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Protecting innovation: the exclusive and combined use of protection methods by French firms

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Abstract :
This study focuses on the decisions made by firms with regard to the protection of their innovative activities. The prior literature has tended to pursue two points of view which have seldom been brought together, emphasising either the separation of the various methods of protection or the benefits of combining multiple techniques. We strive to marry these two perspectives with a view to explaining the decisions made regarding protection methods. We examine four modalities: protection by informal means, patent protection, the combined use of these two techniques and cases in which neither of them is used. An analysis of data emerging from the CIS3 community survey is carried out. More specifically, we explore the uniformity of informal protection techniques. We then identify three factors which influence preferred protection options depending on whether the variables favour the exclusive use of informal methods, the use of patents either alone or alongside other techniques, or a combination of methods with no preference for any particular one.

Key words :
innovation protection, patent, informal methods, CIS3

INTRODUCTION

In a world in which firms are striving above all else to be competitive in their timing, research and development (R&D) and technological progress have come to occupy a pivotal role. Technological advances and product and process innovation all constitute sources of competitive advantage which firms seek to preserve, and in order to do this, the protection of what we shall generically term 'innovation' is crucial in strategic terms. In spite of this, we still have only scant knowledge of organisational practices where the protection of innovation is concerned. The approaches favoured by existing studies are primarily legal (e.g. Wagret, 1994), procedural (e.g. Ayerbe & Mitkova, 2007) and managerial (Granstrand, 2000, Rivette & Kline, 2000) in nature, and therefore tend to deal with two major methods of protection: patents, on the one hand, and less formal techniques such as secrecy or short lead time, on the other.

How do firms choose between these various methods? The literature puts forward a number of enlightening answers to this, but they are by no means exhaustive. We observe that studies tackling protection-strategy decisions emerge from two different—and rarely combined—perspectives. The literature has focused either on the choice to be made between patents and informal methods (Arundel, 2001) or on the complementary nature of the two. Under the first approach, the methods tend either to be pitted against one another or compared, in an attempt to establish whether a firms is likely to opt for a patent or protect innovation by some other means. Work along these lines has emphasised a proclivity for secrecy rather than patenting on the part of businesses (e.g. Hussinger, 2006; Anton & Yao, 2004). The second, more recent, approach involves exploring the complementary nature of the two types of technique and the effects of merging them. Here, authors stress the way in which firms stand to benefit from embracing a range of any number of complementary methods (e.g. Amara et al., 2008). This approach, however, disregards issues relating to dissonance between the methods. Whilst they are not entirely incompatible, then, marrying these two approaches is not without its difficulties.

Combining the two approaches in question is precisely what this article sets out to achieve. We take up the variables which have traditionally been adopted to explain innovation protection decisions and use Community Innovation Survey 3 (CIS3) data to analyse the influence which those variables exert upon decisions to use only patents, only informal methods, a combination of both, or neither. The study gives rise to three noteworthy findings. Firstly, it allows us to ascertain that options for protection include not only patents versus informal methods but also a distinction between the exclusive or combined use of the two. Our paper therefore posits a more diverse model for potential decision outcomes than those which have been presented in prior studies. Secondly, our study leads us to question how helpful it is to group together or distinguish between the various informal methods of protection: we examine the homogeneity of such techniques, and come to argue that they are in fact rather uniform in nature. Thirdly, our paper underscores the significant increase in the use of patents in the 1990s and the widespread nature of this method of protection, whether used exclusively or alongside informal techniques. Our conclusions therefore move away from the prevalence of informal methods which was for some time distinguished in the literature.

The body of this article is divided into five sections. The first of these introduces the distinction between patents and informal ways of protecting innovation. In the second section, we posit a number of hypotheses relating to the variables which emerge from the literature. The third section focuses upon methods used and offers a multinomial logistic regression for this. In the fourth part, we present the results and tests for our hypotheses. The fifth and final section involves a discussion of our findings and highlights avenues for future research.

THEORETICAL BACKGROUND AND RESEARCH QUESTION

The protection of innovation involves a number of different methods. Besides patents, a number of more informal methods can be discerned, such as secrecy, design complexity, or gaining a technological edge. While authors have established descriptions of these different types of methods, the way in which they are used—that is, alone or alongside one another—have yet to be brought fully to light. Such is the basis for our research question.

Methods of protecting innovation

Firms must employ a number of methods of protection in order to secure the potential profits to which innovation can give rise. It is traditionally acknowledged that legal methods, of which patents are the predominant example, are to be found alongside more informal methods, such as secrecy.

A patent is a deed granted by the public authorities with the purpose of recognising the right to an invention which will go on to be used in an industrial context (art. L 611 et seq of the French Intellectual Property Code). Information is thus divulged to the public, and in return for this the patent holder receives the right to exclusive use for a period of 20 years. A de jure monopoly is therefore granted, and this helps the patent holder to reap the fruits of their invention. The effectiveness of patents has often been the subject of debate. Lemley and Shapiro (2005) go so far as to compare them to a lottery ticket. The justification for this comparison is to be found in the fact that very few patents filed beget everlasting innovations. Moreover, if a patent were to be contested by a third party—and this happens particularly frequently when patents are valuable (Allison et al., 2009)—there is every chance that the legal system may question its validity, thus cancelling out the benefit of having invested in obtaining the patent in the first place. It is necessary to stress, however, that the issue of patent fragility is most immediately relevant in the American system. Due to the internal workings of that system, the US Patent and Trademark Office grants a large proportion of the patent applications which it receives (85%) at the risk of authorising a large number of patents whose novelty element is rather dubious. Whilst patent instability may sometimes also be raised in reference to the European system, it is worth keeping it in perspective there. Besides the issue of their robustness, one other criticism frequently levelled at patents relates to their cost. Preparing to file a patent application and, in the case of international coverage, having it translated can pose an obstacle to innovating firms with limited means.

Other than patents, innovation can also be protected by more informal means. The European CIS[1] upon which this study is based identify three such methods, and the same three techniques are highlighted in the literature: secrecy, product design complexity and technological edge. Besides the fact that all of these methods involve less recourse to legal techniques, the extent to which they can be grouped together

1. The details of the study are presented in the methodology section below.

has yet to be established.

Secrecy involves not divulging any crucial information on the innovation carried out by the firms. In this sense, secrecy appears to be at least partially opposed to the idea of the patent, which involves disseminating information. Corbel and Raytcheva (2010) thus observe that a patent holder in effect forsakes secrecy in return for a monopoly. Because of this, some of the literature has looked at dissonance between patents and secrecy. In legal terms, however, the opposition is only a partial one. Patents must form part of firm's legal routines; firms must, for instance, include confidentiality clauses in work contracts and, where necessary, in contracts governing collaborative arrangements with other organisations.

Design complexity is a method based on the close dovetailing of a firm's product components or processes, whereby obstacles to disassembly make it difficult for competitors to copy a given product. This technique therefore smacks of the method of causal ambiguity, which is reputed to protect a firm from competition (King & Zeithalm, 2001; Forgues & Lootvoet, 2006; Powell et al., 2006). A highly strategic move which banks on the difficulty which competitors will experience in understanding the firm's processes, it stands apart from patents, which adopt a clear, pedagogical approach to describing innovation. Furthermore, a number of questions can be asked regarding the deliberate nature of this technique. Do firms really decide to use product design complexity as a method in its own right, or is it, rather, a more general product trait which firms are slowly coming to harness for strategic purposes?

The technique of minimising product development lead time aims to give the firm a significant technological head start, thus furnishing it with a competitive advantage (Tersine & Hummingbird, 1995). Product life cycles can thus be reduced so as to discourage imitation by other firms. However, this method involves significant costs, and can even lead to diseconomies, as has been suggested by Dierickx and Cool (1989).

Whilst separate descriptions of these protection methods can certainly be provided, the extent to which the techniques are similar or opposed is a matter for debate, and the specific question of whether the various informal methods can be grouped together in a unified cohort remains open. One shared feature seems to be that informal methods involve a lesser recourse to legal techniques and lower, though not inexistent, implementation costs. However, this difference is based more on the distinct nature of the patenting process than on a theoretical parity between the informal methods. Below, then, we use the term 'informal methods' (in opposition to patents) but reserve the right to question its logic. Indeed, our empirical section in particular will offer an opportunity to explore the similarities and differences which exist between these methods and the way in which organizations put them to use.

Interaction between protection methods: two points of view

Two different perspectives can be distinguished in studies on the use of patents and other methods of protection. One point of view stresses conflict between protection methods (these include studies by Arundel, 2001; Leiponen & Byma, 2009; Hussinger, 2006), while the other looks at their combined use (as is the case with the work of Ottoz and Cugno, 2008, 2009; Amara et al, 2008).

The conflict approach tends to stress the element of competition between patents and other methods of protection. These authors do not maintain that patent use excludes other methods, but they do suggest that more informal methods of protection, such as secrecy, perform the same functions as patents where innovation protection is concerned, and are therefore compelled to compare the alleged effectiveness of the various methods of protection, which in their eyes can to some extent be substituted one for another.

The findings which emerge from this approach therefore highlight the relative weakness of the patent system as compared with other protection techniques. Firms deem secrecy to be the most effective method (Arundel, 2001). This is particularly clear in the case of small businesses, where swift marketing and secrecy appear to be the most important methods of protection (Leiponen & Byma, 2009). These findings come on the back of an earlier observation according to which at the beginning of the 1990s fewer than half of all innovations went on to be filed as patents (Arundel & Kabla, 1998).

The combined approach, meanwhile, underscores the concurrent, complementary way in which these protection techniques can be used. The underlying idea with such types of analysis is that innovation is better protected when this is done through a wider range of techniques. This argument can be justified on two counts. Firstly, there is a consensus as to the fact that firms use patents concurrently with other, more informal methods, particularly secrecy. A single case of innovation, in all its various facets, can be protected by several methods (Arora, 1997; Cugno & Ottoz, 2006). Highlighting the fact that organizations prefer informal methods, then, sheds only partial light on the way in which they combine multiple methods. Secondly, and in spite of the alleged preference for secrecy and other informal techniques, there was a considerable surge in the number of patent applications from 1990 to 2000 (Kortum & Lerner, 1999). Nonetheless, studies adopting this combined approach are fewer in number than those which foreground conflict between protection methods.

Ottoz and Cugno (2008) bring a theoretical defence for the importance of combining methods. They use examples to show through a balance model how patent coverage encourages innovators to have recourse to secrecy in order to prevent the arrival of new competitors. Amara et al. (2008) stress in empirical terms how patents can complement other methods. They find that firms consider the various techniques not as substitutes for one another but as complementary methods in the sense that they reinforce one another. Tersine and Hummingbird

(1995), meanwhile, show that a technological edge generally complements the effects of patents and secrecy. Faria and Sofka (2010) even take the notion of combined techniques as a starting point, aiming to explain the breadth of innovation protection, which they express as the total of all methods employed regardless of their nature.

Each of these approaches—exclusive versus combined use—allows certain aspects of innovation protection strategies to be brought to the fore. They are not incompatible, but do stress opposing lines of argument. To our knowledge, no study has offered a means of reconciling these two perspectives. There is clearly no systematic tendency for organization to adopt a combination of different methods, and preferences for one particular method are sometimes expressed. In some cases a clear choice is sought, whereas elsewhere combined methods of protection may be used. This is our proposed focus in this paper. Our aim is to contribute to the decisions made regarding use of patents and informal methods and to bring together the two currently prevailing approaches. Our research question is thus as follows: which factors affect the adoption of an exclusive approach to protection (patent versus informal methods) or the adoption of a combined approach to protection? Below, we use the results garnered elsewhere in the literature to build a series of hypotheses which will allow us to tackle our research question.

HYPOTHESES

Prior research, whether adopting the single or combined approach, converges on a series of variables which are deemed essential in explaining industrial property strategies. This applies in particular to CIS studies which refer to a series of homogeneous research methods. We intend to look at how each category of variables may influence strategies for protecting innovation, while not overlooking the fact that there are often grounds for using multiple techniques concurrently.

The nature of innovation

Regardless of the circumstances in which a irms finds itself, the effectiveness of protection methods varies according to the type of innovation being carried out. Product innovation consists in creating a new product or improving an existing one. Process innovation, meanwhile, involves introducing new or significantly altered production processes or service-supply (or product-delivery) methods. In terms of protection, a key difference between the nature of these two types of innovation relates to extent to which they can be explained: product innovation tends to be more readily described than process innovation. Processes leave no tangible trace in the way that products do; they result from a combination of routines and resources particular to the business in question. It can be difficult to locate and describe these processes, and this

often requires more tacit forms of knowledge (Nelson & Winter, 1982; Nonaka, 1994).
The extent to which the nature of innovation can be described has a direct effect on the type of protection which will be preferred. Empirical studies confirm that the nature of innovation is a key factor in choice of protection: secrecy, for example, is customarily preferred where processes are concerned, and product innovation tends to lead to the use patents (Levin et al., 1987; Hanel, 2008; Cohen et al., 2000). Indeed, patent protection requires that the innovation be precisely identifiable, and so this type of protection is more difficult to invoke in the case of process innovation. Likewise, the fact that process description is more difficult means that processes are better suited to informal protection methods. Even where a competitor can easily gain information about a focal firm's resources, that competitor will find it difficult to reconstruct the chain of cause and effect linking the firm's resources and methods with the efficiency of the innovative process.

H1a: In cases of product innovation, a patent alone is more likely to be used than informal methods alone or no protection whatsoever.

H1b: In cases of process innovation, informal methods alone are more likely to be used than a patent alone or no protection whatsoever.

The hypothesis according to which cases of product innovation are likely to call for patent protection does not exclude the possibility of a combined approach. One of the specificities underscored in the literature with regard to informal methods relates to the flexibility of their implementation and the minimal cost which they are supposed to involve. If, therefore, a firm opts for patent protection, it will probably find little difficulty in planning other, informal types of protection as well. The inverse, however, is not necessary true; in other words, informal techniques are not necessarily readily combined with patents, because in that case the more significant part of the marginal cost burden has yet to be shouldered. Thus, while a preference for patents over informal methods leads to patent use (either in isolation or alongside informal protection), it does not necessarily follow that a preference for informal methods will result in their combined use with patents. We therefore posit that product innovation, which we assumed above to involve a higher chance of patent use, also increases the likelihood that patents will be used jointly with other methods. We make no such hypothesis, meanwhile, regarding combined methods in the case of process innovation.

H2: In cases of product innovation, it is more likely that various protection methods will be combined.

Protection capacity

An organization must be able to deploy the various methods of protection. All techniques require a certain number of resources, and firm

size is a traditional indicator of this. The need for resources is most evident in the case of patents, where both filing procedures and the procedures to be followed in the case of imitation demand a minimum level of expertise. Patents are not granted automatically; convincing arguments must be put to national bodies (such as INPI, the French National Industrial Property Institute) or international entities (such as the European Patent Office). Even once the patent becomes valid, in cases of counterfeit the firm will still have to defend its rights and instigate proceedings with the competent bodies or legal systems. In other words, patent use requires an ability on the part of the firm to take advantage of the protection granted not only in financial terms but also, more generally, in terms of expertise. It is therefore crucial that firms have access to a legal or intellectual-property protection department or, more simply, to specialists in the field. Organizations of a certain size will be more likely to have such departments or experts, and we can therefore assume that larger firms use patents more often: it is easier for them to establish a patent-filing policy with a view to turning a profit on their patented inventions (Thurow, 1997).
At the same time, larger organization can also be more likely to use informal methods, in spite of their preference for patents. With techniques such as secrecy, organisations must have a minimum level of resources, and particularly legal ones, if they are to manage the contracts which will allow the flow of information to workers and partners to be monitored and controlled. In order to sustain a technological edge, meanwhile, firms must be able to undertake permanent innovation, and this, too, ultimately requires a certain number of resources. Larger firms are therefore more likely to use both informal methods of protection and patents, which increases the probability that these methods will be used jointly.

H3a: The larger a firm, the more likely it is to combine various protection methods.

Meanwhile, size does not affect both types of protection method to the same degree; rather, patents seem to be much more sensitive to it. One of the comparative criticisms often levelled at patents is their cost (Ayerbe & Mitkova, 2005). Both during application and, potentially, when the patent is invoked, the expense involved undoubtedly depends on the country or geographical area in which it is incurred (Cohen et al, 2002). This explains why small and medium-sized enterprises, even when they are aware of how useful a patent is, more frequently opt for informal methods such as secrecy (Arundel & Kabla, 1998). We can therefore assume that an increase in firm size brings about an increase in the likelihood of patent use which is bigger than the corresponding increase in the likelihood that informal protection techniques will be employed.

H3b: The larger a firm, the more likely it is to use a patent as opposed to informal methods of protection or no protection whatsoever.

Risk exposure

Since protection costs money and must be managed by the firm, is encouraged only to protect innovation when it believes that it is exposed to the risk of appropriation, particularly through the contact which it has with other organisations. Two factors should be noted with regard to the identification of such risk: inter-organisational collaboration, and the size of the business's main market.

Inter-organisational collaboration

Inter-organisational collaboration has become widespread in the field of innovation. Cooperation is a popular means of cost-sharing and gaining access to new know-how or markets. However, joint innovation involves the risks of opportunism and, more generally, appropriation by the partner entity. Organisations must therefore seek to ensure that innovation is protected whether resulting partly or wholly from the partnership in question. This need for a general level of protection ought, then, to encourage the combined use of various methods. Empirical studies have shown that managers use a wide range of protection methods in collaborative circumstances (Hertzfeld et al., 2006).

H4a: In cases of collaboration with other organisations, combined methods are more likely to be used.

We argue, however, that collaborating firms are encouraged more to use patent-based innovation protection techniques (Hertzfeld, Link, & Vonortas, 2006). True cooperation among organisations makes it relatively difficult to use methods involving secrecy or design complexity; thus, while inter-organisational collaboration increases the odds that protection of some kind will be used, formal methods are said to be preferred in these circumstances, potentially alongside informal protection techniques. Patents are also generally perceived as a tool which fosters cooperation in that they clarify the ownership of the fruits of the partnership (Arundel, 2001; Corbel, 2004) but also the search for partners: organizations which already own patents find it easier to attract investors or financial or industrial partners (Mazzoleni & Nelson, 1998; Bhattacharya & Ritter, 1983).

H4b: Collaboration with other organisations correlates positively with a preference for patent use as compared with informal methods or no method whatsoever.

Size of the firm's main market

The size of the firm's main market affects the extent to which it requires protection. Innovation calls for greater protection in large markets than in local ones. This is firstly because significant markets offer greater financial opportunities than local ones, and secondly because more information filters through to potential competitors when markets are large, and this increases the risk of predatory activity. This trend has usually been illustrated in its negative form by niche strategies: firms purposely hold on to a small market so as to diminish its attractiveness

in the eyes of the competition. We can therefore posit the hypothesis that a geographically larger market increases the firm's need to seek innovation protection, which seems in turn to trigger use of a wider selection of protection methods (Faria & Sofka, 2010).

H5a: The larger the firm's main market, the more likely the firm is to use combined methods of protection.

Nonetheless, the implications of being in a large market would suggest that patent protection is the most appropriate technique here. We may well wonder about the effectiveness of informal methods in such cases. If, for example, the firm has sections or branches in faraway places, secrecy or design complexity may become problematic. We can also assume that a technological edge would be difficult to harness in these cases since a larger market means countering a greater number of competitors able to challenge such an advantage. We are therefore compelled to assume that a larger market will encourage an organization to prefer patent protection over informal methods.

H5b: The larger the firm's main market, the more likely it is to use patents rather than informal methods alone or no method whatsoever.

METHODOLOGY

Data

Work carried out on innovation in the 1970s and 1980s by the likes of Mansfield et al. (1977) was based on studies conducted in isolation. In Europe, institutional CIS studies have been appearing since the 1990s (Mairesse & Mohnen, 2005). These studies, which are organised by Eurostat and refer to the Oslo Manual (OCDE, 1997), are carried out jointly in all European countries, and target manufacturing companies but also service-industry businesses: insurers, etc. The CIS studies involve contacting organizations directly for information about innovation activities, thus taking the firm as the unit of analysis (Tether & Tajar, 2008). CIS studies stand out in particular for the type and quantity of information which they yield (Beneito, 2006). Their goal is to collect data on a wide range of innovation activities. They focus not only on R&D expenditure but also on the acquisition of patents and licences, staff training, marketing analysis and organisational change (Peters, 2006). CIS surveys do not, however, include a number of variables which are

sometimes seen as important. The studies do not, for instance, measure the level of vertical integration (Leiponen & Byma, 2009). In more general terms, it is worth noting that CIS studies do not seek to measure psycho-sociological or cognitive variables. For instance, they offer no information about organization culture or managers' attitudes to risk. CIS is of interest to academic researchers, particularly when studies involve country comparisons (such as the work of Faria and Sofka, 2010) or require data which are difficult to obtain directly; in 2006, Laursen and Salter observed that such data had been used in more than 60 recent academic papers. Befo
re launching across various countries, a pilot and pre-test stage is carried out by Eurostat. The survey draws upon a number of specific filter questions on the basis of which innovating companies can be selected (Mairesse & Mohnen, 2005).

Two study phases preceded CIS3: CIS1 was for the period 1990-1992, and CIS2 took place from 1994 to 1996. Our study is based on CIS3 data (which correspond to three years of observation: 1998, 1999 and 2000) on the French manufacturing industries. The survey was launched by SESSI (The French Ministry for the Economy, Finance and Industry's Office of Industrial Studies and Statistics). Most of the questions which appear in the French questionnaire are identical to those included on the European one. For convenience, they appear in a different order, and for the purposes of clarity, they have in some cases been redrafted or completed.

The French system broke new ground in that it made the study obligatory. The questionnaires were sent out from September to November 2001. If firms did not reply after two written reminders, a formal notice was issued, followed by a statement of non-response. For the French CIS3, the overall response rate was higher than 82% (and 86% for the manufacturing industries). The survey was carried out directly with firms' directors, financial managers and R&D managers (Faria & Sofka, 2010).

In the case of the manufacturing industries, the survey was only submitted to firms with more than 20 employees; this gave a total of 22,500 observations. The sample included 5,800 organisations. All firms with more than 500 employees were included. For the purposes of the study, we looked at the firms which were innovating in the manufacturing industry at the time of the survey. By 'innovating firm' we mean those which produced at least one case of product or process innovation during the period in question, as well as firms which had carried out a project with a view to such innovation regardless of whether the endeavour had born fruit. Once these criteria had been applied, the sample included 2,288 firms which could be deemed innovating.

Factor analysis of protection methods

L'une des questions soulevées dans la partie empirique concerne la One of the issues raised in the empirical section relates to the multifaceted nature of innovation protection methods, and more specifically whether what we have termed 'informal protection' methods constitute a group of variables which can be seen to have a facet in common. For

some authors, secrecy may involve certain traits which bring it closer to patent protection than to design complexity or swift marketing.

With a view to exploring the potential similarities between these variables, we conducted a principal component analysis (PCA) in an attempt to highlight the underlying structural factors. We extracted the survey's four protection variables. In the CIS questionnaire, organizations are asked to state whether they used innovation protection methods during the period in question. They are then presented with a list, and indicate whether or not they used each technique during the period in question. In this study, we focus on four protection methods (patents, secrecy, technological edge and design complexity). We turn these into four dichotomous variables (coded 1 if the method was used and 0 if it was not).

Our study differs in its use of binary variables, whereas PCAs are usually used with continuous quantitative variables. We advocate conducting a PCA on the tetrachoric correlations between the binary variables rather than on the covariance matrix (see Reuer & Ariño, 2007, for an example of this taken from the field of management)[2].

2. It should be noted that SPSS offers a specific module, CATPCA, for the factor analysis of categorical variables. In this particular case, the results of that lead to identical conclusions.

The tetrachoric correlation matrix appears in Table 1. It should be noted that in most cases these correlations are stronger than Pearson's correlations. Despite this, the three variables for informal methods (technological edge, secrecy and design complexity) correlate much more strongly with one another than they do with patent protection.

Table 1 – Tetrachoric correlation matrix

	Patents	Technological edge	Design complexity	Secrecy
Patents	1			
Technological edge	0.222***	1		
Design complexity	0.072*	0.741***	1	
Secrecy	0.168***	0.620***	0.670***	1

We used this matrix to carry out a PCA. **Table 2** presents the results of this for a two-factor analysis without a rotational sample;

Table 2 – PCA (two-factor)

Variable	Component 1	Component 2	Commonalities
Patents	0.186	0.970	0.995
Technological edge	0.575	– 0.014	0.798
Design complexity	0.575	– 0.226	0.846
Secrecy	0.550	– 0.077	0.735

L'analyse en deux facteurs permet d'expliquer 85 % de la variance, This two-factor analysis explains 85% of variance, which is usually considered to be a very satisfactory level. Adding further elements thus brings only a limited improvement in the variance explained, at least with eigenvalues far lower than 1 (see **Table 11**, in the appendices).

As suggested by the general indication emerging from the correlation matrix, the informal protection variables are to be found along a single axis, whereas patent protection forms a separate axis all of its own. The clarity of these results, which were obtained without a rotational sample, suggests that variables representing informal protection methods are very similar to one another. Attempts to fuse them into a single common variable are therefore justified.

For the rest of this paper, we will therefore make no distinction between secrecy, technological edge and design complexity, terming all these three 'informal' protection methods. We thus establish the variable of 'informal protection', which will be set at 1 when any one of the informal methods is adopted and 0 when none is used by a given firm.

Measurement of variables

All the variables included in our study are observed through the CIS questionnaire. Each question in the questionnaire is usually preceded by a simple rubric and a tick box. The variables being measured are therefore basically nominal ones. **Table 3** lists all the variables used. Unless we specify otherwise below, the variables were found in the study in the exact form in which they appear here.

Dependent variable [Protection]. The dependent variable is the innovation protection technique opted for. This variable has four modalities and was constructed as follows. Following the PCA (see above), we were left with two binary protection variables: patent (1 if used, 0 if not) and informal protection (1 if used, 0 if not). We cross-tabulated these variables to obtain all possible combinations on the basis of the variable Protection, which includes four exclusive modalities. A firm can opt to use none of these methods of protection (modality 1), only informal methods (modality 2), only patents (modality 3) or a combination of the two (modality 4).

Control variables. Three control variables were used: potential membership of a group, expenditure on innovation and involvement in a particular industry; this last variable gave rise to the construction of dummy variables.

Table 3 – Description of variables

Type of variable	Name	Abbreviation	Description
Dependent variable	Type of protection	Protection	Dependent variable with four modalities: 1 if the firm does not use protection, 2 if the firm uses only informal protection methods, 3 if the firm means to use only patents (filing application), 4 if the firm uses a combination of the two methods
Explanatory variables	International	International	Indicates whether the firm's main market is international in scope (1) or not (0)
	Local	Local	Indicates whether the firm's main market is regional in scope (1) or not (0)
	Employees	ln(employees)	The natural logarithm for number of employees in 1998
	Cooperation	Cooperation	1 if the firm had at least one collaborative arrangement during the period in question
	Product innovation	Product	1 if the firm carried out a product innovation project, 0 if not
	Process innovation	Process	1 if the firm carried out a process innovation project, 0 if not
Control variables	Innovation expenditure	ln(expenditure)	Natural logarithm for total innovation expenditure during the period in question
	Group	Group	1 if the firm belongs to a group and 0 if not
	[Industry]	[Name of sector]	Involvement in a particular industry. 1 if involved, 0 if not (dummy variable)

Involvement in a particular industry. Involvement in a sector is an important control variable. Some industries give rise to types of innovation which are easier to describe, and lead firms to opt for patent protection. Similarly, the prevailing culture in certain industries may be one of patent use, which will again increase the chances that patents will be sought. We propose to use the NACE system for the classification of economic sectors. **Table 4** shows the descriptive statistics for each category of industry. It should be noted that the classification makes a distinction between so-called high-technology (HT) and low-technology (LT) industries.

Analysis of the impact of involvement in a industry is carried out using dummy variables (1 if the firm is involved in a given industry, 0 if it is not). We used the metalworking and machinery manufacturing industries to choose the reference modality since many firms of these types appear in our sample (n = 543) and these industries tend to be seen as slightly above average where technology use is concerned.

Size of the firm's main market. The CIS survey asks firms directly whether their main market is local/regional, national or international, then assigning them an ordinal qualitative variable (1 to 3). We draw dummy variables from this. The reference modality is the national market, against which we identify international markets (1 if international, 0 if not) and local ones (1 if local, 0 if not).

Descriptive analyses

Table 4 presents descriptive analyses of the use of protection methods by industry. It will be noted that the rate of patent application in innovating firms is quite high (49.2%). According to Arundel and Kabla (1998), patents were filed in around 40% of cases in 1991-1992. Over a period of roughly ten years, then, it seems that firms' patent filing strategies changed markedly. This falls in line with the evidence suggesting a surge in patent filing (Van Zeebroeck et al., 2009), particularly from 1990 to 2000 (Kortum & Lerner, 1999).

Further light can be cast on these observations by looking at the way in which protection methods are sometimes combined. **Table 5** presents statistics to describe the variables in the model. Patents and at least one informal method of protection are combined in 23.6% of cases. Whilst protection methods seem to be becoming more widespread, then, combinations thereof are still limited to fewer than a quarter of innovating firms. Twice this number used only one of the two types of protection (23.3% + 24.1%) during the period in question.

Table 4 – Frequency of use of protection methods by industry

	Number of firms	Patents	Secrecy	Complexity	Technological edge	Informal methods
Mining and quarrying (LT)	13	38,5 %	38,5 %	15,4 %	15,4 %	46,2 %
Food (LT)	302	22,2 %	34,1 %	24,2 %	34,1 %	47,4 %
Apparel (LT)	149	30,9 %	23,5 %	21,5 %	28,9 %	41,6 %
Wood, paper and publishing (LT)	138	35,5 %	20,3 %	15,2 %	26,1 %	36,2 %
Chemicals	460	53,3 %	38,3 %	23,7 %	36,1 %	52,2 %
Chemicals (HT)	91	63,7 %	41,8 %	23,1 %	29,7 %	50,5 %
Metalworking and machinery	543	58,2 %	26,5 %	15,5 %	37 %	47,5 %
Office and IT equipment (HT)	16	62,5 %	43,8 %	31,3 %	31,3 %	50 %
Electrical equipment	123	63,4 %	30,1 %	30,9 %	34,8 %	56,1 %
Communication, precision and medical equipment (HT)	209	59,3 %	34 %	37,3 %	44,5 %	59,3 %
Transport equipment	105	65,7 %	23,8 %	22,9 %	28,6 %	38,1 %
Space (HT)	26	73,1 %	65,4 %	46,2 %	57,5	69,2 %
Furniture and salvaged items (LT)	92	2,7 %	21,7 %	14,1 %	22,8 %	33,7 %
Water and electricity	21	47,6 %	38,1 %	9,5 %	42,9	52,4 %
Total	2288	49,2 %	31,2 %	23,4 %	34,8 %	46,9 %

Table 5 – Descriptive statistics for explanatory variables (N = 2288

Variables		
Dependent variable – Protection		
1 – None		28,7 %
2 – Only informal methods		23,3 %
3 – Only patents		24,1 %
4 – Combination of the two		23,6 %
Continuous variables	Average	Standard deviation
lnEmp	5,19	1,39
lnExpendit	6,29	2,11
Dichotomous variables		Frequency
Product		40,00 %
Process		49,60 %
Coop		49,50 %
Internat		50,00 %
Local		5,60 %
Group		37,30 %

Models

correlation matrix can be found in the Appendices, in Table 11. It provides relatively little information: most of the correlations are significant due to the large sample size, but only two variables correlate strongly [ln(Employees) and ln(Expenditure)].

Our paper aims to establish which factors encourage combined as opposed to exclusive use of the different methods of protecting innovation. This involved comparing the circumstances in which various combinations of innovation protection strategies appear, where the combinations are the different modalities of the variable Protection (1 = No protection; 2 = Only informal methods; 3 = Only patents; 4 = Combination of patents and informal methods).

We used a multinomial logistic regression model to assess the impact which the explanatory variables have on decisions on each of the modalities. This model allowed us to compare the way in which a group of variables affects the relative probability that each modality will be used. With four modalities for the dependent variable, six regressions allowed us to compare all modality pairs. Since pair-by-pair modality comparison could offer only a limited insight, we complemented our interpretation by calculating the marginal effects of the explanatory variables on the use of each modality. We also used a Hausman test on the independence of irrelevant alternatives (IIA) hypothesis. No significant value resulted from this, which suggests that the results remain stable regardless of whether all adopted strategies are taken into account or just some of them.

In addition to this analysis of the probability that each modality will be used, it is also necessary to examine the decisions made regarding groups of modalities. Modalities 2 and 3 refer to the exclusive use of

one method of protecting innovation, and therefore correspond to the logic of exclusive use when protection is being selected. Modality 4, meanwhile, involves the combined use of multiple methods. We carried out a logistic regression after the multinomial regression to assess the factors which lead to exclusive or combined use. This allowed us to focus, in the sub-sample of firms which do use protection, on the factors which lead to exclusive use (modalities 2 and 3 together) or combined use of methods of protection (modality 4). In this regard, the regression takes as its basis the fact that the organization has already decided to protect innovation, and the no-protection scenario (modality 1) is therefore excluded. It should be noted that the removal of this modality to work with a limited set of modalities does not skew the results. Since the outcome of the IIA test discussed above was not significant, the relative probabilities that either of two decision outcomes will occur (in this case either modality 2 or 3 on the one hand or 4 on the other) are not affected by the elimination of certain other outcomes (in this case modality 1).

Results

Tables 6 and 7 present the results of the multinomial logistic regression. They allow us to assess the influence which a number of variables exert on the relative probability that combined methods will be used as opposed to each of the other possible outcomes (**Table 6**), the relative probability that no method will be used as opposed to informal methods or patents being used, and the relative probability that patents will be used as opposed to informal methods (**Table 7**). The marginal effects are presented in **Table 8**. Finally, the results of the logistic regression, which specifically compares the probability of using a single method exclusively with that of using two protection methods concurrently, are presented in **Table 9.**

Table 6 – Model 1 on the relative influence exerted on combined methods

Combined methods (4) vs	No method (1)		Only informal methods (2)		Only patents (3)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Constant	5.871***	0.394	4.274***	0.405	2.71***	0.397
Product	– 1.555***	0.208	– 0.823***	0.225	– 0.305	0.234
Process	– 0.264*	0.134	0.116	0.140	– 0.461***	0.131
ln(Emp)	– 0.422***	0.067	– 0.382***	0.068	– 0.102	0.066
Cooperation	– 0.860***	0.138	– 0.374**	0.142	– 0.575***	0.132
Internat	– 0.588***	0.143	– 0.257†	0.149	– 0.456***	0.143
Local	0.457	0.372	– 0.153	0.403	0.278	0.412
ln(Expenditure)	– 0.212***	0.045	– 0.217***	0.046	– 0.136**	0.045
Group	– 0.408†	0.226	– 0.458*	0.232	– 0.227	0.238
Mining and quarrying (LT)	0.338	0.758	– 0.229	0.913	– 1.365	1.146
Food (LT)	1.606***	0.239	1.711***	0.243	– 0.362	0.284
Apparel (LT)	0.695*	0.293	0.587†	0.307	– 0.231	0.324
Wood, paper and publishing (LT)	1.012**	0.327	0.992**	0.340	0.487	0.329
Chemicals	0.209	0.193	0.312	0.198	– 0.157	0.181
Chemicals (HT)	0.463	0.351	0.025	0.400	0.143	0.351
Office and IT equipment (HT)	0.923	0.948	1.674*	0.782	1.245†	0.391
Electrical equipment	0.122	0.318	0.398	0.307	0.021	0.269
Communication, precision and medical equipment (HT)	0.075	0.259	0.269	0.255	– 0.204	0.238
Transport (manufacturing)	0.890**	0.342	0.307	0.399	0.918***	0.287
Space (HT)	– 0.035	0.736	0.419	0.638	– 0.076	0.566
Furniture and salvaged items (LT)	1.360***	0.372	0.874*	0.404	0.307	0.710
Water and electricity	0.424	0.753	1.041	0.731	0.138	0.397
Log likelihood = – 2723.33 ; Pseudo R^2 = 0.13						

† significance of 0.1; * significance of 0.05 **; significance of 0.01; *** significance of 0.001

Table 7 – Model 2 with 'No protection' and model 3 with 'Patents only'

	Model 2				Modèle 3 Brevet seul (3) vs	
No protection (1) vs			Model 3		Informelles seules	
Only patents (3) vs	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
	Only informal methods (2)	Only patents (3)		Only informal methods	1.555***	0.365
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Constant	– 1,597***	0,321	– 3,153***	0,341	1.555***	0.365
Product	0,731***	0,157	1,25***	0,182	– 0.518*	0.205
Process	0,38**	0,126	– 0,197	0,129	0.577***	0.137
ln(Emp)	0,402	0,062	0,32	0,065	– 0.279***	0.068
Cooperation	0,485***	0,130	0,284*	0,135	0.200	0.140
Internat	0,331*	0,132	0,131	0,137	0.199	0.145
Local	– 0,472†	0,265	– 0,429	0,298	– 0.043	0.341
ln(Expenditure)	– 0,004	0,041	0,075†	0,044	–0 .080†	0.046
Group	– 0,05	0,174	0,18	0,19	– 0.230	0.203
Mining and quarrying (LT)	– 0,568	0,847	– 1,704***	1,121	1.136	1.247
Food (LT)	0,104	0,198	– 1,968***	0,256	2.073***	0.264
Apparel (LT)	– 0,107	0,25	– 0,926***	0,279	0.819**	0.300
Wood, paper and publishing (LT)	– 0,02	0,269	– 0,524†	0,27	0.504†	0.293
Chemicals	0,102	0,198	– 0,367†	0,189	0.469*	0.200
Chemicals (HT)	– 0,437	0,409	– 0,319	0,353	– 0.118	0.409
Office and IT equipment (HT)	0,751	0,889	0,321	0,856	0.429	0.682
Electrical equipment	0,276	0,335	– 0,1	0,315	0.377	0.311
Communication, precision and medical equipment (HT)	0,194	0,264	– 0,279	0,264	0.474†	0.266
Furniture and salvaged items (LT)	– 0,485	0,317	– 1,053	0,323	0.567	0.697
Water and electricity	0,617	0,673	– 0,286	0,745	0.903	0.741
Log likelihood = – 2723.33 ; Pseudo R^2 = 0.13						

† significance of 0.1; * significance of 0.05 **; significance of 0.01; *** significance of 0.001

Table 8 – Marginal effects of variables on choice of protection strategy

	No protection (1)		Only informal methods (2)		Only patents (3)		Combination (4)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Product	– 0261***	0.030	0.004	0.025	0.106***	0.023	0.150***	0.021
Process	– 0.028	0.021	0.064	0.019***	-0.073***	0.020	0.038†	0.019
ln(Emp)	– 0.053***	0.010	– 0.034	0.009***	0.032***	0.010	0.055***	0.010
Cooperation	– 0.110***	0.021	0.228	0.019	– 0.024	0.020	0.111***	0.020
Internat	– 0.071***	0.022	0.019	0.020	– 0.027	0.021	0.079***	0.021
Local	0.999†	0.052	– 0.036	0.041	– 0.028	0.047	– 0.034	0.057
ln(Expenditure)	– 0.019**	0.007	– 0.168	0.006**	0.001	0.006	0.034***	0.006
Group	– 0.035	0.031	– 0.041	0.030	0.014	0.030	0.062*	0.031
Mining and quarrying (LT)	0.167	0.157	– 0.024	0.130	– 0.172*	0.069	0.030	0.134
Food (LT)	0.189***	0.041	0.191	0.040***	– 0.210***	0.018	– 0.169***	0.020
Apparel (LT)	0.117*	0.048	0.062	0.045	– 0.109***	0.031	– 0.070†	0.038
Wood, paper and publishing (LT)	0.099†	0.051	0.074	0.050	– 0.048	0.037	– 0.125***	0.032
Chemicals	0.031	0.033	0.051	0.032	– 0.058*	0.025	– 0.024	0.026
Chemicals (HT)	0.088	0.070	-0.036	0.057	-0.011	0.050	– 0.041	0.044
Office and IT equipment (HT)	– 0.049	0.145	0.175	0.152	0.034	0.116	– 0.160***	0.048
Electrical equipment	– 0.006	0.055	0.066	0.055	– 0.028	0.040	– 0.032	0.039
Communication, precision and medical equipment (HT)	0.008	0.045	0.057	0.043	– 0.054	0.033	– 0.010	0.035
Transport (manufacturing)	0.089	0.064	– 0.062	0.050	0.084	0.052	– 0.111***	0.032
Space (HT)	– 0.033	0.128	0.091	0.129	– 0.036	0.089	– 0.020	0.083
Furniture and salvaged items (LT)	0.210***	0.062	0.018	0.054	– 0.095*	0.038	– 0.133***	0.034
Water and electricity	– 0.015	0.116	0.175	0.137	– 0.069	0.089	– 0.090	0.077
Log likelihood = – 2723.33								
Pseudo R^2 = 0.13								

† significance of 0.1; * significance of 0.05 **; significance of 0.01; *** significance of 0.001

Table 9 – Model 4 with logistic regression for the outcomes of combined or exclusive use of protection methods (n = 1606; only one method = 0; two methods = 1)

	Coef.	Std. Err.
Constant	– 4.200***	0.361
Product	0.614**	0.208
Process	0.189	0.119
ln(Emp)	0.228***	0.057
Cooperation	0.475***	0.122
Internat	0.402**	0.127
Local	0.018	0.381
ln(Expenditure)	0.157***	0.039
Group	0.396†	0.212
Extraction (LT)	0.721	0.819
Food (LT)	– 0.829***	0.220
Apparel (LT)	– 0.193	0.279
Wood, paper and publishing (LT)	– 0.626*	0.305
Chemicals	– 0.016	0.162
Chemicals (HT)	– 0.084	0.290
Office and IT equipment (HT)	– 1.382*	0.652
Electrical equipment	– 0.185	0.243
Communication, precision and medical equipment (HT)	0.006	0.208
Transport (manufacturing)	– 0.760**	0.281
Space (HT)	– 0.150	0.490
Furniture and salvaged items (LT)	– 0.613†	0.357
Water and electricity	– 0.546	0.626
Log likelihood = – 933.94505		
Pseudo R^2 = 0.13		

† significance of 0.1; * significance of 0.05 **; significance of 0.01; *** significance of 0.001

Patents versus informal methods

In cases where firms opt for a single type of protection throughout the period in question (regardless of whether they choose modality 2 or 3), the factors which encourage the use of patents or informal methods over the other can be discerned.

Once product innovation has been effectively carried out, the likelihood of adopting no protection strategy whatsoever is reduced. In such cases, patents are preferred over both no protection and the sole use of informal methods. These results support H1a, which predicted that product innovation would engender a preference for patent use.

Meanwhile, when process innovation is effectively carried out, the likelihood of using only informal methods of protection increases signifi-

cantly and the exclusive use of patents is discouraged. The use of no protection whatsoever does not appear to be unpopular in this scenario, but the use of informal methods is still preferred. These findings support H1b.

The size of the firms (expressed in terms of the ln of the number of employees) appears to play a decisive role in decisions on protection strategies: in a larger company, the chances that only patents will be used is higher, and the likelihood that only informal methods or no methods at all will be used is diminished, with no distinction to be made between these two outcomes. These findings lend clear support to H3b, according to which a larger organizations is more likely to opt for patents. However, neither cooperation with other companies nor an international market appear to influence the relative probability that a patent will be chosen over informal methods, which leads us to reject H4b and H5b.

In terms of the control variables, involvement in the food, apparel and chemicals industry (rather than the transport manufacturing indsutry) appears to foster informal methods as opposed to patents. Food and apparel in particular are low-technology industries. Patents are probably an uncommon concept in these sectors, which explains why they are used only infrequently, even in cases of innovation. However, the effect of involvement in sectors which are usually classed as high-technology cannot be clearly discerned. One explanation for this finding may be our choice of reference modality, for which we chose the automobile industry, and compared all other sectors to this. As can be seen in Table 4, however, this industry, although not habitually classed among the high-technology sectors, frequently seeks to protect innovation, and often uses patents in particular. This resulted in there being no clear picture of a comparative influence being exerted by involvement in high-technology sectors.

COMBINED USE OF PROTECTION METHODS

Through the logistic model, **Table 9** gives the variables included in the hypotheses which lead to the concurrent use of multiple methods as opposed to exclusive use of a single one. **Tables 6 to 8**, which complement **Table 9**, show the likelihood that combined methods will be used as opposed to any other eventuality. Product innovation increases the probability that a combination of methods will be used, which lends support to H2. A larger firm size has a significant similar effect, which means that we can support H3a. Finally, circumstances involving collaborative arrangements and an international market increase the likelihood of combined methods, which supports H4a and H5a. However, process innovation does not appear to influence the likelihood that a broader range of protection measures will be sought. Besides the model's component variables, the ln control variable (expenditure), which denotes expenditure on innovation, gives rise to a similar effect: in

other words, it fosters the combined use of the two types of protection. Of these variables, two (large firm size and product innovation) also lead to a preference for patents over informal techniques. Furthermore, our findings indicate no particular preference here for combined methods as compared with patent use. This means that larger firms will tend to prefer patents, whether used exclusively or in jointly with other methods, over other options.

It should be noted that none of the variables gives rise to a reverse trend whereby the probability of using combined informal methods and combined methods would be increased. Whilst the pattern in this case relates to only two variables, it nonetheless gives the impression that there is a certain asymmetry between patents and informal methods. We must exercise caution when interpreting this finding, but one explanation may be that it reflects the lower marginal costs of informal methods compared to patents. Variables which give rise to patent use can also give rise to patent use combined with informal methods since the addition of the latter involves an acceptable level of additional expenditure.

Meanwhile, involvement in a number of sectors (rather than the reference sector of machinery manufacturing and metalworking) seems to diminish the likelihood that combined methods will be used. This relative decrease in the likelihood of combined usage does not, however, lead to a preference for any particular method alone except in the food sector, where informal methods are encouraged. To a lesser extent, there seems in the furniture and salvaged items sector to be a preference for the exclusive use of informal methods rather than a combination of the two types.

So as to render our results more accessible, we represented the probability of choosing one of the four methods available using the only continuous quantitative explanatory variable, namely ln(employees). This representation was done on the basis of various hypotheses. In order to achieve it, we simplified the initial multinomial model, retaining only its component variables. We then calculated the probability that each of the methods of protection would be chosen on the basis of the five significant component variables (product innovation, process innovation, ln of number of employees, collaborative arrangements and international market). Since the only quantitative variable with a generalised effect is firm size, we used this variable as a basis for establishing the probability of decision outcomes. We therefore suggest that probabilities be represented in different scenarios (see Hamilton, 2006, p. 284, for a detailed example). In other words, we propose to represent the relationship between firm size and the probability of various decision outcomes on the basis of the values of the other component variables. In the interests of clarity, we focus on a limited number of scenarios. The first three graphs present organizations which have no degree of exposure to particular risks (no collaboration and no international market). We recall that these variables exert a very strong influence on the chances of multiple methods being combined. The first three graphs show scenarios in which only the type of innovation taking place during the period changes (the three scenarios being product and process

innovation combined, only product innovation and only process innovation). The fourth graph brings on board firms which engage in inter-organisational cooperation and are involved in international markets.

Figure 1 shows how firm size influence engagement in both product and process innovation. **Figure 2** displays the same probabilities, but this time the firm is only engaged in product innovation. In this case, the areas of equiprobability are clearly further to the left. In organizations which pursue only product innovation, the point of equiprobability between informal methods and patents is thus quite low when ln(employees) = 4, which means slightly more than 50 or so employees. **Figure 3** shows the likelihood of various strategy choices based on firm size where the firms engages only in process innovation. Besides the fact that size appears to exert less of an influence in this case, a clear hierarchy of possibilities can be discerned. In such organizations, the chances that a patent or a combination of methods will be used are always lower than the likelihood that only informal methods will be employed. Above all, we can see that the probability that no method will be used remains very high, diminishing slightly as the firms get bigger. **Figure 4** displays the likelihood that various methods of protection will be used when firms are involved in collaboration with other organisations or in international markets. In this scenario, it is assumed that the firm has pursued product innovation alone. The area of equiprobability between patents and informal methods does not appear visually to be very distant from that in **Figure 2**, where the same type of innovation is analysed (only product innovation), although in **Figure 2** neither the international element nor collaboration are taken into account. The probability curve for the use of combined methods has simply moved noticeably upwards, which is only to be expected given that an international market and engagement in collaborative practices tend to encourage organizations to use combined methods (and nothing else.

Figure 1 – Probability of decision outcomes in cases of product and process innovation (cooperation = 0, international market = 0)

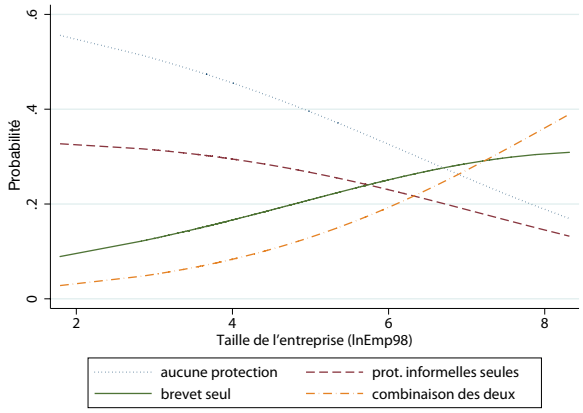


Figure 2 – Probability of decision outcomes in cases of product innovation only (cooperation = 0, international market = 0)

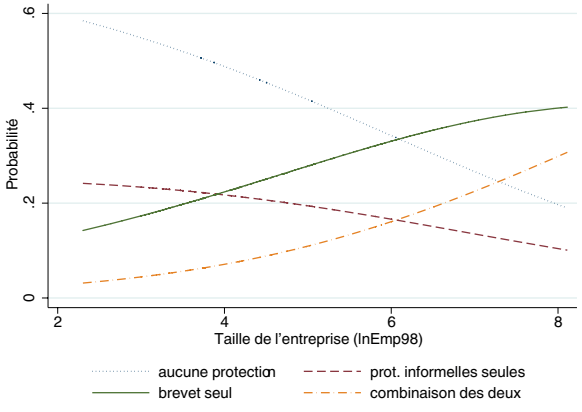


Figure 3 – Probability of decision outcomes in cases of process innovation only (cooperation = 0, international market = 0)

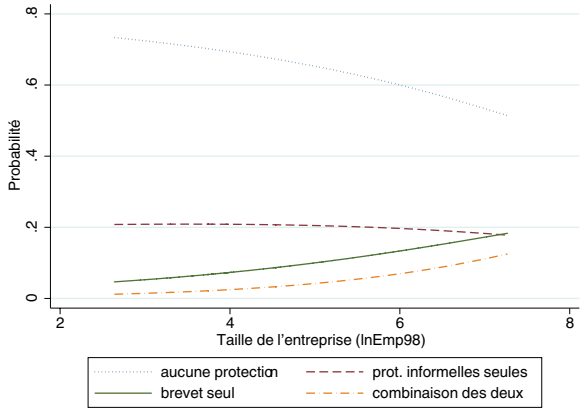
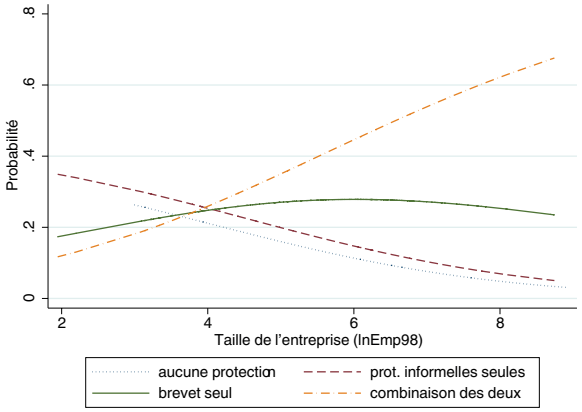


Figure 4 – Probability of decision outcomes in cases of product innovation only, with cooperation and international market

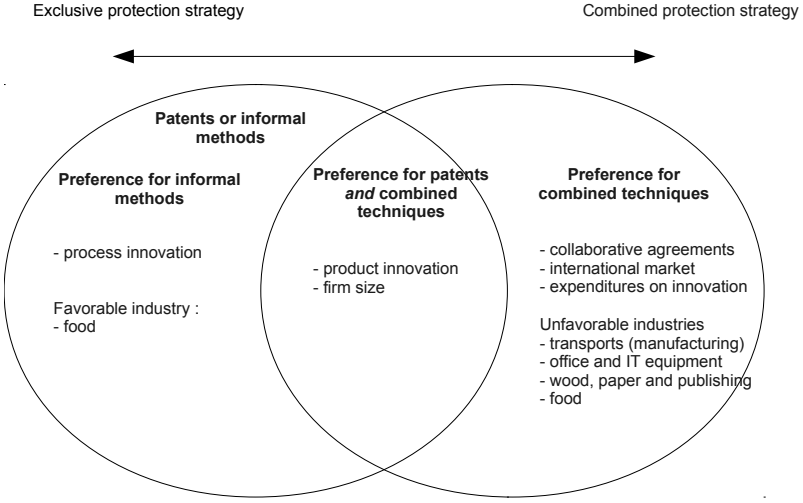


5. Discussion

The aim of this paper was to contribute to the study of strategic decisions in innovation protection by seeking to establish links between the exclusive and combined use of methods of protection. Our study partly adopts variables honed in the prior literature, and in particular uses CIS-type data. This work contributes significantly to the literature in three ways.

Firstly, our study is the first to attempt to describe the circumstances in which patents and informal methods are used concurrently or separately to protect innovation. Our findings throw into relief three series of factors which exert varying influences on protection decision outcomes. **Figure 5** offers an overview of these factors.

Figure 5 – Overview of how different variables affect protection strategies chosen



We firstly identify variables which specifically favour combined methods of protection without a particular discernible preference for either patents or informal methods. More specifically, it seems that the variables correspond to what might be termed exposure to the risk of appropriation (i.e. involvement in inter-organisational cooperation or an international market). These variables reflect the frequency of contact with actors whose behaviour may be damaging for the organisation. In such cases, the breadth of the protection being sought means that a variety of methods is favoured (Amara et al., 2008; Faria & Sofka, 2010). Secondly, we observe that there are variables which lead to the use of either patents or informal methods in particular. It also emerges that process innovation is a weighty factor in the use of informal methods, whereas product innovation tends more to lead to patent use. Firm size is also key: larger firms are more likely to prefer patents. Finally, the third type of effect which we identify tallies in part with the second and reveals that certain variables (firm size, product innovation), while fostering the use of patents as opposed to informal methods alone, tend also to encourage the combined use of both types of protection. No variable, however, is seen to favour at once the use of informal methods alone and the combined use of both types of protection. The findings therefore suggest that patents and informal methods are asymmetrical where their combined use is concerned. A preference for patents leads also to the use of informal methods, but the use of informal methods does not lead to the concurrent adoption of patent protection. This observation chimes in with—though strictly speaking it does not corroborate—the notion that the addition of informal methods to patent protection involves lower marginal costs than the addition of patent protection to informal methods.

Secondly, to our knowledge, this paper is also the first study to tackle the multifaceted nature of the methods used by firms to protect innovation. We conclude that the informal methods which we examined (se-

crecy, the harnessing of a technological edge and design complexity) stem from the same root. This exploratory finding is useful firstly in its bearing upon the notion of secrecy. The degree of similarity between the use of secrecy and that of the other informal methods was a subject for debate. Secrecy can enjoy at least partial implementation via legal means (contracts, regulations), and this is not the case for protection through swift marketing or design complexity. It would therefore have been reasonable to expect the use of secrecy to bear more of a resemblance to that of patents—a legal protection mechanism—than to the other informal protection techniques. Similarly, the deliberate nature of design complexity could be questioned, and this could have been touted as a trait particular to this type of protection. However, our findings point very clearly towards the assimilation of the above methods, at least for the period which we examined. The finding relating to the similarities between informal methods is also useful in that it encourages us to simplify our categorisation of protection methods. The identification of a common factor is clearly helpful when dealing with variables. In the particular case of innovation, the benefit of this is both conceptual and methodological in that it allows us to strike a compromise between simply merging all the protection methods together (e.g. Faria & Sofka, 2010) and making no generalisations whatsoever (e.g. Amara et al., 2008).

Thirdly, our work includes some descriptive elements which allow us to contextualise it against the backdrop of previous studies. Most fundamentally, our findings confirm a surge in the power of the patent (Van Zeebroek et al., 2009). Whilst informal methods have on occasion been presented as being more effective or favoured by firms (e.g. Arundel, 2001), this suggestion sits uncomfortably with our sample, where the use of patents and informal methods seems to be well balanced. At the same time, and in line with the arguments posited by Cugno and Ottoz (2006), we observe that patents and informal methods can be used together within a single business. However, and in spite of the increase in the use of patents both alone and alongside informal methods, the obstacles to using these methods have remained unchanged for around twenty years. In small firms, firms engaging in process innovation or firms still working in low-technology sectors, the likelihood that patents will be preferred over informal methods is significantly lower. On the other hand, the particular industry in which a given business is involved seems to exert only a minor influence on the selection of patents or other methods, except for certain noteworthy cases (low-technology sectors, in this instance). In this respect, our findings tally with those of Leiponen and Byma (2009).

LIMITATIONS AND AVENUES FOR FUTURE RESEARCH

Our study sought to focus on the use of patents and informal methods of protecting innovation. The fact that there are cases in which neither of these types of protection are used, a circumstance often affecting small organizations, does not necessarily mean that those firms make no attempt to protect their innovation. They may, for instance, use rights other than patents, such as designs, models or marks. One way of extending this research project would therefore be to include the other types of intellectual property rights in the range of protection strategies considered. This would make it possible to bring greater detail to our description of the range of legal methods employed by firms to protect innovation (e.g. Roquilly, 2009).

A significant limitation in this paper, and therefore an avenue for future research, relates to the temporary nature of decisions made by firms. Studies examining other periods would undoubtedly bring to light a number of more general observations, but they would be of particular interest since our findings suggest—but fail to prove—that the addition of informal methods to patent use is easier to accomplish than the addition of patent use to informal methods; only data revealing use over time would serve to clarify this issue further. Such data would also make it possible to look at the factors determining strategy changes. We observe that organizations' strategic decisions tend to remain very constant over time (Sydow et al., 2009; Vergne & Durand, 2010). It would therefore be helpful to establish to what extent firms are willing to change their strategies. Specifically in the field of innovation, one issue to explore would be the influence which past choices exert over current decisions, with a view to uncovering any potential lines of dependence. While such lines of enquiry present a number of methodological challenges, particularly concerning the endogenous nature of trends, they nonetheless offer an organic and promising way of pursuing our line of research further.

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APPENDICES

Table 10 – PCA (factor eigenvalues)

Component	Eigenvalues	Proportion of explained variance	Cumulative variance
1	2.406	60.16 %	60.16 %
2	0.996	24.16 %	84.32 %
3	0.391	9.79 %	94.12 %
4	0.235	5.88 %	100 %

Table 11 – Correlation matrix (n = 2288)

	Patents	Informal techniques	ln(employees)	ln(expenditure)	Product	Process	Cooperation	Local market	Interna-tional	Group
Patents	1									
Informal techniques	0.121*	1								
ln(employees)	0.339*	0.188*	1							
ln(expenditure)	0.344*	0.234*	0.648*	1						
Product	0.212*	0.139*	0.102*	0.162*	1					
Process	0.037	0.156*	0.169*	0.172*	– 0.008	1				
Cooperation	0.210*	0.201*	0.282*	0.330*	0.098*	0.165*	1			
Local	– 0.124*	– 0.096*	– 0.161*	– 0.156*	– 0.111*	– 0.016	– 0.078*	1		
International	0.213*	0.173*	0.247*	0.305*	0.090*	0.090*	0.181*	– 0.267*	1	
Group	0.150*	0.079*	0.369*	0.261*	0.051	0.021	0.116*	– 0.126*	0.124*	1

* The correlation significance threshold is 1%