on the firm's decision to innovate than would suggest the single equation estimates. This outcome points in the same direction as the findings of Baldwin, Hanel and Sabourin, (2001). Analysing the data from the 1993 innovation survey they concluded that the relationship is much stronger going from innovation to the decision to use patents than from the use of patents to innovation.

Even though the two stage estimation of the innovation function suggests that patents may not be as strong an incentive for innovation as economic theory claims, the world first innovators are likely to use patents more frequently than trade secrets. Given the sceptical attitude of firms regarding the patent's effectiveness as a means of appropriation of innovation benefits (Baldwin, 1997), firms introducing more original innovators may use patents for multiple other reasons.

The geographical pattern of patenting

In this section we seek to determine which firm and industry characteristics are likely to be associated with a particular geographical pattern of patenting. The three models, estimate respectively the probability that a firm applies for a patent in Canada only, in the US only and in both countries. We started with the full set of explanatory variables used in the previous models and excluded those variables that were statistically not significant

in any of the three models. The results suggest that firms that introduced a Canada-first innovation tend to apply for patents exclusively in Canada (Table III-5, 1st column). The probability of applying for patents in Canada only is further enhanced when the firm belongs to the largest category and is conducting R&D. On the other hand, the probability that a firm patents only in Canada is the same for all three sectors.

The probability that a firm applies for a patent in the US only, is higher for world-first and Canada-first innovators that conduct R&D and did so in a separate unit. These could be mostly US owned firms. Unfortunately, the information on the ownership of firms is not known. When a firm operates in Ontario it is more likely that it files for patents in the US only. Again, the sector in which the firm operates does not affect the probability that it applies for patents only in the United States.

A more important group of firms patented both in Canada and in the US. The distinctive features of these firms are their medium and large size, they were successfully pursuing an export strategy and in addition to conducting R&D, contracted R&D out. The likelihood of filing patents in both countries increases when the firm belongs to the core sector, is located in Ontario or Alberta and receives R&D subsidies and tax credits. Firms operating in the 'other' sector are less likely than others to apply for patents in both countries.

Table III-2. Use of IPRs –Results of Logit Regressions

DEPENDENT VARIABLE	**PATENT**	**TRADEM**	**COPYRIGHT**	**SECRET**	**CONFIDENT.**
Intercept	-2.661 (0.197)a	-2.273 (0.159)a	-3.208 (0.242)a	-2.470 (0.195)a	-1.237 (0.158)
1. FIRM CHARACTERISTICS					
Firm Size					
SIZE-A	-0.390 (0.111)a	-0.391 (0.092)b	-0.267 (0.140)c	0.063 (0.105)	-0.391 (0.097)a
SIZE-B	-0.262 (0.098)a	-0.334 (0.084)a	-0.235 (0.124)c	0.005 (0.094)	-0.376 (0.086)a
SIZE-C	left out	left out	left out	left out	left out
SIZE-D	0.418 (0.135)a	0.152 (0.127)	0.409 (0.159)a	0.311 (0.136)b	0.270 (0.138)b
2. FIRMS PERCEPTIONS					
Competitive conditions					
COMPET	0.103 (0.084)	0.247 (0.071)a	0.167 (0.102)c	0.059 (0.082)	-0.097 (0.074)
STAFF	-0.343 (0.093)a	-0.178 (0.078)	-0.098 (0.111)	0.100 (0.084)	-0.002 (0.081)
Success factors					
NEW MARKET	0.011 (0.128)	0.221 (0.111)b	0.055 (0.153)	0.297 (0.138)b	0.297 (0.116)a
EXPORT MARKET	0.130 (0.086)	0.115 (0.075	-0.025 (0.109)	-0.130 (0.084)	-0.102 (0.077)
REPUTATION	0.163 (0.114)	0.206 (0.093)b	0.048 (0.137)	-0.004 (0.105)	0.105 (0.093)
3. FIRM ACTIVITIES					
R&D activity					
PERFORMS R&D	0.454 (0.120)a	0.229 (0.097)b	0.293 (0. 158)c	0.589 (0.116)a	0.426 (0.098)a
-SEPARATE UNIT	0.463 (0.092)a	0.342 (0.084)a	0.319 (0.112)a	0.547 (0.089)a	0.491 (0.089)a
-CONTRACTS OUT	0.362 (0.100)a	0.239 (0.092)a	0.456 (0.114)a	0.213 (0.096)b	0.415 (0.099)a
USE of IPRs					
PATENTS					
TRADEMARKS					
TRADE SECRETS					
4. GOVT. SUPPORT					
R&D-SUBSIDY	0.471 (0.123)a	0.245 (0.116)b	0.091 (0.145)	0.090 (0.114)	0.609 (0.121)a
R&D-TAX CR.	0.206 (0.094)b	0.088 (0.084)	-0.108 (0.113)	-0.036 (0.090)	0.246 (0.863)a
GVMNT-INTERNET				0.406 (0.078)a	0.695 (0.081)a
4. INDUSTRY CHARACTERISTICS					
CORE Sector	0.343 (0.103)a	0.397 (0.097)a	0.364 (0.129)a	0.057 (0.102)	0.298 (0.101)a
SECONDARY Sector	left out	left out	left out	left out	left out
OTHER Sector	-0.566 (0.096)a	0.504 (0.085)a	0.217 (0.125) c	-0.102 (0.093)	-0.298 (0.084)
5. PROVINCE					
ALBERTA	0.444 (0.147)a	0.177 (0.131)	0.410 (0.182)b	0.234 (0.145)c	0.212 (0.133)
ONTARIO	0.624 (0.111)a	0.190 (0.096)b	0.341 (0.128)a	0.157 (0.108)	0.356 (0.099)a
QUEBEC	**0.056 (0.107)**	0.327 (0.089)a	-0.559 (0.138)a	-0.269 (0.100)a	-0.326 (0.089)a
OTHERS	left out	left out	left out	left out	left out
6. INNOVATION					
W-first	0.691 (0.147)a	0.216 (0.133)	0.326 (0.160)b	0.183 (0.134)	0.339 (0.148)b
C-first	0.496 (0.105)a	0.418 (0.094)	0.391 (0.128)a	0.391 (0.100)a	0.373 (0.099)a
F-first	left out	left out	left out	left out	left out
Product	0.959 (0.141)a	0.820 (0.114)a	0.688 (0.175)a	0.294 (0.132)	0.322 (0.115)a
Both	0.709 (0.116)a	0.619 (0.167)a	0.604 (0.148)a	0.611 (0.108)	0.441 (0.091)a
Process	left out	left out	left out	left out	left out
Sum. statistics					
N (weighted)	8509	8509	8509	8509	8059
Log.likelihood	-2396	-3102	-1730	-2646	3060
Pseudo R^2	0.200	0.088	0.098	0.097	0.145
% concordant #	78.51	66.8	87.6	75.2	69.1
% of firms using IPRs	25.9	36.2	12.0	24.9	43.9

Notes: Weighted regressions. All regressions have probability > chi2 =0.0000
Level of statistical significance of robust std. errors in parentheses : c= 10%, b= 5%, a= 1%.
# denotes % of correctly classified observations based on non-weighted results.

Table III-3. Determinants of Innovation - Logit Regressions

DEPENDENT VARIABLE	**INNOVATOR**	**INNOVATOR World-1st**	**INNOVATOR Canada-1st**	**INNOVATOR Firm-1st**
Intercept	-1.125 (.157)a	-4.664 (.224)a	-2.894 (.129)a	-0.963 (.129)a
1. FIRM CHARACTERISTICS	left out	left out	left out	left out
2. FIRM'S PERCEPTIONS				
Competitive conditions				
COMPET				
TECHCH	0.644 (.112)a			0.291 (.079)a
STAFF	0.219 (.105)b			
Success factors				
NEW MARKET	0.632 (.127)a			0.392 (.109)a
EXPORT MARKET	0.282 (.093)a	0.373 (.126)a	0.289 (0.084)a	0.103 (..074)
REPUTATION	0.250 (.111)b			
3. FIRM ACTIVITIES				
R&D activity				
PERFORMS R&D	1.432 (.115)a	1.308 (.227)a	0.975 (.120)a	1.182 (.089)a
-SEPARATE UNIT	0.049 (.156)		0.158 (.091)c	-0.182 (.094)b
-CONTRACTS OUT				
USE of IPRs				
PATENTS	0.453 (.145)a	1.129 (.128)a	0.777 (0.093)a	0.234 (.092)b
TRADEMARKS	0.192 (.107)	0.127 (.123)	0.227 (0.087)a	0.237 (.078)
TRADE SECRETS	0.705 (.132)a	0.499 (.118)a	0.503 (0.087a	0.001 (.086)a
4. GOVT. SUPPORT				
R&D-SUBSIDY	0.904 (.280)a		0.216 (.117)c	
R&D-TAX CR.	0.238 (.129)c	0.623 (.126)a	0.544 (.095)a	0.337 (0.084)a
GVMNT-INTERNET				
4. INDUSTRY CHARACTERISTICS				
CORE Sector	0.243 (.142)c	0.212 (.117)c	0.026 (.105)	-0.067 (.099)
SECONDARY Sector	left out	left out	left out	left out
OTHER Sector	0.199 (.105)b		-0.075 (0.99)	0.044 (.084)
5. PROVINCE				
ALBERTA	0.422 (.115)a	left out	left out	left out
ONTARIO	0.462 (.119)a	-0.154 (.161)	-0.107 (.101)a	0.471 (.092)a
QUEBEC	0.409 (.102)a	0.161 (.142)	0.347 (.0.096)	-0.083 (.080)
OTHERS	left out	left out	left out	left out
Sum. statistics				
N (weighted)	8509	8509	8509	8509
Log.likelihood	1677.4	-1299	-2417	-3111
Pseudo R^2	0.199	0.169	0.156	0.102
% concordant #	82.4	90.5	76.7	68.7%
% of man. firms	81.3	8.5	14.6	36.3

Notes: Weighted regressions. All regressions have probability > chi2 =0.0000.
Level of statistical significance of robust std. errors: * 10%, ** 5%, *** 1%.
# denotes % of correctly classified observations based on non-weighted results.

Table III-4. Results of 2- Stage Logit vs. Single Equation Logit Estimates

DEPENDENT VARIABLE	**Patent 2nd stage logit**	**PATENT Single Eq**	**INNOVATION 2nd stage logit**	**INNOVATION Single Eq**
Intercept	-2.137 (.184)a	-2.832 (.210)a	-0.402 (.209)b	-1.058 (.154)a
ENDOGENOUS VARIABLES				
PR-INNOVATOR	0.475 (.076)a			
INNOVATOR		0.472 (.142)a		
PR-PATENTS			0.213 (.056)a	
PATENTS				0.592 (.139)a
EXOGENOUS VARIABLES				
1. FIRM CHARACTERISTICS				
Firm Size				
SIZE-A	-0.241 (.116)b	-0.286 (.116)b		
SIZE-B	0.177 (.104)c	-0.198 (.104)b		
SIZE-C				
SIZE-D	0.456 (.142)a	0.407 (.139)a		
2. FIRMS PERCEPTIONS				
Competitive conditions				
COMPET	-0.048 (.089)	-0.026 (.089)		
TECHCH	-0.180 (.104)c	0.108 (.091)		
STAFF	-0.382 (.099)a	-0.287 (.098)a		
Success factors				
NEW MARKET	-o.281 (.140)b	-0.011 (.131)	0.639 (.125)a	0.661 (.125)a
EXPORT MARKET	0.022 (.091)	0.137 (.090)	0.239 (.094)a	0.277 (.093)a
REPUTATION	-0.0002 (.124)	0.106 (.123)	0.216 (.110)b	0.254 (.110)b
3. FIRM ACTIVITIES				
R&D activity				
PERFORMS R&D	##	0.639 (.118)a	1.372 (.121)a	1.511 (.114)a
-SEPARATE UNIT	0.385 (.102)b	0.455 (.096)a	0.060 (.161)	0.118 (.156)
USE of IPRs				
TRADEMARKS	1.569 (.093)a	1.734 (.087)a	left out	left out
4. GOVT. SUPPORT				
R&D-SUBSIDY	0.066 (.152)	0.499 (.132)a	0.848 (.285)a	0.958 (.281)a
R&D-TAX CR.	0.173 (.106)c	0.292 (.098)a	0.199 (.131)	0.249 (.128)a
GVMNT-INTERNET				
4. INDUSTRY CHARACTICS				
CORE Sector	0.162 (.111)	0.273 (.108)a	0.205 (.141)	0.251 (.142)c
SECONDARY Sector		left out	left out	left out
OTHER Sector	-0.928 (.103)a	-0.866 (102)a	0.333 (.112)a	0.219 (.104)b
5. PROVINCE				
ONTARIO	0.320 (.109)a	0.507 (.108)a	0.325 (.128)a	0.472 (.117)a
QUEBEC	-0.370 (.108)a	-0.238 (.105)b	0.361 (.105)a	0.395 (.101)a
OTHERS	left out	left out	left out	left out
Sum. statistics				
N (weighted)	8509	8509	8509	8509
Log.likelihood	-2238	-2231	-2073	2072
Pseudo R^2	0.251	0.253	0.190	0.191
% concordant #	n.a.	79.64	n.a.	82.6

Notes: Weighted 2-stage structural logit regressions. All regressions have probability > chi2 =0.0000.
Level of statistical significance of robust std. errors: c= 10%, b= 5%, a= 1%.
# denotes % of correctly classified observations based on non-weigted results.
The variable PERFORMS RD excluded by the program because of multicollinearity (r=0.82) with the "predicted INNO" variable.

Table III-5 Country of Patent Application - Logit Regressions

DEPENDENT VARIABLE	**Canada only**	**US only**	**Canada and US**
Intercept	-4.400 (.187)a	-4.941 (.321)a	-3.696 (.145)a
1. FIRM CHARACTERISTICS			
Firm Size			
SIZE-A			-.0.486 (.102)a
SIZE-B			-.0202 (.090)b
SIZE-C	left out	left out	left out
SIZE-D	0.556 (.189)a	-0.571 (.355)c	0.156 (.138)
2. FIRMS PERCEPTIONS			
Competitive conditions			
COMPET	0.191 (.118)c		
TECHCH	-0.116 (.127)	0.214 (.177)	
STAFF	-0.200 (.131)	-0.541 (.215)b	
Success factors			
NEW MARKET			
EXPORT MARKET	0.166 (.125)		0.511 (.084)a
3. R&D ACTIVITIES			
PERFORMS R&D ACTIVITY	0.999 (.174)a	0.465 (.293)d	0.851 (.119)a
-IN SEPARATE R&D	0.169 (.128)	0.887 (.200)a	
-CONTRACTS - R&D			0.427 (.084)a
4. GOVERNEMENT			
GVT-SUBSIDY			0.428 (.101)a
GVT-TXC		0.359 (.192)c	0.634 (.087)a
GVT-INTER			0.126 (.103)
5. INDUSTRY CHARACTERISTICS			
Technology sector			
CORE	0.164 (.152)		0.219 (.090)b
SECONDARY	left out	left out	left out
OTHER	-0.002 (.139)		-0.562 (.092)a
6. Innovation			
W-first	-0.119 (.182)	0.632 (.228)a	0.643 (.111)a
C-first	0.657 (.138)a	0.591 (.215)a	0.579 (.092)a
7. Province			
Ontario		0.538 (.237)b	0.634 (.081)a
Québec		-0.48 (.282)c	
Alberta		0.462 (.334)	0.312 (.150)b
Others		left out	left out
Summary statistics			
No. of yes=1 (weighted)	321	154	1006
No obs. (weighted)	8609	8509	8509
Likelihood ratio: Chi2	147	188	1206
% concordant	67	75	80.9
% of all manufacturing firms	3.9	1.8	11.8

Notes: Weighted regressions. Level of statistical significance of std. errors: d=15%, c=10%, b= 5%, a=1%.
All regressions have probability > chi2 =0.0000.

IV. CONCLUSIONS

Even though industry experts do not have a high opinion of the effectiveness of intellectual protection, two thirds of all manufacturing firms in Canada use at least one of the several intellectual property rights. Firms that use specific IP instruments find them generally more effective than those not familiar with them. Firms that use various instruments of intellectual property protection innovated more frequently than those that tried and did not succeed and these still more than those that were not involved in innovation at all.

The proportion of firms (innovating and non- innovating alike) that use IPRs is increasing with the size of firm. Firms operating in the core sector that feeds innovations to the secondary and 'other' sector and to the rest of economy protect their intellectual property more frequently than firms in the secondary sector. Firms operating in the low-tech 'other' sector use them least. The close association of the use of IPRs with the size of firm is also observed within each technology sector. It suggests that the cost of learning and using effectively protection of intellectual property discourages small and medium size firms from using it as frequently as larger firms.

One of the main purposes of intellectual property rights is to encourage innovation and creation by protecting the exclusive character of new products, processes, works of art, software etc. It is therefore not surprising that the most original world-first innovators use all IP instruments more frequently than firms that introduced the less original Canada-first and the imitative firm-first innovations.

Even though carrying out R&D is not a precondition for successful innovation – about one out of three successful innovators did not carry out R&D - those firms that carry out R&D are significantly more likely to innovate than those that do not. Firms that carry out R&D are also more likely to innovate in a more original way and therefore use more frequently intellectual property than those that did not carry out R&D. Firms that conduct R&D use IPRs more and in a different fashion than firms not involved in R&D. The most notable differences between the two groups of firms is observed in the use of patents. The non-users of R&D are much less likely to introduce original innovations that rely on IPRs more than the imitative ones. The R&D performing firms use patents significantly more often.

Firms using intellectual property are more likely to introduce innovations. The largest effect in this respect have trade secrets, patents and trade marks. The results of the econometric analysis suggest that patents and trade secrets are often used by different firms in different situations.

Using patents and also trademarks seems to be an integral part of a successful innovating strategy, which consists of performing regularly R&D financed in part by government subsidies and grants, introducing world first product innovations and exporting. The probability of using patents is about two times higher when the firm operates in the high-tech core sector than in the low tech 'other' sector. In contrast, trade marks are used as

frequently by core sector firms and firms in the 'other' sector. Firms operating located in Quebec are less likely to patent than firms in other provinces.

Firms that introduced mainly Canadian-first innovations seem to rely somewhat less on patents and almost equally on trade secrets like firms in the first group. Like these firms they are also exporting. They are less successful in receiving R&D grants and rely more on R&D tax credits than firms in the first group. Canada-first innovations are likely to be introduced by firms from all sectors. Firms from Quebec are more likely to introduce Canada-first innovations than firms from other provinces.

The majority of innovations are the less original 'firm-first' introduction of new and improved products and production processes already used by other firms in Canada. These innovations are often introduced in response to changes in production and office technologies and as a part of a strategy to seek new markets. These innovations are more likely to be created by firms using patents (probably authorising them to use existing patented technology) and trademarks. The probability of introducing this type of innovation is not specific to any sector. The likelihood of this type of innovation is larger for firms from Ontario than from other provinces and it increases when firms use patents and trademarks.

When it comes to patenting, the majority of firms apply for patent in Canada, but many apply also in the US. Two thirds of firms which apply for patent do so in both countries. Less than 10% of firms that apply for a patent do so exclusively in the US. About 20% apply exclusively for a Canadian patent and some 5% apply elsewhere. The tendency to apply for patents in the US is increasing with the extent of patenting and the size of firm. Firms that apply for more than ten patents tend to patent more in the US than in Canada.

Results of the two-stage method of estimation of a simultaneous two equation model considering the decision to patent and to innovate as mutually interdependent provide an additional evidence that the possession of patents may not be as strong an incentive to innovate as suggested by the results of the single equation approach. These results also cast some doubt on the single equation estimate of the statistically significant positive relationship between the use of patents and the reception of R&D grants.

Overall the evidence suggest that even tough intellectual property rights may not be perfect means of appropriating benefits from innovation, firms that protect their intellectual property succeed in maintaining their profit margins or increasing their profitability more often than firms that do not.

The results of the present study suggest several policy measures. The pervasive evidence shows that the small and medium size firms use all and any intellectual property right less frequently than large firms. This suggest that the cost of obtaining, maintaining and enforcing IPRs by litigation acts as a heavier burden for medium and small size firms. This calls for improved information and training for small and medium size firms on how to use effectively IPRs. Another step in the right direction would be to consider making the cost of applying for, and renewal of, statutory intellectual property instruments (first

of all patents) eligible for tax credits or grants to small and medium size firms. A further study should determine whether small and medium size firms would likely benefit from introduction of a specialised court for litigation of IP related cases.

To conclude, even though the protection of intellectual property is far from being a perfect means for appropriation of benefits from innovation and new technology, its importance, especially for the most original innovations, is well documented. To innovate successfully, firms must not only learn how to conduct R&D to absorb, create and adapt new knowledge, how to find and process market information and how to collaborate. They also have to learn to use efficiently intellectual protection rights and combine them with other appropriation strategies. Further research is needed to evaluate the use and efficiency of these other strategies and compare them with statutory intellectual protection rights.

REFERENCE LIST

1. Amesse, Fernand at al. (1991). The Individual Inventor and the Role of Entrepreneurship: A Survey of the Canadian Evidence. Research Policy.

2. Baldwin, John. (1997). Innovation and Intellectual Property, Statistics Canada, Catalogue 88-515-XPE

3. Baldwin, John, Petr Hanel and David Sabourin. (2000). Determinants of innovative activity in Canadian manufacturing firms. Statistics Canada,

4. Baldwin, John and Petr Hanel. (2001). Innovation and Knowledge Creation in an Open Economy, Cambridge University Press, forthcoming

5. Cohen, Wesley M. and Daniel A. Levinthal. (1989). Innovation and Learning: Two Faces of R&D. The Economic Journal, 99, 569-596.

6. . Cohen, Wesley M. and Steven Klepper. (1996). A reprise of size and R&D. The Economic Journal, 106, 925-951.

7. Cohen Wesley M., Richard R. Nelson and John P. Walsh. (2000) Protecting their intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not), NBER Working paper no. 7552 (February)

8. Dasgupta Partha and Josef Stiglitz.(1980). Industrial Structure and the Nature of Innovative Activity. The Economic Journal, 90,(June),266-293.

9. de la Mothe, John and Gilles Paquet. (1998). Local and Regional Systemts of Innovation, Kluwer Academic Publishers, Boston

10. De Melto, Denis P., Kathryne E. McMullen and R..M. Wills. (1980). Preliminary Report: Innovation and Technological Change in Five Canadian Industries. Ottawa: Economic Council of Canada, Discussion Paper No.176.

11. European Commission (2001). Building an Innovative Economy in Europe: A review of 12 studies of innovation policy and practice in today's Europe. Luxembourg, European Commission,

12. Friedman David,D., William M. Landes and Richard A. Posner, (1991) Some economics of Trade secret

Law. Journal of Economic .Perspectives, vol. 5, no.1.

13. Hall, Bronwyn H. (1998) Innovation and market value, Paper prepared for the NIESR conference on productivity and Competitiveness, London.

14. Hamdani, Daood, "Why do the surveys on innovation and R&D diverge", Statistics Canada Innovation Analysis Bulletin, Vol.2, No.3, September 2000

15. Industry, Science and Technology Canada. (1989). Appendices for the Survey of Intellectual Property Rights in Canada, Final Report, Industry, Science and Technology Canada.

16. Levin, Richard. C., Alvin K. Klevorick, Richard R.Nelson and Sidney G.Winter . (1987). Appropriating the Returns from industrial Research and Development. Brookings Papers on Economic Activity, (3), 783-831.

17. Levin, Richard C. and Petr C. Reiss . (1984). Tests of Schumpeterian Model of R&D and market structure. Griliches (Editor), R&D, patents and productivity . Chicago: The University if Chicago Press.

18. Levin, Richard C. and Peter C. Reiss. (1988). Cost-reducing and demand creating R&D spillovers. RAND Journal of Economics, 19(4), 538-556.

19. Lundvall, Bengt, A. (1992) ed, National Systems of Innovation, London, Pinter

20. Maddala G.S. (1984). Limited-dependent and qualitative variables in econometrics, Cambridge, London, New York, Cambridge University Press,

21. Nelson, Richard. R. (editor), (1993). National Innovation Systems: A Comparative Analysis, New York: Oxford University Press.

22. Niosi, Jorge (2000). Canada's National System of Innovation, McGill-Queen's University Press, Montreal

23. OECD, (1989). Proposed guidelines for collecting and interpreting technological innovation data, Oslo manual, OECD/GD (92) 26 Paris.

24. Pazderka, Bohumir (1999) Patent Protection and Pharmaceutical R&D Spending in Canada, Canadian Public policy, vol.25,no.1 29-46

25. Rafiquzzaman, Mohamed (1999). The Importance of the Intellectual Property Rights System to Economic Performance: A Study of the Canadian Experience. Ottawa: Industry Canada, mimeo

26. Rafiquzzaman, Mohamed and Lorrie Wheeler (1998). Recent Jump in Patenting Activities: Comparative Innovative Performance of Major Industrial Countries, Patters and Explanations, Ottawa, IndustryCanada.

27. Robson, M., Townsend, J., and Pavitt, K. (1988). Sectoral patterns of production and use of innovations in the UK: 1945-1983. Research Policy, 17, 1-14.

28. Scherer, Frederic M. (1965). Corporative inventive output, profits, and growth. Journal of Political Economy, 290-297.

29. Therrien, Pierre. (2000). What Distinguishes Innovative Firms From Other Firms: Results f4rom the 1999 Innovation Survey, mimeo, Market Place Innovation, Industry Canada

30. Trajtenberg Manuel, (2000). Is Canada Missing the Technological Boat? Evidence from the patent data. Ottawa: Industry Canada, Discussion paper no.9.

31. Warda, Jacek (1997). R&D TAX Treatment in Canada: A Provincial Comparison. TheConference Board du Canada.

APPENDIXES

APPENDIX I.

Conversion from NAICS to to Robson, Townsend and Pavitt's Technology Sectors

NAICS	Description	Sector		Sector
		Other		**Secondary**
311	Food	Other		
312	Beverages-Tobacco	Other	326 Plastics-Rubber	Secondary
313	Primary Textiles	Other	327 Non-Metallic	Secondary
314	Textiles	Other	331 Primary Metals	Secondary
315	Clothing	Other	332 Fabricated Metals	Secondary
316	Leather	Other	3335 Fabricated Metals	Secondary
3211	Wood	Other	3361 Transportation	Secondary
3212	Wood	Other	3362 Transportation	Secondary
3219	Wood	Other	3363 Transportation	Secondary
322	Paper	Other	3364 Transportation	Secondary
323	Printing	Other	3365 Transportation	Secondary
337	Furniture	Other	3366 Transportation	Secondary
339	Other man.	Other	3369 Transportation	Secondary
3346	Other man.	Other		
		Core		
324	Refined petroleum	Core		
3251	Chemicals	Core		
3252	Chemicals	Core		
3253	Chemicals	Core		
3254	Chemicals	Core		
3255	Chemicals	Core		
3256	Chemicals	Core		
3259	Chemicals	Core		
3331	Machinery	Core		
3332	Machinery	Core		
3333	Electrical	Core		
3334	Machinery	Core		
3339	Machinery	Core		
3341	Electrical	Core		
3342	Electrical	Core		
3343	Electrical	Core		
3344	Electrical	Core		
3345	Scientific Instruments	Core		
335	Electrical	Core		

Author’s conversion

APPENDIX II

Table A-1. Use of IPRs by Innovation Status and by Firm Employment Size

(% of firms)

Share of total %	20- 49	50-99	100-499	500 +	All
Innovators	75.2	80.6	84.9	87.1	
Unsuccessful	7.9	7.0	6.6	7.4	
Not involved	16.9	12.5	8.5	5.5	
Total	100.0	100.0	100.0	100.0	
All	30.2	31.9	32.4	5.5	100
Use IPRs / Status					
Patents					
Innovators	21.2	25.7	36.8	50.6	29.6
Unsuccessful	11.0	12.9	17.2	22.9	14.1
Not involved	8.0	8.8	8.4	4.0	8.3
All	18.2	22.7	33.1	46.0	25.9
Trademarks					
Innovators	32.8	35.5	47.8	52.4	39.8
Unsuccessful	24.8	23.4	24.5	43.6	25.3
Not involved	17.8	14.6	28.7	16.6	19.1
All	29.6	32.0	44.4	49.8	36.3
Copyrights					
Innovators	9.9	11.4	17.1	24.2	13.7
Unsuccessful	2.9	5.5	7.7	25.6	6.4
Not involved	5.8	2.0	5.6	4.0	4.5
All	8.6	9.9	15.5	23.2	12.0
Secrets					
Innovators	25.2	26.5	31.2	39.8	28.2
Unsuccessful	12.0	16.5	11.1	34.2	14.4
Not involved	9.0	5.0	8.5	3.9	7.5
All	21.4	23.1	27.9	37.4	24.9
Confidentiality					
Innovators	39.5	44.3	58.3	67.0	49.0
Unsuccessful	30.6	27.8	32.8	69.6	32.6
Not involved	17.8	12.5	22.8	7.9	16.9
All	35.1	39.2	53.6	64.0	43.9
Others					
Innovators	2.5	3.1	2.4	4.1	2.8
Unsuccessful	2.5	2.0	1.2	0.0	1.8
Not involved	2.7	1.5	2.9	0.0	2.3
All	2.5	2.8	2.3	3.6	2.6
At least one					
Innovators	65.2	69.2	80.4	87.3	72.9
Unsuccessful	48.7	43.2	53.2	74.0	49.7
Not involved	34.2	31.3	47.1	24.6	35.9
All	58.7	62.7	75.7	82.9	66.8

Source : Statistics Canada Innovation Survey, 1999

Table A-2. Use of IP by Innovation Status and by Sector

(% of manufacturing firms)

Share of total (%)	Core	Secondary	Other	All
Innovators	88.2	78.2	79.1	
Unsuccessful	5.0	8.0	7.6	
Not involved	6.8	14.0	13.3	
Total	100.0	100.0	100.0	
All	21.0	31.3	47.7	100.0
Instruments/ Sector	**(% of firms)**	**(% of firms)**	**(% of firms)**	**(% of firms)**
Patents				
Innovators	47.0	32.6	19.2	29.6
Unsuccessful	29.2	13.9	9.9	14.1
Not involved	13.6	9.6	6.1	8.3
All	43.9	27.9	16.8	25.9
Trademarks				
Innovators	47.0	32.1	41.3	39.8
Unsuccessful	30.0	19.1	28.3	25.3
Not involved	15.8	14.9	22.8	19.1
All	44.1	28.6	37.8	36.3
Copyrights				
Innovators	18.6	11.7	12.5	13.7
Unsuccessful	14.9	4.3	5.4	6.4
Not involved	2.9	5.1	4.5	4.5
All	17.3	10.2	10.9	12.0
Secrets				
Innovators	34.5	29.2	25.1	28.2
Unsuccessful	26.6	12.6	12.0	14.4
Not involved	7.8	9.8	5.8	7.5
All	32.3	25.1	21.5	24.9
Confidentiality				
Innovators	63.9	52.4	40.2	49.0
Unsuccessful	44.4	33.0	28.9	32.6
Not involved	28.4	19.4	12.5	16.9
All	60.5	45.4	35.7	43.9
Others				
Innovators	2.7	3.5	2.3	2.8
Unsuccessful	6.9	1.5	0.6	1.8
Not involved	3.0	2.2	2.3	2.3
All	2.9	3.1	2.1	2.6
At least one				
Innovators	83.8	74.5	66.6	72.9
Unsuccessful	68.3	46.2	46.8	49.7
Not involved	43.4	33.7	35.8	35.9
All	80.3	66.5	61.0	66.8

Source : Author's tabulation from the Statistics Canada Innovation Survey, 1999

Table A-3. Use of IPR by Originality of Innovation and by Firm Employment size

(% of firms that introduced a World-1st, Canada 1st or Firm 1st innovation in a given size class)

Share of innovating firms (%)	20- 49	50-99	100-499	500 +
World-First	7.7	10.0	13.1	19.7
Canada-First	14.1	17.5	21.5	22.9
Firm-First	45.9	45.32	41.3	34.8
Not reported	32.3	27.1	24.2	22.6
Total	100.0	100.0	100.0	100.0
All	30.2	31.9	32.4	5.5
Use of IPR / originality of innovation				
Patents				
World-First	54.9	54.5	67.3	81.5
Canada-First	33.9	38.2	44.8	47.8
Firm-First	14.7	18.1	26.2	43.3
Trademarks				
World-First	52.8	55.5	60.0	65.6
Canada-First	43.8	43.8	54.8	54.6
Firm-First	26.6	29.7	40.4	45.2
Copyrights				
World-First	24.5	25.8	24.4	42.7
Canada-First	18.7	15.6	19.8	25.1
Firm-First	6.3	8.5	13.0	16.9
Secrets				
World-First	29.3	49.2	46.8	48.9
Canada-First	38.6	37.1	35.8	45.8
Firm-First	25.1	19.7	24.5	30.2
Confidentiality				
World-First	49.3	77.1	74.9	88.6
Canada-First	51.9	56.6	66.3	64.1
Firm-First	35.3	38.8	51.8	57.5
At least one				
World-First	85.1	94.1	95.0	100.0
Canada-First	81.7	79.8	87.2	89.7
Firm-First	60.1	63.9	74.1	82.6

Source : Author's tabulation from the Statistics Canada Innovation Survey, 1999.

Table A-4

Methods Used to Protect Intellectual Property, by industry

1997 - 1999 (% Innovating firms)

		Method					
Industries	Firms that protected intellectual property (%)	**Of these, % that used:** Patents	Trademarks	Copyright	Confident. agrements	Trade secrets	Other
Total Manufacturing Industries	72.9	40.3	54.8	18.8	66.7	39.1	3.7
Food Manufacturing	78.4	21.7	73.3	17.7	69.6	45.6	2.7
Beverage and Tobacco Product Manufacturing	87.8	36.3	86.3	35.2	77.3	55.8	3.4
Textile Mills - Textile Product Mills	68.4	35.0	65.3	21.6	52.4	40.5	2.3
Clothing Manufacturing	71.7	12.1	83.2	10.4	35.6	27.2	1.3
Leather and Allied Product Manufacturing	81.4	24.0	64.6	10.3	21.8	39.5	0.0
Sawmills and Wood Preservation, Veneer, Plywood and Engineered Wood Product Manufacturing, Other Wood Product Manufacturing	46.2	22.9	43.8	6.2	55.0	32.6	6.1
Paper Manufacturing	67.4	35.1	42.9	12.4	76.1	34.1	2.1
Printing and Related Support Activities	60.6	21.5	39.2	28.6	70.0	33.4	4.4
Petroleum and Coal Products Manufacturing	92.7	31.6	57.9	13.2	71.1	57.9	5.3
Chemical Manufacturing (excluding 3254)	87.1	47.9	67.4	18.9	80.9	55.0	2.4
Pharmaceutical and Medicine Manufacturing (3254)	94.2	59.4	74.9	29.5	96.0	55.7	0.0
Plastics and Rubber Products Manufacturing	82.1	51.4	51.8	13.9	67.7	41.5	3.9
Non-Metallic Mineral Products Manufacturing	68.7	48.5	51.3	17.3	58.0	45.3	8.9
Primary Metal Manufacturing	66.3	33.7	23.8	13.6	74.6	54.1	0.9
Fabricated Metal Product Manufacturing	70.9	37.4	41.3	13.6	68.0	32.9	4.4
Agricultural, Construction and Mining & Industrial Machinery Manuf. (3331 & 3332)	84.6	72.3	55.2	20.5	71.6	29.3	0.0
Machinery Manuf. (excluding 3331 & 3332)	79.3	54.6	47.7	18.8	68.4	35.0	4.0
Computer and Peripheral Equipment Man.	91.9	44.5	66.9	47.7	94.9	43.9	7.6
Communications Equipment Manufacturing	94.6	53.6	48.4	29.5	91.0	42.3	1.8
Semiconductor and Other Electronic Equipment Manufacturing	84.8	50.7	49.0	32.5	92.2	66.4	5.2
Navigational, Measuring, Medical and Control Instruments Manufacturing + Manufacturing and Reproducing Magnetic and Optical Media	88.5	55.9	54.0	33.3	81.5	39.1	3.3
Electrical Equipment, Appliance and Component Manufacturing	76.2	66.1	56.0	21.7	70.2	33.9	6.0
Motor Vehicle Manufacturing + Motor Vehicle Body and Trailer Manufacturing + Motor Vehicle Parts Manufacturing	77.6	51.5	39.9	21.1	74.5	41.0	1.2
Aerospace Product and Parts Manufacturing	85.6	39.8	28.4	28.6	81.9	47.7	13.8
Railroad Rolling Stock Manufacturing + Ship and Boat Building + Other Transport. Eqpt.	71.3	39.3	37.0	23.6	58.4	32.1	4.9
Furniture and Related Products	61.6	43.0	63.4	16.3	53.1	26.4	3.6
Miscellaneous Manufacturing	75.0	48.9	63.4	30.7	60.5	42.9	3.9

Source: Statistics Canada Innovation Survey, 1999, preliminary results

Table A-5. Use of IPR by Originality of Innovation and by Sector

(% of firms that introduced a World 1st, Canada 1st or firm- 1st innovation in a given sector)

Sector / IPR – originality of innovation	Core (% firms)	Secondary (% firms)	Other (% firms)
Patents			
World-First	73.2	61.7	51.6
Canada-First	54.9	43.7	29.4
Firm-First	37.9	23.8	12.4
Trademarks			
World-First	58.9	50.3	63.7
Canada-First	58.6	35.7	53.6
Firm-First	38.9	26.2	34.7
Copyrights			
World-First	29.2	25.9	24.6
Canada-First	23.9	14.0	19.0
Firm-First	11.7	7.6	10.1
Secrets			
World-First	48.1	45.3	39.2
Canada-First	43.4	36.9	34.4
Firm-First	26.7	24.5	21.2
Confidentiality			
World-First	75.9	72.8	67.0
Canada-First	73.6	60.0	51.7
Firm-First	57.0	46.2	35.2
At least one			
World-First	94.1	97.8	88.5
Canada-First	90.1	83.7	80.2
Firm-First	78.3	69.3	60.9

Source : Author's tabulation from the Statistics Canada Innovation Survey, 1999.

Table A-6 (Q26.2)
Application for Patents in Canada and the United States, 1997 - 1999
Innovators in Manufacturing

	Applied For At Least One Patent	Of These, % That Applied For Patents In:					
		Canada	United States	Both Canada and the United States	Canada Only	United States Only	Neither Canada nor the United States
	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Total Manufacturing Industries	22.4	85.2	75.4	65.8	19.5	9.6	5.1
Food Manufacturing	10.5	80.9	63.6	50.5	30.4	13.2	6.0
Beverage and Tobacco Product Manufacturing	23.8	100.0	41.9	41.9	58.1	0.0	0.0
Textile Mills - Textile Product Mills	20.7	91.8	79.9	71.7	20.2	8.2	0.0
Clothing Manufacturing	3.9	100.0	67.9	67.9	32.1	0.0	0.0
Leather and Allied Product Manufacturing	16.2	88.9	77.8	66.7	22.2	11.1	0.0
Sawmills and Wood Preservation, Veneer, Plywood and Engineered Wood Product Manufacturing, Other Wood Product Manufacturing	6.8	91.9	67.3	61.8	30.1	5.5	2.6
Paper Manufacturing, Printing and Related Support Activities, Petroleum and Coal Products Manufacturing	19.2	76.4	64.8	55.1	21.4	9.7	13.8
Chemical Manufacturing (excluding 3254)	29.4	77.3	71.1	62.0	15.3	9.0	13.6
Pharmaceutical and Medicine Manufacturing (3254)	30.0	93.8	67.2	61.0	32.8	6.2	0.0
Plastics and Rubber Products Manufacturing	30.6	86.4	81.1	73.5	12.8	7.5	6.1
Non-Metallic Mineral Products Manufacturing	20.8	80.0	78.7	67.9	12.1	10.8	9.2
Primary Metal Manufacturing	17.3	100.0	74.9	74.9	25.1	0.0	0.0
Fabricated Metal Product Manufacturing	20.8	80.0	72.6	57.3	22.7	15.3	4.7
Agricultural, Construction and Mining + Industrial Machinery Manufacturing (3331 & 3332)	54.1	94.1	81.3	75.4	18.7	5.9	0.0
Machinery Manufacturing (excluding 3331 & 3332)	33.8	82.8	84.6	73.0	9.8	11.6	5.6
Computer and Peripheral Equipment Manufacturing	36.2	67.9	65.2	46.0	21.9	19.3	12.8
Communications Equipment Manufacturing	48.2	96.6	81.7	78.3	18.3	3.4	0.0
Audio and Video Equipment Manufacturing	40.0	100.0	100.0	100.0	0.0	0.0	0.0
Semiconductor and Other Electronic Equipment Manufacturing	40.9	89.5	88.8	78.3	11.2	10.5	0.0
Navigational, Measuring, Medical and Control Instruments Manufacturing + Manufacturing and Reproducing Magnetic and Optical Media	39.3	75.6	88.6	68.8	6.8	19.8	4.6
Electrical Equipment, Appliance and Component Manufacturing	40.6	91.4	73.3	68.6	22.8	4.7	3.9
Motor Vehicle Manufacturing + Motor Vehicle Body and Trailer Manufacturing + Motor Vehicle Parts Manufacturing	34.5	84.4	77.9	70.2	14.3	7.7	7.8
Aerospace Product and Parts Manufacturing	20.1	73.6	82.0	64.0	9.6	18.0	8.4
Railroad Rolling Stock Manufacturing + Ship and Boat Building + Other Transportation Equipment	20.8	...	80.4	...	19.6	...	0.0
Furniture and Related Products Manufacturing	20.7	84.9	52.7	44.1	40.8	8.6	6.5
Miscellaneous Manufacturing	28.4	95.7	80.2	75.9	19.8	4.3	0.0

Source : Statistics Canada Innovation Survey,1999, Preliminary results

Table A-7a **The Relationship Between the Use of IPRs and Profitability due to Innovation** (Question: 13B)

	Sectors										
IPRs used	**Core**		**Second.**		**Other**		**All**		**All**		
	Chi-2	**Sig**	**Chi-2**	**Sig**	**Chi-2**	**Sig.**	**Chi-2**	**Sig.**	**Phi**	**z**	**Sig.**
Patents	6.13	***	13.73	***	0.82		22.27	***	0.069	-4.72	***
Tradem	20.93	***	9.49	***	5.19	**	28.21	***	0.077	-5.31	***
Copyright	3.15		21.80	***	0.01		12.56	***	0.052	-3.54	***
Secret	0.13		0.73		11.45	***	7.79	***	0.041	-2.79	***
Confidentiality	4.15	*	17.50	***	13.21	***	19.04	***	0.065	-4.36	***

Table A-7b **The relationship between the use of IPRs and maintained profit margin due to innovation** (Question : 13G)

	Sectors										
Secteur	**Core**		**Second.**		**Other**		**All**		**All**		
	Chi-2	**Sig**	**Chi-2**	**Sig.**	**Chi-2**	**Sig.**	**Chi-2**	**Sig.**	**Phi**	**z**	**Sig.**
Patents	26.51	***	10.01	***	4.78	*	41.61	***	0.094	-6.45	***
Tradem	9.40	***	21.52	***	6.58	**	32.97	***	0.084	-5.74	***
Copyright	1.23		12.09	***	0.29		9.99	***	0.044	-3.16	***
Secret	3.62		8.11	***	16.50	***	21.81	***	0.063	-4.67	***
Confidentiality	2.16		8.61	***	4.28	*	17.83	***	0.061	-4.22	***

Significance levels			
The critical values	1%	5%	10%
Chi2 (1 d.f.)	6.63	5.02	3.84
z (1 tail)	2.60	1.95	1.6
symbol	***	**	*

Note. Wherever significant, tests chi2 reject the hypothesis of an independence between the use of a particular IPR and innovation's contribution to firm's profitbility. Due to the layout of underlying contingency tables, the negative value of Z indicates the the level ∀ rejection region according to the altenative hypothesis that the use of IPRs is associated positively with the contribution of innovation to maintained or increased profitability of the firm.

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NOTES

[1] Oslo manual (OECD, 1989). For a review of a series of 12 European studies of innovation policy and practice see European Commission (2001).

[2] The report surveyed a sample of 900 firms, broken down into four groups: Top R&D performers (100), High technology firms (300), medium and low technology firms(400) and Major copyright users (100).

[3] Smaller firms with sales less $5 million used IPRs less than larger firms and were less satisfied with Canadian IPRs.

[4] These responses have to be considered today in a proper perspective. Amendments to the *Copyright Act* introduced in June 1988 extended copyright protection to computer programs, strengthened the right of artists to control who uses their work and improved systems to collect copyrights. The new act also increased penalties for infringement of copyright up to a maximum of $1 million, with prison terms ranging from 6 months to five years. The *Canadian Patent Act* also underwent significant changes in 1989 (for details see the chapter by Gallini, Putnam and Tepperman in this volume).Thus the dissatisfaction and criticism that the Canadian IPRs did not provide sufficient protection and had not kept pace with technological developments may not any more be valid today.

[5] Baldwin's study is based on the Statistics Canada (1993) Survey of Innovation and Advanced Technology which surveyed both small and large manufacturing firms. One of the particularities of the survey was that in case of larger firms, different sections of the questionnaire were addressed to those persons in the firm most likely to be intimately involved with the subject at hand. Thus questions relative to IPRs were answered by the person in charge of intellectual property protection in the firm. These and other methodological differences make it difficult to compare results of this survey with the most recent Statistics Canada Survey of innovation (1999) See the methodological note at the beginning of the section II. for more details regarding the differences between the two surveys.

[6] See the classification of industries in Core, Secondary and 'Other' technology sector in Appendix I.

[7] Note that firms may not have confidence in the effectiveness of patents to protect their inventions from imitation (or other IPRs) and use them anyway for other strategic reasons (Cohen at al. 2000), such as to signal their technological prowess on the stock market (Hall,1998) or on the labour market to attract highly qualified manpower etc.)

[8] The questionnaire did not include such statutory IPRs as Industrial Designs, Integrated Circuit Designs and Plant Breeder's Rights. The widely used other strategies than the statutory IPRs such as: Being first in the market or Complexity of Product Design, were not available options in the questionnaire either.

[9] Firms that innovated successfully are called "innovators" according to Oslo definition (OECD,1989). Note that firms that did not complete their innovation in the 1997-1999 period but might have completed it successfully later are classified as unsuccessful innovators in the 1999 Survey. The survey does not allow to distinguish these cases of incomplete innovations from those that failed for technical or commercial reasons (Therrien, 2000).

[10] The definition used for example in Statistics Canada Survey of innovation, 1999 was:
A new product (good or service) is a product which is new to your firm whose characteristics or intended uses differ significantly from those of your firm previously produced products. A

significantly improved product (good or service) is an existing product whose performance has een significantly enhanced or upgraded. A complex product which consists of a number of components or integrated subsystems may be improved by partial changes to one of the components or subsystems. Changes to your firm's existing products which are purely aesthetic or which involve minor modifications are not to be included.
***During the last three years, 1997 to 1999**, did your firm offer new or significantly improved **products (goods and services)** to your clients?*

(2) New production/manufacturing processes are processes which are new to your firm. They involve the introduction into your firm of new production /manufacturing methods, procedures, systems, machinery or equipment which differs significantly from your firm's previous production/manufacturing processes. Significantly improved production/manufacturing processes involve significant changes to your existing processes which may be intended to produce new or significantly improved products (goods or services)or production/manufacturing processes. Minor or routine changes to processes are not to be included.
During the last three years, 1997 to 1999**, did your firm **introduce new or significantly improved production / manufacturing processes ?

[11] Owing to methodological differences a strict comparison of results of the 1999 and 1993 survey is not possible. The sample unit in the 1999 Survey was the provincial enterprise. The provincial enterprise was defined as being the accumulation of all establishments having the same industry and province codes. Thus if a business operated in the same industry in three provinces, it received three questionnaires. Only enterprises with at least 20 employees and with a gross business income over $250,000 were selected. The questionnaire was sent to and responded by the CEO or a person designated by the CEO as the respondent. The Survey was addressed to a sample of 5220 firms in manufacturing and included special sections for firms producing building & construction products and selected natural resource products. The response rate was over 90%.
There are reasons to believe that the survey might have overestimated the percentage of firms that perform R&D and the percentage of firms that innovate. According to an article by Daood Hamdani (2000), the choice of the reporting unit, the questionnaire design and the lack of definition of R&D explains a significant overestimation in the 1999 Survey of the percentage of firms performing R&D. Even though the article does not explicitly deal with the possible overestimation of the percentage of firms that innovated, the choice of the reporting unit is most likely also responsible for an upward bias in estimation of the of the percentage of firms that innovated.

In contrast, the 1993 Survey was sampled (total sample size 5729) so as o be representative of manufacturing firms of all sizes. It contained a sample of small firms not included in the Business Register as well as larger firms (sample of 1595 head offices) included in the Business Register. The majority of small firms employed less than 20 persons. The small firms were separated into two sample groups, each received the general section and one of the two separate parts of the short version of the questionnaire. The group which is of interest to our purpose here (sample of 1088 small firms) , answered sections : 1-general, 3-innovation and 4 intellectual property. Before sending the long version of the complete questionnaire to head offices of the sample of large firms, the firms were contacted to determine who is best qualified to respond each section of the questionnaire. The intellectual protection section of the questionnaire was addressed to the division or individual responsible for intellectual property protection, the R&D and innovation

section to the R&D manager or product manager and the general section to the head office. The sample is representative of Canadian manufacturing firms. The overall response rate was 85.5%.

To resume, the principal difference between the two surveys is that the 1999 represents large manufacturing "provincial enterprises", the 1993 Survey represents both small and large manufacturing firms.

[12] Patents are often used by competitors to obtain valuable technical information. For example 38 percent of top R&D performers reported to use patents "quite a bit" to obtain information (Industry, Science and Technology Canada, 1989).

[13] Note that the wording of the question relative to the use of IPRs does not necessarily imply that the firm used the particular IPR to protect its most important innovation classified in one of the three "originality" classes. The likelihood that the response concerns the particular innovation is, however, very strong for the world-first innovations. In the case of a 'Canada-first' or even more so a 'Firm-first' innovation, the interpretation of the response that a firm used patent protection to protect its intellectual property may be less directly related to its most important innovation.

[14] See the description of the taxonomy in the Introduction and the classification of industries by technological sector in Appendix I.

[15] This is one of several limitations on effectiveness of patent protection listed in Levin at al (1987) which seems particularly relevant to this particular industry.

[16] Patents in the computer industry were considered effective for 41% of product and 33% of process innovations, compared to respectively 61% and 40% of innovations that considered "lead time" as providing effective protection.

[17] Note that firms can carry out R&D themselves in a separate R&D department or in other departments and they can also contract it out to other firms.

[18] The Chi2 tests rejects the hypothesis of independence between R&D collaboration with universities and use of all IPRs beyond the 0.001 level of significance. Firms that collaborate in R&D with universities are almost twice as likely to use patents than those that do not collaborate. The relationship is strongest for the use of patents. This is true for firms of all sizes and all three technology sectors. The contingency tables are not presented here but they are available on request.

[19] R&D is only one of the innovation inputs and the cost of R&D represents less than half of the total innovation cost in Canada. The basic and applied research accounted for only 17% and the development expenditures (defined more liberally than in official R&D statistics) for 30% of total innovation cost in 1989-1991 period. A recent statistics on the share of officially defined R&D costs in Canada is not available. If European Community data may serve as a reference, the officially defined R&D expenditures range there from 25% of total innovation expenditures in electrical products to just 10% in the pulp and paper sector according to the European Commission (2001).

[20] The number of respondents that have indicated that they applied for a patent in the 1997-1999 period was smaller than the proportion of respondents that indicated in the previous question that they used patents to protect their intellectual property in the same period. The correlation of the two responses was not particularly strong (r=0.76). It suggests that the respondents gave an approximate answer to the more general first question that asked them to enumerate the various ways their firm used to protect its intellectual property. The response could, in the case of patents, include patents licensed from suppliers of technology. In this case the firm did not apply for the patent and would respond "no" to the second question asking specifically whether the firm applied for a patent in Canada, in the US or elsewhere in the 1997-1999 period. This explains at least part of the difference between the response rate to the two questions, their loose wording is probably responsible for the rest.

[21] The lack of information on the country of ownership makes it impossible to determine to what extent firms that patented in the US only were affiliates of US companies.
[22] On industry by industry basis the percentages in the five columns vary, even though they are closely correlated (r=0.98). Since the variations tend to almost cancel out for total manufacturing sector, the figures in the two lines are remarkably similar.
[23] The test z shows that the positive relationship between the use of IPRs and increased profitability is significant well beyond the 1% level. The values of statistics *phi* range between 4% and 9% (Phi can be interpreted as a correlation coefficient (phi= 0-no relationship, phi=1-perfect correlation).
[24] Introduction of an innovation involves various activities including often, but not always, R-D. Therefore the variable of interest here is the return on investment in innovation activity rather than the return on investment in R&D.
[25] The recent research as reviewed by (Cohen & Levinthal , 1989) tends to regard the failure of the empirical literature to obtain robust results on how innovation is related to size of firm and to market structure as an indication that these relationships are more complex than previously believed. More complex modelling of technological change ((Levin & Reiss, 1988), (Levin & Reiss, 1984) suggests that innovation, size of firm and market structure are mutually dependent variables.

[26] Agree or strongly agree with the statement:
Q1b= My clients can easily substitute my products (goods and services) for the products of my competitors.
Q1d= The arrival of new competitors is a constant threat.
Q1e=The arrival of competing products (goods and services) is a constant threat.
Q1i= My products (goods and services) quickly become obsolete
[27] We first tried to reduce the scores on eleven competitive environment related questions to a smaller number of factors by a principal component analysis. Since the results of this more complex approach are less transparent and statistically not better than the ones reported above, we abandoned the principal component approach.
[28] Respondents rated the importance of the Q2a = "Seeking new markets" and Q2c Developing niche or specialized markets".
[29] The concept of technological opportunity goes back at least to (Scherer, 1965)). Levin at al.(1987) measure the extent to which an industry relies on science-based research. (Baldwin, Hanel, & Sabourin, 2000) measure technological opportunity of an industry by the percentage of R&D performers within an industry that have collaborative agreement with universities, colleges or external R&D institutions. The variable proved to be a statistically significant determinant of innovation.
[30] (Lundvall, 1992); (Nelson, 1993); Niosi, Jorge, 2000); de la Mothe and Paquet, 1998).
[31] Variables indicated *"left out"* in Table III-2.
[32] Thus for example in the case of introduction of the world first innovation $I_{w\text{-}1st}$=1 and all other outcomes that include: the less original innovations (Canada-first and firm- first), unsuccessful innovation and being not involved in innovation, obtain $I_{w\text{-}1st}$ =0.
[33] The question on the use of IPRs is quite general. It did not ask respondents to report the IPRs used to protect their most important innovation. Information solicited on the most important included questions regarding the novelty and the type of innovation.
[34] An attempt to estimate a more complex model involving three or more equations with three or more interdependent endogenous variables did not work out. Obviously, we have to heed Griliches' warning of moderation of our demands on our data-our desires have to be kept within the bounds of our means.

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