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TRADE MARK STRATEGIES AND INNOVATIVE ACTIVITIES

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All mistakes remain my own.

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More and more basic aspects of our contemporary societies fall under a logic of significations, an analysis of codes and symbolic systems - [...] that analysis having to articulate itself to the analysis of the process of material and technical production as its theoretical continuation.

— Jean Baudrillard, *La société de consommation*, 1970.

INTRODUCTION

Motivation

The literature in economics of innovation so far has been largely dominated by studies focusing on the technological side of innovative activities. As far as empirical studies are concerned, they have extensively focused on patent data which were seen as the most obvious source of information on inventive change, being both available and by definition related to inventiveness (Griliches 1990).

Trade marks (TMs), by contrast, have rarely been analysed in innovation economics studies to date. When considered in economics literature, it is most often to discuss their possible detrimental effect on competition environment (Chamberlin 1933, Bain 1956) rather than to investigate their role in innovative activities. One possible reason for this is that trade marks, contrary to other intellectual property rights (IPRs), do not seem, *prima facie*, to contribute to the extension of knowledge. As stated by Barnes (2006):

> "According to conventional wisdom, trade mark law has no theoretical or practical connection to copyright and patent law. It is associated with wasteful spending on advertising and with trade and competition rather than with music, literature, art, or clever new inventions. Its purposes seem largely economic and market-oriented. Trade mark law is not designed to elevate discourse or disseminate knowledge the way copyright law does or lead to life enhancing innovation, as patent law does. Trade marks do not enrich the public domain, that collection of useful ideas and uses of ideas that are the basic tools for promoting progress in science and the useful arts. Trade mark law is the poor relation of the intellectual property world, not really "intellectual" at all."(Barnes 2006)

A trade mark can be defined as a sign (word, logo, etc.) which is affixed to a product in order to convey information on its origin. The sign becomes representative of a specific goodwill, and it may be legally protected in order to prevent other parties from infringing on this goodwill by using identical or similar signs. So strictly speaking, trade marks are just a means to convey information on products. They are not properly related to the functional features of the product or the technology incorporated in it, so that there is no direct reason to think that they are related to innovativeness. However, although they may be considered as "not intellectual at all", trade marks - as signs potentially affixed to innovative products - are likely to play indirectly a role in the innovation process.

The role of signs in the perception of innovation

There are numerous examples where names and signs do interfere in the consumers' experience of a product[1]. A well-known example in marketing literature concerns the preference of individuals for Coke® or Pepsi®. Blind test experiences showed that the preference for one or the other drink tends to be random, even though the tested individuals claim to have one favourite brand. McClure *et al.* (2004) showed through brain mapping techniques that the areas of the brain involved when stating the preferred drink are not the same when people know the brand they are drinking and when they do not. Beyond the sphere of branding, there are examples where names tend to play a critical role in our perceptions. One of them, reported by Elliott and Percy (2007), is found in the "Rembrandt Research project", an enterprise undertaken in 1968 by a group of Dutch art history specialists, which aimed at examining a large number of paintings assumed to be by Rembrandt in order to establish a definitive catalogue of the painter's oeuvre. As a result of the project, the number of signed Rembrandt self-portraits around the world was reduced by half, and the financial value of the paintings which were no longer considered by Rembrandt subsequently dropped dramatically. Yet, as pointed out by Elliot and Percy, the actual paintings did not change, only the name associated to them. In the same vein, we may mention an experiment organised by

[1] See for example Elliott and Percy (2007), Chapter 5.

the *Washington Post* in 2007[2], where an internationally recognized violinist, Joshua Bell, played incognito in a metro station in Washington various classical masterpieces on a Stradivarius violin worth several million dollars. During the 43 minutes he played, of the 1097 persons who passed by him, seven stopped to listen for a minute, and twenty-seven gave money, for a total of around $32. Three days before, the same violinist had filled the Boston's stately Symphony Hall, where a number of seats had been sold for more than $100 each. This experiment, run as part of a social study about perception, taste and priorities of people, aimed at investigating whether talent could be recognized in an unexpected context. Notwithstanding its imperfections – the metro station population at 8 a.m. being likely to differ from the target audience of concert halls, the acoustic being different, etc. –, it is illustrative of the fact that the value attributed to products is more than the intrinsic value of the product itself. This is true of basic consumer products and also, maybe all the more, when considering the most advanced and creative pieces of work.

It is well acknowledged that innovation, following the Schumpeterian view, is more than invention[3]. Innovation also entails industrial application and commercialisation, without which inventions would have no economic impact. According to Pavitt (1985), R&D activities correspond only to one half of the expenditure engaged in the introduction of an innovation, the remaining part being divided between engineering and marketing expenditure. This led some authors, such as Rogers (1998), to criticize the use of patents or R&D expenditure as the main proxies for innovative activities, as they are more indicators of invention than of innovation[4]. In the transition from invention to successful marketed innovations, communication and reputation aspects play a critical part. They may condition the fact that the commercialisation of the product succeeds or fails. Without the weight

[2]See Weingarten (2007)

[3]See for example Schumpeter (1939), vol. I, p. 84

[4]Griliches (1990) indirectly provides an answer to the criticism of Rogers, mentioning that patenting firms made the investment effort into the development of the product or idea, indicating thereby the presence of a non-negligible expectation as to its ultimate utility and marketability. Yet, in essence, patents reward the inventor rather than the user of the innovation, which runs counter to the Schumpeterian idea.

of branding and marketing investments, one might wonder what would have been the success of some innovations, such as the iPhone® or the Nespresso® coffee machines. Rogers (1995), who analyses the conditions of diffusion of innovations, states that[5]:

> "the diffusion of innovation is essentially a social process in which subjectively perceived information about a new idea is communicated. The meaning of an innovation is thus gradually worked out through a process of social construction."(Rogers 1995)

In this process of social construction, we may assume that trade marks play a structuring role. As signs affixed to products, trade marks convey not only information on their origin, but also various meanings, objective and subjective, functional and emotional, which may be associated to the products. Beebe (2004) analyses trade marks in semiotic terms[6] and mentions a classical view describing them as a relational system between a signifier – the tangible sign, *e.g.* the word "Nike" –, a signified – the semantic content of the mark, in that case the goodwill of *Nike, Inc.* –, and possibly a third element, the referent, which is the product, in that case the shoes, to which the mark is affixed. By relating those various elements, trade marks operate an organisation and a categorisation of the market offer. In the words of Beebe (2004), if there is something like a "language of commodities"[7], then trade marks are its grammar. We may think that if there are significant ruptures in the market offer, trade marks are likely to reflect those changes, both as a result of those changes, and participating in them.

According to Witt (2009), the emergence of novelty involves three distinct, although simultaneous, operations: a generative one - the production of new recombinations of elements -, an interpretative one - by which those new recombinations are integrated in a new concept -, and, optionnally, an evaluative one - in which utility advantages of the novelty are assessed. Translating this idea into the context of innovation, we may think that trade marks are involved in the second operation,

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[5]in Rogers (1995), preface.

[6]See also Semprini (1992), where trade marks are defined as semiotic objects.

[7]in Marx (1867) p. 143

as they may help integrate various innovative aspects in a new concept. They may also play a part in the third operation, as by conveying various information and symbolic representations associated to the product, they may influence the evaluation done by consumers of the innovation's utility. Trade marks may thus be seen as a constitutive element of innovation.

Potential benefits of considering trade marks in innovation analyses

By concentrating on reputation and communication aspects rather than on technological aspects, trade marks may provide another picture and enrich our understanding of innovative activities. First, they may bring information on certain types of innovations for which traditional indicators are not adapted, especially non-technological innovations or innovations with low-technological content. Those innovations have become increasingly important for economic growth. They consist first in the product innovations that take place in sectors with low technological content, in particular the service sector. Since its second edition, the *Oslo Manual* (OECD and Eurostat 1997) – providing guidelines on the measurement of innovation – mentions that the analysis of innovation should include the service sector. Yet services stand mostly outside the area of patentable items and are generally not associated to any R&D expenses. Another possibility to measure those innovations would be to use innovation surveys, but those, besides the fact that they are submitted to strict confidentiality rules, collect mainly qualitative rather than quantitative information (has the firm introduced such an innovation, yes/no). For this reason, service activities are nearly absent from traditional innovation studies (Cainelli *et al.* 2005). Frame and White (2002) notice, for example, a huge lack of empirical studies on financial innovation, though it constitutes "a bedrock" of financial systems. Contrary to patents and R&D, the spectrum of trade marks is very large; they are present in almost every sector of the economy, including services. Trade marks are especially likely to be important for services, as customers cannot test the service products before buying them and cannot make evidence-based choices. They need then to have particular guarantees that may be brought by trade marks (Elliott and Percy 2007). Thus trade marks could possibly mitigate the lack of information on innovation in the service sector (Hipp and Grupp 2005). Non-technological innovations are also present beyond the service sector; some kinds of non-technological innovations play a role in every sector of the economy. They are defined in the third version of the *Oslo Manual* (OECD and Eurostat 2005). In this last version of the manual the word "technological" was retrieved from the definitions of innovation, and two new categories were added next to product and process innovations: organisational and marketing innovations. An organisational innovation is defined as "the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations", and a marketing innovation is "the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing with the aim of reaching new customers and improving the sales." Those innovations are usually not patented, and they do not correspond to R&D expenses either, as they generally stem from other departments of the firm, *e.g.* the marketing department. Trade marks, by contrast, are intrinsically related to the marketing strategy of the firm, so that they might also bring information on marketing innovation.

But more broadly, taking into account reputation aspects might help improve our understanding of all types of innovations. If marketing and trade mark strategies are the conditions of success of an innovation, analysing their interactions with technical and functional aspects might help understand how the two contribute to the building of the innovation. The reputation of a trade mark may build itself on the nature of the products sold, and the narration brought by the trade mark may also impact the utility gained from the product. It is likely that objective use and subjective representations mutually contribute to the perceived reality of the product. The restriction to technological or functional aspects of innovations, as mirrored in patent data, overlooking the means through which the innovations are perceived, could then be seen as pertaining to what the French philosopher

Maurice Merleau-Ponty would call "the prejudice of an objective world"[8]. Our assumption is that trade marks, by contrast, could enrich the picture of innovation by reflecting the way those innovations are perceived. One major stake is to precisely analyse the role of trade marks in innovative activities, and to make it explicit in economic terms. This constitutes the main object of the present thesis.

Previous studies and contributions of this thesis

Several authors in the previous literature raised the idea that the use of trade marks could be related to innovation. In the Law and Economics approach of trade marks, represented by the Chicago school, trade marks were seen both as a means to reduce consumers' search costs in their purchasing decisions and as an incentive for producers to invest in quality, as they allow them to secure the reputation associated to this quality. Therefore trade marks, in this view, have an impact on the nature of products sold and are likely to lead to improved products. Beyond this line of analysis, a plethora of works in the marketing literature emphasized the importance of trade marks and branding in the commercial success of innovations. The general idea is that they may help innovative firms pre-empt a positioning on the market, and secure the loyalty of customers against the potential entry of competitors. Trade marks have therefore been considered as a means to appropriate the benefits of innovation (Levin *et al.* 1987), and they have been used in a few studies as a proxy for innovative activities (Griffiths *et al.* 2005, Greenhalgh and Rogers 2007a, 2007b, 2012).

The first studies which sought to verify empirically the link between trade mark use and innovative activity date back to the beginning of the last decade (Schmoch 2003 and Mendonça *et al.* 2004). Based on survey results at the firm-level, they

[8] in Merleau-Ponty (1945), p.5 ff. To the assumptions of pure sensations arising out of things perceived and a "universe perfectly explicit in itself" (in Merleau-Ponty, 1945, p.48), Merleau-Ponty opposes the idea of an indeterminate world, primarily established through subjective perceptions: "We are to understand, then, that it is the apprehension of a certain *hylè*, as indicating a phenomenon of a higher degree, the *Sinngebung*, or active meaning-giving operation which may be said to define consciousness, so that the world is nothing but 'world-as-meaning'" (in Merleau-Ponty, 1945, p.xii).

showed that trade marks are significantly related to other innovation variables at the firm level, such as patents or the share of turnover associated to new products. More recently, a study by Götsch and Hipp (2012) sought to investigate, based on German Community innovation survey results, to which types of innovations trade marks are likely to be related. They found trade marks significantly correlated with product innovation, whereas no significant link is observed with process, organisational and marketing innovations. Finally, another line of empirical analysis relating to trade marks and innovation, which has recently emerged, consists in looking at how trade marks interact with other aspects of the innovation process, especially patents (Graevenitz and Sandner 2009, Schwiebacher 2010).

In this recent literature on trade marks and innovation, a number of issues remain unaddressed. One major point is the lack of an explicit model of the impact of trade marks on innovation. When included in innovation models, trade marks are generally used as a proxy for another variable of interest, typically marketing investments (Graevenitz and Sandner 2009), or else innovation itself (Griffiths *et al.* 2005, Greenhalgh and Rogers 2007b). But the proper role played by trade marks in innovative activity has to our knowledge not been analysed. In relation to the latter point, the previous literature does not appear to address the sense of causality of the relation trade mark-innovation. Yet this relation is likely to be characterised by reverse causalities – trade marks being both a means to appropriate the benefits of innovation and an incentive to introduce further innovations –, so that endogeneity issues may have to be considered. Then the distinction between trade marks as firm assets and as IPRs has not specifically been addressed, and the respective impacts of those two elements are generally not disentangled. Finally, previous studies all analysed the link between trade marks and innovative activities focusing on firms. One might wonder if those analyses could be applicable to other actors in society.

This thesis primarily aims at establishing an intrinsic link between trade mark use and innovation. In this purpose, we build an original theoretical model describing the impact of protecting an innovation with a trade mark, presented in the second and third chapters of the thesis. This model assumes a specific sense of causality between the two activities, going from innovation to trade marks. The invention is considered to be given as a starting point, and we address the impact of different protection strategies, including trade mark use on the benefits gained from this invention. This leads us to determining whether innovative firms have an incentive to trade mark, which would justify the existence of a link between the two types of activities.

Besides we seek to test this link empirically. In the previous literature, much emphasis was put on trade marks and innovative activities in the service sector, for which there is a lack of innovation indicators (Schmoch 2003, Hipp and Grupp 2005, Götsch and Hipp 2012). Yet trade marks are likely to play a role in innovative activities beyond service firms. Therefore our empirical investigations consider a broad perimeter of innovation, addressing various innovation types (product, process, organisation and marketing), sectors (high-tech and low-tech manufacturing, knowledge-intensive and less knowledge intensive services), and actors (firms, but also universities). Our approach consists in considering registered trade marks as IPRs, which constitutes the most direct way to empirically observe trade marking activity. This approach may appear restrictive, as trade marks may exist without being legally registered. However one might assume that valuable trade marks tend to be registered. Indeed if the trade mark is not protected, consumers may not be able to distinguish the origin of the product and may buy products from other undertakings, which implies a first market loss. Furthermore the image of the firm is likely to be impaired, as infringement generally stems from firms selling products of lesser price and lesser quality. We may thus reasonably think that most existing trade marks are reflected in trade mark registers. Besides, our analysis seeks precisely to disentangle the role of trade marks as a marketing asset and the role of the associated IPR. In our theoretical framework, we consider trade marks as a tool to legally protect the reputation associated to a product or a feature of a product sold by a firm. It is therefore natural to use registered trade marks as our proxy for innovative activities.

Outline

The thesis is structured as follows. The first chapter lays down the bases of the analysis, by defining trade marks and reviewing the previous literature in economics and management relating to them and to their link with innovation. The approach adopted to define trade marks is the legal one: we look at various features of trade mark law and trade mark system in order to understand what is entailed by a trade mark registration. We then review various lines of studies in the existing literature suggesting that trade marks are likely to play a role in innovative activity. In view of those studies, there are reasons to think that trade marks could be used to measure innovation and complete the information brought by traditional indicators. However, the use of raw trade mark statistics would constitute a very biased indicator of innovation. Trade mark behaviours and their determinants are likely to vary from one firm to another and from one sector to another. It is then necessary to analyse more precisely the patterns of trade mark use by firms and the mechanisms through which they are related to innovative activity, in order to determine in which cases and under which restrictions they can be used to measure innovation.

In the second chapter, we seek to analyse patterns of trade mark use at the firm-level and to investigate if they are related to innovative activities. In this purpose, we first build a theoretical model describing the impact of protecting an innovation by a trade mark, which to our knowledge has never been the object of a formal model in the previous literature. The assumption on which our model relies is that the trade mark enables the firm to prevent its potential competitors from creating confusion on the origin of the product and thus benefiting from the firm's goodwill, built through advertising expenditure. In this framework, we show that the benefit generated by trade mark registration is always higher for innovating firms than for other firms. Based on this model, we deduce that trade marks are likely to be related to innovations which are at the interface of the market and which are likely to be advertised, that is primarily product and marketing innovations.

We then conduct an empirical analysis, relying on a novel, purposely built, firm-level database encompassing the trade marking and patenting activity of French firms obtained through the matching of firm data from ORBIS©, edited by Bureau van Dijk, with IPR databases at the national and European level. Those data were further matched with French results of the 2008 Community Innovation Survey (CIS). In a first step, we address the characteristics of trade marking firms in terms of age, size and sector, in order to get an idea of the general profile of firms relying on trade marks and also to investigate which factors should be controlled for when analysing the trade mark-innovation link. As to this link, we find trade marks to be significantly correlated to product and marketing innovations as reported in the Innovation Survey. The link between trade mark use and product innovation remains significant when we control for patent use, which suggests that trade marks could constitute a complementary source of information. When differentiating the results by categories of sectors, we find that trade marks are significantly related to product innovations beyond the patented ones in all sectors except the high-tech manufacturing sectors. The use of trade marks in relation to innovative activity thus appears to depend on types and sectors of innovations, and in particular on the fact that they are patentable or not. This points towards the existence of interaction effects between patents and trade marks, which we seek to analyse in the third chapter.

The third chapter puts forward some possible explanations of the previous observations by analysing the interrelated effect of trade marks and patents. Specifically, we investigate in a novel approach whether those two IPRs are complements or substitutes. Our approach consists in considering patents and trade marks in their core function as legal protection devices. We use the same theoretical framework as in the second chapter regarding the impact of protecting an innovation by a trade mark, and we extend it by integrating the possibility for firms to patent or not their innovations. We then compare the outcome of innovating firms adopting various IPR strategies - patent or not and/or trade mark or not - and assess the complementarity or substitutability relationship following the supermodularity approach. Based on this framework, we show that the complementarity relationship between trade marks and patents is not straightforward. Depending on the level of advertising spillovers and depreciation rate characterising the market, they are found to be either complementary or substitutable to patents.

We then seek to illustrate the results of our theoretical model through an empirical analysis, which consists in assessing the impact of the various IPR strategies on firms' market value in order to test the supermodularity hypothesis. The sample used for the analysis consists in French publicly traded firms contained in the database ORBIS©. We find that patents and trade marks tend to be complementary in pharmaceutical and chemical industries - likely to be characterised by high advertising spillovers and a low advertising depreciation rate -, whereas in high-tech business sectors (computer and electrical equipment products) - where the spillovers of advertising are likely to be low and its depreciation rate high -, they tend to be substitutes. Those results imply that the relevance of trade marks with regard to innovative activities varies from one market to another, depending on whether or not trade marks tend to be substituted by other means of protection.

The fourth chapter constitutes an illustration of the previous analyses, where the analytical framework is translated into another type of innovating actor: universities. Indeed firms are not the only institutions involved in innovative activity, neither are they the only institutions likely to register trade marks. Academic institutions are likely to register trade marks for various distinct purposes: to protect their general reputation, to better market current and prospective initiatives, and also to better appropriate the output of innovative activities. This chapter aims at exploring this phenomenon so far overlooked by the literature addressing the entrepreneurial activities of universities. Our analysis is exploratory in nature and descriptive in aim. It relies on a novel panel dataset of more than 600 US universities, combining university data, published by the Center for Measuring University Performance, and IPR data - patents and trade marks applications at the United

States Patent and Trademark Office (USPTO). Based on this dataset, we find that the trade marking activity of universities is non negligible and has been steadily increasing over the last three decades. Looking at possible determinants of academic trade marks, we find a robust positive correlation between the number of trade marks applied for by a university and characteristics such as being a private institution, the number of students enrolled, the share of federal research funds received and the presence of a medical school. Besides, relying on information from the classes of products designated in academic trade mark applications, we show that universities register trade marks not only to protect their name and their general reputation, but also increasingly in relation to research outputs.

Finally, in annex of the thesis, we address a number of statistical and methodological issues regarding the construction of aggregated trade mark-based indicators of innovation. If trade marks can reflect innovative activities - and more particularly those with low technological content, for which there is a lack of quantitative indicators -, one can seek to build aggregate trade mark-based indicators in order to compare the level of those innovations at the international, sectoral, or firm-level. However this purpose runs up against a number of problems, such as the lack of cross-country comparability in trade mark data due to the home bias in registrations, the absence of concordance between sectoral classifications of economic activities and the classification used for trade marks, or the heterogeneity in the value of trade mark registrations. In this annex, we examine those various issues and suggest a number of possible methodologies to overcome them.

Before concentrating on the analysis of the link between trade marks and innovative activities, we start in the next chapter with a short presentation of trade marks' main legal aspects.

CHAPTER 1

A REVIEW OF TRADE MARK LEGAL ASPECTS AND PREVIOUS LITERATURE

1.1 Introduction

This first chapter lays down the bases of our analysis by defining trade marks and reviewing the previous business and economics literature pertaining to them and especially to their link with innovation[1]. By essence, trade marks refer to a legal object, an IPR. We therefore sought to characterise them primarily in legal terms. This legal approach is kept throughout the various chapters of this thesis, where trade marks are considered in their core function as legal protection devices.

As defined by the law, a trade mark is a sign (a word, a logo, a phrase, etc.) that enables people to distinguish the goods or services of one party from those of another. The only criterion to register a new trade mark is the novelty of the sign itself, which must not be similar to any already registered trade mark. The purpose is that the mark uniquely identifies a type of products, so as to prevent consumers' confusion. Contrary to patents, the registration of a trade mark does not require the novelty of the product itself. At the legal level, the link between trade marks and innovation is then not straightforward.

In practice, however, trade marks and brands are likely to play a role in the innovative activity of firms. This role has been widely emphasised in the marketing literature (Aaker 1991, Kapferer 1991, Trott 2005). First, trade marks may play a role in the commercialisation of new products. When they launch an innova-

[1] This chapter builds on my working paper "Trademarks as an indicator of product and marketing innovations"(Millot 2009).

tion, firms may associate it to a new brand in order to help the perception of the innovation by consumers: the brand constitutes a basis on which firms advertise their products. Then the trade mark has good chances to become one or even the reference on the market for the product. Indeed the consumers who start buying one innovative product in one brand are likely to remain loyal to this brand. It is then difficult for competitors to enter the market. Thus trade marks can constitute a means to appropriate the benefits of an innovation (Davis 2009). Based on those various assumptions, trade mark data are likely to be related to innovation. However, those intuitions do not constitute an evidence that there is actually a link between trade mark use and innovations. This has to be verified empirically.

Several studies showed through the analysis of empirical data that there is indeed a correlation between trade marks and innovative activity. Based on survey results at the firm level, they found a significant positive correlation between trade mark deposits and several innovation variables (patents, R&D, share of turnover associated to new products, etc.). They found a very significant correlation in the service sector and in particular the knowledge-intensive services (Schmoch 2003, Mendonça *et al*. 2004), in the high-tech sectors (Mendonça *et al*. 2004), and in other sectors, like the pharmaceutical industry, where the product target is directly the consumers (Malmberg 2005). Those results showing a positive and significant correlation between trade marks and innovation in various sectors seem to suggest that trade marks could be used as an indicator for certain kinds of innovations. As such, they would complement the information given by the other indicators which focus on the technological change at the expense of the commercial aspect, and which do not hit certain economic sectors, especially services.

Trade mark legal aspects, as well as the previous studies presented in this chapter, constitute a first conceptual and empirical basis for our analyses of the link trade mark-innovation, which we seek to investigate further in the next chapters of this thesis.

The remaining of this chapter is divided into two sections. The first one defines trade marks and summarises the main legal aspects of the trade mark system, and the second one presents an overview of the existing literature concerning trade marks and their links with innovative activities.

1.2 Definition and legal aspects of trade marks

1.2.1 Defining trade marks

Article 15 of the Agreement on Trade-Related Aspects of Intellectual Property Rights[2] (TRIPs) provides a definition of trade marks, stating that:

> "Any sign, or any combination of signs, capable of distinguishing the goods or services of one undertaking from those of other undertakings, shall be capable of constituting a trade mark"
> (WTO 1994, p.326)

There are several dimensions in this definition.

- First of all, a trade mark is defined in substance: a sign. There is no particular restriction on what kind of sign is eligible for registration: it can be denominations, letters, numerals, figurative signs, combinations of colours, sonorous signs, or any combination of those elements. Some jurisdictions may nevertheless require that signs be visually perceptible.

- Secondly, a trade mark is defined by its function: it uniquely identifies and distinguishes goods or services of one undertaking from those of other undertakings. Hence the sign has to be distinctive. Originally the trade mark law was designed to fulfil the public policy objective of consumer protection. It prevents the public from being misled as to the origin or quality of products.

- Thirdly, a trade mark is defined in legal terms: it is a type of industrial property, *i.e.* it is susceptible of being protected by the law. Trade mark protection grants the owner the exclusive right to use the signs to identify the goods

[2]The Agreement on TRIPs, administered by the World Trade Organization (WTO), sets down minimum standards for intellectual property regulation. It was negotiated at the end of the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) in 1994.

or services produced or to authorize another party to use them in return of payment. Practically, the owner can be any physical or legal person.[3]

Trade marks are intrinsically defined as a combination of those different dimensions. In practice, they should help customers identify and purchase products or services that meet their needs and expectations in terms of, for example, nature, quality, and price. From the owner's point of view, trade marks may be used to build customer loyalty, and may also constitute a basis to advertise widely and attract new customers.

A notion closely related to trade marks is the one of "brand", the latter term being more commonly used in the marketing literature. A brand can be defined as a combination of tangible and intangible elements, as trade marks, designs, logos etc., and the concept, image and reputation those elements transmit about products and/or services (Lom 2004). Brands can be legally protected, in so far as (some of) their parts are protected by IP. In this thesis, we generally use the terms "brand" and "branding" to refer to the commercial use and the customer's perception of the mark, whereas we use "trade mark" to refer more specifically to the legal object[4].

1.2.2 Rights and duties associated to trade marks

A registered trade mark grants the owner exclusive rights to use – or to authorize another party to use – the trade mark in the country where the trade mark is registered and for the goods/services for which it is registered. If someone else seeks to use the registered trade mark (or a similar one) without the owner's agreement, then they can be sued for infringement.

Trade marks, as patents, are protected only in the countries where they are reg-

[3]The majority of trade marks are owned by firms, so that this thesis is mainly focuses on this type of economic actor. However in Chapter 4, we also investigate trade mark use by another type of actor, namely universities.

[4]According to Beebe (2004), the term trade mark is synecdochic in nature: it may be used to describe either the whole (the sign likely to be legally protected by IPR and also the associated goodwill and brand), or the part (only the sign). In this thesis we use the term 'trade mark' to refer only to the sign, and the terms 'goodwill', or 'brands', for the other associated parts.

istered, which corresponds to the territoriality principle[5]. Besides, the trade mark is registered for one or several classes of products. The protection concerns only the products of the class for which it is registered, except for certain well-known trade marks which benefit from protection beyond the registered classes[6]. The fees are increasing with the number of classes of products for which the trade mark is protected. Each trade mark registration office has a classification of products. Most of them[7] now apply the international classification, established in 1957 by the Nice Agreement concerning the International Classification of Goods and Services for the purpose of registering trade marks (see Appendix 1.C)[8]. After registration, the trade mark is protected for a limited period of time (at least seven years, generally ten years). The registration can be renewed indefinitely, upon payment of a fee.

As for any property right, the registered trade mark can then be bought and sold throughout the territory where it is registered. In most jurisdictions, a trade mark may be sold or transferred with or without the underlying goodwill which subsists in the business associated with the mark. This is not the case however in the United States, where a trade mark registration can only be sold and assigned if accompanied by the sale of an underlying asset, for example the machinery used to produce the goods that bear the mark. The owner of a registered trade mark can also license third parties to use the trade mark, through a license or franchise contract. In that case, it is the duty of the licensor (usually the trade mark owner) to monitor the quality of the goods being produced by the licensee to avoid the

[5]According to the territoriality principle, IPRs owe their legal existence to the sovereign powers of individual nations (see Austin 2006 for a discussion)

[6]Recently, certain trade mark laws have been modified to take into account, in some cases, the damages that may be caused by the use of similar trade marks in other non-competing markets. This corresponds to protection against "dilution". This means that for some well known trade marks, infringing use may occur when the trade mark is used in relation to products or services which are neither identical nor similar to the products or services in relation to which the owner's mark is registered, but this use may damage the reputation of the trade mark or make it lose its capacity to signify a single source. Protection against dilution is relatively recent; the United States enacted a law against trade mark dilution only in the mid-1990s, although various states had begun adopting such laws shortly after World War II, and the idea emerged in academic writing as early as the late 1920s.This kind of protection is mentioned in the TRIPs, article 16.

[7]One notable exception yet is Canada, which has not joined the Nice Agreement.

[8]It should be noted that this classification is significantly different from classifications of economic activities. This point is further addressed in the Annex at the end of this thesis.

risk of trade marks being deemed abandoned by the courts.

Besides, in most jurisdictions, trade mark rights must be maintained through actual use of the trade mark. Failure to actively use the mark, or to enforce the registration in the event of infringement, may expose the registration to removal from the register after a certain period of time. All jurisdictions with a mature trade mark registration system provide a mechanism for removal in the event of such non-use, which is usually a period of three years[9]. It is considered as an abandonment of the mark, whereby any party may use the mark. This constitutes an element of guarantee that trade marks reflect well the present situation of the market. We come back on this point in the Annex at the end of this thesis, where we investigate the impact of the clause of actual use on trade mark registrations at the USPTO.

1.2.3 Trade mark systems and procedures

a. Core registration procedure

The procedure to register a trade mark is quite homogeneous across countries. After the applicant has filed the application with the trade mark office, some examiners investigate if the sign fulfils the conditions in order to be protected as a trade mark. There are also absolute grounds for the refusal of a trade mark registration: if the trade mark refers to specific official emblems, if it has a scandalous connotation, or else if it has no distinctive character. Therefore marks that are merely descriptive of the product or service, or that are in common use, generally cannot be registered as trade marks, and remain in the public domain[10]. There are besides

[9]On the matter of the actual use of trade marks, it should be noted that certain jurisdictions, especially in the United States, contain a requirement of actual use for application as well, although the TRIPs (Article 15) state that it may constitute a condition for registrability, but it should not be a condition for filing an application for registration.

[10]For example the trade mark cannot simply be: the name of the product ("Chocolate"), the origin of the product ("fromage de Roquefort", or signs only descriptive of the product or of its quality. Moreover, certain marks can lose their property rights if they become generic through common use, so that the mark no longer performs the essential trade mark function and the average consumer no longer considers that exclusive rights are associated to it. For example, the Bayer company's trade mark "Aspirin" has been ruled generic in the United States in 1921, hence other companies may use

relative grounds for refusal, if the trade mark is similar to an already registered trade mark, which would produce confusion. After the examination phase, the trade mark is published for opposition so that third parties may oppose the registration within a period of a few months (generally three). If no opposition is raised during this period, the trade mark can be registered, for a limited period of time (generally ten years), renewable indefinitely.

The amount of administrative fees required to register a trade mark differs widely from one office to another, *e.g.* from Rs 2500 – around €35 – per class in the Republic of India to €900 for a European Community trade mark (allowing registration in up to three classes), US$325 (€260) per class at the USPTO, or ¥3400 (€35) plus ¥8600 (€90) per class for application, and ¥37600 (€380) per class for registration at the Japan Patent Office (JPO)[11]. Those differences in fees are likely to have an impact on firms' incentives to trade mark or not. We therefore take IPR registration costs into account when modelling the impact of trade mark protection on firms' economic outcomes (in Chapter 2 and 3).

b. International agreements

Various international treaties have been established in order to harmonise the different trade mark registration procedures across countries, and to simplify the application process for applicants targeting multiple countries. Beside the Paris Convention and the TRIPs, which harmonise the trade mark procedure across countries, the most important international agreement for trade marks is the Madrid Protocol, which allows trade mark owners to ask for protection in several countries by filing only one application. It is not possible to file a single trade mark registration which would automatically apply around the world. Since 1996, trade mark owners can register a trade mark which is valid throughout the European Community, through the Community Trade mark (CTM) system, at the Office for Harmonisation in the Internal Market (OHIM). Nevertheless, the CTM system did

that name for acetylsalicylic acid as well (Bayer Co. v. United Drug Co., 272 F. 505 (S.D.N.Y. 1921)).

[11] All the fees correspond to the period August 2012. For USPTO and OHIM, the fees correspond to applications filed electronically.

not replace the national trade mark registration systems: they operate in parallel. Therefore, when investigating trade marking activities of French firms (Chapter 2 and 3), we consider applications both at the European and at the national level in order to have a complete picture, as we cannot infer *a priori* which level of application is more relevant to innovative activities. The various international Agreements concerning trade marks are detailed in Appendix 1.B.

c. Variations in trade mark systems

Certain specificities remain in the different trade mark legal systems. For instance, contrary to other countries' systems, the OHIM does not refuse registration on relative grounds (*i.e.* if the trade mark is similar to an already registered one). It is entirely up to individual entities to monitor and oppose other applications to register. The US legislation also contains some distinct features, such as the concept of incontestability: once the registration is over five years old, it becomes incontestable if it is maintained through a showing of continuous use. It cannot be cancelled on grounds of prior use of a confusing similar mark or on grounds that the mark is merely descriptive. More importantly, the status of unregistered trade marks is to be harmonised in the various laws. In common law systems, unregistered trade marks can be protected as long as they are well-known, if the trade mark owner can prove that he/she effectively used the trade mark, and the use by another causes damages to his/her own business (through the tort of passing off). Some countries on the contrary have pure registration systems, like China, and do not recognize trade mark rights arising through use, although this constitutes a requirement of the Paris convention and of the TRIPs agreement. The various specificities of trade mark legal systems have an impact on the number of applications and their characteristics. Those specificities must then be taken into account in the analysis of trade mark data, especially in international comparisons. We come back on this question more precisely in the Annex at the end of this thesis.

Despite those variations, the various trade mark systems are on the whole relatively harmonised worldwide. If one compares the various trade mark laws, they give roughly the same definition of a trade mark. The application procedures, apart from the fees, are very similar in every country - except in the US. This homogeneity comes partly from the various international conventions and treaties concerning trade mark signed by a large number of countries. For European countries, the national trade mark laws generally correspond to the implementation of European directives, which explains their great similarity. Furthermore, the Paris Convention as well as the TRIPs agreement and the Trade mark Law Treaty give guidelines on the procedures, counting methods and on the scope of the law, which implies a convergence between the legislations[12]. Besides, thanks to the registration systems, trade mark datasets are available with information on the owner, its geographical origin, and the dates of application and registration. Then trade mark data are susceptible to be subjected to various economic analyses. In the following section, we present an overview of the principal economic studies focusing on or referring to trade marks, and in particular those related to their links with innovation.

1.3 Trade marks and innovation: Literature review

1.3.1 Socio-economic role of trade marks

One central question in the economic analysis of trade marks, which has divided the economists, is the question of the impact of trade marks on social welfare[13]. Landes and Posner, figures of the Chicago School "Law and Economics Approach", argue that trade mark law promotes economic efficiency (Landes and Posner 1987). Their basic argument is that trade marks help solve the information asymmetry issue between sellers and buyers, highlighted by Akerlof (1970). The authors build a formal model based on the integration of consumers' search costs whilst choosing their products. Firms use trade marks to signal that their products

[12]Most laws, notably the Chinese and the Hong Kong ones, were slightly modified to be consistent with the TRIPs.

[13]For a detailed review of the theoretical literature on trade marks and social welfare, see Ramello (2006).

are of a certain quality. The investments of firms in trade marks thus reduce search costs by making products and producers easier to identify in the market. When differentiated quality is introduced, the model also predicts that higher trade mark investment goes with higher quality of products, as those investments ensure that the firm, and not its competitors, will benefit from the reputation associated to this quality. According to the authors, trade marks are therefore beneficial to society, at least in view of the two above results, not to mention the potential subjective value that they represent for consumers.

This vision of trade marks contributing to economic efficiency has been challenged in the theoretical industrial organisation literature on brands and barriers to entry. Here, a well-known argument is that firms may use product or brand differentiation to create barriers to entry by incumbents and receive monopoly rents (Chamberlin 1933). This question is precisely explored in a paper by Economides (1988). While acknowledging the advantages offered by trade marks as regards the facilitation of consumer decision and the creation of incentives to quality, Economides argues that trade marks may at the same time give rise to certain market distortions. According to him, trade marks open competition in a new dimension, the marketing and the corresponding mental images. One possible distortion arising from this is that the ability to differentiate in perceptions may lead to too high a number of firms entering the market, as firms may gain market power by targeting different segments of the population. This is likely to be an issue in markets where the entry of too many firms is under-optimal, for example in case of high fixed costs. Trade marks, besides, may give rise to barriers to entry, as brand loyalty tends to reduce the number of differentiated products on the market. Overall, Economides considers that distortions implied by trade marks and their effect on barriers to entry are difficult to quantify, so that nothing can be asserted either on the beneficial or detrimental nature of trade marks on social welfare.

Although they tackle questions potentially related to innovation (incentives to quality; barriers to entry), those studies do not directly address the link between trade marks and innovative activities, which is a question independent of their impact on social welfare. As regards the former question, we turn to the management and marketing literature in order to gain insights into the role of trade mark use in firms' activities.

1.3.2 The use of branding in the launching of new products

Several lines of studies suggest that trade marks are likely to be involved in the innovation process. To start with, many studies in the business literature mention the importance of branding in the commercial implementation of new products. Trott (2005) for example considers that brand names are a key element of the marketing strategy to launch a new product, as well as the other characteristics of the good (technology, packaging, price, etc.)[14]. Brands enable firms to inform consumers about products, their characteristics, their quality and also possibly their novelty. Consumers use them to make their choice between competitive offerings, and they can choose to remain loyal to one preferred brand. Brands are then essential to build a stable long term demand.

According to Aaker (1991), there are several possible branding strategies for firms to launch a new product[15]. Some firms choose to identify each product with a separate name (*e.g.* Procter & Gamble has developed more than 70 separate brands). In contrast, some firms may choose to use an already existing brand and to extend it to the new product (*e.g.* Yamaha is a brand used at the same time for motorbikes, music instruments, and home electronics). Both strategies have drawbacks and advantages. Creating a new brand makes it possible to construct an image without being associated to any existing offer. This may be advantageous for launching a new product, especially if it is very different from the other products of the company. For example, when *Mercedes Benz* launched, with the help of the *Swatch* group, a new line of products, small city-cars, they launched it under a new brand name, *Smart* (an acronym for 'Swatch Mercedes Art Cars'). If the product had been launched under the *Mercedes* brand, it would have been

[14]See Trott (2005) p.160 ff.

[15]See Aaker (1991), Chapter 9.

more confusing for customers and more difficult to attract their interest, especially as *Mercedes* is renowned for spacious comfortable cars. Likewise, according to Aaker (1991), the *Macintosh* computer would not have had an image of its own if it had been called "Apple 360", and on the contrary, *Hewlett Packard* may have been handicapped by the use of the same brand first for its calculators and then for its computers, so that the various product lines are not well differentiated. However, creating a new brand is costly, it implies big communication investments. That is why some firms find it more advantageous to stretch an already existing brand, so as to benefit from the reputation it has already acquired in other markets. This enables firms to launch new products and enter new markets rapidly (*e.g.* the *Virgin* group has launched many products on various markets always using the same brand *Virgin*).

As a consequence, there are various types of relations between brands and products[16], going from the brand associated to a single product (*e.g. Tic-Tac*), to the brand associated to a sample of many products (*e.g. Danone*). Hence the perimeter of what is designated by a brand is relatively vague. The link between a brand and a product is not a one to one link. Some innovations may not be associated with a

[16]Kapferer identifies six main patterns of relations between brands and products (see Kapferer 2008 pp 349-371):

- Product-brand: one name is associated to a single product. This strategy is frequent in the hotel business (*e.g. Accor* group), and the food industry. In the extreme, when the product is very specific and has no equivalent, the brand becomes the only denomination for the product (*e.g. Malibu*, *Tic-Tac*, *Bounty*...); it is then called a *branduct*.

- Line brand: the brand is associated to a line of product, that is to say a set of products complementary to each other (*e.g. Calgon* sells washing powder and water softening salt).

- Range brand: the products bearing the same brand are related by a common principle, a common concept. This strategy is frequently used in the cosmetic, in the textile sectors (Benetton).

- Umbrella brand: the same brand is associated to various products in various markets (*e.g. Yamaha*, *Virgin*). This enables firms to make scale savings, as all their products and all their communications contribute to their notoriety. The drawback is that a failure in one market might harm the brand in all the other segments.

- Source brand: this is identical to umbrella branding, except that the various products have a proper name (*e.g. Nestlé* is the source brand for *Crunch*, *Nescafé*). It is however the source brand that distinguishes the product, the underlying brand alone would not be sufficient.

- Endorsing brand: this is identical to source brands, except that the underlying brands are themselves distinctive of the product. The endorsing brand has only a function of guarantee.

However those definitions are only schematic. In fact many brands correspond to several of those definitions (*e.g. L'Oréal* is sometimes a product brand, sometimes a source brand, *e.g.* for the products *Studio Line*, and sometimes totally absent, *e.g.* for *Dop* products or *Lancôme* products).

new brand, if they give way to a simple brand extension. However, according to Aaker (1991), pioneer innovations are less likely to give way to brand extensions than other products, and are generally related to a new brand name. A study led by M. Sullivan on 98 consumer brands in 11 markets (Sullivan 1992) showed that nine out of eleven brands in a pioneer segment were new brand names. The remaining two were brand extensions that failed. In addition, the survey showed that the more mature the market, the more the strategy of brand extension is used by new entrants on the market. In markets that are new or still developing, the product brand strategy is more adapted because it enables firms to take some risks: if a product does not work, it will not damage the reputation of the other brands of the firm. In the next chapters, we restrict our analyses to the link between innovation and the registration of a new trade mark.[17] [18]

1.3.3 Brands as barriers to entry

Depositing a new brand name may also enable firms to appropriate the benefits of their innovations. Several authors in the business and marketing literature thus mention the key importance of brands as a barrier to entry of new competitors in a market (Baker and Hart 2007[19], Rao 2005, Kapferer 2008). According to Kapferer, brands are used by innovative firms to pre-empt a positioning. They enable firms to create customer loyalty, which means that people will keep on buying the same brand for one product. The brand is then likely to become the nominal reference for the innovation, so that "the brand name patents the innovation" (in Kapferer 2008, p.358). Moreover, beyond the marketing literature, some economists have noticed that trade marks may be used by firms to appropriate the benefits of their

[17]The question of brand extension is addressed in Sandner (2009b), which investigates empirically the respective advantage of brand creation and brand extension for firms. See also Sappington and Wernerfelt (1985), providing a model predicting firms' decision to introduce an innovation under a new brand name or under the established company name.

[18]It should be noted that brand extensions may also be subject to trade mark deposits. For example, "Virgin Cola" is a registered trade mark, as well as the single name "Virgin". With the umbrella branding strategy, the firms save money mostly on communication and advertising costs, but not necessarily on the trade mark deposits themselves.

[19]See p.58 ff.

innovations. Schmalensee (1982) showed through a theoretical approach that pioneer brands are likely to have an advantage compared to others. In his words:

> "When consumers become convinced that the first brand in any product class performs satisfactorily, that brand becomes the standard against which subsequent entrants are rationally judged. It thus becomes harder for later entrants to persuade consumers to invest about their qualities than it was for the first brand."(Schmalensee 1982)

In the same line, Robinson *et al.* (1994) show that in markets for experience goods, pioneer brands tend to have higher market shares as pioneers tend to shape consumer tastes and preferences in favour of the pioneering brand.

The question of appropriability has been the object of a series of empirical papers since the late 1980s, trying to find out empirically what are the mechanisms used by firms for appropriating the benefits of innovation. The results of the "Yale survey" (Levin *et al.* 1987) and of its more recent update (Cohen *et al.* 2000) show that firms use various strategies of appropriation, varying across sectors and also with the size of the firm. Brand names are one of those strategies. According to Davis and Davis 2011, it is the combination of their use to signal novelty and to erect entry barriers which makes trade marks effective in supporting innovation. If they were used only as a signal of novelty, without entry barriers, they would not help firms appropriate the rents of their innovative activities. On the contrary, if they were only used as entry barriers without being associated to novelty, they would tend to decrease the firms' incentive to innovate by diverting resources from the development of new products or processes. This idea of trade marks helping firms appropriate the benefits of their innovation by enabling them to pre-empt a dominant position on the market constitutes the core of our theoretical model describing the link trade mark-innovation, presented in Chapter 2 and 3.

Trade marks can be used alone, or in addition to other appropriation mechanisms. Some firms in particular use them in complement to patents: they build brand reputation during the duration of the patent, and then keep the market power thanks to the brand once the patent has expired. This is particularly the case in the drug industry, where trade marked products are often more successful than their generic equivalents. Trade marks may also be used together with secret to protect an innovation – this was especially the strategy of *Coca-Cola*. They can as well be used to reinforce a lead time strategy, as they are used to attract the early interest of consumers, in particular through intensive advertising. Moreover trade marks may be used in order to protect what the other mechanisms of appropriability do not protect, for example open source software (Davis 2006). Following this idea, a number of studies investigated the complementary or substitute relationship which might exist between trade marks and other appropriability tools, such as patents and copyrights (Somaya and Graham 2006, Graevenitz and Sandner 2009, Schwiebacher 2010). Those studies highlight the existence of both complementary and substitute effects, the predominance of one or the other effect being likely to vary according to sector or firm characteristics. We come back more precisely on those studies in Chapter 3, where we investigate the interactions between trade mark and patent use.

In the light of those previous analyses, there are reasons to think that trade mark deposits are related to innovative activities. They are likely to be used to attract customers through advertising, and to develop loyalty, so that the firm can appropriate the benefits of their innovations. And yet, relatively few studies considered trade mark data as an indicator of innovation. Generally speaking, until now relatively few empirical studies were conducted on trade marks, which is surprising considering the high number of data that are potentially available. Only a few authors tried to explore those data and relate them to other economic variables.

1.3.4 Statistical studies on trade marks

a. At the aggregate level: global distribution of trade mark deposits

First, some authors tried to relate trade mark data to various economic indicators at the aggregate level. Gatrell and Ceh (2003), for example, showed that data on trade mark deposits are significantly related to regional economic outcomes, measured by gross State product and personal income per capita. In support of this finding, they argue that trade marks constitute a measure of innovation and technology production, such as patent or R&D expenditure. Later, Baroncelli *et al*. (2005) conducted a study for the World Bank analysing the global repartition of trade marks. In this study they look at registrations filed by the Madrid protocol across one hundred countries, over the period 1994-1998. They compare the frequency of designation of various countries by trade mark applicants to the import and export shares of those countries. They notice that the countries which register the most trade marks abroad are the same that export the most (that is also the countries with higher levels of income). They argue that the exporting activity implies a need to be recognised abroad, which may be met by trade marks. They find however that the global distribution of trade marks, although skewed towards countries with higher level of income, is not as uneven as the global distribution of patents. Indeed firms in developing countries may be more likely to differentiate themselves by investing in brands rather than in new technologies, which are more costly.

b. At the firm level

Trade mark deposits and firms' performance

Several studies analysed the relation between trade mark deposits and other economic variables at the firm level. Some authors in particular studied the correlation between trade marks and the economic performance of the firm, measured by sales, market value or profit, finding a significant positive impact (Greenhalgh and Longland 2001, Seethamraju 2003, Griffiths *et al*. 2005 and 2011, Greenhalgh and Rogers 2007b and 2012, Krasnikov, Mishra and Orozco 2009, Sandner and Block 2011). Fosfuri and Giaratana (2009) used trade mark deposits, next to new product announcement, as proxies to analyse the impact of rival's product innovation and new advertising on a firm's financial value. They find that rival product announcements tend to decrease firms' market value, through a market share dynamics, whereas rival trade marks, through a market size dynamic, tend to increase it.

Regarding the positive impact of trade mark use on firm performance, some authors explain this partly by the fact that trade marks are a proxy for innovation. Greenhalgh and Rogers (2007b), who find a significant positive impact of trade mark activity on stock market value and productivity levels in UK firms, explain that trade mark activity proxies a range of other unobservable firm characteristics, notably innovation, that raise productivity and product unit values. Griffiths *et al*. (2005) also consider that trade marks proxy innovation. They used trade mark deposits as an indicator of innovative activity, next to patents and designs to investigate the relationship between firms' profits and innovative activity. In Greenhalgh and Rogers (2012), testing the Lancaster model of consumer behaviour under product differentiation, trade marks are also used as a proxy for the introduction of new or improved products. The authors argue that trade marks are signalling elements used by firms to inform consumers and financiers about their new products. According to them:

> "There would be little point in embarking on a program of advertising and other marketing expenditure if the product name was not unique to the firm."(Greenhalgh and Rogers 2012)

They further quote the review of the economics of IP by Besen and Raskind (1991) stating that:

> "[A]lthough trade mark protection did not originate as an incentive for innovation or creativity, it now provides an economic incentive". Besen and Raskind (1991, p.21)

However, in the above papers, the link between innovation and trade marks is not tested explicitly. The positive impact of trade marks on the performance of firms is certainly not only due to their link with innovation. For example, the registration of a new trade mark is also likely to have a positive impact on the commercial success of firms, particularly by opening up new advertising opportunities. Then further verifications need to be done to be able to assess the link between trade marks and innovation. A few papers focused on this link more precisely, and sought to verify empirically that trade marks are related to innovation.

Trade mark deposits and innovative activity

A first verification of the link between trade mark deposits and innovative activity is found in a paper by Allegrezza and Guarda Rauchs (1999), which analyses empirically the determinants of trade mark deposits by firms. Their study is based on a survey of 2 500 Benelux SMEs from the Benelux Trade mark Office (BTO). They find a positive relationship between trade mark deposits and the size of the firm, the intensity with which the firm watches its competitors, the firm's estimation of its competitors' ability to imitate its products, the percentage of exports in turnover, the subjective importance given by decision makers to trade mark protection, and also they find a significant positive relationship with R&D intensity, measured by the frequency with which the firm undertook R&D activities. There seems then to be a link between trade marking activity and innovative activity, proxied by R&D. This link was verified by several authors afterwards.

Schmoch (2003) was the first to specifically explore the potentials of marks as an indicator of innovation, focusing on the service sector. According to him, the analysis of the service sector is made difficult by a lack of appropriate statistical data (see also Hipp and Grupp 2005). Trade marks, contrary to patents apply to services as well as products, so they open up the area of services. Relying on 2001 Community Innovation Survey data of German firms, he finds that there is a significant correlation between trade mark use and the share of turnover associated with innovative products in knowledge-intensive business services, whereas the correlation of patents and innovation in this sector is hardly significant. Schmoch concludes on this basis that trade marks meet all the preconditions to constitute an indicator for service innovation, as they are practically ready for statistical treatment and are highly correlated with the target variable.

Later a study by Mendonça, Pereira and Godinho (2004) extended the analysis to innovation in general, not limiting it to the service sector. They analysed the results of a survey of Portuguese firms on business attitudes towards IPRs. In all sectors considered, they found a significant and positive correlation between the use of patents and the use of trade marks. They also found trade marks to be used more intensively by high-tech manufacturing and knowledge-intensive services firms than by low-tech manufacturing and less knowledge-intensive services firms. They too concluded that trade marks could be used as novel sources of information on innovation.

Another attempt at evaluating the possibility of using trade mark statistics as an innovation indicator was made by Malmberg (2005). His studies adopt a longitudinal approach, and compare trade mark registrations with the launch of new-to-the-firm products for several firms in different sectors – the electromechanical, automotive and pharmaceutical industries – on a period of time of 15 to 60 years. He finds very different results across the sectors. For the electromechanical and automotive sectors, the number of trade mark deposits appears not to be related to the number of new products. According to the author, this is due to the fact that firms in those sectors are often relying on model numbers to identify their products, and these model numbers are seldom registered as trade marks. On the other hand, the numbers of trade marks and of new products seem highly correlated in the pharmaceutical industries, indicating that most of the new products have been trade marked. More generally, the author mentions that trade marks are likely to be well related to innovation in industries with frequent use of trade marks and with products targeting consumers.

More recently, a study by Flikkema, Man and Wolters (2010) sought to directly investigate whether trade marks actually refer to innovation or not through a survey of applicants of trade marks filed at the Benelux Office for Intellectual Property (BOIP). The survey contained three different categories of questions, relating to the motives of trade mark registration, the possible innovative content of the trade mark, and the timing of the registration. The results tend to confirm that the majority of trade marks refer directly to innovative activities, although the motives of registration are not primarily related to appropriating rents from innovation. They find in addition that most trade marks are filed close to the market introduction of products.

Finally, we should mention a recent study by Götsch and Hipp (2012), which investigates which types of innovation can be measured with trade mark-based indicators. Based on the German part of the Community Innovation Survey IV, they find that the use of trade marks is positively and significantly associated to the share of turnover achieved with new products and services in high-tech manufacturing and in knowledge-intensive services, although not in low-tech manufacturing and in less knowledge-intensive service sectors. In addition, they find that for knowledge-intensive service firms, trade mark use is significantly and positively correlated with being a product innovator, whereas no significant correlation is found with other innovation types (process, organisational, marketing). Besides, based on the results of a survey that they conducted on KIBS firms they find that various characteristics influence the use of trade marks such as international distribution markets, competitive market environment, highly standardised products or product accompanying services.

1.4 Conclusion

Throughout this brief overview of the legal foundations of trade marks and of the conceptual and empirical literature pertaining to them, various economic roles of trade marks have been pointed out. Originally, trade mark law was designed in the perspective of consumer protection. Trade marks, by securing the right to exclusively use a specific sign in reference to a product, should allow consumers to distinguish between competitive offers and enable them to purchase the products which best meet their needs and expectations. This is the conceptual approach retained in the founding paper by Landes and Posner (1987). However, since the paper by Landes and Posner, the role and the use of trade marks has significantly evolved. According to Greenhalgh and Rogers (2012), the rapid growth in trade mark activity in the late 1990s has implied a worsening of the information asymmetry between sellers and consumers. Trade marks have increasingly become a key asset for firms to compete in the market, rather than a tool to protect consumers (the protection against dilution being an illustration of this trend). Those evolutions imply considering other roles of the trade marking activity.

Still according to Greenhalgh and Rogers (2012), there are three conceptual views of trade marks in the existing economic literature: trade marks reducing search costs, trade marks proxying innovative efforts, and trade marks used as a strategic barrier to entry. In the last two views, trade marks are seen as a means for firms to appropriate the benefits of their innovation as they make possible to secure the loyalty of consumers, so that pioneer brands have an advantage compared to later entrants. Trade mark data are then likely to be related to innovative activities of firms, and as such they may convey information on aspects of innovation which are not well covered by traditional indicators. Certain empirical studies actually showed a link between trade mark counts and other indicators of innovation performance when they are available, such as innovation as reflected in responses to innovation surveys, R&D (for certain industries), patents, or the number of new product launches. This correlation is particularly high in knowledge-intensive services and in high tech manufacturing sectors like the pharmaceutical industry.

Several points nevertheless remain unaddressed in the literature on trade marks and innovation. First, there is a lack of bridge between the conceptual and empirical literature, as empirical studies at this stage have mostly shown correlations, without addressing the direction of causality, whereas conceptual studies tend to account for causal links between innovative activity and trade mark use. Another point which remains mostly unaddressed is to disentangle the effect of trade mark as IPRs and the effect of the underlying brand and marketing assets. To our knowledge no study has investigated the precise role of the IPR and its interactions with other appropriability means. Finally, the literature on trade marks and innovation has been up to now largely focused on firms. The literature on patents has looked at other type institutions, especially universities, which made it possible to shed light on other types of use of this IPR. One can wonder if this is also possible for trade marks. Those various points are those that we seek to address in the next chapters of this thesis.

1.5 Appendices

Appendix 1.A Short history of trade mark systems

The first kinds of trade marks, as identifying signs for a products, go back to the antiquity. In the Roman Empire, bricks bore the name of their builder. But in terms of jurisdiction, the protection of trade mark by the law originated in the UK, with the tort of Passing off, which is recognised in English Common Law relating to Goodwill since at least 1585, and which prevents one person from misrepresenting his or her goods or services as being the goods and services of the plaintiff.

The first system of trade mark registration was created in France in 1857, with the "Legislation Relating to Commercial Marks and Product Marks". Now it is used throughout the world. In the US, a comprehensive legislation relating to registration of trade marks was enacted as a federal law for the first time in 1870. In England, the Trade Mark Registration Act was enacted in 1875, based on the principle of prior use. In Turkey, a special law for the protection of trade marks, named the "Distinctive Signs Act", was adopted in the year 1871 during the Ottoman Empire; it introduced the registration of trade marks without examination. In Germany, a trade mark protection law, which was based on the principle of no examination, was enacted in 1874 and was later modified with the introduction of the principle of mandatory examination. In Japan, the first trade mark was registered in year 18 of the Meiji era (1885). It was a trade mark for ointments and pills registered by Yuzen Hirai in Kyoto prefecture.

Trade mark protection was incorporated into international law in 1891 by the Madrid Agreement, which gives member trade mark owners the option of having their marks protected in several countries by simply filing one application.

Appendix 1.B International treaties and systems

(i) Treaties governing registration systems for obtaining protection

The Madrid System for international registration of marks - 1891-1989

The Madrid system is the major international system for facilitating the registration of trade marks in multiple jurisdictions. It was established in 1891 and it is ruled by the Madrid Agreement (1891) and the Madrid Protocol (1989). It is administered by the International Bureau of World Intellectual Property Organisation (WIPO). It offers a trade mark owner the possibility to have his trade mark protected in several countries members of the Madrid Union, by simply filing one application in one jurisdiction with one set of fees. As of October 19, 2007, there were 57 contracting states to the Madrid Agreement and 81 to the Madrid Protocol. That does not include some major countries *e.g.* Canada. The United States became party to the Madrid Protocol in 2003.

The Community Trade Mark (CTM) System - 1994

The CTM system, established in 1994, is intended to give proprietors the possibility to register a trade mark with validity throughout the European Community. The registration of a trade mark with the OHIM leads to a right which is effective throughout the European Community as a whole. CTM registration applies indivisibly across all European Community member states. An objection against a CTM application in any member state can defeat the entire application; if there is none, the CTM registration is enforceable in all member states.

(ii) Treaties governing general standards of protection to be provided by States

The Paris Convention for the protection of Industrial Property - 1883

The Paris Convention is the earliest treaty on the protection of trade mark and invention in general, dating back to 1883. It establishes the system of priority rights. Under priority rights, applicants have up to 6 months of grace period to extend the initial trade mark application (first filing of an application anywhere in the world, which generates the priority date) to other member countries and claim the earliest priority. The Paris Convention also lays down a few common rules which all the contracting States must follow, concerning the registrability of trade marks, for example the interdiction to register a trade mark which might create confusion with a trade mark which is well known in the State where the application is made.

The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs) - 1994

The Agreement on TRIPs, administered by the WTO, establishes legal compatibility between member jurisdictions by requiring the harmonisation of applicable laws concerning intellectual property. With respect to trade marks, the agreement defines what types of signs must be eligible for protection as a trade mark and what the minimum rights conferred on their owners must be. The agreement states that marks that have become well known in a particular country shall enjoy additional protection. In addition, the agreement lays down a number of obligations with regard to the use of trade marks, their term of protection, and their licensing or assignment.

(iii) Treaties governing general standards in the registration procedures

The Trade mark Law Treaty (TLT)-1994

The TLT is administered by the WIPO, its aim is to streamline national and regional trade mark registration procedures. It was adopted in Geneva on October 27, 1994 and entered into force on August 1, 1996. It establishes a system in which member jurisdictions agree to standardise procedural aspects of the trade mark registration process. For example, they have to restrain the indications required during the application for a trade mark (name, address of the applicant, indications about trade mark). They also have to apply the same length of the protection (ten years).

(iv) Treaties governing international classification systems

The Nice Agreement concerning the international classification of goods and services for the purpose of the registration of marks-1957

This agreement establishes a classification of goods and services for the purpose of registering trade marks (the Nice Classification). The trade mark offices of the contracting States must indicate, in the official documents and publications in connection with each registration, the numbers of the classes to which the goods or services for which the mark is registered belong. The Classification consists of a list of classes – there are 34 classes for goods and 11 for services – and an alphabetical list of goods and services.

Appendix 1.C International Classification of Goods and Services for the Purposes of the Registration of Marks, established by the Nice Agreement (1957) – Ninth edition, entered into force on January 1, 2007.

GOODS

1. Chemicals used in industry, science and photography, as well as in agriculture, horticulture and forestry; unprocessed artificial resins; unprocessed plastics; manures; fire extinguishing compositions; tempering and soldering preparations; chemical substances for preserving foodstuffs; tanning substances; adhesives used in industry.

2. Paints, varnishes, lacquers; preservatives against rust and against deterioration of wood; colorants; mordants; raw natural resins; metals in foil and powder form for painters, decorators, printers and artists.

3. Bleaching preparations and other substances for laundry use; cleaning, polishing, scouring and abrasive reparations; soaps; perfumery, essential oils, cosmetics, hair lotions; dentifrices.

4. Industrial oils and greases; lubricants; dust absorbing, wetting and binding compositions; fuels (including motor spirit) and illuminants; candles, wicks.

5. Pharmaceutical, veterinary, and sanitary preparations; dietetic substances adapted for medical use, food for babies; plasters, materials for dressings; material for stopping teeth, dental wax; disinfectants; preparations for destroying vermin; fungicides, herbicides.

6. Common metals and their alloys; metal building materials; transportable buildings of metal; materials of metal for railway tracks; nonelectric cables and

wires of common metal; ironmongery, small items of metal hardware; pipes and tubes of metal; safes; goods of common metal not included in other classes; ores.

7. Machines and machine tools; motors and engines (except for land vehicles); machine coupling and transmission components (except for land vehicles); agricultural implements other than hand-operated; incubators for eggs.

8. Hand tools and implements (hand-operated); cutlery; side arms; razors.

9. Scientific, nautical, surveying, electric, photographic, cinematographic, optical, weighing, measuring, signalling, checking (supervision), life-saving and teaching apparatus and instruments; apparatus for recording, transmission or reproduction of sound or images; magnetic data carriers, recording discs; automatic vending machines and mechanisms for coin operated apparatus; cash registers, calculating machines, data processing equipment and computers; fire extinguishing apparatus.

10. Surgical, medical, dental, and veterinary apparatus and instruments, artificial limbs, eyes, and teeth; orthopedic articles; suture materials.

11. Apparatus for lighting, heating, steam generating, cooking, refrigerating, drying, ventilating, water supply, and sanitary purposes.

12. Vehicles; apparatus for locomotion by land, air, or water.

13. Firearms; ammunition and projectiles; explosives; fireworks.

14. Precious metals and their alloys and goods in precious metals or coated therewith, not included in other classes; jewellery, precious stones; horological and chronometric instruments.

15. Musical instruments.

16. Paper, cardboard and goods made from these materials, not included in other classes; printed matter; bookbinding material; photographs; stationery; adhesives for stationery or household purposes; artists' materials; paint brushes; typewriters and office requisites (except furniture); instructional and teaching material (except apparatus); plastic materials for packaging (not included in other classes); playing cards; printers' type; printing blocks.

17. Rubber, gutta-percha, gum, asbestos, mica and goods made from these ma-

terials and not included in other classes; plastics in extruded form for use in manufacture; packing, stopping and insulating materials; flexible pipes, not of metal.

18. Leather and imitations of leather, and goods made of these materials and not included in other classes; animal skins, hides; trunks and travelling bags; umbrellas, parasols and walking sticks; whips, harness and saddlery.

19. Building materials (non-metallic); non metallic rigid pipes for building; asphalt, pitch and bitumen; non metallic transportable buildings; monuments, not of metal.

20. Furniture, mirrors, picture frames; goods (not included in other classes) of wood, cork, reed, cane, wicker, horn, bone, ivory, whalebone, shell, amber, mother-of-pearl, meerschaum and substitutes for all these materials, or of plastics.

21. Household or kitchen utensils and containers (not of precious metal or coated therewith); combs and sponges; brushes (except paint brushes); brush making materials; articles for cleaning purposes; steel wool; unworked or semi worked glass (except glass used in building); glassware, porcelain and earthenware not included in other classes.

22. Ropes, string, nets, tents, awnings, tarpaulins, sails, sacks and bags (not included in other classes); padding and stuffing materials (except of rubber or plastics); raw fibrous textile materials.

23. Yarns and threads, for textile use.

24. Textiles and textile goods, not included in other classes; beds and table covers.

25. Clothing, footwear, headgear.

26. Lace and embroidery, ribbons and braid; buttons, hooks and eyes, pins and needles; artificial flowers.

27. Carpets, rugs, mats and matting, linoleum and other materials for covering existing floors; wall hangings (non textile).

28. Games and playthings; gymnastic and sporting articles not included in other classes; decorations for Christmas trees.

29. Meat, fish, poultry and game; meat extracts; preserved, dried and cooked

fruits and vegetables; jellies, jams, fruit sauces; eggs, milk and milk products; edible oils and fats.

30. Coffee, tea, cocoa, sugar, rice, tapioca, sago, artificial coffee; flour and preparations made from cereals, bread, pastry and confectionery, ices; honey, treacle; yeast, baking powder; salt, mustard; vinegar, sauces (condiments); spices; ice.

31. Agricultural, horticultural and forestry products and grains not included in other classes; live animals; fresh fruits and vegetables; seeds, natural plants and flowers; foodstuffs for animals; malt.

32. Beers; mineral and aerated waters and other non alcoholic drinks; fruit drinks and fruit juices; syrups and other preparations for making beverages.

33. Alcoholic beverages (except beers).

34. Tobacco; smokers' articles; matches.

SERVICES

35. Advertising; business management; business administration; office functions.

36. Insurance; financial affairs; monetary affairs; real estate affairs.

37. Building construction; repair; installation services.

38. Telecommunications.

39. Transport; packaging and storage of goods; travel arrangement.

40. Treatment of materials.

41. Education; providing of training; entertainment; sporting and cultural activities.

42. Scientific and technological services and research and design relating thereto; industrial analysis and research services; design and development of computer hardware and software; legal services.

43. Services for providing food and drink; temporary accommodations.

44. Medical services; veterinary services; hygienic and beauty care for human beings or animals; agriculture, horticulture and forestry services.

45. Personal and social services rendered by others to meet the needs of individuals; security services for the protection of property and individuals.

CHAPTER 2

WHO RELIES ON TRADE MARKS? AN ANALYSIS OF FRENCH FIRMS' TRADE MARKING BEHAVIOURS IN RELATION TO THEIR INNOVATIVE ACTIVITIES

2.1 Introduction

The purpose of this chapter is to analyse firms' trade marking behaviours, to better understand which firms rely on trade marks and what this asset represents for them. A variety of factors and motivations may in fact lead firms to register a new trade mark. Through trade marks firms can make themselves known, notably through advertising, and build their reputation. Trade marks help consumers choose between competing offers. If consumers choose to remain loyal to one specific brand, their loyalty enables firms to charge higher prices, and thus have higher margins[1]. This explains why Elliott and Percy (2007)[2] argue that trade marks play a key role in the financial success of firms.

As mentioned in the previous chapter, trade marks may also help firms appropriate the benefits of their product innovations (Davis 2006). As brands constitute a way to advertise products, firms may associate new brands to new products, in order to help consumers perceive the innovation. When starting to buy an innovative product of a certain brand, consumers are likely to remain loyal to this brand,

[1]According to Davis (2002), 72% of customers in various market sectors would pay a 20% premium for their preferred brands; 50% would pay 30% more; and 25% say price does not matter.

[2]pp. 83-84

thus making it more difficult for competitors to enter the market. Trade marks are also likely to be related to marketing innovations, i.e. changes in the firms' marketing methods aiming to reach new customers and to increase sales. When firms want to reach new customers and change their positioning on the market, it may be useful for them to create a new brand. In turn, the creation of a new brand may encourage marketing innovations, in order to attract customers and to build a loyalty relationship (Aaker 1991, Kapferer 1991, Elliott and Percy 2007).

As detailed in Chapter 1, several studies in the previous literature showed the existence of a correlation between trademark use and innovative activity (Schmoch 2003, Mendonça *et al.* 2004, Malmberg 2005, Flikkema *et al.* 2010, Götsch and Hipp 2012). Based on survey results at the firm level[3], they showed a significant positive relationship between trademark use and various innovation variables like patents, R&D, the share of turnover associated to new products or the number of product launch. The significance of this relation however tends to vary considerably across sectors or types of innovations (Malmberg 2005). The correlation was found to be particularly significant with product innovation in knowledge-intensive services and in high-tech manufacturing sectors (Schmoch 2003, Mendonça *et al.* 2004, Götsch and Hipp 2012). Trade marks were found to be less related to other types of innovations such as process, organisational and marketing innovations, and product innovations in low-tech manufacturing and less knowledge-intensive sector (Götsch and Hipp 2012).

The purpose of this chapter is to explain and test further the results found in this previous literature. We present a theoretical model describing the impact of protecting an innovation by a trade mark, which, to our knowledge, had never been explicitly addressed in the previous theoretical literature. Our study also investigates empirically the relationship between trade mark use, innovation, and the way other factors may affect firms' trade marking behaviours. It does so by analysing the link between trade mark applications and other innovation variables at the firm level – various types of innovation as reflected in innovation survey re-

[3]except Malmberg (2005), who used direct IPR data and various business sources such as annual reports or staff magazines

sults, patent applications – and by looking at the role of firm characteristics such as age, size, market scale, ownership, and sector. We extend the results of the previous literature on trade marks and innovation by looking at all types of innovation in all categories of sectors (high-tech and low-tech manufacturing, knowledge-intensive and less knowledge-intensive services), and by assessing systematically in which sectors and to which types of innovation trade mark use is related or not.

The empirical analysis is based on a purposely-built database combining French firm data from ORBIS©, data on trade mark applications at the French national intellectual property office (INPI) and at the OHIM[4], and patent applications data at INPI and at the European Patent Office (EPO). This dataset was further matched with the French results of the Community Innovation Survey (CIS 2008). The combination of innovation survey data and trade mark administrative data has - to our knowledge - never been used to investigate the link between firm innovation and trade mark use. This method enables us to combine the advantage of the large CIS sample of firms for which we get detailed information on innovation behaviour, and the possibility to trace the number of trade mark applications by firms over time, instead of relying on a discrete variable (has the firm used the IPR or not), which is the only IPR information provided in innovation survey[5].

In addition, our analyses differs from previous studies which were generally restricted to the analysis of correlations between trade mark use and innovation, by trying to impute a sense of causality between those two types of activities. Based on the assumption that trade marks are used as a protection tool for innovation, we test the impact of innovation variables on trade marking activity, whereas previous studies generally followed the reverse approach (using innovation behaviour as dependent variable). We also take into account possible endogeneity issues between trade mark use and innovation using instrumental variables.

Finally, we distinguish between IPR activity at the national and at the European

[4]OHIM is the office for trade mark registration at the European Union level. For more details, see chapter 1

[5]The questions on IPR use have furthermore been removed from the 2008 questionnaire of CIS, which is used in this chapter, so that no information on IPR is available.

level. The reason why both national and European patent and trade mark data are used is that firms can choose between applying for Intellectual Property (IP) protection at either levels, and it is not *ex ante* clear which level is more important or more informative. The national level may better mirror IP activity in volume, but European level IPRs are likely to be of a higher value. The analyses are thus conducted on both levels and as much as possible reported separately.

The remainder of this chapter is structured as follows. The first part describes the matching methodology used to build the firm-level database encompassing IPR activity of French firms and draws up the profile of trade marking firms in terms of age, size, and sector of activity. The second part addresses specifically the link trade mark-innovation. It first presents our theoretical model, and then relies on the results of the Community Innovation Survey matched with the previous dataset to investigate empirically the link between trade mark use and various types of innovative activities across sectors.

2.2 Profile of French trade marking firms

2.2.1 Data and matching methodology

A major problem facing researchers aiming to study the IPR behaviours of firms is the lack of databases integrating firm data and IPR data. To address this shortcoming, we built an integrated database combining firm-level data on French companies from the commercial database ORBIS© and data on trade mark and patent applications from administrative datasets[6]. This enabled us to get thorough and objective information on the IPR activity of an extensive sample of French firms. For all firms, we have information not only on whether or not the firm uses patents or trade marks, but also detailed information such as the number of applications,

[6]Recently, a number of similar initiatives have aimed at linking firm-level data and IPR data, in particular the NBER patent data project, linking USPTO patents to the Standard and Poor's Compustat database on US firms (Hall *et al.* 2001, Cockburn *et al.* 2009), and the Oxford Firm-Level Intellectual Property (OFLIP) database, linking UK firm data from the FAME database and UKIPO patents and trade marks data (Helmers, Rogers and Schautschick 2011). For an overview of other initiatives, see (Helmers, Rogers and Schautschick 2011).

filing dates, expiration dates, technology or product classes, etc..

a. Firm database: ORBIS© (December 2010)

ORBIS©, edited by the Bureau Van Dijk (BvDEP), is a commercial dataset containing structural and financial information on more than 70 million companies or business records around the world. For those firms, ORBIS© contains basic information (such as name, address, NACE sector) as well as a set of accounting and financial data. In its December 2010 version, ORBIS© contained around 10.7 million records on French firms. The database includes data from previous years, allowing the construction of longitudinal sets of data. ORBIS keeps track of inactive firms (firms which went out of business) for at least five years, hence the sample is complete from the year 2005.

The most recent IPR data that are considered in our study are applications filed in 2008, which is used as the year of reference in the following analysis. Restricting to records with available financial information in ORBIS© for the year 2008, the sample counts 1.1 millions business entities (Table 2.1). This is to compare with the French business register data, which contained 2.2 millions records in 2008.

b. IPR databases

We used IPR data from different sources: trade marks and patents applications at the INPI, Community trade mark applications at the OHIM, and patent applications at the EPO. INPI trade mark applications were provided by the corresponding office. Community trade mark applications were retrieved from the OHIM

Table 2.1: Number of French records with available financial information over the years in ORBIS© (December 2010)

	# records with available financial information
2005	882 126
2006	987 698
2007	1 038 497
2008	1 064 477

CTM-download database. INPI and EPO patent applications were retrieved from the EPO managed Worldwide Patent Statistical Database PATSTAT.

It should be noted that the country coverage of the IPR granted by OHIM and EPO is not equivalent, as the procedures and linked effects differ. European patents granted by the EPO may be valid in one or several countries of the European Union, depending on the will of the applicant (it is just a centralised procedure for the application). Conversely, CTM granted by the OHIM are valid throughout the European Union as a whole. Therefore, trade marks are comparatively more difficult to obtain at the European level than patents.

c. Description of matching methodology

None of the above IPR dataset contains systematic indication of firms' identifiers[7], which would make the link with firm-level databases directly possible. Therefore, the matching was performed using the applicant name information. This strategy is not straightforward, as firm denominations may vary across and within the different datasets to be linked. Those variations may stem from spelling mistakes in the name of the firm, different denominations used for the same firm, the addition of terms referring to the legal status, or different name conventions (e.g. *International Business Machines* and *IBM*, *IBM Corp.*, etc.). Thus the matching of the datasets requires harmonising firms' names. This was done using a dictionary covering legal entities, common names and expressions, as well as linguistic rules that may affect the spelling of enterprise names. This information was then used in string matching algorithms – token-based and string-metric-based – which compare the names in the different datasets, and which attribute to each possible match a matching accuracy score. Those algorithms were run automatically using the software "Imalinker" (Idener MultiAlgorithm Linker), developed for OECD by IDENER[8], Seville, in 2011. The application is then automatically matched to the

[7] Although some INPI trade mark applications data contain an indication of the identifier of the firm (siren number), this information is provided on a voluntary basis and is not available for most of the applications.

[8] A spin-off of the University of Seville (Spain), www.idener.es

firm which reaches the best score[9], subject to this score being higher than a certain threshold.

Following this automatic matching, a manual checking of the unmatched applicants with many applications was performed (applicants with ten or more applications over the years 1998-2008 for INPI trade marks, and twenty or more applications for Community trade marks, INPI patents and EPO patent).

d. Matching results

In order to assess the matching results, we look at the proportion of applications and applicants contained in the initial IPR databases that are reflected in the matched database, resulting from the automatic matching procedure and from the manual checks.

We present in Tables 2.2 and 2.3 the matching results for applications filed between the years 2005 and 2008, which is the period for which the ORBIS© sample is complete (e.g. containing all the firms that were recorded as active in ORBIS© during any of these years).

The gap between the matched database and the IPR databases is partly explained by the fact that not all applicants are businesses: part of the applications may come from individuals, from public entities such as Universities, Ministries, or from non-profit associations[10]. Besides some of the applications may stem from small firms not included in ORBIS©.

We observe that the gap between the number of matched applications and the

[9]The ORBIS© database is a collection of business records rather than a consistent business register, so that records for an individual company can be duplicated in the database, depending upon the type of business record considered (e.g. consolidated or unconsolidated economic accounts). This gives rise to ex aequo matching scores in the previous procedure. Matches with ex aequo scores were disambiguated based on various criteria: address of the company (city, postcode and street), branch location or not, financial information missing or not. Parts of the applications remain ambiguous after using those criteria, which are considered as unmatched.

[10]Data on Community trade mark applications as well as patent data from PATSTAT contain some information on the type of applicant, namely if the latter is an individual or not. However, a number of applicants are categorized as individuals, although they are obviously associated to business companies (e.g. Pierre Cardin, 59 rue du Faubourg Saint Honoré). Thus in order not to miss IPR applications from those companies, we performed the matching algorithm on all applications contained in the dataset, including those whose applicants are categorized as individuals.

Table 2.2: Comparison of the number of IPR applications and applicants in the matched database and in the initial IPR databases after each matching step (for applications filed between 2005 and 2008 by French applicants)

		CTM		INPI TM		EPO PAT		INPI PAT	
Applicants	Initial number	8026	100%	154389	100%	5043	100%	14818	100%
	Automatic match	5769	72%	66616	43%	3875	77%	9988	67%
	Manual match	112	1%	429	0%	67	1%	101	1%
	Total match	5881	73%	67045	43%	3942	78%	10089	68%
Applications	Initial number	18035	100%	270214	100%	33280	100%	48683	100%
	Automatic match	13235	73%	127960	47%	23600	71%	34733	71%
	Manual match	1542	9%	12998	5%	6987	21%	6874	14%
	Total match	14777	82%	140958	52%	30587	92%	41607	85%

Note: The number of applicants corresponds to the number of distinct applicant names remaining in the various databases after harmonization of the names.

Table 2.3: Comparison of the number of IPR applications and applicants in the matched database and in the initial databases for France over the years

		CTM			INPI TM			EPO PAT			INPI PAT		
		Initial number	Total match	%	Initial number	Total match	%	Initial number	Total match	%	Initial number	Total match	%
Applicants	2005	2328	1747	75%	39922	17422	44%	1984	1602	81%	5331	3564	67%
	2006	2517	1880	75%	42667	19380	45%	1940	1546	80%	5118	3508	69%
	2007	2641	1975	75%	44878	20282	45%	1959	1589	81%	4913	3430	70%
	2008	2703	2055	76%	45383	20678	46%	1997	1585	79%	3591	2715	76%
Applications	2005	4059	3330	82%	63289	32297	51%	8038	7352	91%	12453	10329	83%
	2006	4373	3590	82%	66406	34875	53%	8206	7534	92%	12459	10348	83%
	2007	4815	3915	81%	70414	37273	53%	8323	7678	92%	12310	10602	86%
	2008	4788	3942	82%	70105	36513	52%	8713	8023	92%	11461	10328	90%

Note: The number of applicants corresponds to the number of distinct applicant names remaining in the various databases after harmonization of the names.

initial number of applications is higher for patents than for trade marks, both at the European level (92% of EPO patent applications matched versus 82% of CTM applications) and at the national level (85% of INPI patent applications matched versus 52% of trade mark applications). This can be explained by the fact that the proportion of applications from non-business applicants (in particular from individuals) is higher for trade marks than for patents (although there is also a non-negligible part of patents filed by non-profit institutions such as universities or research institutes). Moreover the proportion of patent and trade mark applications matched is higher at the European level than at the national level. This suggests that the proportion of applications filed by individuals, non-business applicants, or small firms not included in ORBIS is higher at the national level.

The matching results are relatively stable over time during the period 2005-2008, except for INPI patents, for which the matching results tend to improve in the most recent years (90% of 2008 applications matched, against 83% of 2005 applications). This can be attributed to the fact that during that period the INPI improved the cleaning of applicant names which are provided in PATSTAT (the number of distinct names in the initial database decreased), which result in an improved matching[11].

At the national level, the number of trade mark applications by firms is higher than the number of patent applications (140958 trade mark versus 41607 patent applications in 2005-2008 according to our matched database). The reverse is true at the European level (30587 EPO patent versus 14777 CTM applications), which can be attributed to different procedures (EPO grants European patents based on a centralized procedure but not necessarily valid in all the European countries, whereas CTM applications at OHIM lead to a trade mark valid throughout the European Union countries as a whole, so that Community trade marks are comparatively more expensive and less used than national trade marks). This effect is possibly

[11]This may lead to an underestimation of the number of INPI patent applications in the first year of the sample period compared to the more recent years. In the remainder of the analysis, we do not consider the evolution of patenting activity over time, but only patenting activity in a certain period, so that the results are not affected by this potential bias.

reinforced by the fact that OHIM is relatively new compared to EPO (it was created in 1996, twenty years after EPO), so firms may not have had the time to get used to OHIM as much as to EPO. However, between 2005 and 2008, the number of firms filing CTM at OHIM was higher than the number of firms filing patents at EPO (5881 versus 3942 according to the matched database).

2.2.2 Descriptive statistics: general characteristics of firms using trade marks

This subsection relies on two snapshots of the database described in the previous subsection, in years 2008 and 2005, to analyse the characteristics of French firms using trade marks in terms of age, size, and sector[12]. The aim of this preliminary analysis is to draw up a general portrait of trade marking firms and to investigate the factors which need to be taken into account when studying the trade mark-innovation link, which is the object of the next section.

In the following, we refer to IPR activity of firms using application date as opposed to other dates in the IPR process (*e.g.* the grant date), in order to be as close as possible to the launch of the innovation initiative inside the firm[13]. We present separately the patterns of trade mark use at the national and at the European level, as those patterns are likely to differ and one cannot *a priori* state which level is more relevant to the firms. In order to gain an insight into the evolutions of firms' trade marking behaviours over time, we look at two different points in time, 2008 and 2005, to see if patterns of trade marking use tend to be stable over the years or not. For the two snapshots, we consider firms for which financial information is available in ORBIS© for the corresponding year. This avoids the presence of inactive firms in the sample corresponding to the more recent year, which would

[12] A similar analysis is performed for patents in Chapter 3.

[13] Especially, we do not use grant dates as our purpose is not to investigate successful IPR activities, but the IPR strategy initially chosen by the firm looking for protection. Other options could be adopted. For example, Rogers, Greenhalgh and Helmers (2007), who investigated the relationship between IPR use and performance of United Kingdom small and medium firms, chose to rely on publication date to better proxy innovation output and the start of competitive advantage through innovation, arguing that application date may precede the innovation. However, the impact on the analysis is limited since the delay between application date and publication date is relatively short (six weeks at INPI and generally less than ten weeks at OHIM).

lead to an underestimation of firm's trade marking activity in the more recent years compared to former years. The figures presented in the following subsections then correspond to proportions of firms filing trade mark applications among active firms recorded in ORBIS©, with financial information in the corresponding year.

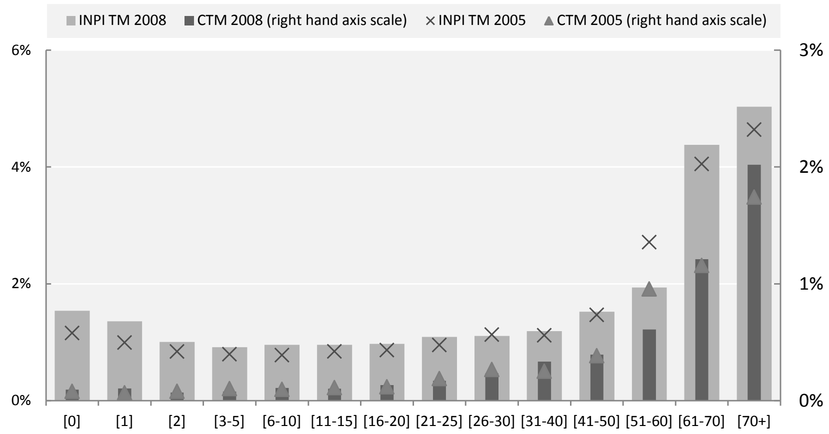
a. *Age distribution of French trade marking firms*

One first factor likely to have an impact on the trade marking behaviour of the firm is its age, as the importance of protecting various reputational assets is likely to evolve during the life time of the firm. Figure 2.1 shows the distribution of firms applying for trade marks at INPI and OHIM by age cohort. Figure 2.2 shows the same distribution weighted by the number of trade mark applications by the firms, i.e. the distribution of applications by age of the applicant firm. Age is defined here as the number of years since incorporation date up until the year of the two database snapshots.

The proportion of trade marking firms over age generally follows a U-shaped pattern. Firms are indeed likely to apply for trade marks in the very beginning of their life cycle when they enter the market, protecting their corporate brand (the name of the company), or the name of their main products. Mature firms are on the other hand likely to apply for trade marks. This may have two explanations. The first one is that mature firms are by definition surviving firms, i.e. firms that were successful in the past, and those firms are then more likely to protect their valuable assets, and particularly their reputation built over the years. They have less financial constraints, cash flows, etc. On top of that, the marketing literature indicates that firms need to reproduce their offer through product innovations or marketing. Those two elements imply that older firms tend to rely more on trade marks.

As can be seen in the detailed statistics presented in Appendix 2.A, youngest firms nevertheless play an important role in trade mark activity, especially at the national level as nearly one-half of the INPI trade mark applications are filed by less than 10 years old firms (against one third of CTM applications). This is due to

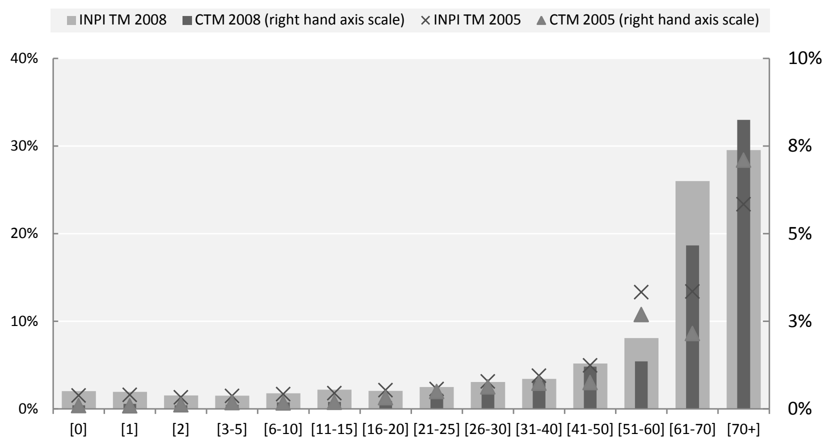
Figure 2.1: Share of French firms applying for trade marks by age, 2005 and 2008 snapshots



Source: Author's compilation on ORBIS© data for France matched with trade mark applications data at INPI and OHIM.

Note: Firms with incorporation date '1900' were dropped from the sample, as this date appears to be used as a default value in ORBIS© and is most of the time not accurate. Detailed statistics are presented in Appendix 2.A

Figure 2.2: Share of French firms applying for trade marks by age, weighted by the number of applications, 2005 and 2008 snapshots



Source: Author's compilation on ORBIS© data for France matched with trade mark applications data at INPI and OHIM.

Note: Firms with incorporation date '1900' were dropped from the sample, as this date appears to be used as a default value in ORBIS© and is most of the time not accurate. Detailed statistics are presented in Appendix 2.A the preponderance of younger firms in the entire population of firms (around 60% of firms in the sample are less than 10 years old).

The shape of the distribution of trade mark use over age is similar for CTM and INPI TM applications. However, when comparing both levels, younger firms – and particularly very young firms, i.e. those in the age cohort 0-2 – tend to file relatively more at the national level. This can be explained by the market firms may want to target, as well as by differences in price between the two procedures, which may make national applications more affordable and hence more accessible to young firms, so that firms start by depositing INPI trade marks when they are young and then deposit CTM when they have grown.

The distribution of trade marking firms by age tends to be stable over time. Between 2005 and 2008, there was a small increase in the share of firms using trade marks, especially at the national level, except for firms between 51 and 60, which showed a significantly higher level of trade marking activity in 2005 than in 2008, both at the national and at the European levels.

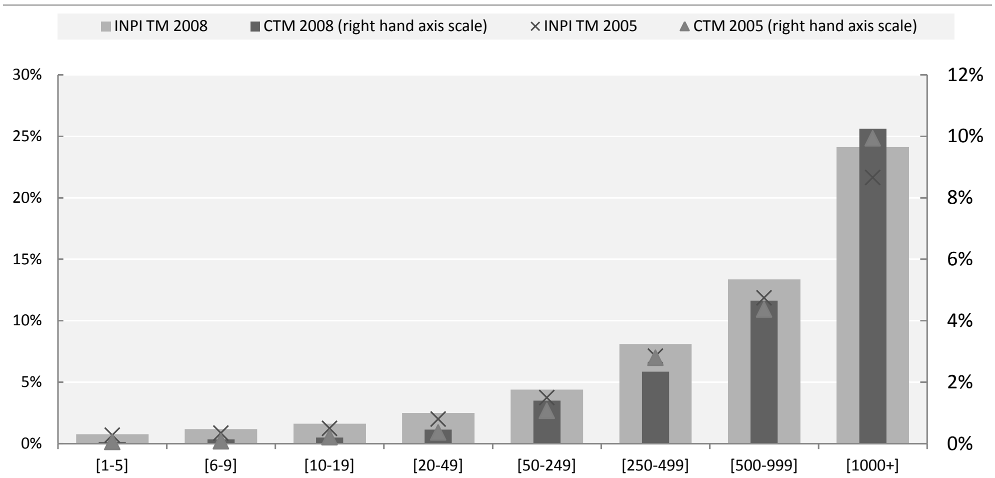
b. Size distribution of French trade marking firms

Scale effects are likely to affect both innovative and IPR activities of firms. Thus firm size, as well as age, may be considered as a determinant factor of trade mark use. Using the number of employees in the reference year as a firm size indicator, Figure 2.3 and Figure 2.4 show the size distribution of trade marking firms, respectively unweighted and weighted by the number of trade mark applications. Detailed statistics are presented in Appendix 2.A.

The large majority of firms filing trade mark applications are SMEs[14] and micro firms[15] (around 90% of trade marking firms for INPI TM, and 75% for CTM). However, when looking at trade marking firms in proportion of the whole sample, the likelihood of applying for trade marks both at European and national levels is exponentially increasing with the size of the firm (Figure 2.3). This pattern is accen-

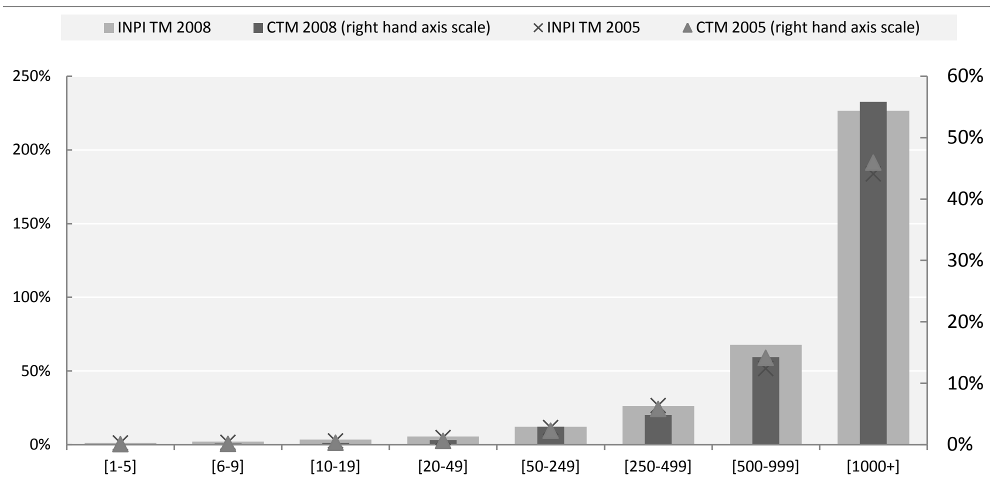
[14] Between 10 and 250 employees.
[15] Less than 10 employees.

Figure 2.3: Proportion of French firms applying for trade marks by size (number of employees), 2005 and 2008 snapshots



Source: Author's compilation on ORBIS© data for France matched with trade mark applications data at INPI and OHIM. Note:Detailed statistics are presented in Appendix 2.A

Figure 2.4: Proportion of French firms applying for trade marks by size (number of employees), weighted by the number of applications, 2005 and 2008 snapshots



Source: Author's compilation on ORBIS© data for France matched with trade mark applications data at INPI and OHIM. Note:Detailed statistics are presented in Appendix 2.A tuated when considering the number of applications by applicant firm size (Figure 2.4). One possible explanation is that bigger firms tend to have more intensive innovative activities. Another explanation may stem from the fact that big firms are typically more aware of IPR procedures, often have dedicated IPR services, and tend to exploit all available protection means.

As it also happens in the case of age, the size distribution differs if one considers the European or the national level: the relative proportion of firms filing at the European level increases with size, which again may be explained by the difference in price between the two procedures.

The size distribution tends to be stable over time. The share of firms using trade marks increased between 2005 and 2008, both at the national level and the European level in all size bands, except for CTM applications in the size band of 250 to 499 employees.

c. Sector distribution of French trade marking firms

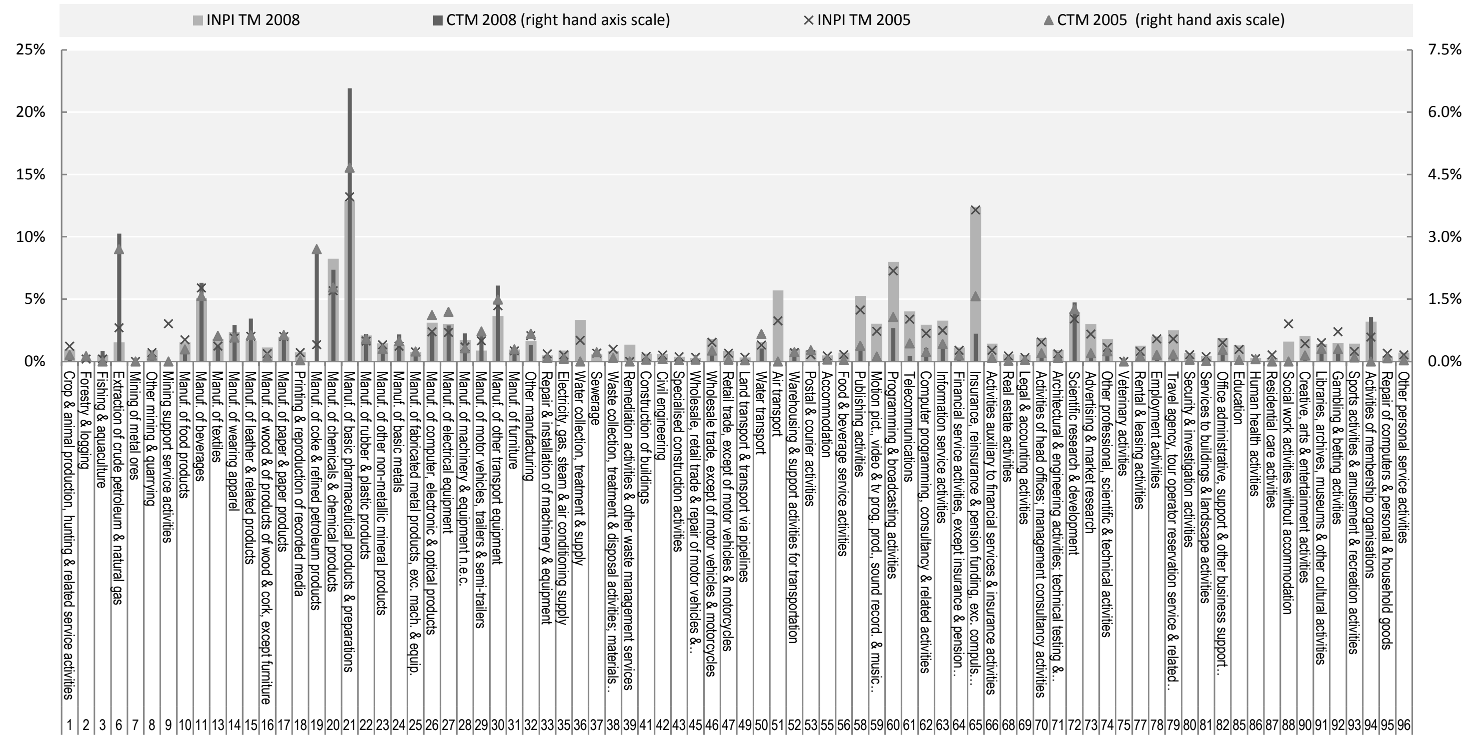
As can be seen in Figures 2.5 and 2.6, showing the sector distribution, respectively unweighted and weighted by the number of applications, of firms filing trade marks relying on the NACE Rev. 2 industry classification codes[16], the likelihood to use trade marks tends to vary significantly across sectors. Sectors with intensive trade marking activity are found both in manufacturing and in services. According to our database, the sectors with the highest trade marking intensity in 2008 were pharma (21), insurance (65), and chemical products (20).

Patterns of trade mark use across sectors tend to differ when comparing the European and national levels. Service firms tend to file relatively more at the national level than manufacturing firms. This can be explained by the fact that services are generally less exportable than goods, so that service firms have fewer incentives than manufacturing firms to protect their reputational assets at the international level.

[16]The December 2010 version of ORBIS© provides sectors information based on NACE rev.1. In order to be consistent with the next section which refers to NACE rev. 2 sectors, we used sector information from the June 2011 version of ORBIS©, which relies on NACE Rev. 2.

The distribution of trade marking activity across sectors tends also to vary significantly over time. Between the years 2008 and 2005, some sectors such as pharma, chemical products and insurance experienced an increase in trade mark filings, whereas other sectors such as motion pictures, video and television programmes production, or telecommunications, experienced a decrease in trade mark filings in proportion of the number of firms (Figure 2.5).

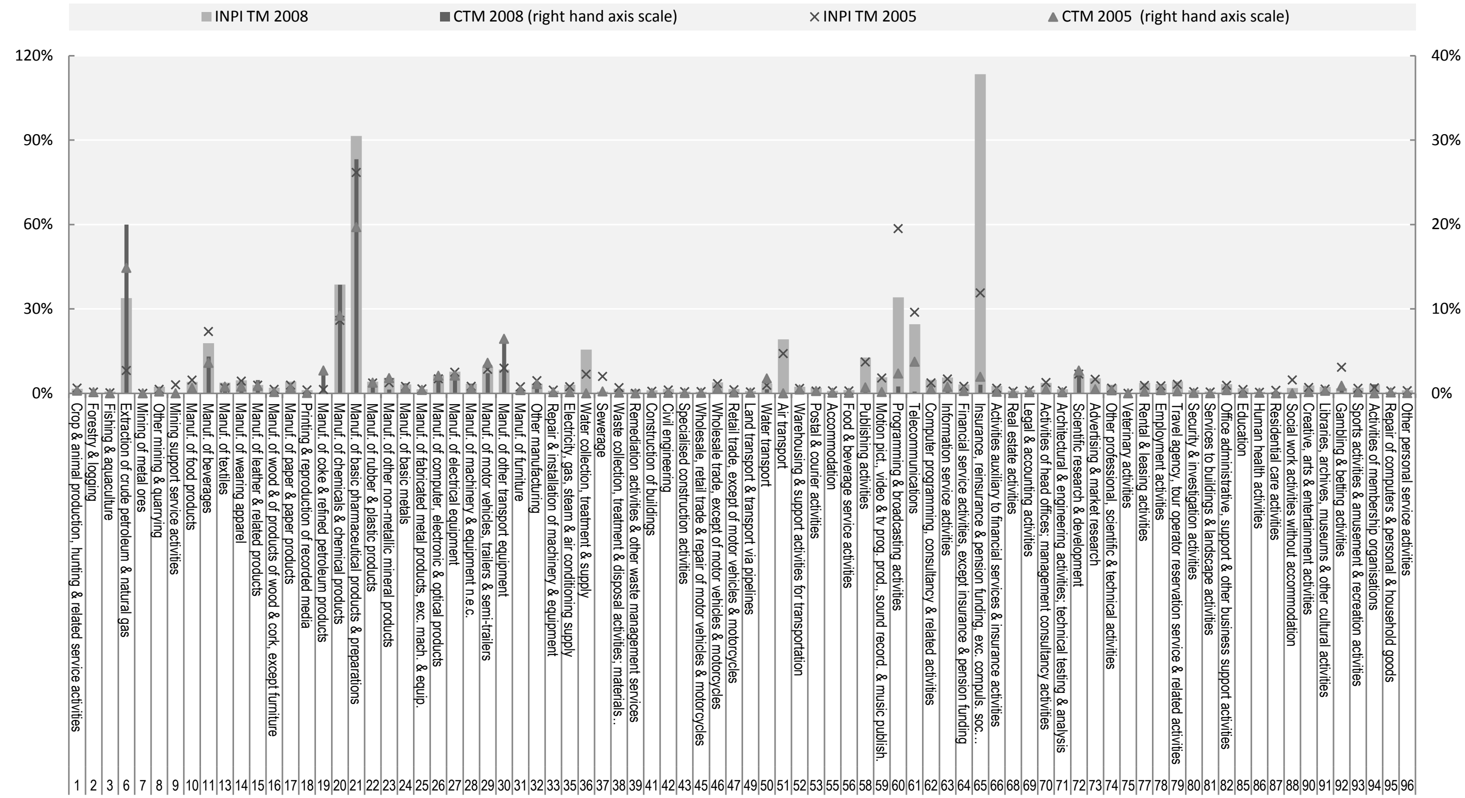
Figure 2.5: Proportion of French firms applying for trade marks across sectors (Nace Rev. 2), 2005 and 2008 snapshots



Source: Author's compilation on ORBIS© data for France matched with trade mark applications data at INPI and OHIM.

Note: The sectors refer to the NACE Rev. 2 classification at the 2 digits level. NACE codes are reported at the bottom of the x axis. Sectors with less than 10 observations in the 2008 or 2005 snapshot - namely sector 05, mining of coal and lignite; 12, manufacture of tobacco products; and 84, public administration and defence, compulsory social security - are not reported on the graph. Detailed statistics are presented in Appendix 2.A

Figure 2.6: Proportion of French firms applying for trade marks across sectors, weighted by the number of applications, 2005 and 2008 snapshots



Source: Author's compilation on ORBIS© data for France matched with trade mark applications data at INPI and OHIM.

Note: The sectors refer to the NACE Rev. 2 classification at the 2 digits level. NACE codes are reported at the bottom of the x axis. Sectors with less than 10 observations in the 2008 or 2005 snapshot - namely sector 05, mining of coal and lignite; 12, manufacture of tobacco products; and 84, public administration and defence, compulsory social security - are not reported on the graph. Detailed statistics are presented in Appendix 2.A

In order to get more easily interpretable results, Figures 2.7 and 2.8 show the intensity of trade mark use by broad sector categories (high-tech and low-tech manufacturing, knowledge-intensive and less knowledge-intensive services), relying on the Eurostat aggregations of manufacturing industries according to technological intensity on the one hand, and of services according to the share of tertiary educated persons on the other hand[17]. We restrict the analysis of services to private services, which are more likely to rely on trade marks than public ones. Detailed information on sector distribution of trade marking firms as well as on the sectors included in each broad categories are presented in Appendix 2.A.

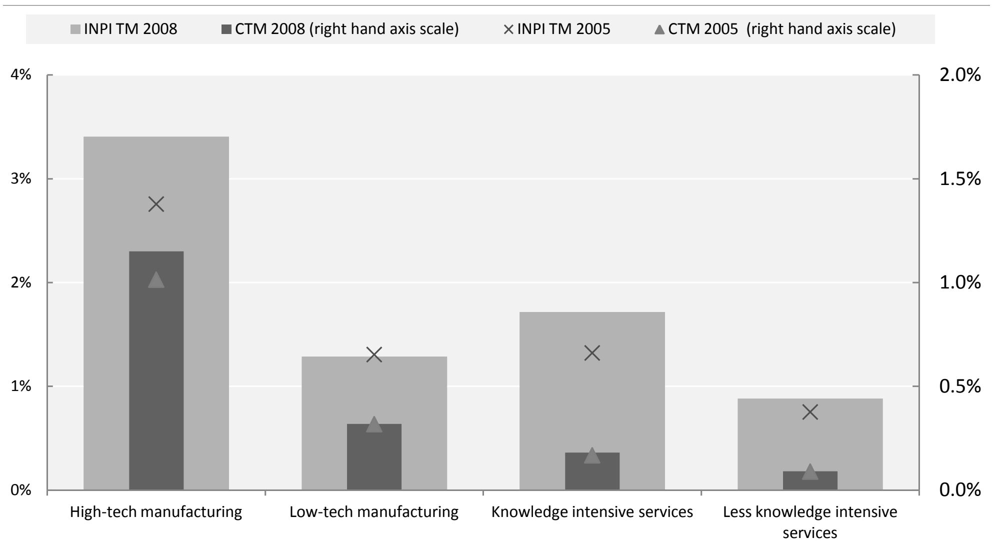
The most trade mark active sectors in France are the high-tech manufacturing sectors, followed by low-tech manufacturing sector and knowledge intensive service firms. Other service firms not belonging to knowledge intensive services, as far as they are concerned, account for an overall important share of the trade mark applications (cf Appendix 2.A), but they nevertheless exhibit a relatively low trade marking activity in proportion to the whole sample.

The use of trade marks seems to be relatively more important in sectors that are technology- or knowledge-intensive, where innovation plays a bigger role: in 2008 firms in high-tech sectors were three times more active in trade marking than firms in low-tech sectors, and firms in knowledge intensive services were twice more active in trade marking than firms in the other service sectors[18]. This seems to be an increasing pattern, as high-tech manufacturing sectors and knowledge-intensive services are the sectors which experienced the most important growth in trade marking activity between 2005 and 2008. This suggests that trade marks tend to play a more important role in more innovative, closer to the technological frontier sectors than in other sectors. The verification of this assumption is the

[17] More information on those aggregations can be found at http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/en/htec_esms.htm#stat_pres (last access in June 2012)

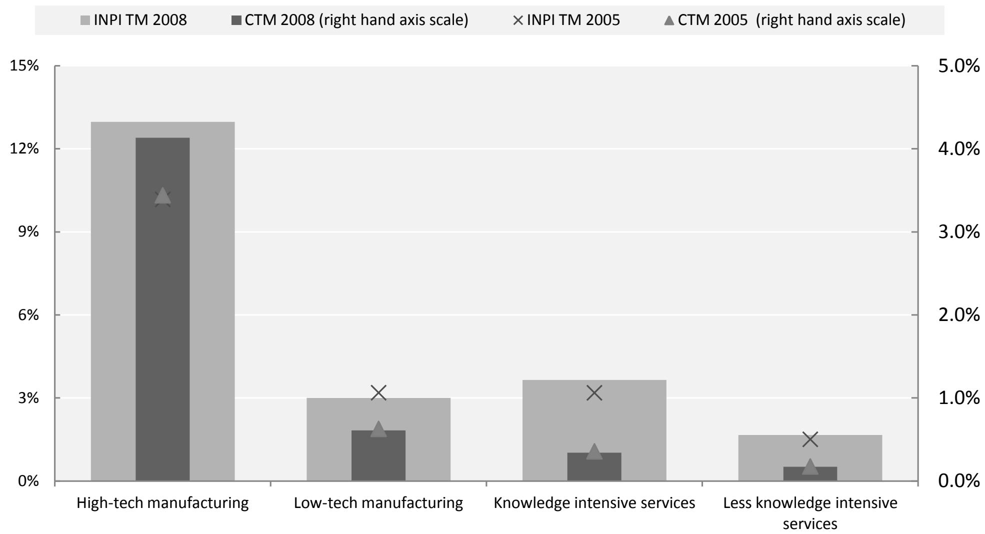
[18] Comparing low-tech manufacturing and knowledge-intensive services firms, both show similar levels of trade mark use, with low-tech being slightly less trade mark active at the national level and slightly more active at the European level. This difference may be explained by the fact that services tend to be less exported that goods, so that service firms are comparatively less likely to rely on trade marks at the European level.

Figure 2.7: Proportion of French firms applying for trade marks across sector categories, 2005 and 2008 snapshots



Source: Author's compilation on ORBIS© data for France matched with trade mark applications data at INPI and OHIM. Note: Sector categories correspond to Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons respectively, restricted to private services.

Figure 2.8: Proportion of French firms applying for trade marks across sector categories, weighted by the number of applications, 2005 and 2008 snapshots



Source: Author's compilation on ORBIS© data for France matched with trade mark applications data at INPI and OHIM.

Note: Sector categories correspond to Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons respectively, restricted to private services.

object of the next section. Overall, the various results presented in this first section suggest that firm-level analyses of trade mark use should take into account firm characteristics, as the patterns of use tend to differ according to age, size, or sector. We therefore control for all those characteristics in the following analyses where we address the link trademark-innovation at the firm-level.

2.3 Link between trade marks and innovative activities

In the following section, we address specifically and explicitly the link between trade mark use by firms and their innovative activities. We first present a theoretical model describing the mechanisms that may explain this link. We then test the results of this model relying on the French results of the Community Innovation Survey 2008, matched with IPR data.

2.3.1 Theoretical model

The following paragraph attempts to provide theoretical foundations for the link between innovative activity and trade mark use by firms, by presenting a formal model of the impact of trade mark protection and comparing the respective benefit of trade marking for innovative and non-innovative firms.

a. Model framework

The two-period game

The framework of the model is a market with two firms, an innovating one (leader) and an imitating one (follower). We assume that it takes a certain amount of time for the follower to start to imitate and to enter the market, so that the model has two distinct periods: a monopoly period where the leader is the only firm on the market, followed by a competition period, characterized by a Cournot-type duopoly between the leader and the follower. The overall profit of the two firms corresponds to the inter-temporal profit over the two periods, with the second period being weighted by a discount rate:

$$V = \pi_1 + r\pi_2, \tag{2.1}$$

where π_1 and π_2 are the profits in the first and second period, respectively, and r is the discount rate between the two periods, with $r > 0$.

Advertising and goodwill properties

Firms incur advertising expenditure, which enable them to build a goodwill which positively affects the demand for the product. Following Nerlove and Arrow (1962), we assume that advertising expenditure are cumulative: the goodwill of the firm is supplied at each period with advertising expenditure, and depreciates at rate δ. In our two-period framework, this translates into an equation of evolution of the goodwill stock G_t from the first period to the second period: $G_2 = (1-\delta)G_1 + a_2$, where a_2 is the amount of advertising expenditure of the second period, G_1 and G_2 are the goodwill stocks in the first and second period, respectively, and δ is the depreciation rate of advertising between the two periods. The firms only start advertising expenditure when they enter the market, so the goodwill stock in the first period is equal to the amount of advertising expenditure in the first period, $G_1 = a_1$.

Besides, we assume that advertising expenditure are not totally appropriable by firms (Friedman 1983), and are subject to spillovers. The interpretation of those spillovers is that the advertising performed by a firm is partly advertising for the product in general and not for its own brand, so that the competitor can benefit from it. Advertising expenditure can be divided into two parts: a first part corresponds to advertising for the product in general, and benefits all the firms in the market, and a second part corresponds to advertising for the brand, which only benefits the firms that have incurred advertising expenditure. We write s the share of advertising expenditure corresponding to advertising for the product, *i.e.* the level of advertising spillovers.

Effect of trade mark

Regarding the function of trade mark, we stick to the legal definition and consider that trade marks prevent other parties from benefiting from the reputation built by the firm by creating confusion on the origin of the product. We assume that in the absence of trade mark, the competitor is able to imitate not only the functional features of the product, but also its appearance and the signs referring to the brand image (*e.g.* the brand name). In that case, no part of the advertising expenditure can be appropriated by the firm. Advertising expenditure and goodwill have therefore the characteristics of a public good: they benefit all the firms present in the market (the level of advertising spillovers s is equal to 1). When a trade mark is filed, confusion on the origin of the product is on the contrary not possible, so that a non-null share of advertising expenditure, $0 < 1 - s < 1$, only benefits the firm which has incurred them (this share corresponding to advertising for the brand).

A key assumption of our model is that if the innovating firm files a trade mark, all the advertising expenditure incurred during the monopoly period correspond to advertising for the brand and benefit only its own goodwill. The reputation of the product during the monopoly period coincides with the reputation of the monopoly brand, so that the brand entirely captures the reputation of the product. This means that the follower will benefit from no spillover on the advertising expenditure incurred during the monopoly period. Indeed to benefit from the spillovers, since the respective brand images of the leader and the follower are not confusable, the follower needs first to start to advertise its product so that the customers realise that the products are identical. The advertising spillovers are then only effective in the second period when the follower enters the market. By contrast if the leader files no trade mark, the competitor can play on confusion and thus benefit from advertising expenditure incurred by the leader in all periods, including the monopoly period, as customers mistakenly attribute the goodwill of the leader to the product sold by the competitor.

In summary, the amount of goodwill benefiting the leader and the follower in the second period, depending on the fact that a trade mark has been filed or not, are the following:

	Trade mark	No trade mark
Leader	$(1-\delta)a_1 + a_2 + s\overline{a_2}$	$(1-\delta)a_1 + a_2 + \overline{a_2}$
Follower	$sa_2 + \overline{a_2}$	$(1-\delta)a_1 + a_2 + \overline{a_2}$

where a_2, $\overline{a_2}$ are the advertising expenditure incurred in the second period by the leader and the follower respectively, a_1 is the advertising expenditure incurred by the leader in the first period, δ is the depreciation rate of advertising over the two periods, and $0 < s < 1$ is the amount of advertising spillovers in case of trade mark.

Inverse demand function

We assume that the inverse demand function facing each firm in the market is negatively related to the quantities sold by each firm. We then assume that advertising increases customers' willingness to pay for the product (Brady 2009), so that the goodwill stock has a positive impact on the price for a given quantity sold. The inverse demand function facing each firm is given by:

$$P(Q_t, \overline{Q_t}, G_t),$$

with $\frac{\partial P}{\partial Q_t} < 0$; $\frac{\partial P}{\partial \overline{Q_t}} < 0$ and $\frac{\partial P}{\partial G_t} > 0$,

where Q_t and $\overline{Q_t}$ are the quantities sold by the firm and its competitor in t, and G_t represents the goodwill stock of the firm.

Moreover we assume linear costs of production, so that in each period the profit of the firm is given by:

$$\pi_t = (P(Q_t, \overline{Q_t}, G_t) - c)Q_t - a_t, \tag{2.2}$$

where c is the marginal cost of production, and a_t are the advertising expenditure incurred in t.

b. *Outcome of trade mark filing*

Based on the above framework, we derive the outcome of trade marking on the profits of the firms. We then compare the respective benefit of trade marking for the leader and for the follower. The inter-temporal profit of the innovating firm is, from (2.1) and (2.2):

$$\begin{aligned} V &= (P(Q_1, 0, a_1) - c)Q_1 - a_1 + r(P(Q_2, \overline{Q_2}, G_2) - c)Q_2 - ra_2 - (1_{TM=1})\, C_{TM} \\ &= \pi_1(Q_1, a_1) + r(P(Q_2, \overline{Q_2}, G_2) - c)Q_2 - ra_2 - (1_{TM=1})\, C_{TM}, \end{aligned}$$

and the inter-temporal profit of the follower is:

$$\overline{V} = r(P(\overline{Q_2}, Q_2, \overline{G_2}) - c)\overline{Q_2} - r\overline{a_2} - (1_{TM=1})\, C_{TM},$$

where $1_{TM=1}$ denotes the fact that the firm registered a trade mark not, and C_{TM} is the registration cost of the trade mark.

Case with trade mark

If a trade mark is filed, the goodwill benefiting respectively the leader and the follower are:

$$G_2 = (1 - \delta)a_1 + a_2 + s\overline{a_2}$$

and

$$\overline{G_2} = sa_2 + \overline{a_2},$$

The model is solved through backward induction: the firms first determine their optimal levels of advertising expenditure and quantities sold in the second period considering the advertising expenditure of the leader in the first period given, and then the leader maximizes its inter-temporal profit on the choice variables of the first period.

- *1st step: maximization of the second period profits on Q_2, $\overline{Q_2}$, a_2, $\overline{a_2}$, considering a_1 given:*

The respective programs of the leader and of the follower are given by:

$$\max_{Q_2,a_2}(P(Q_2,\overline{Q_2},G_2)-c)Q_2-a_2 \Leftrightarrow \max_{Q_2,a_2}(P(Q_2,\overline{Q_2},(1-\delta)a_1+a_2+s\overline{a_2})-c)Q_2-a_2$$

and

$$\max_{\overline{Q_2},\overline{a_2}}(P(\overline{Q_2},Q_2,\overline{G_2})-c)\overline{Q_2}-\overline{a_2} \Leftrightarrow \max_{\overline{Q_2},\overline{a_2}}(P(\overline{Q_2},Q_2,sa_2+\overline{a_2})-c)\overline{Q_2}-\overline{a_2}$$

The system of first order conditions corresponding to the maximization programs is:

$$\begin{cases} \frac{\partial P\left(Q_2,\overline{Q_2},(1-\delta)a_1+a_2+s\overline{a_2}\right)}{\partial Q_2}Q_2+P\left(Q_2,\overline{Q_2},(1-\delta)\,a_1+a_2+s\overline{a_2}\right)-c=0 \\ \frac{\partial P\left(Q_2,\overline{Q_2},(1-\delta)a_1+a_2+s\overline{a_2}\right)}{\partial a_2}Q_2=1 \\ \frac{\partial P\left(\overline{Q_2},Q_2,sa_2+\overline{a_2}\right)}{\partial Q_2}\overline{Q_2}+P\left(\overline{Q_2},Q_2,sa_2+\overline{a_2}\right)-c=0 \\ \frac{\partial P\left(\overline{Q_2},Q_2,sa_2+\overline{a_2}\right)}{\partial \overline{a_2}}\overline{Q_2}=1 \end{cases}$$

The system yields the following Nash-Cournot equilibrium:

$$\begin{cases} Q_2=\overline{Q_2}=Q_2^{TM*} \\ (1-\delta)\,a_1+a_2+s\overline{a_2}=sa_2+\overline{a_2}=G_2^{TM*} \end{cases} \Leftrightarrow \begin{cases} Q_2=\overline{Q_2}=Q_2^{TM*} \\ \overline{a_2}=\frac{G_2^{TM*}}{(1+s)}+\frac{s(1-\delta)a_1}{(1-s^2)} \\ a_2=\frac{G_2^{TM*}}{(1+s)}-\frac{(1-\delta)a_1}{(1-s^2)} \end{cases}$$

where G_2^{TM*} and Q_2^{TM*} are the optimal levels of goodwill and quantity sold in the second period, which are equal for the leader and for the follower.

- *2nd step: maximization on Q_1, a_1:*

The leader then chooses Q_1 and a_1 which maximize its inter-temporal profit, Q_1^{TM*} and a_1^{TM*}. The inter-temporal profits of the leader and the follower in case they file a trade mark are:

$$\begin{aligned} V^{TM} = \quad & \pi_1\left(Q_1^{TM*}, a_1^{TM*}\right) + r\left(P\left(Q_2^{TM*}, Q_2^{TM*}, G_2^{TM*}\right) - c\right) Q_2^{TM*} \\ & -r\left(\frac{G_2^{TM*}}{(1+s)} - \frac{(1-\delta)\,a_1^{TM*}}{(1-s^2)}\right) - C_{TM} \end{aligned} \tag{2.3}$$

and

$$\overline{V}^{TM} = r\left(P\left(Q_2^{TM*}, Q_2^{TM*}, G_2^{TM*}\right) - c\right) Q_2^{TM*} - r\left(\frac{G_2^{TM*}}{(1+s)} + \frac{s\,(1-\delta)\,a_1^{TM*}}{(1-s^2)}\right) - C_{TM} \tag{2.4}$$

Case without trade mark

If no trade mark is filed, the goodwill benefiting the leader and the follower in the second period is:

$$G_2 = \overline{G_2} = (1-\delta)\,a_1 + a_2 + \overline{a_2},$$

- *1st step: maximization of the second period profits on Q_2, $\overline{Q_2}$, a_2, $\overline{a_2}$, considering a_1 given:*

$$\max_{Q_2, a_2}\left(P\left(Q_2, \overline{Q_2}, (1-\delta)\,a_1 + a_2 + \overline{a_2}\right) - c\right) Q_2 - a_2$$

and

$$\max_{\overline{Q_2},\overline{a_2}} \left(P\left(\overline{Q_2}, Q_2, (1-\delta)\, a_1 + a_2 + \overline{a_2}\right) - c\right) \overline{Q_2} - \overline{a_2}$$

The programs of the two firms in the second period are symmetrical, and the system of first order conditions yields the following Nash-Cournot equilibrium:

$$\begin{cases} Q_2 = \overline{Q_2} = Q_2^{noTM*} \\ (1-\delta)\, a_1 + a_2 + \overline{a_2} = G_2^{noTM*} \end{cases} \Leftrightarrow \begin{cases} Q_2 = \overline{Q_2} = Q_2^{noTM*} \\ a_2 = \overline{a_2} = \frac{G_2^{noTM*} - (1-\delta) a_1}{2} \end{cases}$$

- *2nd step: maximization on Q_1, a_1:*

The leader then chooses Q_1 and a_1 which maximize its inter-temporal profit, Q_1^{noTM*} and a_1^{noTM*}. The inter-temporal profits of the leader and the follower in case no trade mark is filed are:

$$\begin{aligned} V^{noTM} = \quad & \pi_1 \left(Q_1^{noTM*}, a_1^{noTM*}\right) + r \left(P\left(Q_2^{noTM*}, Q_2^{noTM*}, G_2^{noTM*}\right) - c\right) Q_2^{noTM*} \\ & - r \frac{G_2^{noTM*} - (1-\delta)\, a_1^{noTM*}}{2} \end{aligned} \tag{2.5}$$

$$\overline{V}^{noTM} = r \left(P\left(Q_2^{noTM*}, Q_2^{noTM*}, G_2^{noTM*}\right) - c\right) Q_2^{noTM*} - r \frac{G_2^{noTM*} - (1-\delta)\, a_1^{noTM*}}{2} \tag{2.6}$$

Comparison of trade marking benefits

The respective benefits of trade marking for the leader and for the follower are thus given by, from 2.3 - 2.6:

$$
\begin{aligned}
V^{TM} - V^{noTM} = \quad & \pi_1 \left(Q_1^{TM*}, a_1^{TM*} \right) + r \left(P \left(Q_2^{TM*}, Q_2^{TM*}, G_2^{TM*} \right) - c \right) Q_2^{TM*} \\
& - r \left(\frac{G_2^{TM*}}{(1+s)} - \frac{(1-\delta)\, a_1^{TM*}}{(1-s^2)} \right) - \pi_1 \left(Q_1^{noTM*}, a_1^{noTM*} \right) \\
& - r \left(P \left(Q_2^{noTM*}, Q_2^{noTM*}, G_2^{noTM*} \right) - c \right) Q_2^{noTM*} \\
& + r \frac{G_2^{noTM*} - (1-\delta)\, a_1^{noTM*}}{2} - C_{TM}
\end{aligned}
$$

$$
\begin{aligned}
\overline{V}^{TM} - \overline{V}^{noTM} = \quad & r \left(P \left(Q_2^{TM*}, Q_2^{TM*}, G_2^{TM*} \right) - c \right) Q_2^{TM*} - r \left(\frac{G_2^{TM*}}{(1+s)} + \frac{s\,(1-\delta)\, a_1^{TM*}}{(1-s^2)} \right) \\
& - r \left(P \left(Q_2^{noTM*}, Q_2^{noTM*}, G_2^{noTM*} \right) - c \right) Q_2^{noTM*} \\
& + r \frac{G_2^{noTM*} - (1-\delta)\, a_1^{noTM*}}{2} - C_{TM}
\end{aligned}
$$

So the difference of benefits is:

$$
\begin{aligned}
\left(V^{TM} - V^{noTM} \right) - \left(\overline{V}^{TM} - \overline{V}^{noTM} \right) = \quad & \pi_1 \left(Q_1^{TM*}, a_1^{TM*} \right) - \pi_1 \left(Q_1^{noTM*}, a_1^{noTM*} \right) \\
& + r \frac{(1-\delta)\, a_1^{TM*}}{(1-s)}
\end{aligned}
\tag{2.7}
$$

Besides, we have a_1^{TM*} chosen to maximize the inter-temporal profit of the leader in case a trade mark is filed, so $V^{TM}\left(a_1^{TM*}\right) > V^{TM}\left(a_1^{noTM*}\right)$. Rewriting this inequality according to (2.3), this gives:

$$\pi_1\left(Q_1^{TM*},a_1^{TM*}\right)+r\left(P\left(Q_2^{TM*},Q_2^{TM*},G_2^{TM*}\right)-c\right)Q_2^{TM*}$$
$$-r\left(\frac{G_2^{TM*}}{(1+s)}-\frac{(1-\delta)\,a_1^{TM*}}{(1-s^2)}\right)>$$
$$\pi_1\left(Q_1^{noTM*},a_1^{noTM*}\right)+r\left(P\left(Q_2^{TM*},Q_2^{TM*},G_2^{TM*}\right)-c\right)Q_2^{TM*}$$
$$-r\left(\frac{G_2^{TM*}}{(1+s)}-\frac{(1-\delta)\,a_1^{noTM*}}{(1-s^2)}\right)$$
$$\Leftrightarrow$$
$$\pi_1\left(Q_1^{TM*},a_1^{TM*}\right)-\pi_1\left(Q_1^{noTM*},a_1^{noTM*}\right)>$$
$$r\left(\frac{G_2^{TM*}}{(1+s)}-\frac{(1-\delta)\,a_1^{TM*}}{(1-s^2)}\right)-r\left(\frac{G_2^{TM*}}{(1+s)}-\frac{(1-\delta)\,a_1^{noTM*}}{(1-s^2)}\right)$$

If we transpose this inequality to (2.7), this gives:

$$\left(V^{TM}-V^{noTM}\right)-\left(\overline{V}^{TM}-\overline{V}^{noTM}\right)>$$
$$r\left(\frac{G_2^{TM*}}{(1+s)}-\frac{(1-\delta)\,a_1^{TM*}}{(1-s^2)}\right)-r\left(\frac{G_2^{TM*}}{(1+s)}-\frac{(1-\delta)\,a_1^{noTM*}}{(1-s^2)}\right)+r\frac{(1-\delta)\,a_1^{TM*}}{(1-s)}$$
$$\Leftrightarrow$$
$$\left(V^{TM}-V^{noTM}\right)-\left(\overline{V}^{TM}-\overline{V}^{noTM}\right)>$$
$$r\frac{(1-\delta)\,a_1^{noTM*}}{(1-s^2)}+rs\frac{(1-\delta)\,a_1^{TM*}}{(1-s^2)}>0$$

So the benefit of trade marking is comparatively higher for the leader than the follower.

c. *Model implications*

The results of the previous model suggest that innovators have a higher incentive than non-innovators to file for trade marks. Indeed, innovating firms benefit from a temporary monopoly period during which their brand reputation coincides with the product reputation. When they then face competition, trade marks enable them to appropriate not only part of the advertising expenditure incurred during the competition period, but also the reputation built during their monopoly period. Thus innovative firms benefit comparatively more than non-innovative ones from filing a trade mark to protect their brand. This implies that we should observe a positive correlation between firms' innovative activity and trade mark use.

The framework of the model applies to innovations that are at the interface with consumers and which can be advertised, typically product or marketing innovations, or any innovation relating to characteristics of products or services that the consumer is likely to value. The results are less likely to apply to process or organizational innovations, which take place inside firms, and that consumers are presumably less likely to value per se. However, in certain cases the model could apply to some process or organizational innovations when those innovations directly affect the consumer's experience of the product (e.g. innovations in the way to deliver products such as those implemented by *UPS*). This is why in the following we empirically test the existence of a link between trade mark use and all the different types of innovation: product, process, marketing and organizational innovations.

To sum up, the various hypotheses that we deduce from our theoretical model and that we propose to test empirically are the following:

- *H1: There is a positive correlation between trade mark use and product and marketing innovations at the firm level.*
- *H2: To a lower extent, process and organizational innovations may be positively correlated to trade mark use as long as those innovations have an impact on the consumer's experience of the product.*

Furthermore, the link between trade marks and innovation is likely to be subject to reverse causalities, as firms that have a strong brand and which file for trade marks in order to protect it have in return an incentive to innovate. Indeed, according to the marketing literature, the building of a strong brand involves differentiating from other competitive offers, which, according to Elliott and Percy (2007), can be achieved through various incremental innovations, especially marketing innovations, e.g. innovations concerning distribution outlets (e.g. *Pizza Hut* mini stores in supermarkets), packaging, the use of cause-related marketing, celebrities associated to the promotion of the product, or also the "fashionisation" of functional objects (e.g. *Nokia* selling mobile phones with a range of alternative covers). This enables firms to attract new customers for the brand or to adopt a certain positioning. In our empirical analysis, we therefore test the presence of endogeneity stemming from reverse causalities.

2.3.2 Empirical investigation

a. Data

In the following subsections, the link between innovative activity and trade mark use is tested empirically, relying on innovation survey data at the firm level. The French results of the Community Innovation Survey (CIS) 2008 were used, covering 20114 firms, distributed between manufacturing, service, and other sectors (mining and electricity, gas and water supply). The data include a range of variables characterizing firms' innovative behaviours over the years 2006-2008, in particular information on the introduction or not by the firm of different types of innovation (product, process, organisational and marketing innovations), as well as general information on the firm such as main activity (Nace Rev. 2 code), number of employees and turnover in initial and final year of observation (2006-2008).

Those firm-level data were also matched to the database described in the previous section resulting from the matching of ORBIS© with IPR data. This enabled us to have further information on the firm – especially the age (inferred from the year of incorporation in ORBIS©), which is an important determinant of trade mark behaviour and which is not available in CIS results –, and detailed information on the IPR activity of firms. The reason why we had to rely on those matched data was that, contrary to previous waves, the 2008 wave of the Community Innovation

Survey did not contain information on IPR activity. Besides, this strategy makes it possible to have continuous information on the IPR activity of the firm (number of applications filed in each year), whereas the information contained in previous waves of CIS is only binary (has the firm used this type of IPR or not). Restricted to firms included in ORBIS© and for which the variable "year of incorporation" is not missing, the final sample contains 19967 observations.

b. Trade mark use and introduction of different types of innovation across sectors

The following subsection presents basic statistics on the use of trade marks by innovative and non-innovative firms, by type of innovation. The purpose is to see whether the firms that innovate do use trade marks, and whether they use them more frequently than non innovative firms. We present the results for the whole sample and also separately for various categories of sectors (high-tech and low tech manufacturing, knowledge-intensive services and other services). We also present the same statistics for patents, that are used here as a benchmark of innovation proxy. This also allows us to compare the patterns of use of the two different types of IPR.

In the previous section we hypothesized that trade marks can be related to different types of innovation, as long as it has an interface with the consumer, a feature that can be advertised or that the consumer is likely to value. Here we present the results separately for each type of innovation investigated in the Community Innovation Survey 2008 (product, process, organisational or marketing innovations), although we expect trade marks to have a stronger link with product and marketing innovation.

The detailed statistics of trade mark and patent use at the European and at the national levels according to innovation behaviours are presented in Appendix 2.B.

Trade marks and product innovations

Figure 2.9 shows the proportion of firms filing at least one trade mark/patent application (either at the national or at the European level) in the subsamples of product-innovative and not product-innovative firms across sectors. If trade marks were to be a perfect indicator of product innovation we would observe the highest proportion of trade mark use by product innovating firms (100%), and the lowest proportion (0%) of trade mark use in the sample of non-product innovating firms. In addition, the figure reports the mean square contingency coefficient (phi-coefficient), reflecting the correlation between trade mark use and introduction of a product innovation, corresponding to the Pearson correlation coefficient estimated for two binary variables[19].

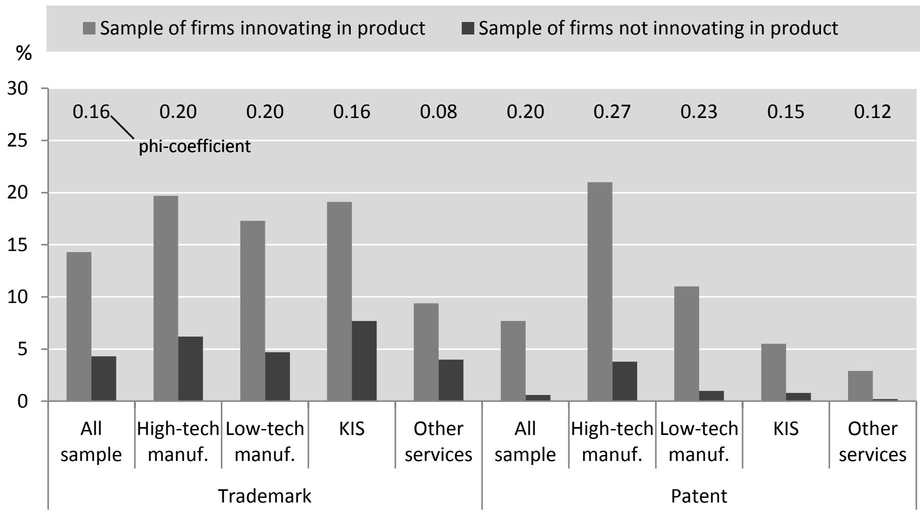
Overall, product innovating firms are more active in trade marking and patenting than non-innovating ones in all sectors. Product innovating firms in high-tech manufacturing sectors tend to use patents more than trade marks, whereas the reverse is true for firms in the service sectors, and to a lower extent for firms in the low-tech manufacturing sectors. However, although patents are less frequently used by product innovating firms in low-tech manufacturing and service sectors, the gap between the proportion of firms using them among innovative firms and among non innovative firms is higher for patents than for trade marks. The number of product innovating firms depositing trade marks in low-tech manufacturing and in services is higher than those depositing patents, but the number of not product innovating firms depositing trade marks is also higher. The phi-coefficient, measuring the association between IPR-use and product innovation is higher for patents in low-tech manufacturing sectors (0.23 vs 0.20 for trade marks) and in other services (0.12 vs 0.08 for trade marks), and it is similar in

[19]The phi-coefficient measures the association of two dichotomous variables as follows: Let us assume two dichotomous variables X and Y, and the following contingency table:

		X	
		0	1
Y	0	a	b
	1	c	d

where a, b, c, and d correspond to the frequencies of observations, then $\phi = \frac{ad-bc}{\sqrt{(a+b)(c+d)(a+c)(b+d)}}$. The phi-coefficient corresponds to the square root of the chi-square divided by the total number of observation. The advantage of this measure compared to the chi-square is that it is not sensitive to the number of observation, so that it can be compared across different samples with different sizes (here, across the different categories of sectors).

Figure 2.9: Share of French firms filing trade mark/patent applications in 2006-2008 across sectors, according to product innovation behaviour



Source: Author's compilation on CIS 2008 results, matched with trade mark and patent applications data.

Notes: The statistics are weighted, using sampling weights adjusted for non response. Sector categories correspond to Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons respectively.

knowledge-intensive services (0.15 for patents and 0.16 for trade marks). This may imply that trade marks are less appropriate than patents to measure product innovation whatever the sector. We investigate this point further in the multivariate analysis presented at the end of this section.

Trade marks and marketing innovations

The same exercise was performed with marketing innovation. Figure 2.10 presents the proportion of firms that file trade mark or patent applications in the subsamples of marketing innovative firms and non-marketing innovative firms.

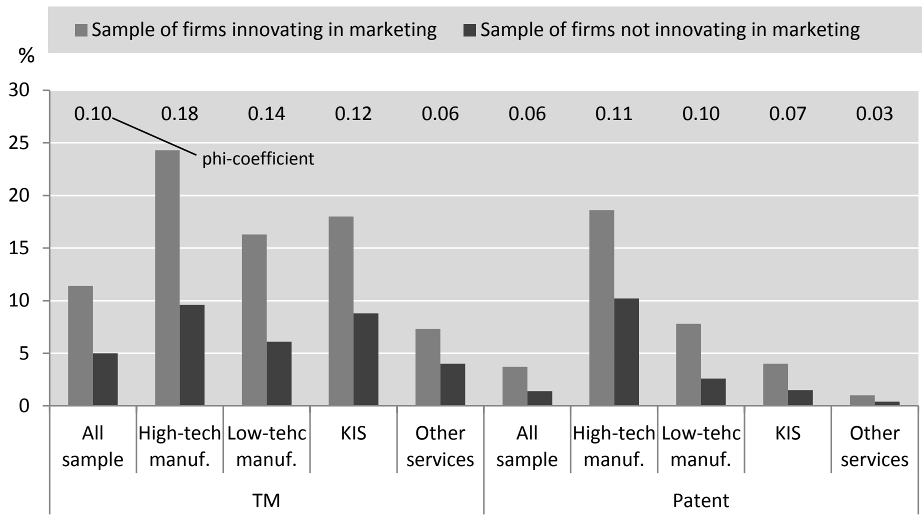
Marketing innovative firms appear to be more active than others in patenting and trade marking. Besides, the gap between innovative firms and non-innovative firms is deeper for trade marks than for patents, as in all sectors the phi-coefficient is higher for the former than for latter. This suggests that those types of innovations are better reflected by trade marks than by patents.

Comparing those results to the previous ones on product innovation, we observe that the share of firms using trade marks among marketing innovative firms is generally lower than among product innovative firms (respectively 11% and 14% on the whole sample), except in high-tech manufacturing sectors where 24% of marketing innovating firms use trade marks, against 20% of product innovating firms. This may suggest that firms in high-tech sectors, although they do not as a priority use trade marks to protect their product innovations, rely on trade marks for other types of activities such as those related to marketing.

Trade marks and process and organisational innovations

Finally, we performed the same exercise on process and organisational innovations (Figures 2.11 and 2.12). Those types of innovation generally take place during the production process, and are not valued by the consumers per se. According to our theoretical model, there is no benefit to use trade marks in association to in-

Figure 2.10: Share of French firms filing trade mark/patent applications in 2006-2008 across sectors, according to marketing innovation behaviour



Source: Author's compilation on CIS 2008 results, matched with trade mark and patent applications data.

Note: The statistics are weighted, using sampling weights adjusted for non response. Sector categories correspond to Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons respectively.

novation in those cases, so that we expect the link between trade marks and those types of innovation to be weaker.

As expected, trade mark use seems less associated to process and even less with organisational innovations. In all sectors, the share of innovating firms using trade marks is lower for those types of innovations than for product or marketing innovations. Besides, the phi-coefficient for trade mark use and innovation is relatively low, suggesting a weak link with those types of innovation. For process innovation, firms seem to rely more on patents than on trade marks, at least in manufacturing sectors where the phi-coefficient is equal to 0.13 for patents, against 0.10 for trade marks[20]. For organisational innovation, the phi-coefficient for trade marks as for patents is very low in all sectors (although it is relatively high, 0.12, for trade marks in high-tech manufacturing sectors, it is much lower than for product or marketing innovations), which suggests that those types of innovation are generally not protected by IPRs.

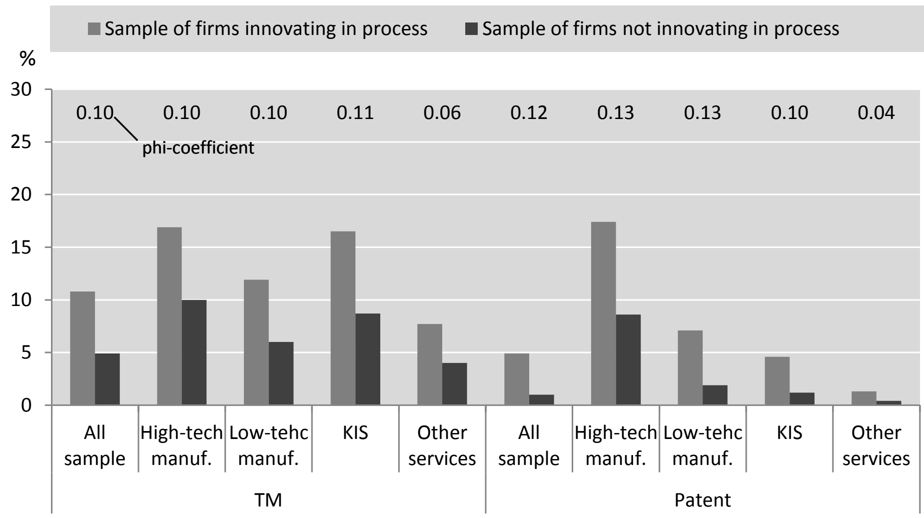
However, the correlation between trade mark use and process and organisational innovations is still positive. Indeed, we may assume the different types of innovations to be related to each other, and that changes in process and organisation may lead to the introduction of product or marketing innovations, which as far as they are concerned take place at the interface with the market. Through this channel, we may observe that trade mark use is also related to process or organisational innovations.

Summary of correlations – multidimensional mapping of trade mark use andvarious innovation types

The basic statistics presented above provide a first insight into the link existing between trade marks and various types of innovation, considering each type of innovation separately. However, as mentioned above, all the various types of

[20]It should be noted that for service firms, trade marks seem to play a comparatively more important role for process innovation, which may be explained by the fact that the frontier between product and process innovations is less clear in service sectors.

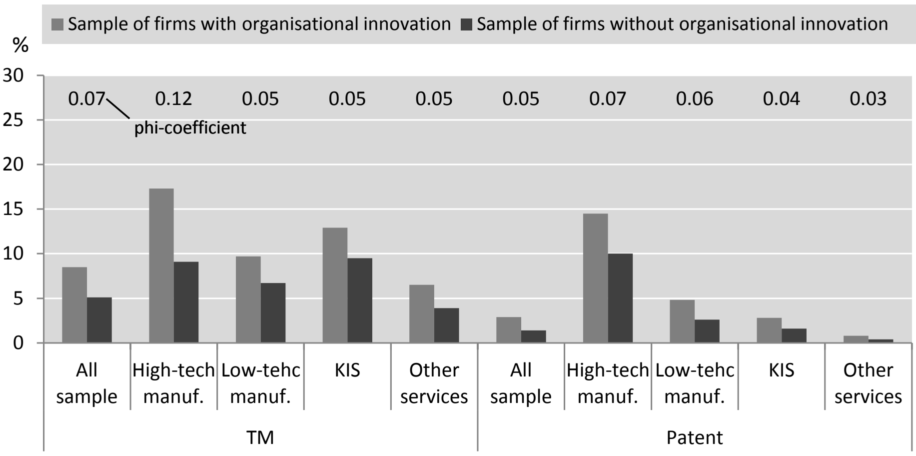
Figure 2.11: Share of French firms filing trade mark/patent applications in 2006-2008 across sectors, according to process innovation behaviour



Source: Author's compilation on CIS 2008 results, matched with trade mark and patent applications data.

Note: The statistics are weighted, using sampling weights adjusted for non response. Sector categories correspond to Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons respectively.

Figure 2.12: Share of French firms filing trade mark/patent applications in 2006-2008 across sectors, according to organisational innovation behaviour



Source: Author's compilation on CIS 2008 results, matched with trade mark and patent applications data.
Note: The statistics are weighted, using sampling weights adjusted for non response. Sector categories correspond to Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons respectively.

innovation are generally themselves correlated between each other, as introducing an innovation is likely to bring other types of innovations. A number of firms, examples of which are *Mc Donalds* or *Ikea*, tend to be innovative in all dimensions: product, process, marketing or organisational innovations. In the following paragraph, we consider all the different types of innovations together, in order to see how trade marks do relate to the various types of innovations when taking those interactions into account.

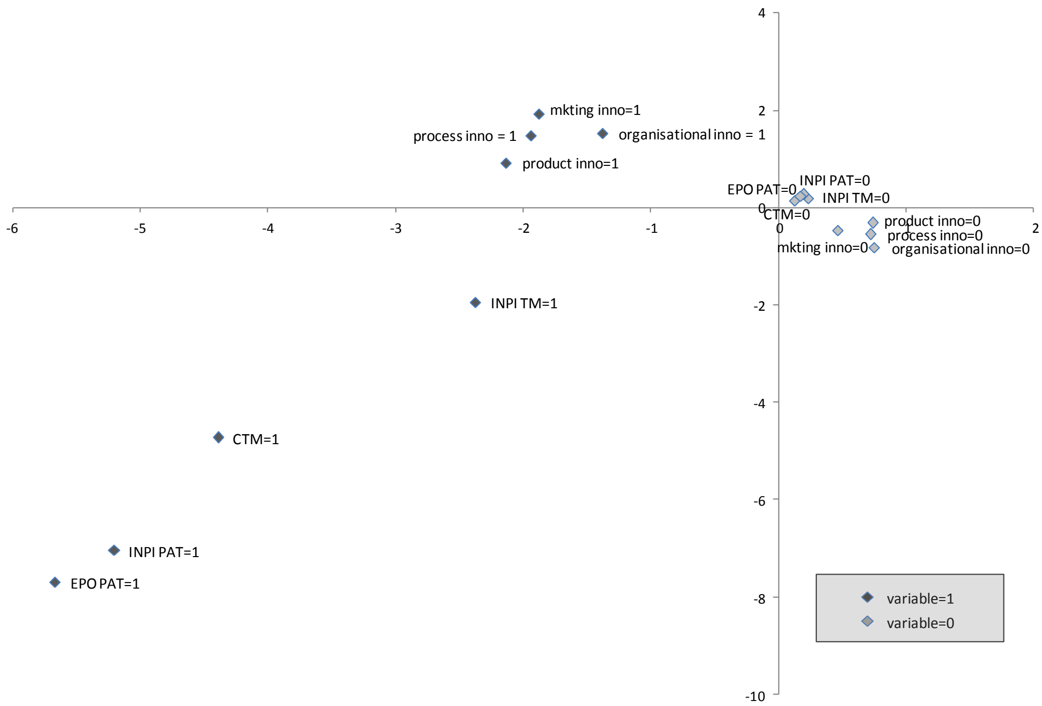
We present the results of multidimensional mapping exercises aiming at summarizing the association between trade mark use and the different innovation types. Two data analysis techniques were used, reaching different levels of results. First we present a multi-correspondence analysis (MCA), which provides a mapping of all the modalities of the different variables, enabling us to explore the proximity between trade mark use and the fact that firms are innovating or not in different types of innovation. Second, a classic multidimensional scaling (MDS) of variables was used in order to have more precisions on the proximity between the different innovation variables.

Multiple Correspondence Analysis

To explore which types of innovations tend to co-occur together and which ones tend to co-occur with trade mark use, we performed a MCA on the dichotomous variables of trade mark use and the different types of innovation presented above. MCA is a descriptive method designed to examine relationships between more than two categorical variables. The object of MCA is to summarize the rows (individuals, here the firms) and columns (categorical variables) of a data table in a low dimensional-space, so that proximity in the space reflects similarity of categories or individuals. The proximity between categories of the different variables indicates that those categories tend to happen together in the observations. MCA computes the total variation (inertia) of the data matrix based on Chi-2 statistics (measuring the distance separating the original distribution from the distribution assuming that the variables are independent). The more discriminating dimensions are then retained based on the percentage of inertia explained. (see Le Roux and Rouanet 2010 for a detailed explanation of the MCA methodology).

Two axes were retained in the multiple correspondence analysis, which explain 84% of the total inertia of the data (the first axis explains 75% and the second, 9%). The first axis, horizontal, reflects innovativeness in general, with all modalities of innovation variables equal to one found on the left hand side of the graph, and modalities equal to zero found on the right hand side (Figure 2.13). The modalities of trade mark and patent variables are also distributed in the same way along this first axis, which suggests that trade marks and patents are related to innovative behaviour, confirming our previous findings. Along this dimension, the types of IPRs which seem to be the most strongly related to innovativeness are patents (EPO ones followed by national ones), followed by Community trade marks, and lastly national trade marks, which still appear clearly on the left hand side of the graph.

Figure 2.13: Multiple correspondence analysis on trade mark use and types of innovation



Source: Author's compilation on CIS 2008 results, matched with trade mark and patent applications data.

Note: INPI TM, CTM, INPI PAT, EPO PAT correspond to the dichotomous variable indicating if the firm has applied for the corresponding IPR during the years 2006 to 2008.

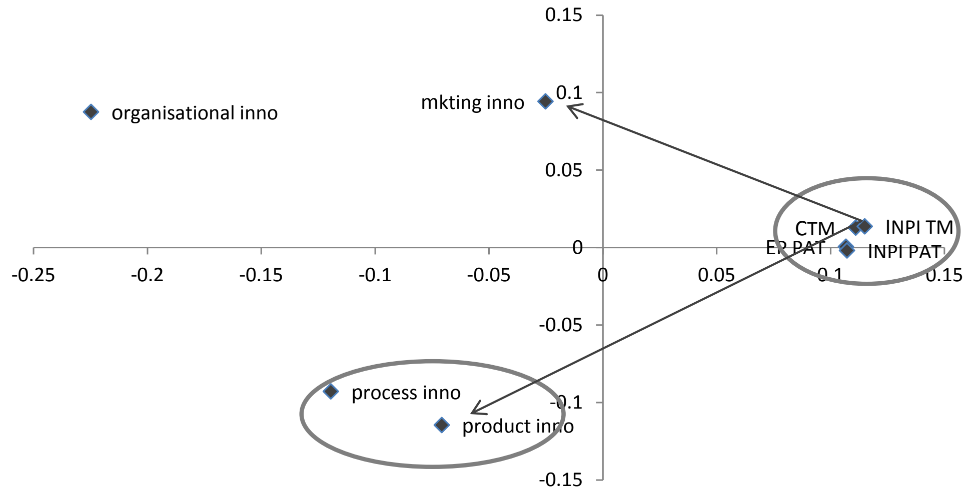
The second axis, vertical, tends to differentiate between technological (product and process) and non-technological (marketing and organisational) innovations. Yet we can notice that all innovation types variables are found very close to each other, which suggests that the various types of innovation are highly correlated. However, we can observe that modalities indicating trade mark use, both at national and European level are found closer to product innovation than to other types of innovation. This supports the idea that the relation between trade marks and innovation is mainly conveyed by the characteristics of the product, which are those valued by consumers, which tends to be in line with our theoretical model.

Multidimensional scaling

To get further insights into how the different types of innovation relate to each other, we performed also a classic MDS of the previous variables. We first computed a dissimilarity matrix of the various variables included in the analysis, reporting the Euclidian distance separating each variable from each other, based on the value they take for the various observations in the dataset. This dissimilarity matrix served as a basis for representation in a low-dimensional space. One major difference with the previous analysis is that MDS plots similarities between variables whereas MCA presents proximities between modalities taken by categorical variables (0 or 1 in the case of dichotomous variables). Thus, contrary to the previous one, this exercise does not retain the innovativeness (innovation=0/1) as an explaining factor, which enables us to explore more dimensions of similarities and dissimilarities between the various variables. (See Borg and Groenen 2005 for a detailed presentation of multidimensional scaling techniques).

The two dimensions retained by the MDS overall explain 80% of the variance (60% for the horizontal axis and 20% for the vertical axis). The vertical axis, as previously, seems to differentiate technological (product and process) from non-technological innovations (organisational and marketing). The horizontal axis, on the other hand, seems to differentiate innovations according to their market vis-

Figure 2.14: Multidimensional scaling of trade mark use and types of innovation



Source: Author's compilation on CIS 2008 results, matched with trade mark and patent applications data.
Note: INPI TM, CTM, INPI PAT, EPO PAT correspond to the dichotomous variable indicating if the firm has applied for the corresponding IPR during the years 2006 to 2008.

ibility, organisational and process innovations being placed on the left hand side compared to marketing and product innovation (Figure 2.14). Variables regarding trade mark and patent use are all found very close to each other, on the right hand side of the graph, which suggests that they are first and foremost associated to innovations with market visibility. They do not seem to be strongly explained by the technological/non-technological dimension, although patents appear slightly below trade marks on the graph, closer to technological innovations. The type of innovation which is found closest to trade mark use is marketing innovation, followed by product innovation. Lastly, product innovation and process innovation are found to be strongly associated, which could imply that trade marks are associated also to process innovation through their proximity to product innovation. Organisational innovations are found relatively distant from all the other variables.

In sum, those two different mapping exercises enabled us to get insights into how the different types of innovation relate to each other and to the use of trade marks by firms. We find trade mark use to be strongly associated to innovativeness of firms in general, and more specifically we find trade marks to be more closely associated to innovations which are at the interface with the market, namely product and marketing innovations. This is in line with our theoretical assumptions that the relation between trade marks and innovation is mainly conveyed by characteristics of the product, which are those valued by consumers, an assumption which is supported by the statement of Abbing (2010) that " brand can best be defined as the relationship an organisation has with the outside world". However, the various types of innovations are themselves found to be strongly associated to each other, particularly product and process innovations, so that trade marks may also be associated to other types of innovation. Those exploratory results are analysed in more details in a multivariate econometric model, which is the object of the next and final subsection.

c. Multivariate econometric model

This final subsection investigates the link between trade mark use and various types of innovation through an econometric analysis. To test the hypotheses resulting from our theoretical model, our general strategy consists in regressing trade mark use on variables relating to innovation behaviour, taken as independent variables. Previous studies aiming at analysing the link between trade marks and innovation have generally adopted the reverse approach, regressing variables relating to innovation (such as turnover associated to new product) on trade marking activity (Schmoch 2003, Götsch and Hipp 2012). In our theoretical framework, in contrast, the sense of causality is assumed to be from innovation to trade mark use, as we state that innovating firms have higher incentives to use trade marks than other firms. What we seek to investigate is not the innovative behaviour of firms depending on their trade marking activities, but their IPR strategy choices depending on their innovative activities. This why we choose to use firm trade marking activity here as the dependent variable.

In the following subsection, we consider the overall trade marking activity of the firm including both the applications made at the national and at the European levels.

In addition to variables reflecting the innovation behaviour of firms (introduction of different types of innovations, share of turnover associated to the introduction of new products), the set of explanatory variables includes various characteristics of firms, which are likely to have an impact on the trade marking behaviour of firms:

- **Number of employees**: in all the following regressions, we control for size, as scale effects are likely to affect both innovative and IPR activities of firms. We use the log of the number of employees in 2008 as a proxy for size.

- **Age**: in the previous section of this chapter, we observed that age is an important determinant of trade marking behaviour of firms. Although firms are likely to apply for trade marks in the very beginning of their life cycle when they enter the market, protecting their corporate brand, mature firms are also likely to apply for trade marks, as they have less financial constraints and are more likely to protect their valuable assets, and in particular their reputation built over the years. Besides, as stated by Götsch and Hipp (2012), experienced firms are more likely to use trade marks as they have gained more knowledge on existing laws and IPR over the years, and have a better sense of which instruments are useful or not. We thus expect a positive effect of age on trade marking activity of firms.

- **Firm is part of an enterprise group**: on the one hand, one may argue that being part of a group, especially for young innovative firms, enables firms to access certain types of IPR management skills, so that it would have a positive impact on trade marking activity. On the other hand, as Götsch and Hipp (2012) argue, a firm that is not part of a group may apply for more trade marks as it cannot rely on the registered trade mark of the parent company, the latter being likely to manage all the IPR activity of the group in a centralized manner. The expected effect of this variable may then be either positive or negative.

- **Firm sells product in foreign markets**: we may expect that the larger the market scale of the firm, the more likely it is to use trade marks. Indeed, when products are sold only on a local market scale, there is generally no confusion on the origin of the product, and firms may rely on informal means instead of trade marks to protect their reputation. In contrast, the need of trade marks is more important when reaching a larger market scale, and especially when firms export their products or services on foreign markets, as trade marks can then be used as a signalling tool to enter new markets.

- **Past use of trade marks**: the use of trade marks is likely to be a persistent activity over time[21]. Firms that never experienced IPR use have to acquire knowledge on the IPR procedures, so that it may constitute a barrier to start this kind of activity. We thus control for the fact that firms already used trade marks in the past, by tracking their trade mark applications during the seven years before our sample period, from 1998 to 2005.

Table 2.4 lists all the different variables used in the regressions and their sources. General descriptive statistics for those variables, as well as the global correlation matrix, are provided in Appendix 2.C and Appendix 2.D.

Specification 1: Probit model considering all types of innovations

In a first step, we investigate whether trade marks are correlated to the various types of innovation. We do so using a probit model taking as dependent variable the dichotomous variable indicating whether the firm applied for trade marks during the years 2006 to 2008, and including all the dichotomous variables corresponding to each type of innovation in the set of explanatory variables, controlling for various variables likely to have an impact on trade marking activity, as described above[22]. The results are presented in Table 2.5.

[21] Innovation activities and patenting activities have for example been found to be persistent over time (Cefis 2003)

[22] In all the econometric analysis, we do not include sampling weights in the regressions, as the

Table 2.4: List of variables used in the regressions

Dependent variable	TM_dicho	Dummy variable: has the firm applied for TM at INPI or OHIM between 2006 and 2008 or not	INPI, OHIM
	TM	Number of TM applications filed by the firm at INPI or OHIM between 2006 and 2008	INPI, OHIM
Explanatory variables	Product inno	Dummy variable: has the firm introduced any product innovation between 2006 and 2008 or not	CIS
	Process inno	Dummy variable: has the firm introduced any process innovation between 2006 and 2008 or not	CIS
	Organ inno	Dummy variable: has the firm introduced any organisational innovation between 2006 and 2008 or not	CIS
	Mkting inno	Dummy variable: has the firm introduced any marketing innovation between 2006 and 2008 or not	CIS
	Turnover inno	Share of innovative turnover associated with product innovations (either new to the firm or new to the market)	CIS
	PAT_dicho	Dummy variable: has the firm applied for a patent at INPI or EPO between 2006 and 2008 or not	PATSTAT
	PAT	Number of patent applications filed by the firm at INPI or EPO between 2006 and 2008	PATSTAT
	Group	Dummy variable Is the firm part of an enterprise group or not	CIS
	Foreign market	Dummy variable: does the firm sell products in the foreign market or not	CIS
	L_employees	Log of the number of employees in 2008	CIS
	Age	Age of the firm in 2008 (based on incorporation date)	ORBIS
	TM_stock_dicho	Dummy variable: did the firm filed TM applications at OHIM or INPI between 1998 and 2005 or not	INPI, OHIM
	Sector dummies	Dummy variables for sector based on NACE Rev. 2: depending on specification, either 2 digit NACE codes or high-tech, low-tech manufacturing, knowledge-intensive, less knowledge-intensive services, other sectors based on Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons respectively	CIS

Table 2.5: Results of the Probit model considering all types of innovations across sectors

	(1)	(2)	(3)	(4)	(5)
Sample	All firms	High-tech manuf.	Low-tech manuf.	KIS	Other services
Model	Probit	Probit	Probit	Probit	Probit
Dependent variable	TM_dicho	TM_dicho	TM_dicho	TM_dicho	TM_dicho
Product inno	0.223** (0.039)	0.306** (0.108)	0.373** (0.070)	0.211** (0.081)	0.048 (0.080)
Process inno	0.020 (0.039)	-0.055 (0.102)	0.001 (0.070)	-0.009 (0.086)	0.086 (0.079)
Organ inno	-0.092** (0.035)	0.083 (0.097)	-0.214** (0.065)	-0.037 (0.077)	-0.065 (0.070)
Mkting inno	0.202** (0.036)	0.196+ (0.101)	0.262** (0.070)	0.078 (0.078)	0.136* (0.069)
Group	-0.026 (0.034)	-0.065 (0.115)	-0.128+ (0.071)	-0.032 (0.069)	-0.016 (0.060)
Foreign market	0.258** (0.034)	0.353* (0.147)	0.205** (0.066)	0.142* (0.066)	0.218** (0.062)
Age	0.001 (0.001)	0.002 (0.002)	0.000 (0.001)	0.002 (0.001)	-0.001 (0.001)
L_employees	0.124** (0.011)	0.067+ (0.036)	0.184** (0.027)	0.087** (0.022)	0.174** (0.020)
TM_stock_dicho	1.313** (0.031)	1.289** (0.087)	1.223** (0.058)	1.228** (0.066)	1.300** (0.059)
High-tech manuf.	0.131+ (0.070)				
Low-tech manuf.	0.173** (0.061)				
Knowledge intensive services	0.395** (0.061)				
Other services	0.159** (0.058)				
_cons	-2.607** (0.062)	-2.122** (0.192)	-2.442** (0.110)	-1.456** (0.288)	-2.804** (0.126)
Sector dummies (2digit)	No	Yes	Yes	Yes	Yes
Pseudo R^2	0.283	0.291	0.310	0.262	0.274
N	19967	1805	5067	3450	6933

Notes: Coefficients correspond to marginal effects. The regressions are unweighted . Robust probit model estimates. Standard errors are given within parentheses. **p<0.01 *p<0.05 +p<0.1
Aggregate sector categories correspond to Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons respectively. Firms outside manufacturing and services sectors are used as the reference variable.

Overall, when introducing all types of innovations together in the set of explanatory variables, we find that trade marks are significantly and positively correlated with product and marketing innovation, which is in line with our theoretical model, whereas they are not significantly related to process innovation, and negatively and significantly related to organizational innovation. Significant positive coefficients are found for product innovation in all sectors, except in other services where no significant link is observed, and where only marketing innovation is found significantly related to trade marking activity. This may be explained by the relatively low level of innovation activities in those sectors, which may concentrate all their innovative efforts on incremental innovations such as marketing ones. Besides marketing innovation is found to be significantly and positively correlated to trade mark use in all sectors except in knowledge-intensive services, where no significant correlation is found. In those sectors, only product innovation is found significantly correlated with trade marking activity, which suggests that those firms rely comparatively less on innovations related to marketing. In all categories of sectors, no significant link is found between process innovations and trade mark use. The same is observed for organizational innovations, except in low-tech manufacturing sectors where a significant negative coefficient is obtained. This suggests that in those sectors, firms which are likely to introduce organizational innovations are different from those relying on market reputation and which are likely to introduce trade marks. Further investigations at a more detailed level of sector would be needed to interpret this result more precisely.

Regarding the other determinants of trade mark use, as expected, we find that size is significantly and positively related to trade marking activity in all sectors, bigger firms being more likely to file trade mark applications than smaller ones. In contrast, age is never significant, which may be due to the fact that this variable is highly correlated with size. The exporting activity of the firm, as expected, is found to relate positively with the use of trade marks. Being part of a group tends to have

strata to which those weights refer are selected based on firm sector and size, which are already controlled for in the regressions. All the results are then presented unweighted.

a negative impact on trade marking activity in all sectors, although only significant in low-tech manufacturing sectors. This suggests that in low-tech manufacturing, more than in other industries, firms which are part of a group tend to have their trade marks registered at the level of the group. Finally, trade marking activity is found to be highly persistent, the fact to have already used trade marks in the past having a significant link with the present use of trade marks.

As shown in the results on the whole sample (regression 1), the sectors which appear to rely most on trade marks are in knowledge-intensive services. High-tech manufacturing firms in contrast tend to rely less on trade marks than low-tech manufacturing firms or service firms. Those results may be due to the fact that high-tech manufacturing firms, more than in other sectors, rely on other types of intellectual property protection, such as patents. We come back on this point in the second specification of this multivariate analysis.

The same regressions were run separately at the European and national levels, the results are presented in Appendix 2.E. On the whole sample, the results are similar at both levels of trade mark applications: trade mark use is found to be significantly and positively correlated with product and marketing innovation, whereas the correlation with process innovation is not significant and is significantly negative for organisational innovations. Product innovation is always significantly positively related to trade marks in manufacturing sectors, whereas for service sectors, product innovation is found significantly correlated to trade marking activity only in knowledge-intensive services at the national level. This may be explained by the fact that services are less likely to be exported than goods, so that firms in service sectors tend to need international protection for their product innovations less than manufacturing firms, and tend to use less Community trade marks. Marketing innovations, as far as they are concerned, tend to be more strongly correlated to trade mark use at the national level, which might be due to the fact that those types of innovation are more dependent on cultural factors and less likely to be extended to foreign markets. It might also reflect the fact that marketing innovations tend to be of lower value than product innovations, so that they are mostly protected only at the national level, which is less expensive than a Community trade mark. Overall, the explanatory power of the model is higher for Community trade marks (around 40%) than for national trade marks (around 25%), which suggests that innovative activity is a stronger explanatory factor for Community trade marks, whereas national trade marks may be also determined by other unobserved factors.

Specification 2: Refined model considering product innovation and patent use

In the following, we focus on product innovation, and we investigate whether trade marks are likely to bring additional information to patent indicators in various sectors. We analyse the determinants of firms' trade marking activity, considering here product innovation as explanatory variable and controlling for patent activity, in addition to the same set of firm characteristics as above. To test the robustness of our results, we use two types of specifications: the first one considers, as above, dichotomous variables of IPR and innovation activity, and the second one considers discrete variables for IPR activity (total number of trade mark/patent applications filed by the firm during the years 2006 to 2008) and a continuous variable for product innovation (the share of turnover associated to new products). We rely on probit model estimations for the dichotomous specifications and on negative-binomial regressions for the continuous ones. Indeed in the second type of regressions, the dependent variable corresponds to a count data (taking only integer positive values), which is why we choose a count model specification. Furthermore, this variable shows signs of overdispersion, as the variance is much larger than the mean (see descriptive statistics in Appendix 2.C), which is why we use the Negative Binomial specification rather than a Poisson model.

The relation between trade marking activity and product innovation is also likely to be subject to reverse causalities, as firms that invest in branding and file for trade mark applications are likely to introduce product innovations in order to differentiate from other competitive offers and keep their brand strong (Elliott and Percy 2007). We thus run in addition instrumented regressions in order to take this possible endogeneity into account[23].

We use two different instruments for product innovation: support, which corresponds to the dummy variable indicating whether the firm received some public financial support for innovation during the years 2006-2008, and process innovation. Indeed, the attribution of support for innovation is by definition related to the innovative activity of the firm and is a priori not linked to trade mark use: criteria to receive public support tend to relate to various upstream innovation activities such as research and development expenditure rather than to the following commercial exploitation of the innovation. As far as process innovation is concerned, the previous analyses of this chapter tend to show that trade marks are not significantly related to this type of innovation otherwise than through its link to other types of innovations, such as product innovation. As stated by Götsch and Hipp (2012), "it does not seem to make much sense to protect back office activities such as process innovations which are not directly recognized by the market. However, it seems more likely that a firm will protect new products or marketing innovations by using trade marks." As we saw in the previous analyses, product and process innovations are strongly correlated, so that process innovation is also a good candidate to be used as an instrument for product innovation[24]. Both instruments, *support* and *process* innovation, are dichotomous variables and are taken from the Community Innovation Survey results. The results of the probit and negative binomial estimations are shown in Tables 2.6 and 2.7, respectively.

Overall, the positive relationship between trade marks and product innovation still holds when controlling for patent use, as we obtain a significant positive coefficient in the total sample. This is true both at the dichotomous and continuous

[23]Results of the Durbin and Wu-Hausman test run after 2-stage least square regressions conclude that the product innovation variable is indeed endogenous: the hypothesis of exogeneity of the product innovation variable is not accepted at 5% level.

[24]Results of the Hansen test of overidentifying restrictions, run after gmm estimation of the model, tend to conclude in favour of joint validity of the two instruments, the Hansen statistics obtained is 0.91, associated to a p-value of 0.34.

Table 2.6: Results of Probit model on product innovation across sectors

	(6)	(7)	(8)	(9)	(10)	(11)
Sample	All sample	All sample	High-tech manuf.	Low-tech manuf.	KIS	Other services
Model	Probit	Probit IV	Probit IV	Probit IV	Probit IV	Probit IV
Dependent variable	TM_dicho	TM_dicho	TM_dicho	TM_dicho	TM_dicho	TM_dicho
Product inno	0.217**	0.337**	0.347	0.350*	0.318*	0.321*
	(0.034)	(0.072)	(0.226)	(0.139)	(0.124)	(0.164)
PAT_dicho	0.499**	0.464**	0.716**	0.479**	0.613**	0.597**
	(0.056)	(0.059)	(0.109)	(0.104)	(0.154)	(0.201)
Group	-0.019	-0.025	-0.065	-0.133+	-0.025	-0.014
	(0.034)	(0.034)	(0.118)	(0.070)	(0.069)	(0.060)
Foreign market	0.236**	0.216**	0.271+	0.195**	0.095	0.189**
	(0.034)	(0.035)	(0.159)	(0.067)	(0.068)	(0.064)
Age	0.001	0.001+	0.002	0.000	0.002	-0.001
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
L_employees	0.111**	0.104**	-0.005	0.154**	0.077**	0.165**
	(0.011)	(0.012)	(0.039)	(0.029)	(0.023)	(0.021)
TM_stock_dicho	1.296**	1.283**	1.210**	1.184**	1.192**	1.265**
	(0.031)	(0.032)	(0.094)	(0.060)	(0.068)	(0.061)
High-tech manuf.	0.045	0.030				
	(0.072)	(0.073)				
Low-tech manuf.	0.167**	0.166**				
	(0.061)	(0.061)				
Knowledge intensive services	0.429**	0.419**				
	(0.061)	(0.061)				
Other services	0.201**	0.209**				
	(0.058)	(0.058)				
_cons	-2.563**	-2.556**	-1.759**	-2.314**	-1.391**	-2.756**
	(0.062)	(0.063)	(0.197)	(0.112)	(0.287)	(0.127)
Sector dummies (2digit)	No	No	Yes	Yes	Yes	Yes
N	19967	19967	1805	5067	3450	6933

Notes: The regressions are unweighted. Robust estimates. Stata QVF package was used to estimate the instrumented negative binomial regressions (see Hardin, Schmiediche and Carroll 2003). Standard errors are given within parentheses. **p<0.01 *p<0.05 +p<0.1.

Aggregate sector categories correspond to Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons respectively. Firms outside manufacturing and services sectors are used as the reference variable.

Table 2.7: Results of Negative Binomial regressions on product innovation across sectors

	(12)	(13)	(14)	(15)	(16)	(17)
Sample	All sample	All sample	High-tech manuf.	Low-tech manuf.	KIS	Other services
Model	NegBin	NegBin IV	NegBin IV	NegBin IV	NegBin IV	NegBin IV
Dependent variable	TM	TM	TM	TM	TM	TM
Turnover inno	0.009** (0.002)	0.019** (0.006)	0.010 (0.011)	0.022* (0.011)	0.011+ (0.007)	0.057** (0.015)
PAT	0.002** (0.000)	0.002** (0.000)	0.001** (0.000)	0.003+ (0.002)	0.003 (0.004)	-0.000 (0.043)
Group	0.061 (0.099)	0.087 (0.101)	0.126 (0.263)	-0.162 (0.153)	0.050 (0.179)	-0.124 (0.178)
Foreign market	0.612** (0.102)	0.375** (0.105)	0.408 (0.304)	0.455* (0.180)	0.204 (0.172)	0.238 (0.166)
Age	0.002 (0.002)	0.005** (0.002)	0.008* (0.003)	0.001 (0.002)	0.007** (0.003)	0.001 (0.003)
L_employees	0.368** (0.030)	0.360** (0.029)	0.215** (0.069)	0.539** (0.062)	0.280** (0.043)	0.367** (0.051)
TM_stock_dicho	2.844** (0.084)	2.784** (0.087)	2.873** (0.225)	2.199** (0.138)	2.479** (0.156)	2.776** (0.156)
High-tech manuf.	0.352+ (0.185)	0.391* (0.192)				
Low-tech manuf.	0.384* (0.169)	0.331* (0.165)				
Knowledge intensive services	1.066** (0.171)	0.927** (0.175)				
Other services	0.319* (0.152)	0.344* (0.159)				
_cons	-4.770** (0.164)	-4.735** (0.167)	-3.893** (0.515)	-5.597** (0.398)	-4.381** (0.394)	-6.105** (0.508)
Sector dummies (2digit)	No	No	Yes	Yes	Yes	Yes
N	19967	19967	1805	5067	3450	6933

Notes: The regressions are unweighted. Robust estimates. Stata QVF package was used to estimate the instrumented negative binomial regressions (see Hardin, Schmiediche and Carroll 2003). Standard errors are given within parentheses. **p<0.01 *p<0.05 +p<0.1.

Aggregate sector categories correspond to Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons respectively. Firms outside manufacturing and services sectors are used as the reference variable.

level (regression (6) and (12) respectively), and this also holds on the total sample when the regressions are instrumented to take into account the possible endogeneity of the product innovation variable. When considering the results across sectors, the two specifications indicate that the positive relationship between trade marking activity and product innovation is significant in all categories of sectors except high-tech manufacturing sectors. This suggests that in those sectors, patents already capture most of the information on product innovations. Patents, for their part, tend to be overall positively related to trade marks. However, the results of the second specification suggest that this relationship tends to differ across sectors, as the coefficient for patents is the most significant in high-tech manufacturing sectors, followed by low-tech manufacturing sectors, whereas it is not significant in service sectors. In sum, the above results suggest that trade marks may bring significant additional information compared to patent on product innovation in low-tech manufacturing and in services sectors, whereas in high-tech manufacturing sectors, firms tend to rely first on patents to protect their product innovations, so that trade marks are comparatively less informative to measure product innovative activity in those sectors.

The following table summarises the results of our multivariate analyses, recapitulating the significant links we found between trade mark use and the various types of innovative activities across sectors. When no precision is made, the sign reported is significant for trade mark use both at the European and at the national level (except for product innovation controlling for patent use, for which the results are not differentiated between European and national levels).

Summary of multivariate analyses: significant links between trade mark use and innovative activities:

	All sample	High-tech manuf.	Low-tech manuf.	KIS	Other services
Product inno.	+	+	+	+ (national)	
Process inno.					
Organ. inno.	-		-		
Marketing inno.	+	+ (national)	+		+ (national)
Product inno., controlling for patent use	+		+	+	+

2.4 Conclusion

This chapter aimed at analysing firms' trade marking behaviour in order to understand which types of firms rely on trade marks, based on a purposely built exhaustive firm-level database encompassing the trade marking and patenting activity of French firms. It investigated whether trade marks are related to innovative activity across sectors by looking at the link between trade marks and various innovation types, as reflected in innovation survey results.

Through a theoretical model, we show that innovating firms have higher incentives than other firms to file for trade mark applications. Trade marks enable firms to protect their reputation built over time through advertising expenditure and in the case of innovative firms, they enable the firm to fully appropriate the reputation built during its monopoly period. Based on this framework, we conclude that trade marks are likely to be related to innovations that are at the interface with consumers and which can be advertised, typically product or marketing innovations, or any innovation relating to characteristics of products or services that the consumer is likely to value.

Overall, we find a significant and positive relationship between trade mark applications and product and marketing innovations, which is in line with our theoretical model, whereas no significant relationship is found with process and a negative correlation is found with organisational innovations. The relationship between trade mark use and product innovation is still significant when controlling also for patent applications, which suggests that using trade marks can bring further information on product innovation beyond patented innovations. The result holds when instrumenting the model to control for possible endogeneity of the product innovation variable. Differentiating by groups of sectors, trade marks are found to be significantly related to product innovations beyond patented ones in all sectors except in high-tech manufacturing.

To sum up, we can conclude that trade marks are used in relation to innovation for marketing innovations, and product innovation in services and low-tech manufacturing sectors, whereas patents do not seem to serve the purpose. Trade marks then represent a key-source of information for those types of innovation. High-tech manufacturing firms, despite their relatively high level of trade marking activity, mostly rely on patents to protect their product innovations. They may however use trade marks to protect other kinds of assets, in particular marketing innovations. In order to get insights on why trade marks may be more related to innovation in certain sectors than in others, we investigate in the next chapter how trade marks may interact with other possible appropriability means.

2.5 Appendices

Appendix 2.A Patterns of trade mark use by size, age, sector

Age distribution of French firms using trade marks

	2008					2005				
	# Firms	# CTM applications	# INPI TM applications	# CTM active firms	# INPI TM active firms	# Firms	# CTM applications	# INPI TM applications	# CTM active firms	# INPI TM active firms
[0]	38 040 (3.6%)	41 (1.4%)	775 (3.3%)	36 (2.5%)	585 (5.1%)	33 664 (3.8%)	32 (1.2%)	517 (2.8%)	27 (2.3%)	390 (4.8%)
[1]	101 600 (9.6%)	146 (5%)	1 986 (8.5%)	107 (7.6%)	1 380 (12.2%)	85 803 (9.8%)	76 (3%)	1 378 (7.6%)	58 (5%)	854 (10.6%)
[2]	96 102 (9.1%)	99 (3.4%)	1 492 (6.4%)	67 (4.8%)	967 (8.5%)	69 482 (7.9%)	82 (3.3%)	921 (5.1%)	56 (4.8%)	585 (7.2%)
[3-5]	216 174 (20.5%)	261 (9.1%)	3 251 (13.9%)	170 (12.2%)	1 975 (17.4%)	155 462 (17.8%)	279 (11.3%)	2 307 (12.7%)	161 (13.9%)	1237 (15.3%)
[6-10]	198 653 (18.8%)	369 (12.8%)	3 538 (15.2%)	214 (15.3%)	1 898 (16.8%)	178 343 (20.4%)	303 (12.2%)	3 013 (16.7%)	173 (14.9%)	1391 (17.3%)
[11-15]	139 066 (13.1%)	283 (9.8%)	3 065 (13.1%)	141 (10.1%)	1 331 (11.7%)	140 416 (16%)	263 (10.6%)	2 527 (14%)	157 (13.5%)	1185 (14.7%)
[16-20]	110 652 (10.5%)	249 (8.6%)	2 273 (9.7%)	147 (10.5%)	1 075 (9.5%)	85 785 (9.8%)	275 (11.1%)	1 838 (10.1%)	102 (8.8%)	743 (9.2%)
[21-25]	55 712 (5.2%)	241 (8.4%)	1 394 (5.9%)	95 (6.8%)	607 (5.3%)	39 645 (4.5%)	197 (7.9%)	900 (4.9%)	75 (6.4%)	378 (4.7%)
[26-30]	31 204 (2.9%)	139 (4.8%)	961 (4.1%)	73 (5.2%)	346 (3%)	25 457 (2.9%)	160 (6.4%)	799 (4.4%)	68 (5.8%)	288 (3.5%)
[31-40]	33 181 (3.1%)	271 (9.4%)	1 142 (4.9%)	111 (7.9%)	395 (3.4%)	28 138 (3.2%)	206 (8.3%)	1 067 (5.9%)	71 (6.1%)	315 (3.9%)
[41-50]	17 798 (1.6%)	215 (7.5%)	922 (3.9%)	70 (5%)	271 (2.3%)	21 030 (2.4%)	158 (6.4%)	1 045 (5.7%)	81 (7%)	309 (3.8%)
[51-60]	9 506 (0.9%)	129 (4.5%)	769 (3.3%)	58 (4.1%)	184 (1.6%)	4 495 (0.5%)	121 (4.9%)	599 (3.3%)	43 (3.7%)	122 (1.5%)
[61-70]	1 735 (0.1%)	81 (2.8%)	451 (1.9%)	21 (1.5%)	76 (0.6%)	1 209 (0.1%)	26 (1%)	162 (0.8%)	14 (1.2%)	49 (0.6%)
[70+]	4 112 (0.3%)	339 (11.8%)	1 215 (5.2%)	83 (5.9%)	207 (1.8%)	4 072 (0.4%)	289 (11.7%)	951 (5.2%)	71 (6.1%)	189 (2.3%)

Source: Author's compilation on ORBIS© data for France matched with trade mark applications data at INPI and OHIM.

Notes: The percentages between parentheses correspond to the share of the age cohort in the total sample. Firms with incorporation date '1900' were dropped from the sample, as this date appears to be used as a default value in ORBIS© and is most of the time not accurate.

Appendix 2.A (Continued) Patterns of trade mark use by size, age, sector

Sector distribution of French firms using trade marks (NACE Rev. 2)

			2008					2005				
			# Firms	# CTM applications	# INPI TM applications	# CTM active firms	# INPI TM active firms	# Firms	# CTM applications	# INPI TM applications	# CTM active firms	# INPI TM active firms
other	1	Crop & animal production, hunting & related service activities	9942	22	160	14	96	6932	22	129	11	85
other	2	Forestry & logging	2217	0	3	0	3	1524	2	7	2	3
other	3	Fishing & aquaculture	793	2	5	2	4	498	0	1	0	1
other	5	Mining of coal & lignite	6	0	0	0	0	7	0	0	0	0
other	6	Extraction of crude petroleum & natural gas	65	13	22	2	1	74	11	6	2	2
other	7	Mining of metal ores	26	0	0	0	0	28	0	0	0	0
other	8	Other mining & quarrying	1324	3	31	3	12	1407	3	20	2	10
other	9	Mining support service activities	45	0	0	0	0	33	0	1	0	1
low-tech	10	Manuf. of food products	20487	152	836	65	313	16833	105	792	49	293
low-tech	11	Manuf. of beverages	1582	69	281	30	80	1525	55	335	24	90
low-tech	12	Manuf. of tobacco products	5	0	1	0	1	5	0	14	0	1
low-tech	13	Manuf. of textiles	2192	13	83	8	40	2270	18	44	14	28
low-tech	14	Manuf. of wearing apparel	2839	43	132	25	67	2764	22	120	16	52
low-tech	15	Manuf. of leather & related products	774	12	23	8	13	793	7	23	5	16
low-tech	16	Manuf. of wood & of products of wood & cork, except furniture	4235	14	85	6	48	3964	6	56	4	25
low-tech	17	Manuf. of paper & paper products	1060	9	44	7	21	1097	7	32	7	22
low-tech	18	Printing & reproduction of recorded media	6987	3	82	2	51	7011	3	84	2	50
low-tech	19	Manuf. of coke & refined petroleum products	74	2	0	2	0	74	2	1	2	1
high-tech	20	Manuf. of chemicals & chemical products	1990	256	770	44	164	2133	196	553	38	121
high-tech	21	Manuf. of basic pharmaceutical products & preparations	350	97	320	23	45	386	76	303	18	51
low-tech	22	Manuf. of rubber & plastic products	3319	38	139	22	69	3480	44	128	19	57
low-tech	23	Manuf. of other non-metallic mineral products	3810	17	209	8	55	3657	66	138	11	49
low-tech	24	Manuf. of basic metals	766	9	24	5	10	816	5	20	4	10
low-tech	25	Manuf. of fabricated metal products, exc. mach. & equip.	13328	53	189	32	103	13302	54	211	32	103
high-tech	26	Manuf. of computer, electronic & optical products	2376	37	152	17	74	2691	56	139	30	64
high-tech	27	Manuf. of electrical equipment	1735	35	134	15	52	1759	37	132	21	41
high-tech	28	Manuf. of machinery & equipment n.e.c.	4871	55	167	33	84	5055	28	126	16	59
high-tech	29	Manuf. of motor vehicles, trailers & semi-trailers	1380	33	132	10	12	1383	50	118	10	23
high-tech	30	Manuf. of other transport equipment	602	37	51	11	22	604	39	54	9	27
low-tech	31	Manuf. of furniture	3835	21	46	11	37	3405	13	79	10	29
low-tech	32	Other manufacturing	5618	35	191	22	92	4933	54	222	33	102
low-tech	33	Repair & installation of machinery & equipment	10990	9	94	8	54	9666	13	111	8	59
other	35	Electricity, gas, steam & air conditioning supply	2593	3	79	2	23	1532	2	36	1	8
other	36	Water collection, treatment & supply	180	0	28	0	6	177	0	12	0	3
other	37	Sewerage	520	0	3	0	3	450	1	27	1	3
other	38	Waste collection, treatment & disposal activities; materials recovery	2571	2	40	1	21	2332	2	47	2	23
other	39	Remediation activities & other waste management services	74	0	1	0	1	60	0	0	0	0
other	41	Construction of buildings	19312	15	204	8	121	15648	8	114	7	63
other	42	Civil engineering	3789	8	56	5	23	3486	2	41	2	18
other	43	Specialised construction activities	136148	62	766	42	514	98160	33	585	31	373
lkis	45	Wholesale, retail trade & repair of motor vehicles & motorcycles	39315	24	212	18	114	35602	21	221	16	119
lkis	46	Wholesale trade, except of motor vehicles & motorcycles	81168	478	3113	235	1465	78333	433	2703	206	1207
lkis	47	Retail trade, except of motor vehicles & motorcycles	134706	102	1974	72	1131	110138	109	1406	48	731
lkis	49	Land transport & transport via pipelines	25554	25	197	10	82	20776	16	103	6	69
kis	50	Water transport	639	3	22	2	10	454	8	13	3	6
kis	51	Air transport	193	0	37	0	11	184	0	26	0	6
lkis	52	Warehousing & support activities for transportation	4620	10	107	6	47	4450	20	78	10	32
other	53	Postal & courier activities	452	0	9	0	4	369	1	3	1	2
lkis	55	Accommodation	22760	25	195	11	112	21573	16	194	10	96
lkis	56	Food & beverage service activities	66439	78	754	30	471	51208	28	441	18	283
other	58	Publishing activities	7355	56	936	31	387	7402	52	825	28	306
kis	59	Motion picture, video & tv prog. prod., sound record. & music publish.	8456	21	483	14	256	7506	12	409	9	182
kis	60	Programming & broadcasting activities	375	3	128	3	30	468	11	274	5	34
kis	61	Telecommunications	1515	3	372	2	61	1149	43	331	5	39
kis	62	Computer programming, consultancy & related activities	17893	151	864	58	528	13714	66	509	31	310
kis	63	Information service activities	3049	18	171	12	100	2612	20	133	11	65
kis	64	Financial service activities, except insurance & pension funding	48069	148	1506	82	537	38423	105	957	56	345
kis	65	Insurance, reinsurance & pension funding, exc. compuls. social security	298	3	338	2	37	255	5	91	4	31
kis	66	Activities auxiliary to financial services & insurance activities	12903	21	330	15	185	11197	20	202	10	101
lkis	68	Real estate activities	69059	23	609	18	387	60131	20	457	11	268
kis	69	Legal & accounting activities	11085	14	138	5	58	9788	13	100	4	31
kis	70	Activities of head offices; management consultancy activities	40370	170	1499	82	767	30461	141	1169	61	476
kis	71	Architectural & engineering activities; technical testing & analysis	31681	46	462	30	298	26126	32	239	23	162

Appendix 2.A (Continued) Patterns of trade mark use by size, age, sector

kis	72	Scientific research & development	1335	35	88	19	53	1112	30	76	14	38
kis	73	Advertising & market research	11068	29	593	19	331	10091	49	503	20	222
kis	74	Other professional, scientific & technical activities	6916	18	213	15	123	5311	19	98	13	60
other	75	Veterinary activities	697	0	0	0	0	332	0	0	0	0
lkis	77	Rental & leasing activities	7860	28	293	15	99	7280	15	203	9	59
kis	78	Employment activities	2485	4	83	3	50	1875	7	50	3	34
lkis	79	Travel agency, tour operator reservation service & related activities	3080	8	131	5	77	2935	7	94	5	53
kis	80	Security & investigation activities	3142	2	33	2	21	2378	1	14	1	13
lkis	81	Services to buildings & landscape activities	14079	6	85	6	61	10220	1	47	1	40
lkis	82	Office administrative, office support & other business support activities	11935	26	386	18	222	10089	38	288	28	152
other	84	Public administration & defence; compulsory social security	13	0	0	0	0	10	0	0	0	0
other	85	Education	11430	8	208	6	148	9186	4	125	3	89
other	86	Human health activities	12095	1	58	1	33	9229	6	35	5	21
other	87	Residential care activities	1705	0	9	0	5	1703	0	18	0	9
other	88	Social work activities without accommodation	1254	0	23	0	20	463	0	22	0	14
other	90	Creative, arts & entertainment activities	4043	11	112	3	82	3427	5	71	5	49
other	91	Libraries, archives, museums & other cultural activities	358	1	8	1	5	331	1	5	1	5
other	92	Gambling & betting activities	334	2	6	1	5	335	3	31	1	8
other	93	Sports activities & amusement & recreation activities	4843	11	96	5	69	4088	5	73	4	33
Other	94	Activities of membership organisations	94	1	3	1	3	51	0	1	0	1
Lkis	95	Repair of computers & personal & household goods	5589	0	29	0	23	3926	4	34	3	26
Other	96	Other personal service activities	26707	18	280	9	188	21521	6	203	6	114
High-tech manufacturing firms			13304	550	1726	153	453	14011	482	1425	142	386
Low-tech manufacturing firms			81901	499	2459	261	1054	75595	474	2410	240	987
Knowledge-intensive services			201472	689	7360	365	3456	163104	582	5194	273	2155
Less knowledge-intensive services			486164	833	8085	444	4291	416661	728	6269	371	3135

Source: Author's compilation on ORBIS© data for France matched with trade mark applications data at INPI and OHIM.
Note: Sector categories Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons respectively, restricted to private services.

Employment distribution of French firms using trade marks

	2008					2005				
	# Firms	# CTM applications	# INPI TM applications	# CTM active firms	# INPI TM active firms	# Firms	# CTM applications	# INPI TM applications	# CTM active firms	# INPI TM active firms
[1-5]	338 468 (68.7%)	273 (13%)	4 061 (28.5%)	187 (20.2%)	2 596 (43%)	262 138 (60%)	210 (11.5%)	2 964 (24.6%)	145 (17.5%)	1 806 (37%)
[6-9]	60 861 (12.3%)	135 (6.4%)	1 305 (9.1%)	85 (9.1%)	727 (12%)	69 849 (15.9%)	84 (4.6%)	1 075 (8.9%)	53 (6.4%)	600 (12.3%)
[10-19]	42 486 (8.6%)	125 (5.9%)	1 453 (10.2%)	84 (9%)	692 (11.4%)	47 034 (10.7%)	144 (7.9%)	1 176 (9.7%)	98 (11.8%)	584 (11.9%)
[20-49]	30 835 (6.2%)	236 (11.2%)	1 730 (12.1%)	142 (15.3%)	770 (12.7%)	36 326 (8.3%)	221 (12.1%)	1 736 (14.4%)	132 (15.9%)	727 (14.9%)
[50-249]	15 363 (3.1%)	451 (21.5%)	1 875 (13.1%)	215 (23.2%)	676 (11.1%)	17 115 (3.9%)	388 (21.3%)	1 981 (16.4%)	183 (22.1%)	641 (13.1%)
[250-499]	2 046 (0.4%)	99 (4.7%)	536 (3.7%)	48 (5.1%)	166 (2.7%)	2 290 (0.5%)	133 (7.3%)	607 (5%)	64 (7.7%)	163 (3.3%)
[500-999]	1 010 (0.2%)	144 (6.8%)	684 (4.8%)	47 (5%)	135 (2.2%)	1 054 (0.2%)	149 (8.1%)	544 (4.5%)	46 (5.5%)	125 (2.5%)
[1000+]	1 132 (0.2%)	632 (30.1%)	2 564 (18%)	116 (12.5%)	273 (4.5%)	1 067 (0.2%)	490 (26.9%)	1 960 (16.2%)	106 (12.8%)	231 (4.7%)

Source: Author's compilation on ORBIS© data for France matched with trade mark applications data at INPI and OHIM. Note: The percentages between parentheses correspond to the share of the size band in the total sample.

Appendix 2.B Trade mark and patent use according to innovating behaviour: share of firms using each type of IPR in each subsample, and phi-coefficient between IPR use and innovation

	Product innovation														
	All sample			High-Tech			Low-Tech			KIS			Other services		
	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ
TM	14.3	4.3	0.16	19.7	6.2	0.20	17.3	4.7	0.20	19.1	7.7	0.16	9.4	4.0	0.08
Patent	7.7	0.6	0.20	21.0	3.8	0.27	11.0	1.0	0.23	5.5	0.8	0.15	2.9	0.2	0.12
CTM	3.9	0.6	0.11	7.5	1.6	0.14	5.2	0.9	0.13	4.7	1.1	0.11	1.8	0.5	0.05
EPO patent	4.8	0.3	0.17	15.4	1.9	0.25	6.1	0.5	0.18	3.7	0.6	0.12	1.1	0.1	0.08
INPI TM	12.5	4.0	0.14	16.6	5.5	0.18	14.5	4.2	0.18	16.7	7.4	0.14	8.6	3.8	0.08
INPI patent	6.3	0.5	0.18	17.0	3.5	0.23	9.2	0.9	0.21	4.2	0.6	0.13	2.5	0.2	0.11
	Marketing innovation														
	All sample			High-Tech			Low-Tech			KIS			Other services		
	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ
TM	11.4	5.0	0.10	24.3	9.6	0.18	16.3	6.1	0.14	18.0	8.8	0.12	7.3	4.0	0.06
Patent	3.7	1.4	0.06	18.6	10.2	0.11	7.8	2.6	0.10	4.0	1.5	0.07	1.0	0.4	0.03
CTM	2.8	0.9	0.07	9.6	3.0	0.13	4.8	1.4	0.09	4.2	1.5	0.08	1.3	0.5	0.03
EPO patent	2.4	0.8	0.06	14.1	6.8	0.11	5.0	1.2	0.10	2.7	1.1	0.06	0.5	0.1	0.04
INPI TM	10.2	4.6	0.09	20.6	8.2	0.16	13.7	5.4	0.12	16.3	8.2	0.11	6.8	3.8	0.06
INPI patent	3.1	1.2	0.06	16.2	8.2	0.11	6.2	2.2	0.09	3.0	1.1	0.06	0.8	0.3	0.03
	Process innovation														
	All sample			High-Tech			Low-Tech			KIS			Other services		
	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ
TM	10.8	4.9	0.10	16.9	10.0	0.10	11.9	6.0	0.10	16.5	8.7	0.11	7.7	4.0	0.06
Patent	4.9	1.0	0.12	17.4	8.6	0.13	7.1	1.9	0.13	4.6	1.2	0.10	1.3	0.4	0.04
CTM	2.9	0.8	0.08	7.2	2.7	0.11	3.7	1.2	0.08	4.4	1.2	0.10	1.4	0.5	0.04
EPO patent	3.2	0.5	0.11	13.9	4.9	0.16	3.9	0.9	0.10	3.4	0.7	0.10	0.5	0.1	0.04
INPI TM	9.4	4.5	0.09	13.9	8.8	0.08	9.9	5.3	0.08	14.4	8.3	0.09	7.0	3.9	0.06
INPI patent	3.9	0.9	0.10	13.6	7.6	0.10	5.9	1.6	0.12	3.3	0.9	0.08	1.0	0.3	0.04
	Organisational innovation														
	All sample			High-Tech			Low-Tech			KIS			Other services		
	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ	Inno.	Not inno.	ϕ
TM	8.5	5.1	0.07	17.3	9.1	0.12	9.7	6.7	0.05	12.9	9.5	0.05	6.5	3.9	0.05
Patent	2.9	1.4	0.05	14.5	10.0	0.07	4.8	2.6	0.06	2.8	1.6	0.04	0.8	0.4	0.03
CTM	2.0	0.9	0.05	6.4	2.9	0.09	2.6	1.6	0.03	3.0	1.5	0.05	1.1	0.5	0.03
EPO patent	1.9	0.7	0.05	10.8	6.4	0.08	2.8	1.3	0.06	2.0	1.1	0.04	0.3	0.1	0.02
INPI TM	7.6	4.7	0.06	14.7	7.8	0.11	8.4	5.8	0.05	11.4	8.9	0.04	6.0	3.7	0.05
INPI patent	2.4	1.1	0.05	11.8	8.4	0.06	3.9	2.3	0.04	2.3	1.1	0.04	0.7	0.3	0.02

Source: Author's compilation on CIS 2008 results, matched with trade mark and patent applications data

Note: The statistics are weighted, using sampling weights adjusted for non response. Sector categories correspond to Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons respectively

Appendix 2.C Descriptive statistics on regressions used for the empirical analysis

Variable	Mean - unweighted	Mean - weighted	Std. dev. - unweighted	Std. dev. - weighted	Min	Max
Characteristics of the firm – continuous variables						
Employees	232.89	62.15	1836.63	687.33	10	145936
L_employees	3.82	3.21	1.44	0.91	2.30	11.89
Age	23.63	21.00	19.64	16.49	0	248
Turnover inno	6.83	4.98	18.41	16.26	0	100
Characteristics of the firm – dichotomous variables						
Group	45.27%	34.17%				
Foreign market	36.38%	27.04%				
Support	5.95%	3.69%				
Continuous IPR variables						
TM	0.69	0.26	7.48	3.24	0	703
CTM	0.13	0.04	2.95	1.17	0	380
INPI_TM	0.57	0.22	5.47	2.53	0	333
PAT	1.05	0.22	22.07	8.75	0	2117
EP_PAT	0.49	0.10	9.97	4.05	0	781
INPI_PAT	0.56	0.12	12.85	5.00	0	1336
Dichotomous IPR variables						
TM_dicho	10.00%	6.07%				
CTM_dicho	2.82%	1.20%				
INPI_TM_dicho	8.85%	5.52%				
PAT_dicho	4.43%	1.82%				
EP_PAT_dicho	3.00%	1.06%				
INPI_PAT_dicho	3.64%	1.50%				
TM_stock_dicho	14.90%	9.38%				
CTM_stock_dicho	4.57%	2.07%				
INPI_TM_stock_dicho	13.57%	8.72%				
Dichotomous innovation variables						
Product inno	25.68%	17.83%				
Process inno	27.16%	20.43%				
Organ inno	35.32%	29.44%				
Mkting inno	19.72%	16.73%				
Sector distribution						
High-tech manufacturing	4.81%	9.04%				
Low-tech manufacturing	19.55%	25.38%				
Knowledge-intensive services	15.34%	17.28%				
Other services	42.20%	34.72%				
Other sectors	18.11%	13.58%				

Appendix 2.D

Pairwise correlation matrix of the variables included in the regression

	L_employees	Age	Turnover inno	TM	CTM	INPI TM	PAT	EP PAT	INPI PAT	TM_dicho	CTM_dicho	INPI_TM_dicho	PAT_dicho	EP_PAT_dicho	INPI_PAT_dicho	TM_stock_dicho	CTM_stock_dicho	INPI_TM_stock_dicho	Product inno	Process inno	Organ inno	Mkting inno	Group	Foreign market	Support
L_employees	1																								
Age	0.24*	1																							
Turnover inno	0.10*	0.02*	1																						
TM	0.14*	0.06*	0.04*	1																					
CTM	0.07*	0.04*	0.03*	0.72*	1																				
INPI TM	0.14*	0.06*	0.04*	0.95*	0.47*	1																			
PAT	0.09*	0.03*	0.03*	0.49*	0.65*	0.33*	1																		
EP_PAT	0.09*	0.03*	0.03*	0.44*	0.55*	0.32*	0.96*	1																	
INPI_PAT	0.08*	0.02*	0.03*	0.49*	0.69*	0.32*	0.97*	0.87*	1																
TM_dicho	0.17*	0.06*	0.12*	0.31*	0.12*	0.34*	0.07*	0.06*	0.06*	1															
CTM_dicho	0.15*	0.07*	0.08*	0.29*	0.29*	0.24*	0.12*	0.12*	0.12*	0.43*	1														
INPI_TM_dicho	0.15*	0.05*	0.10*	0.31*	0.08*	0.36*	0.04*	0.04*	0.04*	0.95*	0.24*	1													
PAT_dicho	0.19*	0.06*	0.16*	0.14*	0.10*	0.13*	0.19*	0.19*	0.17*	0.20*	0.18*	0.17*	1												
EP_PAT_dicho	0.17*	0.04*	0.14*	0.13*	0.10*	0.13*	0.23*	0.25*	0.20*	0.16*	0.18*	0.13*	0.76*	1											
INPI_PAT_dicho	0.17*	0.06*	0.14*	0.13*	0.10*	0.12*	0.19*	0.18*	0.19*	0.19*	0.17*	0.16*	0.91*	0.58*	1										
TM_stock_dicho	0.20*	0.09*	0.13*	0.19*	0.08*	0.20*	0.06*	0.06*	0.05*	0.39*	0.25*	0.37*	0.20*	0.17*	0.18*	1									
CTM_stock_dicho	0.19*	0.09*	0.10*	0.21*	0.16*	0.19*	0.11*	0.11*	0.10*	0.29*	0.42*	0.22*	0.22*	0.21*	0.20*	0.45*	1								
INPI_TM_stock_dicho	0.18*	0.09*	0.12*	0.19*	0.07*	0.21*	0.05*	0.05*	0.04*	0.38*	0.20*	0.37*	0.17*	0.14*	0.16*	0.96*	0.30*	1							
Product inno	0.21*	0.03*	0.66*	0.07*	0.04*	0.07*	0.04*	0.04*	0.04*	0.16*	0.11*	0.14*	0.20*	0.17*	0.18*	0.17*	0.14*	0.15*	1						
Process inno	0.18*	0.03*	0.36*	0.05*	0.03*	0.05*	0.03*	0.03*	0.03*	0.10*	0.08*	0.09*	0.12*	0.11*	0.10*	0.09*	0.09*	0.08*	0.50*	1					
Organ inno	0.17*	0.01	0.22*	0.03*	0.02*	0.03*	0.02*	0.02*	0.02*	0.07*	0.05*	0.06*	0.05*	0.05*	0.05*	0.07*	0.05*	0.06*	0.32*	0.43*	1				
Mkting inno	0.09*	0.00	0.21*	0.05*	0.02*	0.05*	0.02*	0.02*	0.01*	0.10*	0.07*	0.09*	0.06*	0.06*	0.06*	0.09*	0.08*	0.09*	0.31*	0.31*	0.40*	1			
Group	0.36*	0.04*	0.09*	0.05*	0.03*	0.05*	0.03*	0.03*	0.03*	0.08*	0.08*	0.06*	0.08*	0.07*	0.07*	0.10*	0.10*	0.08*	0.14*	0.13*	0.12*	0.10*	1		
Foreign market	0.22*	0.12*	0.20*	0.07*	0.04*	0.07*	0.04*	0.04*	0.04*	0.17*	0.14*	0.15*	0.17*	0.14*	0.15*	0.20*	0.17*	0.18*	0.27*	0.19*	0.14*	0.13*	0.17*	1	
Support	0.11*	0.01*	0.21*	0.04*	0.02*	0.04*	0.05*	0.05*	0.05*	0.13*	0.09*	0.11*	0.20*	0.17*	0.18*	0.10*	0.08*	0.09*	0.29*	0.26*	0.14*	0.12*	0.03*	0.17*	1

Note: correlations taking into account sampling weights adjusted for non response. Stars denote 5% level significance of the correlation coefficient

Appendix 2.E Results of the Probit model considering all types of innovations results at the European level

	(1)	(2)	(3)	(4)	(5)
Sample	All firms	High-tech manuf.	Low-tech manuf.	KIS	Other services
Model	Probit	Probit	Probit	Probit	Probit
Dependent variable	CTM_dicho	CTM_dicho	CTM_dicho	CTM_dicho	CTM_dicho
Product inno	0.229**(0.061)	0.360*(0.156)	0.302**(0.104)	0.157(0.152)	0.136 (0.141)
Process inno	0.014(0.062)	0.030(0.140)	-0.049(0.107)	0.226(0.152)	-0.044 (0.134)
Organ inno	-0.099+(0.057)	-0.010(0.133)	-0.179+(0.098)	-0.164(0.139)	-0.036 (0.129)
Mkting inno	0.142*(0.059)	0.050(0.141)	0.228*(0.098)	0.018(0.133)	0.101 (0.145)
Group	0.084(0.060)	-0.009(0.172)	0.050(0.108)	0.086(0.124)	0.041 (0.123)
Foreign market	0.564**(0.062)	0.441(0.278)	0.544**(0.127)	0.657**(0.120)	0.443**(0.114)
Age	0.002*(0.001)	0.004+(0.002)	0.001(0.002)	0.005**(0.002)	-0.002 (0.002)
L_employees	0.136**(0.017)	0.130**(0.047)	0.232**(0.038)	0.069+(0.036)	0.196**(0.034)
CTM_stock_dicho	1.549**(0.055)	1.478**(0.116)	1.329**(0.099)	1.624**(0.124)	1.836**(0.125)
High-tech manuf.	0.283+(0.145)				
Low-tech manuf.	0.345*(0.139)				
Knowledge intensive services	0.383**(0.140)				
Other services	0.260+(0.136)				
_cons	-3.683**(0.143)	-3.238**(0.357)	-3.475**(0.186)	-2.561**(0.386)	-3.396**(0.212)
Sector dummies (2digit)	No	Yes	Yes	Yes	Yes
Pseudo R^2	0.391	0.358	0.369	0.370	0.429
N	19967	1805	5065	3191	6297

Notes: Coefficients correspond to marginal effects. Robust probit model estimates. Standard errors are given within parentheses. **p<0.01 *p<0.05 +p<0.1

Aggregate sector categories correspond to Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons respectively. Firms outside manufacturing and services sectors are used as the reference variable. In regression (5), firms in NACE Rev.2 sectors 53, 68, 81 were dropped from the sample as those variables predict failure perfectly.

Appendix 2.E (Continued) Results of the Probit model considering all types of innovations results at the national level

	(1)	(2)	(3)	(4)	(5)
Sample	All firms	High-tech manuf.	Low-tech manuf.	KIS	Other services
Model	Probit	Probit	Probit	Probit	Probit
Dependent variable	INPI_TM_dicho	INPI_TM_dicho	INPI_TM_dicho	INPI_TM_dicho	INPI_TM_dicho
Product inno	0.207** (0.040)	0.292** (0.110)	0.358** (0.072)	0.180* (0.082)	0.048 (0.081)
Process inno	0.018 (0.040)	-0.100 (0.104)	0.023 (0.072)	-0.043 (0.087)	0.097 (0.079)
Organ inno	-0.080* (0.036)	0.096 (0.101)	-0.181** (0.067)	-0.061 (0.077)	-0.040 (0.070)
Mkting inno	0.204** (0.037)	0.194+ (0.103)	0.258** (0.072)	0.110 (0.079)	0.120+ (0.069)
Group	-0.029 (0.035)	0.015 (0.118)	-0.163* (0.073)	-0.040 (0.070)	-0.015 (0.060)
Foreign market	0.201** (0.035)	0.258+ (0.148)	0.116+ (0.067)	0.082 (0.067)	0.186** (0.064)
Age	0.001 (0.001)	0.003+ (0.002)	-0.000(0.001)	0.001 (0.001)	-0.001 (0.001)
L_employees	0.117** (0.011)	0.039 (0.037)	0.163** (0.028)	0.093** (0.022)	0.162** (0.020)
INPI_TM_stock_dicho	1.293** (0.032)	1.308** (0.092)	1.202** (0.060)	1.228** (0.068)	1.238** (0.061)
High-tech manuf.	0.108 (0.071)				
Low-tech manuf.	0.127* (0.061)				
Knowledge intensive services	0.379** (0.060)				
Other services	0.137* (0.057)				
_cons	-2.558** (0.061)	-2.019** (0.196)	-2.329** (0.111)	-1.402** (0.290)	-2.809** (0.131)
Sector dummies (2digit)	No	Yes	Yes	Yes	Yes
Pseudo R^2	0.260	0.284	0.281	0.256	0.247
N	19967	1805	5067	3450	6933

Notes: Coefficients correspond to marginal effects. Robust probit model estimates. Standard errors are given within parentheses. **p<0.01 *p<0.05 +p<0.1

Aggregate sector categories correspond to Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons respectively. Firms outside manufacturing and services sectors are used as the reference variable.

CHAPTER 3

ASSESSING INTERACTIONS BETWEEN INTELLECTUAL PROPERTY RIGHTS: ARE TRADE MARKS AND PATENTS COMPLEMENTARY OR SUBSTITUTE STRATEGIES TO PROTECT INNOVATION?

3.1 Introduction

After having established in the previous chapter that trade marks can be used as means to appropriate the benefits of innovation, we seek to analyse in the present one their possible interactions with another type of appropriability means, namely patents[1]. A number of studies in the previous literature state that the benefits of innovations for firms strongly depend on their ability to develop complementary appropriability means (Teece 1986, Levin *et al.* 1987, Cohen *et al.* 2000). IPRs are a major factor of firms' appropriability strategies. Patents, which enable the protection of new technologies, are the most obvious type of IPRs related to innovation and the most extensively studied in economics literature. But patents alone do not guarantee that the firm will benefit from innovation. This also requires the development of market-based assets, to ensure the success of the commercialisation of the innovation (Rogers 1998, Jennewein 2005, Aaker 2007). Trade marks are one of these market-based assets. As seen in the previous chapter, they constitute an-

[1]This chapter is based on a paper co-authored with Patrick Llerena (Llerena and Millot 2013), which relies to a large extent on my theoretical modelling and statistical and econometric analyses.

other means of appropriating the benefits of innovation, whose effects are likely to be interrelated with the effects of patents.

While there are a number of studies on the complementarity between technological investments and advertising or marketing investments (Hirschey 1982, Snyder and King 2007, Brekke and Straume 2008, Askenazy *et al*. 2010), the relationship between patents and trade marks was rarely investigated. A few papers empirically tested the complementarity between patents and trade marks at the firm-level considering them as proxies for technological and marketing investments (Graevenitz and Sandner 2009, Schwiebacher 2010). However those studies did not disentangle the value of the IPRs (*i.e.* the patent or trade mark premium) and the value of the protected assets: the observed complementarity between IPRs mirrors the complementarity of their respective underlying investments. Somaya and Graham (2006), as far as they are concerned, observed complementarity effects in the joint use of various IPRs (namely copyrights and trade marks in software industries), which they explain mainly by economies of scales in organisational resources deployed for IP management. None of those studies investigated the interaction effects of IPRs in their core function as legal protection devices. Yet the effects of various protection means are likely to be interrelated. One might consider that the different types of protections tend to overlap so that their marginal effect would be lower when several types of IPRs are used. Nevertheless, patent and trade mark protections are also likely to reinforce each other. Indeed, the monopoly position that is established by a patent can favour the establishment of a strong trade mark and, in return, trade marks can be used to extend the benefits of the patents. Statman and Tyebjee (1981), for example, observe that due to brand loyalty, the expiration of patents for ethical drugs has only a minor effect on their market dominance. In their words, “the patent period is used to transfer the value of the patent into the trade mark”.

Our study addresses the interaction effects that occur between trade marks and patents as legal devices that enable the protection of a certain brand and a certain technology, respectively, disentangling the value of the IPRs and the value of their underlying investments. Through a basic model that encompasses the separate and combined effects on the profits of an innovating firm of using both IPRs, we analyse the conditions in which they can be considered substitute or complementary. For this, we rely on the concept of supermodularity, which enables complementarities to be addressed in a discrete-choice model environment (see Milgrom and Roberts 1990, 1995).

As in the previous chapter, the model consists of a duopoly in which one firm innovates (leader) and another imitates (follower), and in which each firm may choose to incur advertising expenditure. Those expenditure are not entirely appropriable, so that competitors can benefit from the effects of advertising spillovers. In this chapter, we introduce the possibility for the leader to patent its innovation or not. Filing a patent grants the right to prevent competitors from using the patented technology. Although patents do not always make it possible to perfectly exclude other firms from the market, they tend to decrease competition. In our model, we schematically assume that if the firm files a patent, it benefits from a monopoly power for a limited period, whereas without patent the innovation is instantaneously imitable by the competitor. For trade marks, we keep the same framework as in the previous chapter and consider that they grant the right to prevent other parties from creating confusion on the origin of the product and therefore benefiting from the reputation that has been built by the firm. Without trade mark, advertising has the characteristics of a public good and benefits equally all firms in the market, while filing a trade mark enables the firm to appropriate part of its advertising expenditure. In addition, if the firm registers a trade mark, the reputation that is built during the monopoly period entirely benefits the monopoly firm, so that the competitor does not benefit from any spillovers of advertising that is launched during the patent period. The interaction between patents and trade marks is then characterised by two counterbalancing effects: a substitution effect, as the trade mark has no impact on the firm's profit during the patent period, and a complementary effect, as the reputation built in the monopoly period has an impact *a posteriori* on the trade mark benefits after the patent has expired. The main prediction of our theoretical model is that the predominance of the complementarity or the substitution effect is not straightforward. Depending on the levels of advertising spillovers and depreciation rate, the two IPRs can be found to be either substitutes, or complements.

Using a firm-level database that encompasses the trade marking and patenting activity of a sample of publicly traded French firms, we test the complementary or substitute relationship between patents and trade marks across various sectors. We find that in chemical and pharmaceutical industries, where the depreciation rate of advertising is likely to be low and advertising spillovers high, the two IPRs tend to be complementary, whereas in high-tech business sectors (manufacture of computer, electronic and optical products and of electrical equipment), which are likely to be characterized by high advertising depreciation rates and low advertising spillovers, the two IPRs are found to be substitutes, which confirms our theoretical predictions.

The remainder of this chapter is organised as follows. As a preamble to the study, Section 3.2 presents some descriptive statistics on the joint or separate use of patents and trade marks, using the firm-level IPR database described in the previous chapter. Section 3.3 then lays out the theoretical framework that is used to describe the effects of trade mark and patent protections at the firm-level, from which we analytically derive some predictions on their complementary or substitute relationship. Finally, Section 3.4 presents our empirical strategy with which we test the model predictions and our main empirical findings.

3.2 Descriptive statistics

In the following, we use the database presented in the previous chapter (see Chapter 2, Data and matching methodology) to explore patterns of patent and trade mark use by French firms contained in the database ORBIS©, according to various characteristics of the firms. Using cross-section data for the year 2008, we investigate the combined or separate use of the two IPRs by firms, as a first indication of possible complementary or substitution effects.

3.2.1 Combined and separate use of patents and trade marks

On the whole sample, only a small minority of firms (1.3%) applied for trade marks or patents in 2008. Among them, the majority applied for trade marks only and no patents (1.11%), whereas only a small share applied for patents only (0.17%), and an even smaller share, only 0.05%, applied for both types of IPRs (Table 3.1). The latter result suggests that firms only rarely combine the two types of IPRs. This distribution is nevertheless likely to differ depending on various characteristics of the firm such as age, size or sector, which is the object of our investigations in the remainder of this section. .

Table 3.1: French firms applying for trade marks and/or patents in 2008

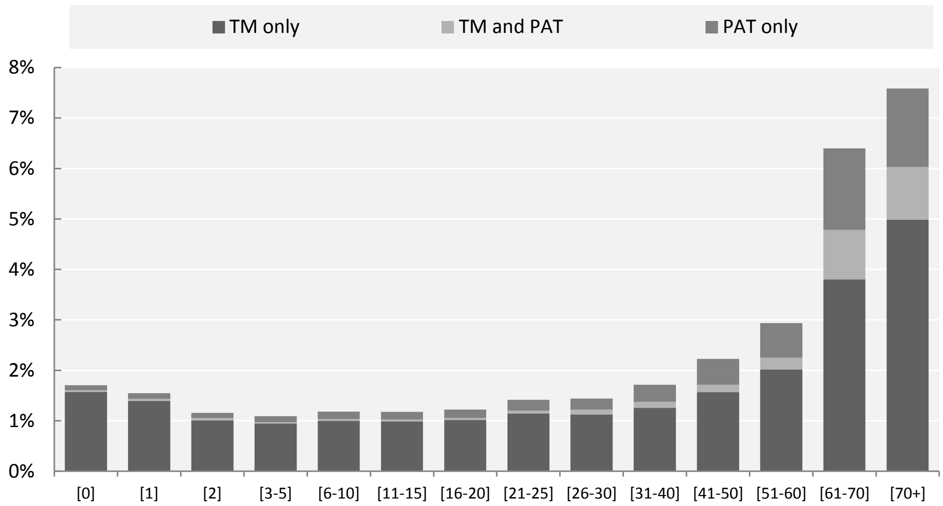
	# Firms	%
no TM and no PAT	1040438	98.68%
TM only	11680	1.11%
PAT only	1740	0.17%
TM and PAT	540	0.05%

Source: Author's compilation on ORBIS© data for France matched with trade mark and patent applications data at INPI, OHIM and EPO.
Notes: Trade mark and patent applications refer to applications either at the national or at the European level.

3.2.2 Age and size distribution of firms using patents and/or trade marks

Figure 3.1 presents the age distribution of French firms filing only trade marks, or only patents, or both types of applications in 2008. We observe that patents as well as trade marks tend to be more frequently used by old firms (more than 40 years old) than by younger ones. Besides, we observe that the relative proportion of firms filing patents only, or both patents and trade marks in the population of IPR active firms tends to be increasing with age. The relative proportion of firms filing only trade marks, in contrast, tends to be decreasing with age. The older the firms, the more they tend to file IPR applications of any kind, whether patents or trade marks and the more they tend to combine both types of IPRs. Younger firms, for their part, tend to rely more frequently on trade marks only.

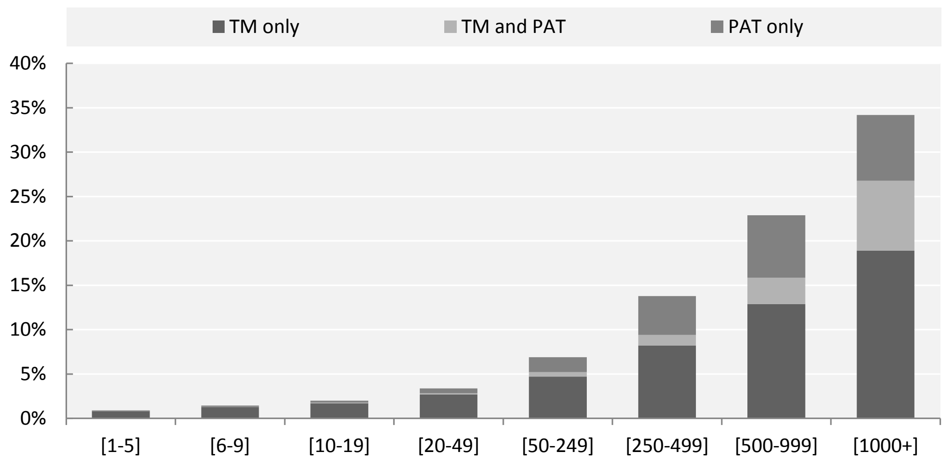
Figure 3.1: French firms applying for trade marks and/or patents by age in 2008, as % of all firms



Source: Author's compilation on ORBIS© data for France matched with trade mark and patent applications data at INPI, OHIM and EPO.
Notes: Trade mark and patent applications refer to applications either at the national or at the European level. Age is defined as the number of years since incorporation date until 2008. Firms with incorporation date '1900' were dropped from the sample, as this date appears to be used as a default value in ORBIS© and is most of the time not accurate. Detailed statistics by age are presented in Appendix 3.A.

In Figure 3.2 we present the size distribution of firms filing trade mark and/or patent applications in 2008. Similarly to what we observed in the age distributions, the relative proportion of IP active firms filing both patents and trade marks increases with size, whereas the opposite pattern can be observed for firms filing only trade marks (i.e. the relative proportion of firms decreases with size). This suggests that the bigger the firm, the more active it is in IP, and the more it tends to rely on both IP types. This might be explained by the fact that big firms are typically more aware of IP procedures, often have dedicated IP services, and tend to exploit all protection means available.

Figure 3.2: French firms applying for trade marks and/or patents by size (number of employees) in 2008, as % of all firms



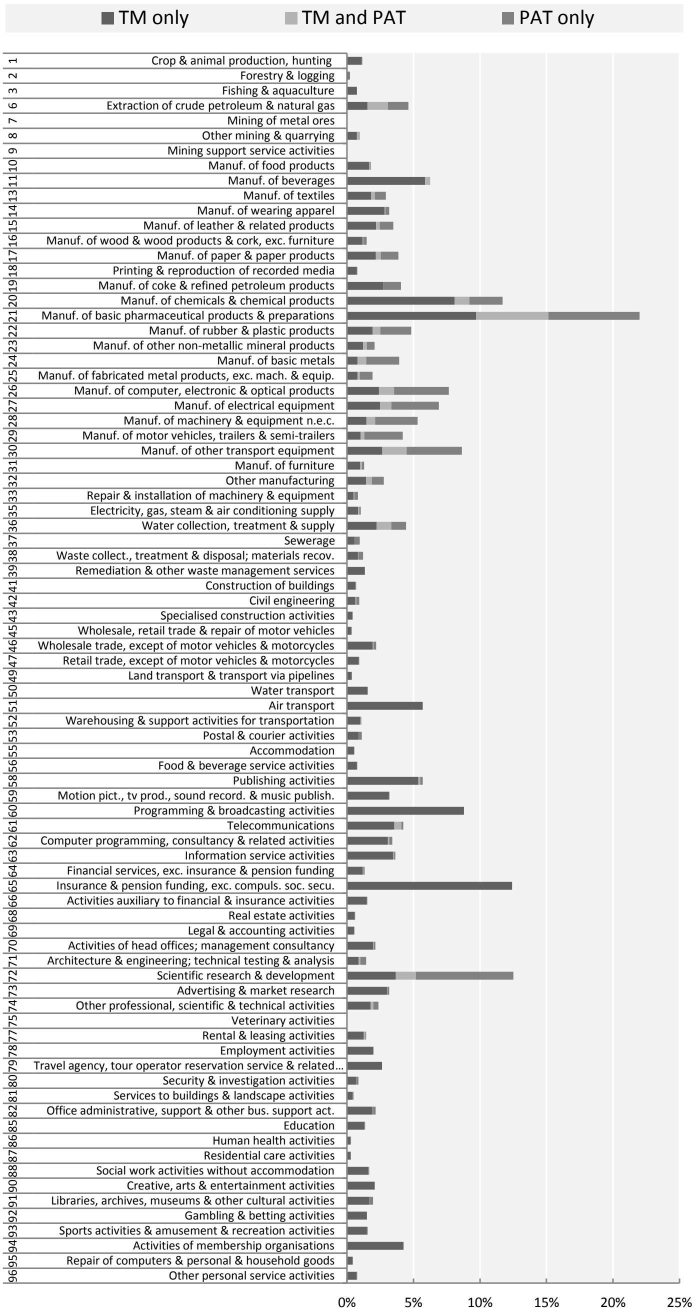
Source: Author's compilation on ORBIS© data for France matched with trade mark and patent applications data at INPI, OHIM and EPO.
Notes: Trade mark and patent applications refer to applications either at the national or at the European level. Detailed statistics by size are presented in Appendix 3.A.

3.2.3 IPR activity by sector

According to our data, the most IPR active firms in France in 2008 are in high-tech manufacturing sectors, where firms show to use patents, trade marks, or both types of IP more frequently than in other sectors (Figure 3.3 and Figure 3.4). They are followed by low-tech manufacturing sectors and knowledge-intensive services, which ave overall similar levels of IPR activity. In knowledge-intensive services - except for scientific research and development[2] -, as well as in other service sectors, firms tend to rely primarily on trade marks rather than patents. The proportion of firms using both types of IPRs is in addition very small. This may mirror the fact that, as innovations in service sectors are often not patentable, firms may use trade marks as a substitute means of appropriability.

[2]In scientific research and development sectors (72 in NACE Rev. 2), a large number of firms do rely on patenting. Interestingly, we nevertheless observe that the proportion of firms applying for trade marks in 2008 is also important, and that the proportion of firms filing only trade marks is not negligible, which may suggest that trade marks are used to protect some of the research outputs which are not eligible to patents.

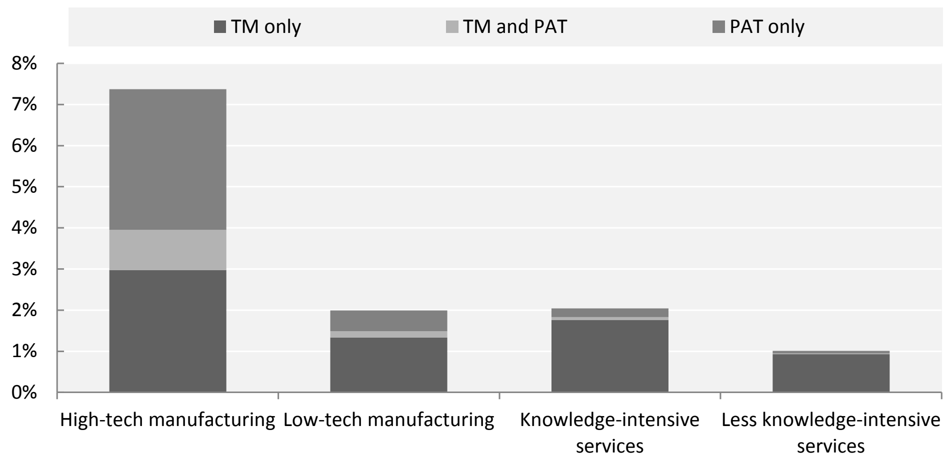
Figure 3.3: French firms applying for TM and/or patents across sectors in 2008, as % of all firms



Source: Author's compilation on ORBIS© data for France matched with trade mark and patent applications data at INPI, OHIM and EPO.

Notes: Applications either at the national or at the European level. The sectors refer to the NACE Rev.2 classification at 2-digit level (codes on the left of the y-axis). Sectors 05, 12, and 84 are not reported on the graph due to a too small number of observations. Detailed statistics by sector are presented in Appendix 3.A.

Figure 3.4: French firms applying for TM and/or patents across sector categories in 2008, as % of all firms



Source: Author's compilation on ORBIS© data for France matched with trade mark and patent applications data at INPI, OHIM and EPO:

Notes: Trade mark and patent applications refer to applications either at the national or at the European level. Sector categories correspond to Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons, respectively, restricted to private services. Detailed statistics by sector are presented in Appendix 3.A.

Overall, the above descriptive statistics indicate that the patterns in combined or separate use of patents and trade marks tend to differ according to various characteristics of firms. This suggests that depending on the firm, the two types of IP rights may be used either as complementary or as substitute protection tools. In the following analysis, we seek to assess the interrelated effects between patents and trade marks and to analyse the conditions under which they can be considered as complementary or substitute.

3.3 Theoretical Model

3.3.1 General framework

a. Model timing and IP strategy choices

The starting point of the model is a firm introducing an innovation, leading to the creation of a new market for a product. The innovating firm can choose to register a patent, a trade mark, or both or neither of them. IPR-related choices are considered binary: the firm can register at most one of each type of IPRs. If the innovating firm files a patent, the model has two distinct periods: a monopoly period under the patent protection and then a competition period, characterised by a Cournot-type duopoly between the innovating firm (leader) and an imitating firm (follower). We assume the innovation to be instantaneously imitable, so if no patent is filed by the innovating firm, the competition starts immediately in the first period, right after the innovation is introduced.

b. Advertising properties and effect of trade mark

As in the previous chapter (see 2.3.1, 'Advertising and goodwill properties'), firms may choose to incur advertising expenditure, which enable them to build a goodwill that positively affects the demand for the product. The goodwill of the firm is supplied at each period with advertising expenditure, and depreciates at rate δ between the two periods. Advertising expenditure are assumed not to be totally appropriable by firms: part of the advertising launched by a firm corresponds to advertising for the product in general and not for its own brand, so that its competitors may benefit from advertising spillover effects.

To model the effect of trade mark, we follow the same approach as described in the previous chapter (see 2.3.1, 'Effect of trade mark'). We assume that in the absence of a trade mark, the competitor may imitate not only the technology associated to the product, but also the signs referring to the brand image, so that advertising expenditure and goodwill have the characteristics of a public good and benefit equally all the firms present in the market. The total amount of second period advertising expenditure benefiting the follower is then $\overline{a_2} + sa_2$ if the leader files a trade mark, where a_2 and $\overline{a_2}$ are the amounts of advertising expenditure incurred by the leader and the follower in period 2 and $0 < s < 1$ is the level of advertising spillovers benefiting the follower, and $\overline{a_2} + a_2$ if the leader does not file a trade mark.

As we did previously, we assume that in case a firm has a monopoly power in a given period, all the advertising expenditure incurred during that monopoly period correspond to advertising for the brand, and are thus totally appropriable by a trade mark. Therefore, if the leader files both a trade mark and a patent, all the advertising expenditure incurred during the patent period benefit only its own goodwill. If the leader files a patent but no trade mark, by contrast, the competitor can play on confusion on the appearance of the product and thus benefit from the advertising expenditure incurred by the leader during the monopoly period, as customers will mistakenly attribute the goodwill of the leader to the product sold by the competitor. Finally, if no patent is filed, the follower is active in both periods and benefits in each period either from a share s of the leader's advertising expenditure, in case a trade mark is filed, or from the totality of the leader's advertising expenditure, in case no trade mark is filed.

In summary, the amount of goodwill benefiting the leader and the follower in the second period, depending on the IPR strategy adopted by the leader, is the following:

		TM	No TM
PAT	Leader	$(1-\delta)\,a_1 + a_2 + \overline{s a_2}$	
	Follower	$\overline{a_2} + s a_2$	$\overline{a_2} + (1-\delta)\,a_1 + a_2$
No PAT	Leader	$a_2 + (1-\delta)\,a_1 + \overline{s}\,(\overline{a_2} + (1-\delta)\,\overline{a_1})$	
	Follower	$\overline{a_2} + (1-\delta)\,\overline{a_1} + s\,(a_2 + (1-\delta)\,a_1)$	$\overline{a_2} + (1-\delta)\,\overline{a_1} + a_2 + (1-\delta)\,a_1$

where a_2 and $\overline{a_2}$ are the advertising expenditure incurred in the second period by the leader and by the follower, respectively, a_1 and $\overline{a_1}$ are the levels of advertising expenditure in the first period, δ is the depreciation rate of advertising over the two periods, $\overline{s}$ is the level of advertising spillovers benefiting the leader[3], and s is the level of advertising spillovers benefiting the follower if the leader files a trade mark.

In the first period, the amount of goodwill benefiting the leader and the follower, depending on the IPR strategy adopted is:

		TM	No TM
PAT	Leader	a_1	
	Follower	-	
No PAT	Leader	$a_1 + \overline{s a_1}$	
	Follower	$\overline{a_1} + s a_1$	$\overline{a_1} + a_1$

c. Inverse demand function

As in the previous chapter, the inverse demand function facing each firm in the market is negatively related to the total amount of quantities sold, and positively related to the goodwill stock of the firm. For the sake of simplicity, in this chapter we assume that the relationship between price and quantities is linear, which corresponds to a quadratic utility functions of customers (Dixit 1979). In addition, we

[3]Unlike in the previous chapter, we consider here distinct levels of advertising spillovers for the follower and the leader. Indeed, contrary to the previous chapter analysis, we are here only interested in the leader's IPR strategy, and we make no assumption on the follower's strategy. The follower may himself either register a trade mark or not. We therefore consider the parameter $\overline{s}$, corresponding to the level of spillovers benefiting the leader as given, and we look at the effect of the leader's IPR strategy on economic outcomes of the two firms.

assume diminishing returns of the effect of goodwill stock on price, so that in the following, the inverse demand function facing the leader is given by:

$$P_t = \alpha - \beta \left(Q_t + \overline{Q}_t \right) + \tau \sqrt{G_t}, \tag{3.1}$$

where Q_t and $\overline{Q}_t$ are the quantities sold by the firm and its competitor in t and G_t represents the goodwill stock of the firm, with α, β and τ strictly positive parameters. The inverse demand function facing the follower is symmetrical.

d. Supermodularity analysis

Based on this framework, we compare the inter-temporal profits resulting from the various IPR strategies to investigate the complementarity relationship between the various protection means. Complementarities are usually characterised in economics by the fact that the mixed partial derivatives of a pay-off function are positive, which indicates that the marginal returns of an input are higher if the level of the other input is higher (Ennen and Richter 2010). This framework implies that the inputs considered are continuous, therefore it cannot be used to characterise complementarities between discrete variables, and, *a fortiori,* between binary choices. This is the case in our model as the firm registers at most one trade mark and one patent.

A more general formal model of complementarity was introduced by Milgrom and Roberts (1990, 1995), based on the mathematical work on supermodularity on lattices (Topkis 1978, 1987), which makes it possible to address complementarity in the context of discrete choices in which pay-offs are not continuous. (Ennen and Richter 2010). In this theory, two inputs which can be used by the firm or not are complements only if using one input while also using the other input has a higher incremental effect on performance than using one input alone (following the intuitive idea that "the whole is more than the sum of its parts")[4].

[4]For a review of the use of the supermodularity theory in economic analyses, see Amir (2005). For a review of the empirical literature on complementarity and supermodularity in organizations, see Ennen and Richter (2010).

In the case of only two activities - patents and trade marks in our case -, the supermodularity of the profit function is easily stated. We test the validity of the following fundamental inequality, where V is the inter-temporal profit gained from innovation and the exponents indicate the presence or not of a trade mark (TM) or a patent (PAT) :

$$V^{TM,PAT}+V^{0,0}>V^{TM,0}+V^{0,PAT}. \tag{3.2}$$

If this inequality is verified, the two types of IPRs are complementary, whereas if the reverse inequality is verified, they are substitutes.

3.3.2 Outcome of the various intellectual property strategies

Based on the above framework, we derive the outcome of the various IPR strategies on the profit of the innovating firm.

a. Case with patent protection

If the leader registers a patent, its inter-temporal profit is, from (3.1):

$$V=\left[\alpha-\beta Q_1+\tau\sqrt{G_1}-c\right]Q_1-a_1+r\left[\alpha-\beta\left(Q_2+\overline{Q_2}\right)+\tau\sqrt{G_2}-c\right]Q_2-ra_2-C_{PAT}-(1_{TM=1})C_{TM},$$

where c is the cost of production, assumed linear, r is the discount rate between the two periods (with $r>0$, decreasing with the duration of the patent), and C_{PAT} and C_{TM} correspond to the costs of filing a trade mark and a patent, respectively.

If the innovating firm files a trade mark:

Replacing G_1 and G_2 by their expressions, the inter-temporal profits of the leader can be rewritten as:

$$V=\left[\alpha-\beta Q_1+\tau\sqrt{a_1}-c\right]Q_1-a_1+r\left[\alpha-\beta\left(Q_2+\overline{Q_2}\right)+\tau\sqrt{(1-\delta)a_1+a_2+\overline{sa_2}}-c\right]Q_2-ra_2-C_{PAT}-C_{TM}. \tag{3.3}$$

The inter-temporal profit of the follower is:

$$\overline{V}=r\left[\alpha-\beta\left(\overline{Q_2}+Q_2\right)+\tau\sqrt{\overline{a_2}+sa_2}-c\right]\overline{Q_2}-r\overline{a_2}. \tag{3.4}$$

The model is solved through backward induction: the firms first determine their optimal levels of advertising expenditure and quantities sold in the second period considering the stock of advertising expenditure of the leader in the first period as given, then the leader maximises its inter-temporal profit on the choice variables of the first period.

1st step: maximisation of the second period profits on Q_2, $\overline{Q_2}$, a_2 and $\overline{a_2}$ considering a_1 as given:

The respective programs of the leader and the follower are:

$$\max_{Q_2,G_2}\left(r\left[\alpha-\beta\left(Q_2+\overline{Q_2}\right)+\tau\sqrt{(1-\delta)a_1+a_2+\overline{s}\overline{a_2}}-c\right]Q_2-ra_2\right)$$

and

$$\max_{\overline{Q_2},\overline{G_2}}\left(r\left[\alpha-\beta\left(\overline{Q_2}+Q_2\right)+\tau\sqrt{\overline{a_2}+sa_2}-c\right]\overline{Q_2}-r\overline{a_2}\right).$$

The system of first order conditions yields the following Nash-Cournot equilibrium:

$$\begin{cases} Q_2^* = \frac{\alpha-\beta\overline{Q_2}^*+\tau\sqrt{(1-\delta)a_1+a_2^*+\overline{s}\overline{a_2}^*}-c}{2\beta} \\ \sqrt{(1-\delta)\,a_1+a_2^*+\overline{s}\overline{a_2}^*}=\frac{\tau}{2}Q_2^* \\ \overline{Q_2}^* = \frac{\alpha-\beta Q_2^*+\tau\sqrt{\overline{a_2}^*+sa_2^*}-c}{2\beta} \\ \sqrt{\overline{a_2}^*+sa_2^*}=\frac{\tau}{2}\overline{Q_2}^* \end{cases} \Leftrightarrow \begin{cases} Q_2^*=\overline{Q_2}^*=\frac{2(\alpha-c)}{6\beta-\tau^2} \\ a_2^*=\frac{1-\overline{s}}{1-\overline{s}s}\left(\frac{\tau(\alpha-c)}{6\beta-\tau^2}\right)^2-\frac{1-\delta}{1-\overline{s}s}a_1 \\ \overline{a_2}^*=\frac{1-s}{1-\overline{s}s}\left(\frac{\tau(\alpha-c)}{6\beta-\tau^2}\right)^2+s\frac{(1-\delta)}{(1-\overline{s}s)}a_1 \end{cases}. \tag{3.5}$$

The optimal quantities in the second period are equal for the two firms. Considering $\overline{s}=s$, the optimal amount of advertising expenditure in period 2 is higher for the follower. Indeed, since the follower does not benefit from advertising expenditure incurred in period 1, it has to catch up with the leader in order to sell at the same price (in a Cournot competition framework[5]).

From first order condition on Q_2, and the previous expression of Q_2^* and a_2^* in (3.5), (3.3) becomes:

$$V=\left[\alpha-\beta Q_1+\tau\sqrt{a_1}-c\right]Q_1-a_1+r\beta\left(\frac{2(\alpha-c)}{6\beta-\tau^2}\right)^2-r\frac{1-\bar{s}}{1-\bar{s}s}\left(\frac{\tau(\alpha-c)}{6\beta-\tau^2}\right)^2+r\frac{1-\delta}{1-\bar{s}s}a_1-C_{PAT}-C_{TM}.$$

2nd step: maximisation of the leader inter-temporal profit on a_1, Q_1:

The system of first order conditions on Q_1, a_1 yields:

$$\begin{cases} Q_1^* = \dfrac{\alpha+\tau\sqrt{a_1^*}-c}{2\beta} \\ \sqrt{a_1^*} = \dfrac{\tau}{2\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)}Q_1^* \end{cases} \Leftrightarrow \begin{cases} Q_1^* = \dfrac{2\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)(\alpha-c)}{4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2} \\ a_1^* = \left(\dfrac{\tau(\alpha-c)}{4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2}\right)^2 \end{cases}.$$

The model has an interior solution if $4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2>0$ (guaranteeing that Q_2^*, $\overline{Q_2}^*$, Q_1^*, $\overline{a_2}^*$ and a_1^* are positive) and $\left(\frac{4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2}{6\beta-\tau^2}\right)^2 > \frac{1-\delta}{1-\bar{s}}$ (guaranteeing that a_2^* is positive), i.e. if β, the negative impact of quantities on demand is large enough compared to the impact of advertising τ, and the depreciation rate of advertising δ is large enough.

The final profit of the innovating firm in case it files both a patent and a trade mark is then equal to:

$$V^{TM,PAT}=\beta\left(\frac{2\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)(\alpha-c)}{4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2}\right)^2-\left(\frac{\tau(\alpha-c)}{4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2}\right)^2+r\beta\left(\frac{2(\alpha-c)}{6\beta-\tau^2}\right)^2-r\frac{1-\bar{s}}{1-\bar{s}s}\left(\frac{\tau(\alpha-c)}{6\beta-\tau^2}\right)^2$$
$$+r\frac{1-\delta}{1-\bar{s}s}\left(\frac{\tau(\alpha-c)}{4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2}\right)^2-C_{PAT}-C_{TM}.$$

This expression simplifies into:

[5]In other competition frameworks, we might observe that followers have lower advertising expenditure than leaders, and compensate by a significantly lower selling price of the same product, which corresponds for example to the situation of firms selling generic drugs.

$$V^{TM,PAT}=(\alpha-c)^2\left(\frac{1-r\frac{1-\delta}{1-\bar{s}s}}{4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2}+r\beta\left(\frac{2}{6\beta-\tau^2}\right)^2-r\frac{1-\bar{s}}{1-\bar{s}s}\left(\frac{\tau}{6\beta-\tau^2}\right)^2\right)-C_{PAT}-C_{TM}. \qquad (3.6)$$

If the innovating firm does not register a trade mark:

In that case the inter-temporal profit expressions of the leader and the follower write:

$$V=\left[\alpha-\beta Q_1+\tau\sqrt{a_1}-c\right]Q_1-a_1+r\left[\alpha-\beta\left(Q_2+\overline{Q_2}\right)+\tau\sqrt{(1-\delta)a_1+a_2+\bar{s}\overline{a_2}}-c\right]Q_2-ra_2-C_{PAT}$$

$$\overline{V}=r\left[\alpha-\beta\left(\overline{Q_2}+Q_2\right)+\tau\sqrt{\overline{a_2}+(1-\delta)a_1+a_2}-c\right]\overline{Q_2}-r\overline{a_2}.$$

Maximising V on a_2, Q_2, and $\overline{V}$ on $\overline{a_2}$, $\overline{Q_2}$ considering a_1 given yields the following Nash-equilibrium:

$$\begin{cases} Q_2^* = \frac{\alpha-\beta\overline{Q_2}^*+\tau\sqrt{(1-\delta)a_1+a_2^*+\bar{s}\overline{a_2}^*}-c}{2\beta} \\ \sqrt{(1-\delta)\,a_1+a_2^*+\bar{s}\overline{a_2}^*} = \frac{\tau}{2}Q_2^* \\ \overline{Q_2}^* = \frac{\alpha-\beta Q_2^*+\tau\sqrt{\overline{a_2}^*+(1-\delta)a_1+a_2^*}-c}{2\beta} \\ \sqrt{\overline{a_2}^*+(1-\delta)\,a_1+a_2^*} = \frac{\tau}{2}\overline{Q_2}^* \end{cases} \Leftrightarrow \begin{cases} Q_2^* = \overline{Q_2}^* = \frac{2(\alpha-c)}{6\beta-\tau^2} \\ \overline{a_2}^* = 0 \\ a_2^* = \left(\frac{\tau(\alpha-c)}{6\beta-\tau^2}\right)^2-(1-\delta)\,a_1 \end{cases}.$$

In the case where the leader files no trade mark, the follower relies entirely on the advertising spillovers and does not itself incur any advertising expenditure in the second period.

The inter-temporal profit of the leader then writes

$$V=\left[\alpha-\beta Q_1+\tau\sqrt{a_1}-c\right]Q_1-a_1+r\beta\left(\frac{2(\alpha-c)}{6\beta-\tau^2}\right)^2-r\left(\frac{\tau(\alpha-c)}{6\beta-\tau^2}\right)^2+r(1-\delta)a_1-C_{PAT}$$

Maximising V on a_1, Q_1 yields:

$$\begin{cases} Q_1^* = \frac{\alpha+\tau\sqrt{a_1^*}-c}{2\beta} \\ \sqrt{a_1^*} = \frac{\tau}{2(1-r(1-\delta))} Q_1^* \end{cases} \Leftrightarrow \begin{cases} Q_1^* = \frac{2(1-r(1-\delta))(\alpha-c)}{4\beta(1-r(1-\delta))-\tau^2} \\ a_1^* = \left(\frac{\tau(\alpha-c)}{4\beta(1-r(1-\delta))-\tau^2}\right)^2 \end{cases}.$$

A solution exists on the condition that $4\beta\left(1-r\left(1-\delta\right)\right)-\tau^2>0$ (guaranteeing that Q_2^*, $\overline{Q_2}^*$, Q_1^* and a_1 are positive) and $\left(\frac{4\beta(1-r(1-\delta))-\tau^2}{6\beta-\tau^2}\right)^2>(1-\delta)$ (guaranteeing that a_2^* is positive), i.e. if β, is large enough compared to τ, and δ is large enough.

The profit of the innovating firm in case it files a patent but no trade mark is then equal to:

$$V^{0,PAT}=\beta\left(\frac{2(1-r(1-\delta))(\alpha-c)}{4\beta(1-r(1-\delta))-\tau^2}\right)^2-\left(\frac{\tau(\alpha-c)}{4\beta(1-r(1-\delta))-\tau^2}\right)^2+r\beta\left(\frac{2(\alpha-c)}{6\beta-\tau^2}\right)^2-r\left(\frac{\tau(\alpha-c)}{6\beta-\tau^2}\right)^2 +r(1-\delta)\left(\frac{\tau(\alpha-c)}{4\beta(1-r(1-\delta))-\tau^2}\right)^2-C_{PAT}.$$

This expression simplifies into:

$$V^{0,PAT}=(\alpha-c)^2\left(\frac{(1-r(1-\delta))}{(4\beta(1-r(1-\delta))-\tau^2)}+r\beta\left(\frac{2}{6\beta-\tau^2}\right)^2-r\left(\frac{\tau}{6\beta-\tau^2}\right)^2\right)-C_{PAT}. \quad (3.7)$$

b. Case without patent protection

If the innovative firm does not protect its innovation with a patent, the competition starts in the first period. Inter-temporal profits are given by:

$$V=\left[\alpha-\beta\left(Q_1+\overline{Q_1}\right)+\tau\sqrt{a_1+\bar{s}\overline{a_1}}-c\right]Q_1-a_1+r\left[\alpha-\beta\left(Q_2+\overline{Q_2}\right)+\tau\sqrt{a_2+(1-\delta)a_1+\bar{s}(\overline{a_2}+(1-\delta)\overline{a_1})}-c\right]Q_2-ra_2 -(1_{TM=1})C_{TM}$$

and

$$\overline{V}=\left[\alpha-\beta\left(Q_1+\overline{Q_1}\right)+\tau\sqrt{\overline{a_1}+sa_1}-c\right]\overline{Q_1}-\overline{a_1}+r\left[\alpha-\beta\left(Q_2+\overline{Q_2}\right)+\tau\sqrt{\overline{a_2}+(1-\delta)\overline{a_1}+s\left(a_2+(1-\delta)a_1\right)}-c\right]\overline{Q_2}-r\overline{a_2},$$

with $0 < s < 1$ in case a trade mark is filed and $s = 1$ in case no trade mark is filed. Maximising V on a_2, Q_2, and $\overline{V}$ on $\overline{a_2}$, $\overline{Q_2}$ considering a_1 and $\overline{a_1}$ given yields the following symmetrical Nash-equilibrium:

$$\begin{cases} Q_2^* = \frac{\alpha-\beta\overline{Q_2}^*+\tau\sqrt{a_2^*+(1-\delta)a_1+\bar{s}\left(\overline{a_2}^*+(1-\delta)\overline{a_1}\right)}-c}{2\beta} \\ \sqrt{a_2^* + (1-\delta)\,a_1 + \bar{s}\left(\overline{a_2}^* + (1-\delta)\,\overline{a_1}\right)} = \frac{\tau}{2}Q_2^* \\ \overline{Q_2}^* = \frac{\alpha-\beta Q_2^*+\tau\sqrt{\overline{a_2}^*+(1-\delta)\overline{a_1}+s\left(a_2^*+(1-\delta)a_1\right)}-c}{2\beta} \\ \sqrt{\overline{a_2}^* + (1-\delta)\,\overline{a_1} + s\left(a_2^* + (1-\delta)\,a_1\right)} = \frac{\tau}{2}\overline{Q_2}^* \end{cases} \Leftrightarrow \begin{cases} Q_2^* = \overline{Q_2}^* = \frac{2(\alpha-c)}{6\beta-\tau^2} \\ a_2^* = \frac{1-\bar{s}}{1-\bar{s}s}\left(\frac{\tau(\alpha-c)}{6\beta-\tau^2}\right)^2 - (1-\delta)\,a_1 \\ \overline{a_2}^* = \frac{1-s}{1-\bar{s}s}\left(\frac{\tau(\alpha-c)}{6\beta-\tau^2}\right)^2 - (1-\delta)\,\overline{a_1} \end{cases}.$$

The inter-temporal profits of the leader and the follower then write:

$$V=\left[\alpha-\beta\left(Q_1+\overline{Q_1}\right)+\tau\sqrt{a_1+\bar{s}\overline{a_1}}-c\right]Q_1-a_1+r\beta\left(\frac{2(\alpha-c)}{6\beta-\tau^2}\right)^2-r\frac{1-\bar{s}}{1-\bar{s}s}\left(\frac{\tau(\alpha-c)}{6\beta-\tau^2}\right)^2+r(1-\delta)a_1$$

and

$$\overline{V}=\left[\alpha-\beta\left(Q_1+\overline{Q_1}\right)+\tau\sqrt{\overline{a_1}+sa_1}-c\right]\overline{Q_1}-\overline{a_1}+r\beta\left(\frac{2(\alpha-c)}{6\beta-\tau^2}\right)-r\frac{1-s}{1-\bar{s}s}\left(\frac{\tau(\alpha-c)}{6\beta-\tau^2}\right)^2+r(1-\delta)\overline{a_1}.$$

Maximising V on a_1, Q_1 and $\overline{V}$ on $\overline{a_1}$, $\overline{Q_1}$ yields:

$$\begin{cases} Q_1^* = \frac{\alpha-\beta\overline{Q_1}^*+\tau\sqrt{a_1^*+\bar{s}\overline{a_1}^*}-c}{2\beta} \\ \sqrt{a_1^* + \bar{s}\overline{a_1}^*} = \frac{\tau}{2(1-r(1-\delta))}Q_1^* \\ \overline{Q_1}^* = \frac{\alpha-\beta Q_1^*+\tau\sqrt{\overline{a_1}^*+sa_1^*}-c}{2\beta} \\ \sqrt{\overline{a_1}^* + sa_1^*} = \frac{\tau}{2(1-r(1-\delta))}\overline{Q_1}^* \end{cases} \Leftrightarrow \begin{cases} Q_1^* = \overline{Q_1}^* = \frac{2(1-r(1-\delta))(\alpha-c)}{6\beta(1-r(1-\delta))-\tau^2} \\ a_1^* = \frac{1-\bar{s}}{1-\bar{s}s}\left(\frac{\tau(\alpha-c)}{6\beta(1-r(1-\delta))-\tau^2}\right)^2 \\ \overline{a_1}^* = \frac{1-s}{1-\bar{s}s}\left(\frac{\tau(\alpha-c)}{6\beta(1-r(1-\delta))-\tau^2}\right)^2 \end{cases}.$$

An interior solution exists on the condition that $6\beta\left(1-r\left(1-\delta\right)\right)-\tau^2 > 0$

(guaranteeing that Q_2^*, $\overline{Q_2}^*$, Q_1^*, $\overline{Q_1}^*$, a_1^* and $\overline{a_1}^*$ are positive) and $\left(\frac{6\beta(1-r(1-\delta))-\tau^2}{6\beta-\tau^2}\right)^2 > (1-\delta)$ (guaranteeing that a_2^* and $\overline{a_2}^*$ are positive), i.e. if β is large enough compared to τ, and δ is large enough.

The leader's inter-temporal profit in case it files a trade mark but no patent equals:

$$\begin{aligned} V^{TM,0} &= \beta\left(\frac{2(1-r(1-\delta))(\alpha-c)}{6\beta(1-r(1-\delta))-\tau^2}\right)^2 - \frac{1-\bar{s}}{1-\bar{s}s}\left(\frac{\tau(\alpha-c)}{6\beta(1-r(1-\delta))-\tau^2}\right)^2 + r\beta\left(\frac{2(\alpha-c)}{6\beta-\tau^2}\right)^2 - r\frac{1-\bar{s}}{1-\bar{s}s}\left(\frac{\tau(\alpha-c)}{6\beta-\tau^2}\right)^2 + \\ &\qquad r(1-\delta)\frac{1-\bar{s}}{1-\bar{s}s}\left(\frac{\tau(\alpha-c)}{6\beta(1-r(1-\delta))-\tau^2}\right)^2 - C_{TM} \\ &= (\alpha-c)^2\left((1-r(1-\delta))\left(\frac{4\beta(1-r(1-\delta))-\frac{1-\bar{s}}{1-\bar{s}s}\tau^2}{\left(6\beta(1-r(1-\delta))-\tau^2\right)^2}\right) + r\beta\left(\frac{2}{6\beta-\tau^2}\right)^2 - r\frac{1-\bar{s}}{1-\bar{s}s}\left(\frac{\tau}{6\beta-\tau^2}\right)^2\right) - C_{TM}. \end{aligned} \tag{3.8}$$

In case neither a patent nor a trade mark is filed, the expression of the inter-temporal profit is the same as above, with $s = 1$ and no filing cost:

$$V^{0,0} = (\alpha-c)^2\left((1-r(1-\delta))\left(\frac{4\beta(1-r(1-\delta))-\tau^2}{\left(6\beta(1-r(1-\delta))-\tau^2\right)^2}\right) + r\beta\left(\frac{2}{6\beta-\tau^2}\right)^2 - r\left(\frac{\tau}{6\beta-\tau^2}\right)^2\right). \tag{3.9}$$

3.3.3 Comparison of outcomes and complementarity analysis

a. Determination of the optimal IPR strategy

Based on the previous results, we seek to determine the optimal IPR strategies for innovating firms, by comparing the inter-temporal profits resulting from the different IPR combinations.

From (3.6) and (3.7), we get:

$$\begin{aligned} V^{TM,PAT} - V^{0,PAT} &= (\alpha-c)^2\left(\frac{1-r\frac{1-\delta}{1-\bar{s}s}}{4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2} - r\frac{1-\bar{s}}{1-\bar{s}s}\left(\frac{\tau}{6\beta-\tau^2}\right)^2 - \left(\frac{(1-r(1-\delta))}{\left(4\beta(1-r(1-\delta))-\tau^2\right)} - r\left(\frac{\tau}{6\beta-\tau^2}\right)^2\right)\right) - C_{TM} \\ &= (\alpha-c)^2\left(\frac{\tau^2 r(1-\delta)\left(\frac{\bar{s}s}{1-\bar{s}s}\right)}{\left(4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2\right)\left(4\beta(1-r(1-\delta))-\tau^2\right)} + r\bar{s}\left(\frac{\tau}{6\beta-\tau^2}\right)^2\frac{1-s}{1-\bar{s}s}\right) - C_{TM} \\ &= K_1 - C_{TM}, \end{aligned} \tag{3.10}$$

with $K_1 > 0$.

From (3.8) and (3.9):

$$\begin{aligned}
V^{TM,0}-V^{0,0} &= (\alpha-c)^2\left(\frac{(1-r(1-\delta))\left(4\beta(1-r(1-\delta))-\frac{1-\bar{s}}{1-\bar{s}s}\tau^2\right)}{\left(6\beta(1-r(1-\delta))-\tau^2\right)^2}-r\frac{1-\bar{s}}{1-\bar{s}s}\left(\frac{\tau}{6\beta-\tau^2}\right)^2-\frac{(1-r(1-\delta))\left(4\beta(1-r(1-\delta))-\tau^2\right)}{\left(6\beta(1-r(1-\delta))-\tau^2\right)^2}+r\left(\frac{\tau}{6\beta-\tau^2}\right)^2\right)-C_{TM} \\
&= (\alpha-c)^2\left((1-r(1-\delta))\left(\frac{\tau^2\bar{s}\frac{1-s}{1-\bar{s}s}}{\left(6\beta(1-r(1-\delta))-\tau^2\right)^2}\right)+r\bar{s}\left(\frac{\tau}{6\beta-\tau^2}\right)^2\frac{1-s}{1-\bar{s}s}\right)-C_{TM} \\
&= K_2-C_{TM}, \qquad (3.11)
\end{aligned}$$

with $K_2 > 0$. Considering sufficiently low filing costs, it is always beneficial for the innovative firms to file a trade mark.

Besides, from (3.6) and (3.8), we get

$$\begin{aligned}
V^{TM,PAT}-V^{TM,0} &= (\alpha-c)^2\left(\frac{1-r\frac{1-\delta}{1-\bar{s}s}}{4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2}-(1-r(1-\delta))\left(\frac{4\beta(1-r(1-\delta))-\frac{1-\bar{s}}{1-\bar{s}s}\tau^2}{\left(6\beta(1-r(1-\delta))-\tau^2\right)^2}\right)\right)-C_{PAT} \\
&= (\alpha-c)^2\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)\frac{\left(6\beta(1-r(1-\delta))-\tau^2\right)^2-\left(4\beta(1-r(1-\delta))-\frac{1-\bar{s}}{1-\bar{s}s}\tau^2\right)\left(4\beta(1-r(1-\delta))-\tau^2\left(1+\frac{\bar{s}sr(1-\delta)}{1-\bar{s}s-r(1-\delta)}\right)\right)}{\left(4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2\right)\left(6\beta(1-r(1-\delta))-\tau^2\right)^2}-C_{PAT} \\
&= K_3-C_{PAT},
\end{aligned}$$

with $K_3 > 0$.

From (3.7) and (3.9):

$$\begin{aligned}
V^{0,PAT}-V^{0,0} &= (\alpha-c)^2\left((1-r(1-\delta))\left(\frac{\left(6\beta(1-r(1-\delta))-\tau^2\right)^2-\left(4\beta(1-r(1-\delta))-\tau^2\right)^2}{\left(4\beta(1-r(1-\delta))-\tau^2\right)\left(6\beta(1-r(1-\delta))-\tau^2\right)^2}\right)\right)-C_{PAT} \\
&= K_4-C_{PAT},
\end{aligned}$$

with $K_4 > 0$.

As for trade marks, the benefit of filing a patent is positive if the filing costs are sufficiently low. This may not always be the case as the registration of a patent - more than a trade mark - is a relatively complex procedure and requires some human and financial resources. Therefore the costs of filing a patent may outweigh the benefits gained from the patent protection.

Considering sufficiently low levels of filing costs, we have:

$$V^{TM,PAT} > \left\{ V^{TM,0}, V^{0,PAT} \right\} > V^{0,0}.$$

The optimal IPR strategy for the innovating firm is thus always to register both a patent and a trade mark when considering negligible filing costs. Besides, the trade mark benefit differs depending on whether a patent is also filed or not. We then seek to analyse this difference in order to conclude about the complementary or substitute relationship between the two IPRs.

b. Complementarity analysis

In the following, we investigate in which conditions the supermodularity inequality (3.2) is verified, i.e. where the difference $\left(V^{TM,PAT} - V^{0,PAT}\right) - \left(V^{TM,0} - V^{0,0}\right)$ is positive. This amounts to comparing the benefit of filing a trade mark in case of patent protection and in case of no patent. From (3.10) and (3.11) we deduce that:

$$V^{TM,PAT} - V^{0,PAT} - \left(V^{TM,0} - V^{0,0}\right) = (\alpha - c)^2 \left(\frac{\tau^2 r (1-\delta) \frac{\bar{s}s}{1-\bar{s}s}}{\left(4\beta\left(1 - r\frac{1-\delta}{1-\bar{s}s}\right) - \tau^2\right)\left(4\beta(1-r(1-\delta)) - \tau^2\right)} - (1 - r(1-\delta)) \frac{\tau^2 \bar{s} \frac{1-s}{1-\bar{s}s}}{\left(6\beta(1-r(1-\delta)) - \tau^2\right)^2} \right).$$

We have

$$\frac{\partial\left[V^{TM,PAT} - V^{0,PAT} - \left(V^{TM,0} - V^{0,0}\right)\right]}{\partial s} = (\alpha - c)^2 \left(\frac{(1-r(1-\delta))\tau^2(1-\bar{s})\bar{s}}{\left(6\beta(1-r(1-\delta)) - \tau^2\right)^2 (1-\bar{s}s)^2} + \frac{(1-\delta) r \tau^2 \bar{s}}{\left(4\beta\left(1 - r\frac{1-\delta}{1-\bar{s}s}\right) - \tau^2\right)^2 (1-\bar{s}s)^2} \right).$$

This expression is always positive if $1 - r(1-\delta) > 0$, which is always true under the conditions of existence of an equilibrium. The level of complementarity between trade marks and patents is thus increasing with the level of advertising spillovers.

For s approaching 0, we have

$$\left(V^{TM,PAT}-V^{0,PAT}\right)-\left(V^{TM,0}-V^{0,0}\right)\rightarrow(\alpha-c)^2\left(-(1-r(1-\delta))\frac{\tau^2\bar{s}\frac{1-s}{1-\bar{s}s}}{\left(6\beta(1-r(1-\delta))-\tau^2\right)^2}\right),$$

which is always negative under the conditions of existence of an equilibrium, so trade marks and patents are substitutes. For s approaching 1, we have

$$\left(V^{TM,PAT}-V^{0,PAT}\right)-\left(V^{TM,0}-V^{0,0}\right)\rightarrow(\alpha-c)^2\left(\frac{\tau^2 r(1-\delta)\frac{\bar{s}}{1-\bar{s}}}{\left(4\beta\left(1-r\frac{1-\delta}{1-\bar{s}}\right)-\tau^2\right)\left(4\beta(1-r(1-\delta))-\tau^2\right)}\right),$$

which is positive under the conditions of existence of an equilibrium. So for high values of s, trade marks and patents are complementary. Indeed, in the first period, trade marks provide full protection of the goodwill in case of patent protection, whereas in case of no patent protection, trade marks still allow a non null level of advertising spillovers s. The higher those advertising spillovers, the more beneficial it is to reinforce the trade mark with a patent.

Besides, we have

$$\frac{\partial\left[V^{TM,PAT}-V^{0,PAT}-\left(V^{TM,0}-V^{0,0}\right)\right]}{\partial\delta}=(\alpha-c)^2 r\tau^2\left(\frac{1}{\left(4\beta(1-r(1-\delta))-\tau^2\right)^2}+\bar{s}\frac{1-s}{1-\bar{s}s}\frac{6\beta(1-r(1-\delta))+\tau^2}{\left(6\beta(1-r(1-\delta))-\tau^2\right)^3}-\frac{1}{1-\bar{s}s}\frac{1}{\left(4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2\right)^2}\right).$$

This expression is negative for sufficiently high values of s, so above a certain threshold of advertising spillovers, the complementarity tends to decrease with the depreciation rate of advertising. Indeed with high depreciation rates, only a small proportion of the goodwill accumulated in the monopoly period is transferred to the second period, which tends to decrease the complementarity effect.

For δ approaching its minimum value, for which $\left(4\beta\left(1-r\left(1-\delta\right)\right)-\tau^2\right)=0$, we have

$$V^{TM,PAT}-V^{0,PAT}-\left(V^{TM,0}-V^{0,0}\right)\rightarrow+\infty$$

and for δ approaching 1, we have

$$V^{TM,PAT} - V^{0,PAT} - \left(V^{TM,0} - V^{0,0}\right) \to -(\alpha - c)^2 \frac{\tau^2 \bar{s}\left(\frac{1-s}{1-\bar{s}s}\right)}{\left(6\beta - \tau^2\right)^2} < 0$$

So for high levels of depreciation rate of advertising, patents and trade marks tend to be substitutes.

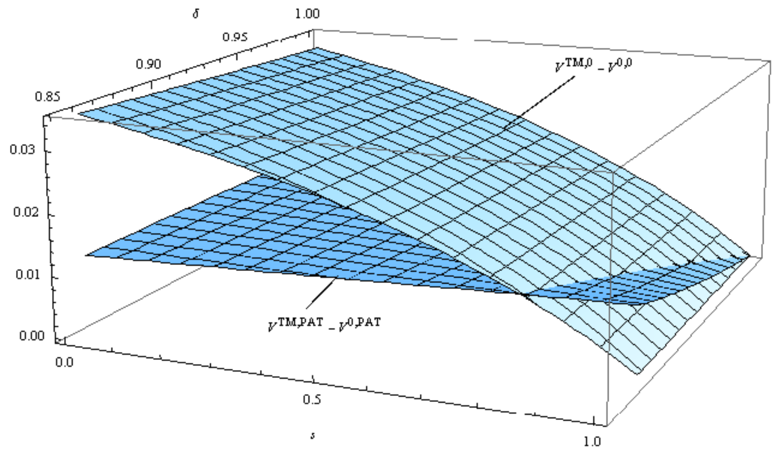
Without loss of generality, we can consider the parameters of the inverse demand function β and τ as given, as well as $\bar{s}$, the amount of spillovers benefiting the leader. In the following, we consider $\beta = \tau = 1$, and $\bar{s} = \frac{1}{2}$. In addition we attribute a definite value to the discount rate between the two periods r. A reasonable value for r is 0.6[6]. Lastly, we attribute a value of 1 to the common scaling parameter $(\alpha - c)^2$. We can then represent the level of trade mark benefits in case of patent and of no patent according to s and δ, considering negligible costs of IPRs (Figure 3.5)[7]. The inter-temporal profits resulting from each IPR strategy are represented in Appendix Appendix 3.B.

Under the assumptions of the model, depending on the of level of advertising spillovers s and on the level of depreciation of advertising expenditure, patents and trade marks can be found to be either complementary or substitute. The interpretation of the results is the following. The interaction between patents and trade marks is characterised by two counterbalancing effects. There is on the one hand a substitution effect. The trade mark benefits the firm only when it faces competition. As we assume that patent leads to a non-competition period, trade marks are comparatively less advantageous for the pioneer firm when there is also a patent filed. In the extreme, if the protection offered by patents was infinite in time, the benefit of trade mark would be null as the firm would not need to protect its brand from confusion with other firms. On the other hand, we find a complementary ef-

[6] Assuming an annual interest rate of r_0, and a patent period of T years, the discount rate between the two periods in the model can be approximated by $r \equiv \frac{\sum_{t=0}^{T}\left(\frac{1}{1+r_0}\right)^t}{\sum_{t=T+1}^{\infty}\left(\frac{1}{1+r_0}\right)^t} = 1 - \left(\frac{1}{1+r_0}\right)^T$. Taking $r_0 = 0.05$, and considering that the patent period lasts twenty years, we obtain a value of $r \simeq 0.6$.

[7] The conditions of the model require that $\left(\frac{4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2}{6\beta-\tau^2}\right)^2 > \frac{1-\delta}{1-\bar{s}}$, so that with $\beta = \tau = 1$ and $\bar{s} = \frac{1}{2}$, the model does not admit an equilibrium for $\delta < 0.85$.

Figure 3.5: Benefits of trade mark filing



$\beta = \tau = 1$, $r = 0.6$, $\bar{s} = \frac{1}{2}$, $(\alpha - c)^2 = 1$. Values of s and δ verifying $\left(\frac{4\beta\left(1 - r\frac{1-\delta}{1-\bar{s}s}\right) - \tau^2}{6\beta - \tau^2} \right)^2 > \frac{1-\delta}{1-\bar{s}}$

fect: the trade mark makes it possible to capture entirely the goodwill built during the monopoly period. The trade mark benefits in the second period will be all the more important if the firm benefited from a monopoly period, so that trade marks in the second period are comparatively more advantageous if the firm had a patent filed in the first period.

Depending on the levels of advertising spillovers and advertising depreciation rate, either the first effect or the second effect can be predominant. For sufficiently high values of advertising spillovers and low values of advertising depreciation rate, patents and trade marks are found to be complementary. This is likely to be the case for example in pharmaceutical industries. Indeed in those sectors the depreciation of advertising tends to be low (as the products tend to have relatively long life cycles and remain stable over time). In addition in those sectors the technology is well codified, which implies that innovations can be perfectly duplicated, so that advertising performed by firms is very likely to benefit the product in general. The level of advertising spillovers in those sectors is then relatively high. In contrast, in other high-tech sectors such as computer and electronic products, the depreciation rate of advertising tends to be high (as the product life cycle is short) and advertising spillovers tend to be low (the technology not being well codified, the characteristics of the product are hardly identified by the customer, so that advertising is above all advertising for the brand). In those sectors the substitution effect tends to outweigh the complementarity effect. This does not necessarily imply that firms use only one type of IPR, as in the case of negligible registration costs the optimal strategy is always to file both a patent and a trade mark. However, in those cases the incremental benefit of using both types of IPRs instead of one is lower.

3.4 Empirical investigation

3.4.1 Tested hypotheses and methodology

This section presents some empirical evidence aiming at illustrating the theoretical model presented above. The general purpose is to test the complementarity between the use of trade marks and the use of patents by firms as tools to protect their assets. The theoretical model considers the link between patents and trade marks at the product level. However, this framework is not directly transferable to empirical analysis, since IPR data are generally not available at the product level. Therefore, in the following, we shift the framework of analysis from product-level to firm-level. Although those frameworks are not equivalent (as firms are likely to sell several products on the market), we may assume that the IPR strategies observed at the firm-level are representative of the strategy adopted by the firm at each product launch (a number of companies registering systematically new trade marks, or patents, or both each time they introduce a new product on the market). Our empirical strategy then consists in estimating and comparing the firms' performance resulting from various IPR strategies. We use the market value of the firm as a measure of firm performance, which enables an inter-temporal analysis of the effects of IPRs: assuming efficient stock markets, the firm's market value is equal to the sum of its discounted future profits, which is the target variable in our previous theoretical model. Another measure of performance, such as the present profit margin at time t, would be inadequate as the context of the model is dynamic, with inter-temporal effects of IPR strategy choices.

We follow the market value approach, which combines accounting data with the valuation on the stock market. This approach has been used in particular to assess returns to innovation (Griliches 1981, Hall *et al.* 2000, Greenhalgh and Rogers 2007b, Sandner and Block 2011). The general idea of those models is that investors estimate a firm's value according to the returns that they expect from its assets (either tangible or intangible). The purpose of those models is to disentangle the contribution of tangible and intangible assets, intangible assets being proxied by measures of R&D, the number of patents or the number of trade marks. In our model, by contrast, the intangible assets of the firm are considered as given, and IPRs are considered in their function to appropriate the benefits of those assets. We thus seek to analyse how the IPR strategy affects the profit of the firm, everything else being equal, in particular their levels of R&D and innovative activity, reflected in intangible assets. Thus we include both tangible and intangible assets in explanatory variables. We consider

$$V = qA, \tag{3.12}$$

where A is the amount of firm's total assets (tangible and intangible). Taking natural logarithms on both sides of (3.12), the previous equation can be rewritten as $\ln(V) = \ln(q) + \ln(A)$. We assume that the coefficient q depends on the IPR strategy of the firm: $q_{TM,PAT}$, $q_{TM,0}$, $q_{0,PAT}$, $q_{0,0}$.

Following the supermodularity approach (see Mohnen and Röller 2003 and Guidetti *et al.* 2009 for deeper methodological explanations on empirical tests of supermodularity), our estimation strategy is to regress the log of the market value of the firm on the log of its assets, including the four dummies associated to the potential IPR strategies in the set of explanatory variables: use of no patent and no trade mark ($1_{0,0}$), of trade marks but no patents ($1_{TM,0}$), of patents but no trade marks ($1_{0,PAT}$), and of both patents and trade marks ($1_{TM,PAT}$). All dummies are included in the regression, which is thus "without constant". This is necessary in order to get all the estimates of coefficients and variance/covariance. The first model specification is:

$$\ln(V)=\beta_1(1_{0,0})+\beta_2(1_{TM,0})+\beta_3(1_{0,PAT})+\beta_4(1_{TM,PAT})+\gamma\ln(A) \tag{3.13}$$

Going back to the model equation $\ln(V) = \ln(q) + \ln(A)$, the coefficients β correspond to the evaluation of $\ln(q)$ corresponding to the various IPR strategies, and γ allows for non constant returns to scale. From the previous theoretical section, we derive that complementarity holds if $\beta_1 + \beta_4 > \beta_2 + \beta_3$. To investigate this, we apply a one-sided t-test with null hypothesis $H_0 : \beta_1 + \beta_4 - \beta_2 - \beta_3 > 0$.

The previous specification considers the IPR strategies as invariant for the firms, which are assumed to always rely on the same combination of IPRs to protect their innovations. In order to relate more precisely the returns of the firms' assets and their IPR strategy, we introduce a second specification, focusing on the difference in firm's market value between two points in time ($t = 1$ and $t = 2$). According to the previous framework, we have:

$$\frac{V_2}{V_1} = q\frac{A_2}{A_1}, \tag{3.14}$$

where V_t is the market value in t , and A_t is the amount of firm's total assets in t. Here the coefficient q varies depending on the IPRs acquired by the firm between the two periods $t = 1$ and $t = 2$. This means that the growth in market value depends on the IPR strategy specifically associated to the assets acquired between the two periods. Taking the logarithms on both sides of (3.14), the second model specification corresponds to:

$$\ln(V_2)=\ln(V_1)+\beta_1(1_{0,0})+\beta_2(1_{TM,0})+\beta_3(1_{0,PAT})+\beta_4(1_{TM,PAT})+\gamma\ln(A_2)-\gamma\ln(A_1), \tag{3.15}$$

where the dummy variables correspond to the use of the corresponding IPR between $t = 1$ and $t = 2$.

The IPR strategy is likely to be dependent on the life cycle of the firm: firms tend to file more IPR applications in their early life time (protecting the name of the firm or their core technology). Thus, in the two previous specifications we control for the age of the firm. We also add controls for sector.

The various hypotheses tested stemming from the theoretical model are:

$\begin{cases} H_{1a} : \beta_2 > \beta_1 \\ H_{1b} : \beta_3 > \beta_1 \\ H_{1c} : \beta_4 > \beta_1 \end{cases}$: inter-temporal profits are higher if the firm uses IPR protection.

$\begin{cases} H_{1d} : \beta_4 > \beta_3 \\ H_{1e} : \beta_4 > \beta_2 \end{cases}$: inter-temporal profits are higher if the firm chooses to use both a patent and a trade mark than only one type of IPR.

Those hypotheses are always verified in the framework of the theoretical model if IPRs registration costs are negligible.

$H_0 : \beta_1 + \beta_4 > \beta_2 + \beta_3$: supermodularity hypothesis.

The above inequality does not depend on IPRs registration costs. According to the theoretical model prediction, the result should depend on market characteristics, and is thus likely to vary across sectors.

3.4.2 Data sources and descriptive statistics

a. Dataset building

The various tests described in the previous paragraph are performed on a firm-level database encompassing the trade marking and patenting activity of a sample of French firms listed on the stock exchange, linking several data sources. General information on firms, as well as accounting and financial variables were retrieved from the database ORBIS© (April 2011 version[8]). Since market value is used as the dependent variable in the regression, the sample is restricted to publicly traded

[8]It should be noted that because the analyses presented in the previous chapter and in the first section of this chapter have been performed at different points in time, the version of ORBIS© that were used are different (December 2010 version used in the previous analyses), as we used the versions that were made available at the OECD.

firms. The year considered for the estimation is 2007, before the worsening of the late 2000s financial crisis, in order to avoid the exogenous variation of stock market variables.[9] A second reason for avoiding the crisis period is that the model focuses on firms' IPR activity, and the latter is generally hampered during recession periods. Restricted to French firms for which financial and accounting data in 2007 are available, the sample contains 785 observations[10].

The firm data were matched with data about trade marks and patents applied for at the national and European levels over the period 1998-2007. National and Community trade mark applications were provided by the INPI and by the OHIM, respectively, and data on national and EPO patents were retrieved from the EPO *PATSTAT* database[11].

The matching methodology used consists in linking the company name in the firm database to the applicant name listed in the various IPR databases, using an automatic computer-based procedure. This procedure first harmonises the names in both firm and IPR datasets, to take into account possible variations in denominations that firms may use, based on the algorithm developed by Magerman, Van Looy, and Xiaoyan (2006). The matching is then done according to exact identity of the harmonised names. This matching methodology is thus quite careful, favouring the occurrence of false-negatives over false-positives in the results[12].

[9]NB: the market value is considered at the end of 2007, a time at which the sub-prime crisis had already begun, yet with much lower impact on market prices

[10]To be consistent with the theoretical model, the sample should ideally be restricted to innovative firms. Otherwise we cannot know if firms have no IPR activity because they do not innovate (which would have a negative impact on market value compared to other firms) or because they innovate but do not protect their innovations with IPRs. One possibility to have information on innovating behaviour would be to match the dataset with innovation survey data. However, because of the small size of innovation survey samples, this would reduce our sample size drastically (from 785 to 170 observations), which would not allow us to achieve significant results differentiated by sectors. Nevertheless the large majority of publicly traded firms innovate: based on our sample of listed French firms matched with the French results of the Community Innovation Survey 2008, containing in total 170 observations, 113 (66%) innovated in product or in service during the years 2006-2008, which is a much larger proportion than in the complete CIS sample (26%).

[11]Since the number of observations is

[12]Because of convenience reasons related to the availability of matching software at the OECD, the computer-based procedure used for this analysis is not the same as the one used for the matched database used in the previous chapter and in section 3.2 of this chapter. The two procedures are nevertheless comparable as they rely on similar algorithms of name harmonisation.

b. Variables used and descriptive statistics

The dependent variable used in the regressions is the natural logarithm of the firm's market value, V. The market value of a firm is defined as the sum of its market capitalisation and the market value of its debt. Following Blundell *et al.* (1999), Hall and Oriani (2006), and Sandner and Block (2011), we calculated the firm's market value as the sum of the nominal value of market capitalisation and outstanding debt. Finally, outstanding debt was calculated as the sum of long term debt and current liabilities as reported in ORBIS©.

In the set of explanatory variables we use "total assets" as directly contained in ORBIS© database, defined as the sum of tangible and intangible assets. Although IPRs are sometimes qualified as "intangible assets", patents and trade marks applied for by the firm are not accounted for in the intangible assets. The latter are recorded on balance sheets at cost, so IPRs are only included in intangible assets if they have been acquired from an external source (see International Accounting Standards Board 2007). For IPRs acquired internally, what is recorded is their corresponding investments (R&D or brand equity investments), and not the IPR itself whose financial value is not possible to assess. This avoids the presence of an endogeneity issue in the joint inclusion of IPR dummies and intangible assets in the set of explanatory variables in the regressions. The variable "intangible assets" in ORBIS© contains R&D, advertising and organisational expenses (see Giannetti 2003). Thus what the model captures is the respective effects of intangible investments and of the use of IPRs to protect those investments, which is in line with the theoretical framework used in Section 3.3.

The dummy variables corresponding to the IPR strategy relate to the fact that the firm applied for at least one patent and/or at least one trade mark during the period considered. In the first specification, the period over which the IPR behaviour is tracked is 1998-2007 which, we assume, describes the usual IPR behaviour of the firm. In the second specification, the IPR behaviour is considered only in the years 2006-2007, since the model focuses on the difference in market value before and after this period. Table 3.2 gives descriptive statistics for the final dataset.

The different IPR strategies are not equally represented in the sample. A large majority of firms in the sample use IPRs: 78% applied for at least one patent or one trade mark during 1998-2007, and 57% used IPRs in the only two years 2006-2007 (the proportion might be even higher since the matching methodology tends to favour false negatives). Those high shares can be explained by the fact that the sample contains only publicly listed companies, which tend to be more active in IP than the whole population of firms. The use of trade marks is much more frequent than the use of patents (76% of firms used trade marks, 33% used patents in 1998-2007). The proportion of firms using both types of IPRs in 1998-2007 is 21%, so the complementary states correspond to nearly half of the sample (43%).

3.4.3 Results

In this section, we estimate the market value equations based on the specifications (3.13) and (3.15) presented above.

Specification (3.13) is estimated by:

$$\ln V_t = \beta_1(1_{0.0}) + \beta_2(1_{TM,0}) + \beta_3(1_{0,PAT}) + \beta_4(1_{TM,PAT}) + \gamma \ln(A_t) + \sigma age + i.sector,$$

in $t = 2007$ where V is the firm's market value, A is the amount of the firm's total assets, and *i.sector* corresponds to the dummy variables of the sectors (NACE Rev. 2, 2-digit level). The dummy variables of trade mark and/or patent use indicate whether the firm applied for at least one patent or one trade mark at the national or European level between 1998 and 2007 (based on the application date). We also estimated for comparison the same model with constant, omitting the dummy variable corresponding to no IP right application.

Specification (3.15) is estimated by:

Table 3.2: Descriptive Statistics for the Final Sample

Variable	Obs	Mean	Std. Dev.	Min	Max
Valuation and assets variables (bil.euros)					
Market Value 2007[1]	785	3.242	14.510	0.0005	214.77
Market Capitalisation 2007[1]	785	1.843	9.518	0.0001	148.471
Long Term Debt 2007[1]	785	0.505	2.147	0	32.686
Current Liabilities 2007[1]	785	0.896	3.987	0.00005	48.692
Total Assets 2007[1]	785	2.641	11.561	0.0003	186.149
Market Value 2005[2]	556	3.598	14.349	0.001	177.499
Market Capitalisation 2005[2]	556	1.917	8.808	0.0003	130.278
Long Term Debt 2005[2]	556	0.559	2.613	0	42.636
Current Liabilities 2005[2]	556	1.122	4.453	0	44.788
Total Assets 2005[2]	556	3.120	12.874	0.0004	171.136
Age					
Age of the firm in 2007	785	38.590	42.141	0	375

IP strategy distribution	**1998-2007[1]**	**2006-2007[2]**	**TM 2006-2007 / PAT 2006[2]**
TM, PAT	168 (21%)	72 (13%)	60 (11%)
$TM, 0$	433 (55%)	228 (41%)	240 (43%)
$0, PAT$	16 (2%)	19 (3%)	14 (3%)
$0, 0$	168 (21%)	237 (43%)	242 (44%)

Sector distribution[3]			
High-Tech Manuf.	77 (10%)[1]		48 (9%)[2]
Medium-High-Tech Manuf.	79 (10%)[1]		58 (10%)[2]
Medium-Low-Tech Manuf.	43 (5%)[1]		39 (7%)[2]
Low-Tech Manuf.	98 (12%)[1]		78 (14%)[2]
Knowl.-Intensive Services	251 (32%)[1]		177 (32%)[2]
Less Knowl.-Intensive Services	170 (22%)[1]		100 (18%)[2]
Other sectors	67 (9%)[1]		56 (10%)[2]

[1]Sample restricted to firms for which market value in 2007 is known: 785 observations
[2]Sample restricted to firms for which market value in 2007 and 2005 is known: 556 observations
[3]Sector categories corresponding to Eurostat aggregation of manufacturing industries and services according to R&D intensity and share of tertiary educated persons, respectively, based on NACE Rev.2.

$$\ln(V_{t_2}) = \ln(V_{t_1}) + \beta_1(1_{0.0}) + \beta_2(1_{TM,0}) + \beta_3(1_{0,PAT}) + \beta_4(1_{TM,PAT}) + \gamma_1 \ln(A_{t_2}) - \gamma_2 \ln(A_{t_1}) + \sigma age + i.sector,$$

in $t_2 = 2007$ and $t_1 = 2005$, and where the dummy variables of trade mark and/or patent use indicate if the firm applied for at least one patent or one trade mark at the national or European level between 2006 and 2007 (application date).

Table 3.3 presents the results of the regressions on the complete sample. In both specifications coefficients are all significant at the 1% level, except for age, which is only significant (at 5% level) in the first specification. The global explanatory power of the model is very high, above 99% in both specifications. This is explained both by the use of without constant specification and by the very high explanatory power of the variable total asset in market value regressions (as can be seen in column 1 of the results).

The results regarding the first specification (presented in column 4) tend to be in line with the theoretical model predictions. The order of the coefficients for IPR variables are consistent with the expectations: the one-sided t-tests give significant positive results, except for $1_{0,PAT}$>$1_{0,0}$ and $1_{TM,PAT}$>$1_{0,PAT}$, for which the results are not significant. This is also supported by the results of the regression without constant (column 3), where all IPR dummies have positive coefficients, significant at 1% level except $1_{0,PAT}$. In the second specification (column 6), the tests also tend to give positive results, although they are generally not significant (significant at 10% level only for $1_{TM,PAT} > 1_{0,0}$). We also estimated the second specification considering only patent applications in 2006, in order to take into account a possible delay between patent and trade mark applications. The results are stable whether considering patent applications in the two years or only in 2006 (see results in Appendix 3.C).

To investigate if the complementarity hypothesis holds, we apply a one-sided t-test on the obtained coefficients, with null hypothesis: $H_0 : \beta_1 + \beta_4 - \beta_2 - \beta_3 > 0$. The one-sided t-test rejects the null hypothesis at 5% level if the value of the t

Table 3.3: Market value regression and one-sided t-tests on the total sample

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable : ln (Market Value 2007)						
ln (Total Assets 2007)	0.915**		0.914**	0.914**	0.937**	0.879**
	(0.010)		(0.010)	(0.010)	(0.014)	(0.031)
$1_{0,0}$ (98-07)				-5.793**	-6.111**	
				(0.162)	(0.196)	
$1_{0,PAT}$ (98-07)		0.061	0.079	-5.715**	-6.192**	
		(0.449)	(0.150)	(0.220)	(0.199)	
$1_{TM,0}$ (98-07)		0.673**	0.184**	-5.609**	-5.898**	
		(0.206)	(0.045)	(0.160)	(0.188)	
$1_{TM,PAT}$ (98-07)		1.488**	0.254**	-5.540**	-5.838**	
		(0.263)	(0.051)	(0.164)	(0.195)	
age			-0.001*	-0.001*	-0.001	0.000
			(0.000)	(0.000)	(0.001)	(0.000)
ln(MV2005)						0.735**
						(0.042)
ln (Total Assets 2005)						-0.631**
						(0.047)
$1_{0,0}$ (06-07)						-1.409**
						(0.293)
$1_{0,PAT}$ (06-07)						-1.407**
						(0.296)
$1_{TM,0}$ (06-07)						-1.380**
						(0.289)
$1_{TM,PAT}$ (06-07)						-1.334**
						(0.284)
constant	-5.712**	4.646**	-5.793**			
	(0.138)	(0.933)	(0.162)			
N	785	785	785	785	556	556
R-sq	0.960	0.220	0.962	0.994	0.995	0.998
$1_{TM,0} > 1_{0,0}$				4.10**		0.92
$1_{0,PAT} > 1_{0,0}$				0.53		0.03
$1_{TM,PAT} > 1_{0,0}$				4.96**		1.64+
$1_{TM,PAT} > 1_{0,PAT}$				1.22		1.03
$1_{TM,PAT} > 1_{TM,0}$				1.64+		1.04
Complementarity test: one-sided Student test (t statistics): $H_0 : 1_{TM,PAT} - 1_{0,PAT} > 1_{TM,0} - 1_{0,0}$						
				-0.06		0.58
			-	-		-

Notes: OLS robust estimates. Standard errors in parentheses. ** p<0.01, * p<0.05, + p<0.1. All regressions also contain controls for sector at the Nace Rev.2 2-digit level statistic is lower than -1.645 (then substitutability (non strict) holds). If the value of the t statistic is higher than 1.645, then strict complementarity holds at 5% level (the previous threshold is 1.282 at 10% level, and 2.326 at 1% level). The complementarity test does not give any significant result on the total sample. This could be expected since the theoretical model indicates that the results are likely to vary across sectors. To investigate this hypothesis, we estimated the previous model on sub-samples corresponding to two different sectors, both highly innovative: pharmaceutical and chemical products on the one hand and high-tech business sectors (manufacture of computer, electronic and optical products and of electrical equipment) on the other hand. The results are presented in Table 3.4[13].

We find that the results of the supermodularity test vary across sectors. In pharmaceutical and chemical sectors, the test tends to be in favour of the complementarity hypothesis (at 1% level in the second specification). We find that in those sectors the benefit of filing a trade mark alone is not significant, whereas the effect of filing a trade mark and a patent is significantly higher than the effect of filing a patent alone. Similarly, filing a patent alone tends to have a negative impact on market value, whereas filing a patent jointly with a trade mark tends to have a higher impact on performance than filing a trade mark alone. In pharmaceutical and chemical sectors indeed, innovation often consists in launching new drugs or chemical products based on new molecules, and competitors are generally able to launch perfect substitutes on the market. In this situation, advertising is for a large part likely to be advertising for the product in general, so that it is not easily appropriable by the firm even if the latter registers a trade mark. Besides, drugs and chemical products tend to have relatively long life cycles, so that the advertising depreciation rate over time is likely to be relatively low. In those types of sectors, the theoretical model predicts that the complementarity effect tends to outweigh the substitution effect so that it is in the firms' interest to use patents jointly with

[13]Pharma and Chemicals correspond to firms in NACE Rev. 2 sectors 20 (manuf. of chemicals and chemical products), 21 (manuf. of basic pharmaceutical products and pharmaceutical preparations), and 86 (human health activities). Computer and electrical equipment correspond to firms in NACE Rev. 2 sectors 26 (manuf. of computer, electronic and optical products) and 27 (manuf. of electrical equipment).

Table 3.4: Market value regression and one-sided t-tests on pharma/chemicals and and high-tech business sectors

	(1) Pharma & Chemicals	(2) Pharma & Chemicals	(4) Computer & elec. equipment	(5) Computer & elec. equipment
Dependent variable : ln (Market Value 2007)				
ln (Total Assets 2007)		0.862**	0.886**	0.829**
		(0.212)	(0.033)	(0.072)
$1_{0,0}$ (98-07)	-5.678**		-5.410**	
	(0.591)		(0.386)	
$1_{0,PAT}$ (98-07)	-5.654**		-5.255**	
	(0.433)		(0.355)	
$1_{TM,0}$ (98-07)	-5.225**		-5.189**	
	(0.519)		(0.380)	
$1_{TM,PAT}$ (98-07)	-5.001**		-5.130**	
	(0.475)		(0.356)	
age	-0.003+	0.001	0.001	0.005*
	(0.002)	(0.002)	(0.002)	(0.002)
ln(MV2005)		1.055**		0.811**
		(0.211)		(0.134)
ln (Total Assets 2005)		-0.945**		-0.710**
		(0.183)		(0.156)
$1_{0,0}$ (06-07)		0.742		-0.594
		(1.726)		(0.789)
$1_{0,PAT}$ (06-07)		-0.029		-0.156
		(1.444)		(0.792)
$1_{TM,0}$ (06-07)		0.615		-0.717
		(1.590)		(0.773)
$1_{TM,PAT}$ (06-07)		0.816		-0.564
		(1.589)		(0.755)
N	49	31	72	47
R-sq	0.993	0.998	0.991	0.998
One-sided Student test: t statistic				
$1_{TM,0} > 1_{0,0}$	1.22	-0.58	1.01	-1.24
$1_{0,PAT} > 1_{0,0}$	0.07	-2.46**	0.64	3.45**
$1_{TM,PAT} > 1_{0,0}$	1.92*	0.30	1.30+	0.33
$1_{TM,PAT} > 1_{0,PAT}$	6.00	3.60**	0.77	-2.83**
$1_{TM,PAT} > 1_{TM,0}$	1.53+	1.55+	0.49	1.36+
Complementarity test: $H_0 : 1_{TM,PAT} - 1_{0,PAT} > 1_{TM,0} - 1_{0,0}$				
	0.51	2.83**	-0.36	-1.86*
		Complem.		*Substitut.*
	-	*(0.01 level)*	-	*(0.05 level)*

Notes: OLS robust estimates. Standard errors in parentheses. ** p<0.01, * p<0.05, + p<0.1

trade marks in order to build goodwill during the monopoly period and continue to benefit from it after the expiration of the patent.

In computer and electrical equipment sectors, by contrast, the supermodularity test in the second specification tends to be in favour of substitutability. In those sectors we find that filing a patent alone has a significant positive impact on market value, whereas filing trade marks has no positive impact. Furthermore filing a patent jointly with a trade mark tends to have a lower impact on market value than filing a patent alone. This suggests that in those sectors the crucial asset to be protected is the technology, and that it is on the contrary not beneficial to invest in the protection of goodwill. This might be explained by the fact that in those sectors relying on cutting-edge technology, the depreciation rate of products and therefore of advertising tends to be very high. The patent period is then likely to cover the major part of the life cycle of the technology, so that products are less likely to be imitated and trade mark protection is less needed. In that case, the substitution effect tends to outweigh the complementarity effect.

3.5 Conclusion

In the paper by Amara and Traoré (2008), which shows complementarities between the use of various intellectual property protection mechanisms for firms in KIBS sectors the authors call for future research on the factors that could explain those complementarities. One of those factors is the interaction of the legal mechanisms themselves. The main contribution of the study presented in this chapter is to assess the interrelated effects of IPRs considering them in their core function as legal protection devices instead of as proxies of other underlying assets. We tackle this question both through a formal theoretical model and through an empirical analysis. Using a basic modelling approach, we compare the outcome of adopting various IPR strategies for innovating firms that commercialise their own innovation: patent or not and/or trade mark or not, and then assess the complementarity or substitutability relationship between the two IPRs based on the supermodularity approach.

The main finding of our model is that the complementary or substitute relationship between trade marks and patents is not straightforward. We find that the interaction between the two IPRs is characterized by two counterbalancing effects: a temporal substitution effect – as the patent period reduces the time during which the firm faces competition and needs a trade mark to protect its reputation against other firms - and a complementarity effect – as the trade mark enables the firm to extend the reputational benefits of the monopoly period beyond the expiration of the patent. We show that the predominance of one or the other effect depends on exogenous parameters, especially the levels of advertising depreciation rate and spillovers. If the spillovers are low and the depreciation rate is high, for example in sectors such as high-tech business sectors, then trade marks are likely to be substitutes, so the benefits of registering a trade mark will be all the more important if the firm cannot register a patent. In contrast, if advertising spillovers are high and the advertising depreciation rate is low, for example in sectors such as pharmaceutical or chemical products, then trade marks and patents are likely to be complementary. The optimal IPR strategy of firms may then vary from one context to another, from one firm to another. Following the conclusion of Teece (1986) that the profit gained from innovation depends on the possibility of the firm to use complementary assets, our model goes a step further and states that the relationship between the various assets is itself dependent on the context in which the firms operate.

The implications of this model are twofold. First, there are implications for IPR management within firms. We show that beyond the question of the eligibility of the innovation to the various types of IPRs, the profitability of a diversified IPR strategy depends on context elements, which need to be taken into account to determine the benefits and costs of the various combinations. Failure to identify complementarity (resp. substitutability) between some protection mechanisms may lead to under-exploitation (resp. over-exploitation) of synergies and under-protection (resp. over-protection) of innovations. Secondly the model has implications for economic analyses. Whenever investigating firms' IP activity, for example as a proxy for other intangible assets, one should bear in mind the existence of context-dependent interaction effects between the various types of protection.

The above study constitutes a first attempt at assessing interrelation effects between trade marks and patents as protection devices, thus restricting to a simple analytical framework. A number of extensions could be considered to refine the analysis. On the theoretical side, more sophisticated models could be considered, e.g. with more general specifications of demand, other competition frameworks, or taking into account gradual levels of competition associated to patent protection. The empirical study, for its part, is here restricted to publicly listed firms. Further analyses could be used to test if those results are also supported on the whole sample, as we have seen in the first section that the patterns are likely to vary with the age or the size of the firm. Finally, issues regarding the timing of the various IPRs could be explored more deeply.

Overall, the results of the present and previous chapters tend to confirm that trade marks play a part in innovative activities, as they constitute a means among others to protect innovations. As for now our empirical analysis was restricted to the framework of firms. However the use of trade marks to protect innovations is likely to apply also to other innovative actors. In the next chapter we explore trade marking activities of one specific type of actor, universities.

3.6 Appendices

Appendix 3.A Detailed descriptive statistics

Trade mark and/or patent applications by age in 2008

	# Firms	# TM applications	# PAT applications	# Firms active with only PAT applications	# Firms with only TM applications	# Firms with TM and PAT applications
[0]	38040	816	103	37	598	13
[1]	101600	2132	220	111	1415	45
[2]	96102	1591	370	101	971	41
[3-5]	216174	3512	1147	253	2043	59
[6-10]	198653	3907	1358	298	1983	70
[11-15]	139066	3348	1926	209	1370	57
[16-20]	110652	2522	1627	184	1123	45
[21-25]	55712	1635	744	119	638	32
[26-30]	31204	1100	743	68	351	30
[31-40]	33181	1413	1932	112	417	40
[41-50]	17798	1137	647	91	279	26
[51-60]	9506	898	1689	65	192	22
[61-70]	1735	532	516	28	66	17
[70+]	4112	1554	2952	64	205	43

Trade mark and/or patent applications by size (number of employees) in 2008

	# Firms	# TM applications	# PAT applications	# Firms with only PAT applications	# Firms with only TM applications	# Firms with TM and PAT applications
[1-5]	338468	4334	975	241	2684	51
[6-9]	60861	1440	146	90	774	14
[10-19]	42486	1578	202	89	722	34
[20-49]	30835	1966	441	169	826	41
[50-249]	15363	2326	789	259	722	78
[250-499]	2046	635	674	90	168	24
[500-999]	1010	828	525	71	130	30
[1000+]	1132	3196	8970	84	214	89

Source: Author's compilation on ORBIS© data for France matched with trade mark and patent applications data at INPI, OHIM and EPO.

Notes: Trade mark and patent applications refer to applications either at the national or at the European level.

Appendix 3.A (Continued) Detailed descriptive statistics

Trade mark and/or patent applications by NACE Rev. 2 sector in 2008

			# Firms	# TM applications	# PAT applications	# Firms with only PAT applications	# Firms with only TM applications	# Firms with TM and PAT applications
other	1	Crop & animal production, hunting	9942	182	5	5	109	0
other	2	Forestry & logging	2217	3	2	2	3	0
other	3	Fishing & aquaculture	793	7	0	0	6	0
other	6	Extraction of crude petroleum & natural gas	65	35	21	1	1	1
other	7	Mining of metal ores	26	0	0	0	0	0
other	8	Other mining & quarrying	1324	34	3	0	10	3
other	9	Mining support service activities	45	0	0	0	0	0
low-tech	10	Manuf. of food products	20487	988	52	16	342	9
low-tech	11	Manuf. of beverages	1582	350	6	0	93	6
low-tech	13	Manuf. of textiles	2192	96	64	18	40	6
low-tech	14	Manuf. of wearing apparel	2839	175	18	8	80	2
low-tech	15	Manuf. of leather & related products	774	35	12	8	17	2
low-tech	16	Manuf. of wood & wood products & cork, exc. furniture	4235	99	15	11	50	2
low-tech	17	Manuf. of paper & paper products	1060	53	64	14	23	4
low-tech	18	Printing & reproduction of recorded media	6987	85	3	2	52	1
low-tech	19	Manuf. of coke & refined petroleum products	74	2	38	1	2	0
high-tech	20	Manuf. of chemicals & chemical products	1990	1026	1555	50	161	22
high-tech	21	Manuf. of basic pharmaceutical products & preparations	350	417	433	24	34	19
low-tech	22	Manuf. of rubber & plastic products	3319	177	371	77	64	19
low-tech	23	Manuf. of other non-metallic mineral products	3810	226	302	22	46	11
low-tech	24	Manuf. of basic metals	766	33	187	19	6	5
low-tech	25	Manuf. of fabricated metal products, exc. mach. & equip.	13328	242	357	128	106	21
high-tech	26	Manuf. of computer, electronic & optical products	2376	189	1419	98	57	27
high-tech	27	Manuf. of electrical equipment	1735	169	653	62	43	15
high-tech	28	Manuf. of machinery & equipment n.e.c.	4871	222	665	156	71	32
high-tech	29	Manuf. of motor vehicles, trailers & semi-trailers	1380	165	2646	40	14	4
high-tech	30	Manuf. of other transport equipment	602	88	1098	25	16	11
low-tech	31	Manuf. of furniture	3835	67	17	6	38	5
low-tech	32	Other manufacturing	5618	226	280	51	81	24
low-tech	33	Repair & installation of machinery & equipment	10990	103	97	31	54	6
other	35	Electricity, gas, steam & air conditioning supply	2593	82	43	3	22	2
other	36	Water collection, treatment & supply	180	28	5	2	4	2
other	37	Sewerage	520	3	3	2	3	0
other	38	Waste collect., treatment & disposal; materials recov.	2571	42	19	9	21	1
other	39	Remediation & other waste management services	74	1	0	0	1	0
other	41	Construction of buildings	19312	219	7	3	126	2
other	42	Civil engineering	3789	64	44	8	24	3
other	43	Specialised construction activities	136148	828	704	58	538	10
lkis	45	Wholesale, retail trade & repair of motor vehicles	39315	236	37	15	127	2
lkis	46	Wholesale trade, except of motor vehicles & motorcycles	81168	3591	603	148	1570	59
lkis	47	Retail trade, except of motor vehicles & motorcycles	134706	2076	81	58	1165	9
lkis	49	Land transport & transport via pipelines	25554	222	5	1	86	1
kis	50	Water transport	639	25	0	0	10	0
kis	51	Air transport	193	37	0	0	11	0
lkis	52	Warehousing & support activities for transportation	4620	117	4	3	46	1
other	53	Postal & courier activities	452	9	1	1	4	0
lkis	55	Accommodation	22760	220	9	6	121	0
lkis	56	Food & beverage service activities	66439	832	38	14	491	4
other	58	Publishing activities	7355	992	60	14	395	10
kis	59	Motion pict., tv prod., sound record. & music publish.	8456	504	4	4	266	0
kis	60	Programming & broadcasting activities	375	131	0	0	33	0
kis	61	Telecommunications	1515	375	960	2	54	8
kis	62	Computer programming, consultancy & related activities	17893	1015	114	42	550	18
kis	63	Information service activities	3049	189	9	3	106	2
kis	64	Financial services, exc. insurance & pension funding	48069	1654	157	44	568	24
kis	65	Insurance & pension funding, exc. compuls. soc. secu.	298	341	0	0	37	0
kis	66	Activities auxiliary to financial & insurance activities	12903	351	6	2	194	1
lkis	68	Real estate activities	69059	632	63	23	397	3
kis	69	Legal & accounting activities	11085	152	3	1	59	2
kis	70	Activities of head offices; management consultancy	40370	1669	540	50	797	14
kis	71	Architecture & engineering; technical testing & analysis	31681	508	695	139	281	34
kis	72	Scientific research & development	1335	123	454	98	49	20
kis	73	Advertising & market research	11068	622	21	11	337	4
kis	74	Other professional, scientific & technical activities	6916	231	74	26	123	14
other	75	Veterinary activities	697	0	0	0	0	0
lkis	77	Rental & leasing activities	7860	321	531	5	100	8
kis	78	Employment activities	2485	87	1	0	49	1
lkis	79	Travel agency, tour operator reservation service & related activities	3080	139	0	0	81	0
kis	80	Security & investigation activities	3142	35	6	4	22	1

Appendix 3.A (Continued) Detailed descriptive statistics

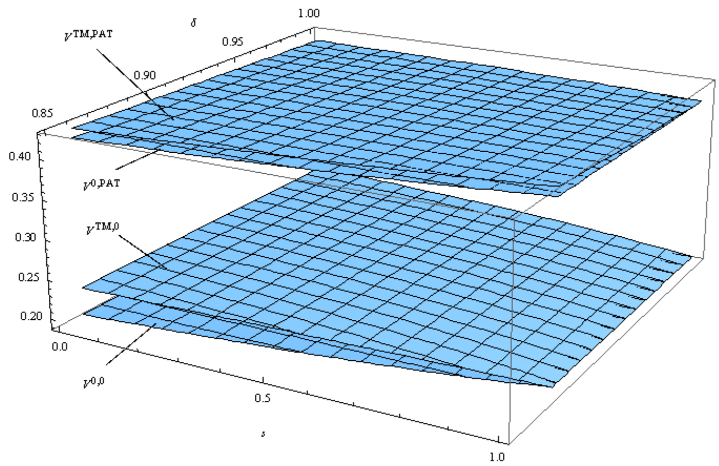
lkis	81	Services to buildings & landscape activities	14079	91	7	5	63	1
lkis	82	Office administrative, support & other bus. support act.	11935	412	53	24	230	4
other	85	Education	11430	216	6	3	152	1
other	86	Human health activities	12095	59	11	2	32	2
other	87	Residential care activities	1705	9	0	0	5	0
other	88	Social work activities without accommodation	1254	23	1	1	20	0
other	90	Creative, arts & entertainment activities	4043	123	1	1	84	0
other	91	Libraries, archives, museums & other cultural activities	358	9	1	1	6	0
other	92	Gambling & betting activities	334	8	0	0	5	0
other	93	Sports activities & amusement & recreation activities	4843	107	2	2	73	0
other	94	Activities of membership organisations	94	4	0	0	4	0
lkis	95	Repair of computers & personal & household goods	5589	29	2	2	23	0
other	96	Other personal service activities	26707	298	15	8	193	2
High-tech manufacturing			13304	2276	8469	455	396	130
Low-tech manufacturing			81901	2958	1885	412	1094	124
Knowledge-intensive services			201472	8049	3044	426	3546	143
Less knowledge-intensive services			486164	8918	1433	304	4500	92

Source: Author's compilation on ORBIS© data for France matched with trade mark and patent applications data at INPI, OHIM and EPO.

Notes: Trade mark and patent applications refer to applications either at the national or at the European level.

Appendix 3.B Outcomes of the various IPR strategies according to s and δ

Inter-temporal profits resulting from the various IP strategies



$\beta{=}\tau{=}1$, $r{=}0.6$, $\bar{s} = \frac{1}{2}$, $(c-\alpha)^2{=}1$. Values of s and δ verifying $\left(\frac{4\beta\left(1-r\frac{1-\delta}{1-\bar{s}s}\right)-\tau^2}{6\beta-\tau^2}\right)^2 > \frac{1-\delta}{1-\bar{s}}$

Appendix 3.C Estimation of the second specification considering 2006 patent applications

Variables	All sample	Pharma & Chemicals	Computer & elec. equipment
Dependent variable : ln (Market Value 2007)			
ln (Total Assets 2007)	0.879**	0.904**	0.827**
	(0.031)	(0.202)	(0.071)
age	0.000	0.001	0.005**
	(0.000)	(0.002)	(0.002)
ln(MV2005)	0.736**	1.063**	0.793**
	(0.042)	(0.213)	(0.150)
ln (Total Assets 2005)	-0.631**	-0.999**	-0.688**
	(0.047)	(0.158)	(0.169)
$1_{0,0}$ (06-07,06)	-1.415**	0.847	-0.736
	(0.295)	(1.749)	(0.893)
$1_{0,PAT}$ (06-07,06)	-1.421**	0.077	-0.301
	(0.304)	(1.457)	(0.895)
$1_{TM,0}$ (06-07,06)	-1.382**	0.701	-0.791
	(0.290)	(1.608)	(0.862)
$1_{TM,PAT}$ (06-07,06)	-1.356**	0.931	-0.795
	(0.287)	(1.609)	(0.864)
N	556	31	47
R-sq	0.998	0.998	0.997
One-sided Student test: t statistic			
$1_{TM,0} > 1_{0,0}$	1.07	-0.66	-0.54
$1_{0,PAT} > 1_{0,0}$	-0.08	-2.41**	3.50**
$1_{TM,PAT} > 1_{0,0}$	1.44+	0.34	-0.89
$1_{TM,PAT} > 1_{0,PAT}$	0.78	3.75**	-4.05**
$1_{TM,PAT} > 1_{TM,0}$	0.61	1.88*	-0.05
Complementarity test: $H_0 : 1_{TM,PAT} - 1_{0,PAT} > 1_{TM,0} - 1_{0,0}$			
	0.36	2.94**	-3.62**
	-	Complem. *(0.01 level)*	*Substitut. (0.01 level)*

Notes: OLS robust estimates. Standard errors in parentheses. ** p<0.01, * p<0.05, + p<0.1. The regression on the whole sample also contain controls for sector at the Nace Rev.2 2-digit level

CHAPTER 4

UNIVERSITIES' TRADE MARK PATTERNS AND POSSIBLE DETERMINANTS - AN EXPLORATORY INVESTIGATION

4.1 Introduction

In the previous chapters, we focused on the link between trade marking and innovative activities in the context of firms. In the present chapter, we seek to investigate whether the issues regarding the protection of marketing and reputation assets in relation to innovation could be extended to other contexts[1]. We focus on another type of actors, which are knowledge producers, which are likely to play a role in innovative activities and which may use IPRs, namely universities.

The US Patent and Trade mark Law Amendment Act of 1980, commonly known as the Bayh-Dole Act, constitutes the legal framework enabling the transfer of federally funded inventions generated by universities, small businesses and non-profit organisations. Over the last three decades many scholars have engaged in assessing the effect of such an important piece of legislation over universities' "third function", *i.e.* entrepreneurial and economic development activities (see Etzkowitz 1998, 2003 and Kutinlahti 2005, for a survey of the literature)[2]. University patenting and licensing, academic patent quality, university-industry technol-

[1]This chapter is based on an article co-authored with Mariagrazia Squicciarini and Hélène Dernis and published in *Economics of Innovation and New Technology* (Squicciarini, Millot and Dernis 2012), in which I have directly contributed to all statistical and econometric analyses. This chapter also includes further original econometric results.

[2]The entrepreneurial and economic development activities function is supposed to be carried out in addition to the traditional education and research functions.

ogy transfer, and university entrepreneurship were extensively investigated (*e.g.* Mowery *et al.* 2001, 2004, Thursby and Thursby 2003, Shane 2004, Verspagen 2006, Åstebro and Bazzazian 2010, Crespi *et al.* 2010), whereas other aspects have been overlooked. The literature on the link between trade marks and innovation (see Chapter 1 for a review) focuses mainly on firms. To the best of our knowledge, no study in fact investigates university trade marking behaviours and determinants. Trade marks nevertheless represent one of the knowledge appropriation and commercialisation devices universities may want to exploit. Universities acting entrepreneurially and behaving rationally may in fact rely on the full array of IPRs conferred by the law, and hence use trade marks as well as patents. University trade marks are thus at the centre of the following analysis aiming to understand whether and to what extent universities use trade marks, which university-specific variables contribute to explaining IPR use by academia, and how trade mark use relates to academic research activities and academic patenting.

Our analysis relies on a novel panel dataset containing information about universities located in the United States (US). It covers the period 1997 – 2007 and combines: trade mark data obtained from the USPTO; patent data extracted from the EPO managed PATSTAT database; and university characteristics data published by the US Center for Measuring University Performance (henceforth MUP)[3]. The latter are used as control variables to investigate the way university specific characteristics may influence academic patenting and trade marking behaviours, *e.g.* the number of student or the amount of funds devoted to research.

Unlike in the two previous chapters, the following analysis is primarily descriptive and does not formally identify mechanisms explaining the trade marking activity of universities. The main reason behind this is that the objective function in the case of universities, more than in the case of firms, is not straightforward and is likely to be manifold. The tension or compatibility between those various objectives was addressed in a number of papers in the previous literature (*e.g.* Etzkowitz 1998, Thursby & Thursby 2007, Åstebro & Bazzazian 2010). The reward

[3]Visit http://mup.asu.edu/index.html for further details about the centre and its data collections.

system in universities is generally based on the norms of science, not on profits. But universities may also behave as entrepreneurial actors and seek to maximize their funding. They may at the same time seek to improve the social welfare by extending knowledge through their research activities or by providing educational services. When targeting the latter objective, they may want to increase the overall quantity of students, or to communicate the highest level of knowledge to a small number of students. It is then difficult to identify a general framework which would account for universities' incentives to use one or another type of IPR. The estimates shown therefore address relationships rather than causal links. Selection and endogeneity concerns are at present overlooked, as our main goal is to gain some broad knowledge about the way academic institutions possibly use trade marks. Despite its simplicity, the analysis proposed contributes to a better understanding of universities' strategic behaviours related to the appropriation of the knowledge they generate, and to the way they deal with their intangible assets - especially their "innovative property" (Corrado *et al.* 2009).

Our results suggest the existence of a significant and positive relationship between trade mark activities by academic institutions and university characteristics such as the number of students enrolled, the presence of medical schools, the share of federal research funds received, and being a private institution. In addition, trade mark behaviours appear to be persistent, as having had registered trade marks in the past positively relate to applying for trade marks over the period considered. Significant and negative relationships instead emerge between trade mark behaviours and the number of universities located in the same State. When distinguishing trade marks according to the classes of products in which they are registered, different patterns of trade mark use emerge inside universities. Some trade marks tend to be associated to the general reputation of the universities, or merchandising activities, whereas others tend to relate more precisely to their research activities and outputs.

The remainder of this chapter is organized as follows. Section 4.2 discusses the possible reasons why universities might apply for trade marks, and the relationships that may exist between patenting and trade marking activities. Section 4.3 presents the first-hand dataset built for the analysis and Section 4.4 shows some descriptive statistics about US universities patenting and trade marking behaviours. Finally, Section 4.5 outlines the analytical strategy followed and the results obtained about the possible drivers of academic trade marking activities and the way patents and trade marks are used by universities.

4.2 Why rely on trade marks?

According to Etzkowitz (1998), universities are increasingly engaged in collaboration with industries, and increasingly involved in close collaboration types. Etzkowitz identifies three degrees and forms of academic involvement in industrial activities:

> "(1) the product originates in the university but its development is undertaken by an existing firm, (2) the commercial product originates outside of the university, with academic knowledge utilized to improve the product, or (3) the university is the source of the commercial product and the academic inventor becomes directly involved in its commercialization through establishment of a new company."(Etzkowitz 1998)

If universities are directly involved in the commercialization of products related to their research activities, they may seek the best strategy to appropriate the returns of their innovations.

Along the previous chapters of this thesis, we argued that trade mark registration can be used to proxy (some types of) firms' innovative activities. Firms are likely to rely on trade marks to appropriate the benefits of their innovation, either as a substitute or as a complement to patent. In this chapter, we propose that the main findings regarding trade mark use vis-à-vis patents, innovative activities and firm performance, could be applicable - at least to a certain extent - to academic institutions. In particular we believe that US universities committed to effectively accomplish their three main functions[4] might rely on trade mark registration to

[4] Teaching, research, and economic development. See Etzkowitz (2003) for a discussion.

signal, protect or better exploit some of their key intangible assets. Through trade marks universities may legally protect their reputation, market their current and prospective activities, and better appropriate and sell their innovative output.

Reputation, a key asset for academic institutions, may be considered as the equivalent to what brands represent for enterprises. Reputation drives the selection and self-selection of students and professors alike; may raise the likelihood of obtaining external funds - be they private or public -; facilitates networking with other top institutions and with the private sector; and more generally grant academic institutions a number of competitive advantages over their local and global competitors. It may hence be reasonable to expect that, when getting established or at later stages, universities might trade mark their names or logos, to better manage their "brand".

Similarly to the way firms would behave, entrepreneurial universities might further register trade marks when launching new educational products (*e.g.* new master courses); when opening new departments or research centres or units (*e.g.* "Spacewatch", University of Arizona); or when offering new services and products (*e.g.* "ACSI", University of Michigan)[5]. When the latter result from research and innovation activities, trade mark registration may be observed in conjunction with patent filing (*e.g.* "Bioglass", University of Florida[6]).

In what follows we shed some light on the entrepreneurial behaviour of academic institutions and investigate the relationships that may exist between trade mark registration and a number of institutional characteristics (*e.g.* universities being private or public) and performance variables, like the number of students enrolled, the funding obtained, and the patents owned.

[5] A brief description of the examples cited, as well as additional ones, can be found in Appendix 4.A.

[6] USPTO patents number 4,478,904 and 4,103,002.

4.3 The data

Data on academic Intellectual Property (IP) are extracted from the USPTO "Trade mark Casefile Dataset (1884-2010)" and the EPO worldwide patent statistical database ("Patstat", April 2011). Patstat contains data on USPTO patents granted since 1974, and patent applications since 2000. While featuring a wealth of information about trade marks and patents respectively, these datasets do not include any indication about the type of the applicant or owner of the IPR considered - whether a private individual, a firm, or a university. The allocation of patents and trade marks to academic institution has therefore to be inferred from the very name of applicant(s). To this end, a slightly modified version of the patent-based algorithm developed by Van Looy *et al.* (2006)[7] has been used for the identification of academic applicants owning patent and trade mark rights at USPTO. Trade mark data have then been double checked to correct for the possible allocation of rights to entities mistakenly identified as universities (*e.g.* "University book store").

The sample used in our study includes applicants categorized as universities - both private and public ones -, university hospitals, and the different types of offices and organizations entrusted with the commercial exploitation of university IPRs[8]. The pieces of information contained in our dataset underwent two name harmonization and consolidation procedures, one automatic, the second manual. Data were first regrouped and harmonized to account for possible name variations - including misspelling - using a new name harmonization algorithm purposely developed by Idener© for the OECD (2011). IPR portfolios were then consolidated manually at the individual university level, to avoid that parts of the very same institution might mistakenly be considered as different bodies (*e.g.* "Georgetown University" and "Georgetown University Medical Center" being consolidated into

[7]This keyword-based algorithm relies on patent data to identify the different types of patent owners. It subdivides IPR users into five non mutually exclusive categories: individual applicants; firms or business enterprises; government agencies and (private or public) non-profit organisations; universities and higher education institutions (*i.e.* academic applicants); and hospitals. See Van Looy *et al.* (2006) for more details.

[8]Examples are: "Board of Trustees", "Research Foundation", "Research Services and Development Company", "President and Fellows", "Board of Regents", etc..

"Georgetown University")[9].

Table 4.1 shows the number of academic IPR applicant names obtained after each data consolidation step. As can be seen, the name harmonization and consolidation procedure followed substantially reduces the noise contained in the data, with the number of distinct trade mark and patent owners contained in the final sample being only one seventh of the initial one[10].

Table 4.1: Number of distinct US academic IPR owners identified after each consolidation step

Number of Distinct academic IP owners	USPTO Patents	USPTO Trade marks
Identified by Van Looy et al.'s (2006) algorithm	5490	9941
Identified after removing entities mistakenly identified as universities		6798
Identified after OECD (2011) name harmonisation algorithm	2440	2838
Identified after manual consolidation	785	1423

Source: Author's own compilation on OECD (2011), Patent Database and U.S. Patent & Trade mark Office (2011), "The USPTO Trade mark Casefile Dataset (1884-2010)"

These IPR data were matched to university-related data compiled by the Center for Measuring University Performance (henceforth MUP) of Arizona State University. MUP annually ranks universities on the basis of a number of variables obtained from public sources (*e.g.* National Science Foundation). MUP data are available online[11], cover the period 1997 – 2007, and encompass more than 600 academic institutions (the so-called "Top American Research Universities"). MUP data are typically collected at the geographic campus level, whereas IPR ownership data may sometimes not be as detailed. In very few (although important) cases data were therefore further consolidated at the aggregate entity level[12]. Ta-

[9] The university-related names considered and the consolidated list are available from the author upon request.

[10] The number of patent applications and trade mark registrations does not change throughout the consolidation procedure. The name harmonisation carried out aims at avoiding that patents and trade marks be split between institutions mistakenly identified as different entities.

[11] http://mup.asu.edu/research_data.html (last accessed 30 June 2011).

[12] Campus-related consolidation was carried out in the following cases: City University of New York - 11 campuses; University of California - 9 campuses; University of Hawaii - 2 campuses; University of Houston - 3 campuses.

ble 4.2 shows the overall number and proportion of academic IPR owners and of patent applications/trade mark registrations that were matched to the institutional data contained in the MUP panel.

Table 4.2: Number and share of distinct academic IPR owners and IPR applications matched to institutions in the MUP panel

Number of	Patents	Trade marks
Academic IP owners	359 (46%)	434 (30%)
applications / registrations	60545 (93%)	10173 (73%)

Source: Author's own compilation on OECD (2011), Patent Database, U.S. Patent & Trade mark Office (2011), "The USPTO Trade mark Casefile Dataset (1884-2010)" and Center for Measuring University Performance data.

In the case of patents, 359 academic IPR owners were matched to universities in the MUP sample (*i.e.* 46% of our academic patent sample). These universities account for 93% of all patent applications we found to belong to academic institutions. In the case of trade marks, MUP proves to only provide data concerning 30% of the US academic institutions that registered trade marks. They nevertheless account for 73% of all trade marks registered by universities in the United States.

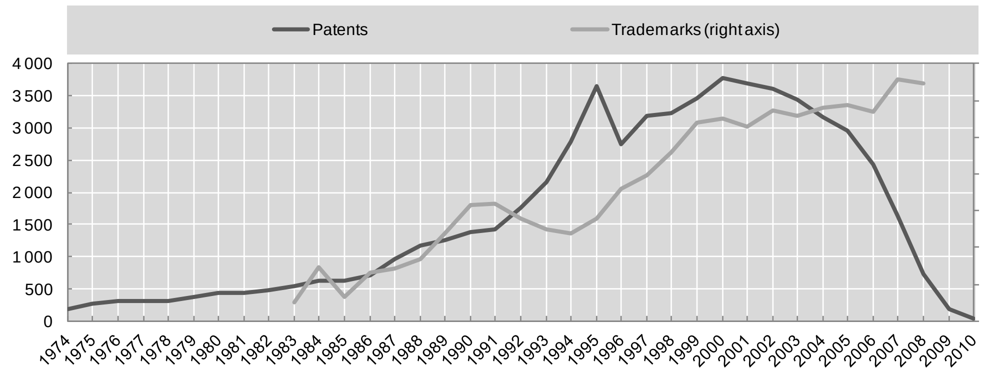
4.4 Descriptive Statistics

4.4.1 IPR activities of United States universities, 1974 - 2010

The yearly number of patents and trade marks granted by the USPTO to US universities has been growing steadily over the last three decades[13]. Although the overall number of patents granted to universities (60545 in total during the period considered) is significantly higher than the number of academic trade mark applications (10173), the utilization of both types of IPR increased after the US Patent and Trade mark Law Amendment Act of 1980.

[13]Patent grants data are available from 1974 until 2010; trade mark applications data relate to the period 1983 - 2008.

Figure 4.1: Yearly number of academic IPR applications at USPTO



Source: Author's own compilation on OECD (2011), Patent Database and U.S. Patent & Trade mark Office (2011), "The USPTO Trade mark Casefile Dataset (1884-2010)"
Note: Patent data correspond to patents granted. Patents are allocated to years according to the dates of application. USPTO patent data and trade mark data are available and complete from 1974 and 1983, respectively.

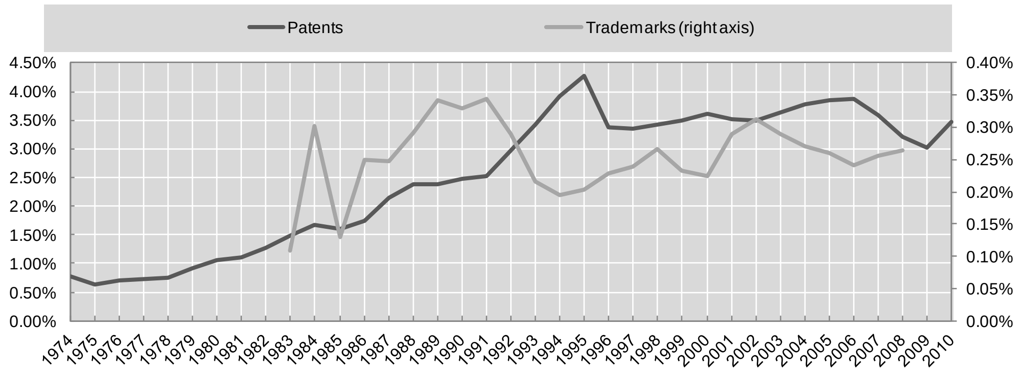
As can be seen from Figure 4.1, which shows the yearly number of academic IPR applications at USPTO, the peak in patenting activities happens in 1995, due to a change in the patent regime[14]. Figure 4.2 compares the figures related to patents and trade marks owned by universities with the total number of patent and trade mark applications made at USPTO over the period considered (by all US applicants). The proportion of patents granted to academic applicants shows an overall increasing trend, although not a constant one, and a seemingly decreasing pattern since the 2000s (as also found by Leydesdorff and Meyer 2010).

4.4.2 Universities' main characteristics

The sample used in the present study relies on data from 621 US universities, whose main characteristics and IP activities (if any) are observed over the period 1997 – 2007. Table 4.3 summarizes some key features of the institutions considered (the corresponding detailed yearly statistics are shown in Appendix 4.B). The first

[14]On 8 June 1995 the term of patent was modified, and made dependent on the priority date instead of the issue date. No more submarine patents could thus be kept (*i.e.* patents whose issuance and publication are intentionally delayed).

Figure 4.2: Yearly proportion of academic IPR in all US applications at USPTO, 1974 - 2010



Source: Author's own compilation on OECD (2011), Patent Database and U.S. Patent & Trade mark Office (2011), "The USPTO Trade mark Casefile Dataset (1884-2010)"
Note: Patent data correspond to patents granted. Patents are allocated to the various years according to the date of application. USPTO patent data and trade mark data are available and complete from 1974 and 1983, respectively.

two variables, namely "Total research expenditures", "Share of federal funds" are time varying; conversely, the presence of a "Medical school", "University age" since establishment, the number of "Students in 2006", the "Share of graduates", and the "Number of universities in State" are time invariant. In particular, the number of students and the share of graduates refer to the year 2006[15].

Almost 60% of the universities in the sample are public institutions. These are on average younger than their private counterparts - with age being defined as the number of years elapsed from establishment until 2006. Public universities are also on average much bigger than private ones in terms of number of students (on average 16,000 in public universities; 6,000 in private ones), although their share of graduate students is much smaller than the one featured by private academic institutions (24% and 34%, respectively).

When it comes to overall research expenditure, private and public institutions invest on average a very similar amount of money per year, although given the dif-

[15]Data about the number of students are available for the years 2004 and 2006, but the number of graduates is available only for the year 2006.

Table 4.3: Universities' main characteristics, 1997 – 2007

	N. obs.	Total research expenditures		Share of federal funds		Medical school	University age (in 2006)		Students in 2006 (in thous.)		Share of graduates (%)		Number of Unis in State	
		μ	σ	μ	σ		μ	σ	μ	σ	μ	σ	μ	σ
Overall sample	621	83,493	192,679	0.6	0.23	0.18	115	49	12.32	14.62	0.27	0.3	22.33	15.5
Public universities	369	82,885	210,867	0.58	0.22	0.19	106	46	15.86	16.73	0.24	0.2	19.62	14.5
Private universities	252	84,418	161,187	0.63	0.24	0.18	128	50	6.44	6.92	0.34	0.3	26.3	16.2

Source: Author's own compilation on Center for Measuring University Performance data (2011).
Legend: μ = mean; σ = standard deviation
Note: Fund figures at constant prices (base year 2007).

ference in size the amount of funds per student differs notably. Finally, on average, around 19% of public and 18% of private universities feature medical schools.

MUP data further provide an indicator of the way federal research funds are allocated (in the fiscal year 2004) across disciplines, regrouped into 9 main categories: Computer Sciences, Engineering, Environmental Sciences, Life Sciences, Mathematical Sciences, Physical Sciences, Psychology, Social Sciences and Other Sciences. Institutions with 95% or more funds concentrated in a certain area *j* are identified as "All *j*"; those with 75 to 94% in one field are denoted as "Heavy *j*"; those with 50 to 74% as "Strong *j*"; and with 25 to 49% as "Moderate *j*". Several research focuses may coexist, *e.g.* "Strong Life Sciences and Moderate Computer Sciences", and those institutions whose expenditure are distributed evenly across all disciplines are identified as "Mixed". Based on this MUP indicator we build a university-specific variable called "*main federal research focus*", indicating the discipline in which the proportion of research expenditure is highest. Table 4.4 displays the frequencies of the pairs subject area / intensity of the research focus, and of the main federal focuses.

Table 4.4: Universities' research focus, 2004

	Research focus						Main federal research focus
	All	Heavy	Strong	Moderate	Low	Mixed	
Computer sciences	0	3	5	2	8	10	8
Engineering	7	8	29	33	35	10	68
Environmental sciences	2	8	20	20	19	10	42
Life sciences	72	64	102	127	1	10	334
Mathematical sciences	0	1	3	3	4	10	6
Physical sciences	6	7	27	45	28	10	62
Psychology	0	3	9	6	11	10	14
Social sciences	0	2	5	8	6	10	11
Other sciences	3	0	5	2	5	10	9

Source: Author's own compilation on Center for Measuring University Performance data (2011).

4.4.3 Our sample: academic institutions and use of IPR

Table 4.5 shows some academic IP-related statistics. Data suggest that the majority of universities in the sample did not make use of IPR during the years 1997-2007, with median values (not displayed here) that are zero for all variables considered. The only exception is represented by the median value of the before 1997 number of trade marks, which takes value 1 - that is, that most universities registered at least one trade mark in the past.

Public and private universities exhibit very similar trade mark application figures, as well as average patent applications and grants data. Big differences conversely exist in the distribution of private and public institutions when it comes to patenting : the distribution of private universities looks much less dispersed than that of public ones, as highlighted by standard deviations, and the maximum yearly number of patents applied for and granted.

Figure 4.3 shows the number of trade marks registered and patents applied for by academic institutions in the various States over the period 1997 - 2007. The area of the circle is proportional to the overall number of applications - with the darker circle denoting patents and the lighter trade marks. The horizontal axis displays the number of universities located in each state, while the vertical axis indicates the average number of IPR applications made by universities in the considered

Table 4.5: Universities' trade mark and patent activities, 1997 - 2007

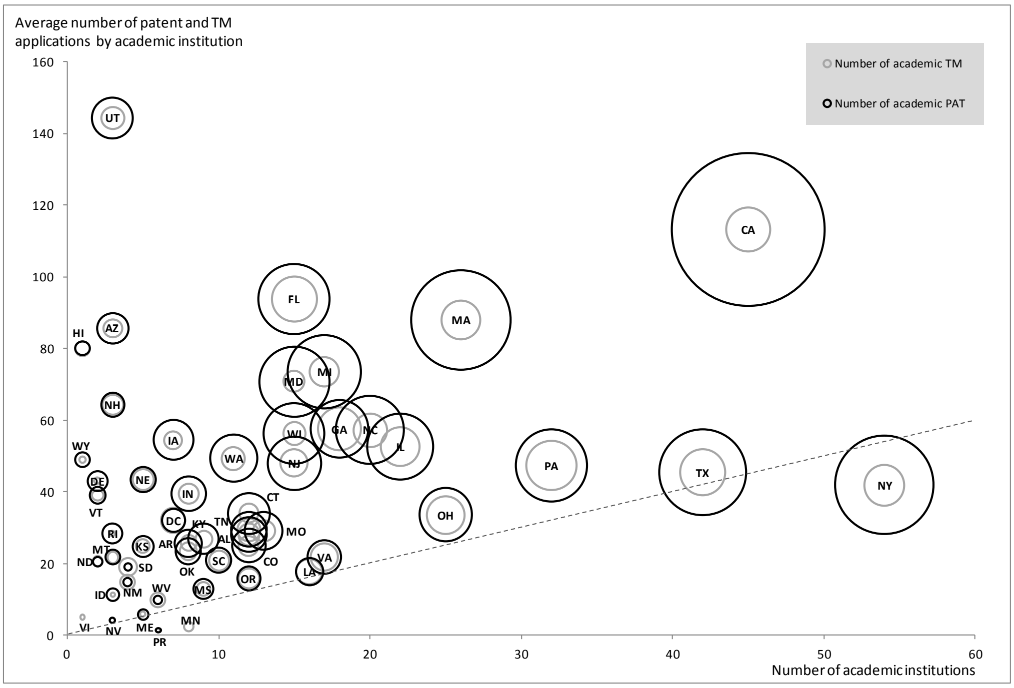
	Year	N obs.	Trademarks				Patent applications				Patent granted			
			Mean	P75	Sd	Max	Mean	P75	Sd	Max	Mean	P75	Sd	Max
Overall sample	1997	621	0.65	0	2.72	38	0.07	0	0.42	7	5.29	1	22.77	452
	1998		0.76	0	2.5	27	0.17	0	0.85	14	5.33	2	23.53	466
	1999		0.89	0	2.42	22	0.29	0	1.55	30	5.74	2	24.99	499
	2000		0.89	0	2.5	22	0.52	0	2.38	48	6.24	2	26.16	516
	2001		0.86	0	3.04	45	5.33	1	25.81	518	6.08	2	27.56	549
	2002		0.94	0	2.54	21	5.51	1	25.39	508	5.96	2	25.3	493
	2003		0.91	0	2.68	33	5.62	1	25.2	487	5.71	2	23.59	430
	2004		0.98	0	3.06	30	5.41	1	21.69	400	5.25	1	19.55	341
	2005		0.96	1	3	37	5.47	2	21.03	366	4.88	2	17.92	300
	2006		0.97	1	2.83	34	5.14	2	19.82	325	4.04	2	15.24	239
	2007		1.09	1	2.9	29	4.17	1	15.65	259	2.71	1	9.99	145
Public universities	1997	369	0.7	0	2.74	38	0.05	0	0.42	7	5.34	2	26.19	452
	1998		0.74	0	2.42	23	0.13	0	0.82	14	5.18	2	26.33	466
	1999		0.96	0	2.69	22	0.29	0	1.75	30	5.87	2	28.39	499
	2000		0.86	0	2.26	18	0.52	0	2.69	48	6.53	3	29.87	516
	2001		0.77	0	2.56	35	5.34	2	29.54	518	6.16	3	31.35	549
	2002		0.88	0	2.5	21	5.6	2	29.36	508	6.17	2	28.86	493
	2003		0.81	0	2.28	23	5.79	2	28.93	487	5.92	2	26.32	430
	2004		1.03	0	3.46	30	5.58	2	24.51	400	5.5	2	21.67	341
	2005		1.03	0	3.1	37	5.6	2	22.79	366	5.18	2	19.46	300
	2006		1.07	1	3.23	34	5.26	3	20.82	325	4.3	2	16.05	239
	2007		1.12	1	3.02	29	4.29	2	16.72	259	2.91	2	10.31	145
Private universities	1997	252	0.58	0	2.68	38	0.09	0	0.4	3	5.21	1	16.59	140
	1998		0.8	0	2.63	27	0.23	0	0.9	7	5.56	1	18.75	154
	1999		0.79	1	1.97	15	0.29	0	1.21	12	5.55	1	18.98	161
	2000		0.94	0	2.82	22	0.51	0	1.85	17	5.83	1	19.55	164
	2001		1	0	3.63	45	5.32	1	19.13	179	5.95	1	20.86	189
	2002		1.03	1	2.6	19	5.37	1	18.12	161	5.65	1	18.98	177
	2003		1.06	1	3.16	33	5.38	0	18.48	155	5.4	1	18.94	174
	2004		0.92	1	2.38	22	5.16	0	16.77	138	4.88	0	16	135
	2005		0.87	1	2.86	34	5.29	1	18.19	169	4.45	1	15.43	143
	2006		0.82	0	2.11	16	4.95	1	18.29	187	3.66	1	13.98	141
	2007		1.04	0.5	2.72	20	3.99	1	13.98	120	2.43	1	9.51	109
Before 1997 trademarks	Overall	621	5.95	5	15.25	165	0.04	0	0.34	6	40.91	11	164.12	2639
	Public unis	369	6.38	5	17.7	165	0.02	0	0.19	3	39.64	14	166.56	2639
	Private unis	252	5.31	5	10.69	66	0.06	0	0.48	6	42.76	7.5	160.79	1890

Source: Author's own compilation on OECD (2011), Patent Database, U.S. Patent & Trade mark Office (2011), "The USPTO Trade mark Casefile Dataset (1884-2010)" and Center for Measuring University Performance data.

State. The dotted 45 degree line depicted accounts for the different x and y axis scales used.

During the period considered, academic patenting happens more frequently than academic trade marking. While differences emerge across States, the number of patents almost always exceeds that of trade marks. New York, California, Texas, Pennsylvania and Massachusetts are the States in which universities were most IP-active during the year 1997-2007. With a few exceptions - New York in particular and a few other States appearing below the 45 degree line - on average

Figure 4.3: Academic trade mark and patent applications by State (1997-2007)



Source: Author's own compilation on OECD (2011), Patent Database, U.S. Patent & Trade mark Office (2011), "The USPTO Trade mark Casefile Dataset (1884-2010)" and Center for Measuring University Performance data.

universities own at least one IPR each, with universities in Utah that seem to rely proportionally more on intellectual property protection than academic institutions located in other States.

4.4.4 Distribution of patents and trade marks by IPC and Nice classes

The patenting activity of US universities appears mainly related to material science, medicine, microbiology, and electrics and electronics. This can be seen by looking at the main International Patent Classification (IPC)[16] classes academic

[16]The international Patent Classification (IPC) established by the Strasbourg Agreement 1971 (and continuously revised since then – the current version entered into force on 1 January 2011), provides for a hierarchical system of language independent symbols for the classification of patents and utility models according to the different areas of technology to which they pertain. The IPC divides technology into eight sections with approximately 70,000 subdivisions, with different levels

patents belong to (see Table 4.6).

Table 4.6: Top 10 IPC classes in academic patent applications

IPC	IPC code description	% of total academic applications
A61K	Preparations for medical, dental, or toilet purposes.	14%
G01N	Investigating or analysing materials by determining their chemical or physical properties.	8%
C12N	Micro-organisms or enzymes; compositions thereof; propagating, preserving, or maintaining micro-organisms; mutation or genetic engineering; culture media.	7%
C07K	Peptides .	5%
H01L	Semiconductor devices; electric solid state devices not otherwise provided for.	5%
C12Q	Diagnosis; surgery; identification .	4%
A61B	Measuring or testing processes involving enzymes or micro-organisms; compositions or test papers therefore; processes of preparing such compositions; condition-responsive control in microbiological or enzymological processes.	4%
G06F	Electric digital data processing .	3%
C07D	Heterocyclic compounds.	2%
G02B	Optical elements, systems.	2%

Source: Author's own compilation on OECD (2011), Patent Database
Note: Statistics presented at the IPC subclass level.

As mentioned in Chapter 1, trade mark registrations detail the list of goods or services (or both) to which the trade mark would apply. These are classified according to the "Nice Classification", containing 45 distinct classes of products. As could be expected, trade mark registration by US academic institutions mainly pertain to education-related services, followed by the kind of items that relate to the Universities' name or brand and that are sold as gadgets, *e.g.* clothing and stationery. These types of trade marks are typically registered in classes 41, 25, 16, 21, 14, and 28 (see Table 4.7). Examples are "MIT", which is a registered trade mark of the Massachusetts Institute of Technology, and is protected in classes 41, 16 and 25; and the "CALIFORNIA STATE UNIVERSITY STANISLAUS VOX VERITAS VITA MCMLX" trade mark, protected in the very same classes.

A second group of trade mark classes often used by universities relates to high-tech products, and to research and scientific services - namely class 42 (Research

of aggregation, namely: section, class, subclass, group, subgroup. See www.wipo.int for more details.

Table 4.7: Top 10 classes designated in academic trade mark applications

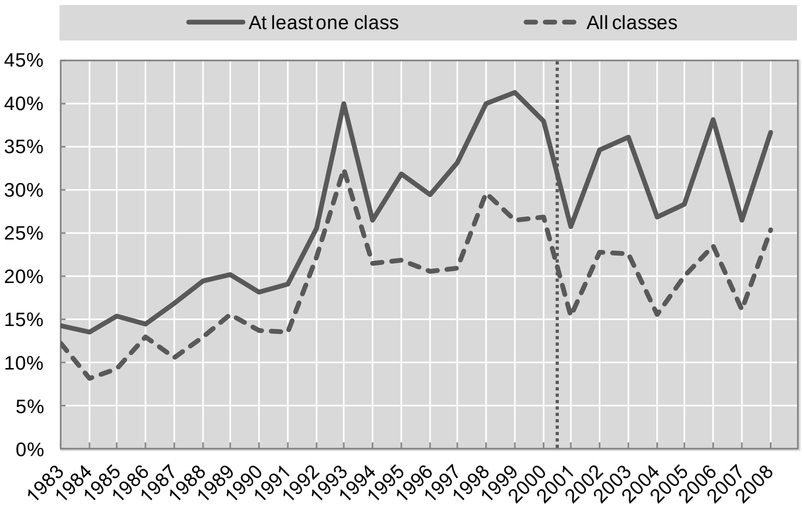
Class	Description	Share in academic applications	Share in all TM applications
41	Education services; providing of training; entertainment; sporting and cultural activities.	32.34%	7.69%
25	Clothing, footwear, headgear	13.32%	5.52%
16	Paper, cardboard and goods made from these materials, not included in other classes; printed matter; bookbinding material; photographs; stationery; adhesives for stationery or household purposes; artists' materials; paint brushes; typewriters and office requisites (except furniture); instructional and teaching material (except apparatus); plastic materials for packaging (not included in other classes); printers' type; printing blocks.	11.44%	5.69%
42	Scientific and technological services and research and design relating thereto; industrial analysis and research services; design and development of computer hardware and software.	6.31%	6.96%
21	Household or kitchen utensils and containers; combs and sponges; brushes (except paint brushes); brush-making materials; articles for cleaning purposes; steelwool; unworked or semi-worked glass (except glass used in building); glassware, porcelain and earthenware not included in other classes.	4.99%	1.54%
9	Scientific, nautical, surveying, photographic, cinematographic, optical, weighing, measuring, signaling, checking (supervision), life-saving and teaching apparatus and instruments; apparatus and instruments for conducting, switching, transforming, accumulating, regulating or controlling electricity; apparatus for recording, transmission or reproduction of sound or images; magnetic data carriers, recording discs; automatic vending machines and mechanisms for coin-operated apparatus; cash registers, calculating machines, data processing equipment and computers; fire-extinguishing apparatus.	4.33%	11.26%
35	Advertising; business management; business administration; office functions.	3.20%	8.57%
14	Precious metals and their alloys and goods in precious metals or coated therewith, not included in other classes; jewellery, precious stones; horological and chronometric instruments.	2.59%	1.28%
28	Games and playthings; gymnastic and sporting articles not included in other classes; decorations for Christmas trees.	2.35%	2.91%
44	Medical services; veterinary services; hygienic and beauty care for human beings or animals; agriculture, horticulture and forestry services.	2.26%	1.39%

Source: Author's own compilation on U.S. Patent & Trade mark Office (2011), "The USPTO Trade mark Casefile Dataset (1884-2010)"

services), 9 (Computer software) , and 44 (Medical services). Other classes which may relate to research activities are class 1 (chemical products), class 5 (pharmaceutical products), class 10 (medical apparatus), class 31 (plants and seeds, organic products), class 35 (advertising, business management, business services), and class 36 (Finance, Insurance, Real estate). Examples of academic trade marks registered in the various Nice classes that may relate to the output of university research activities can be found in Appendix 4.C.

The proportion of academic trade marks registered in classes seemingly related to research output has been increasing over the three last decades, reaching around one third of all applications in 2008 (Figure 4.4). This may suggest that academic

Figure 4.4: Proportion of academic trade marks filed in classes that may relate to research output (classes 1, 5, 9, 10, 31, 35, 42, 44)



Source: Author's own compilation on U.S. Patent & Trade mark Office (2011), "The USPTO Trade mark Casefile Dataset (1884-2010)".

institutions initially relied on trade marks to protect or better sell their "brand", and in later years - from the 1990s - began to use them in relation to their research activities.

As can be seen (Table 4.8), the vast majority of academic IP - especially patents - belongs to institutions mainly engaged in life-science research, followed by engineering and physical sciences.

In all disciplines most institutions file at least one trade mark, and only a minority file patents only. In life sciences and engineering, joint use of trade marks and patents is relatively frequent, whereas in disciplines like mathematics, social sciences, psychology it is common to observe more trade mark registrations than patent applications (Figure 4.5). The list of the top 50 academic applicants of patents and trade marks during the period 1997-2007 can be seen in Appendix 4.D, which further displays the top 50 Universities in terms of trade marks registered in classes seemingly related to research activities.

Table 4.8: IP use by main federal research focus, 1997 - 2007

	Patents	Trade marks	Trade marks in classes 1, 5, 9, 10, 35, 42, 44
Computer Sciences	131	102	38
Engineering	3146	816	153
Environmental Sciences	246	236	35
Life Sciences	17739	4014	964
Mathematical Sciences	0	11	0
Physical Sciences	1578	572	57
Psychology	5	67	5
Social Sciences	165	42	2
Mixed	344	177	26
Other Sciences	3	15	0

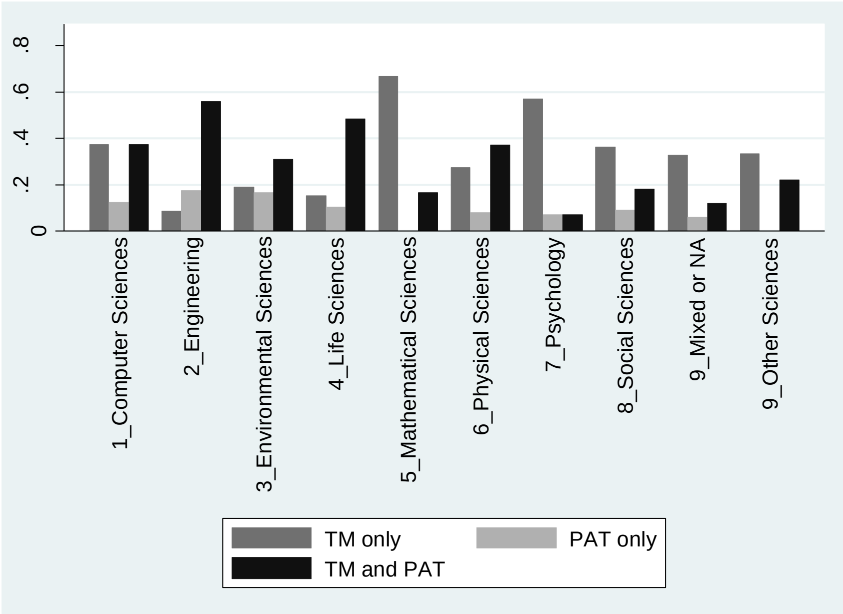
Source: Author's own compilation on OECD (2011), Patent Database, U.S. Patent & Trade mark Office (2011), "The USPTO Trade mark Casefile Dataset (1884-2010)" and Center for Measuring University Performance data. Note: The plain line corresponds to academic trade marks filed in at least one of the above mentioned classes, and the dotted line corresponds to academic trade marks filed exclusively in the above mentioned classes.

4.5 Empirical analysis and main results

In the following subsection, we rely on count data models to shed some light on the possible institutional characteristics and factors that may explain trade mark registrations by US universities. The following estimations cannot be considered as an assessment of causality relationships, as data selectivity or endogeneity issues are unaddressed, due to data availability constraints and the lack of analytical framework to interpret university incentives to trade mark. We therefore limit ourselves at this stage to uncover possible relationships. Our dependent variable, tm_{it}, is the number of trade marks applied for by institution i at time t (in years). The control variables we use account for some university-specific characteristics and for the innovative behaviours of universities. They are listed in Table 4.9, together with a short explanation of their content.

A first group of explanatory variables relates to general institutional characteristics of the university, which are all university specific and time invariant. $Control_i$

Figure 4.5: Proportion of academic institutions with joint or separate use of patents and trade marks by main federal research focus (1997-2007)



Source: Author's own compilation on OECD (2011), Patent Database, U.S. Patent & Trade mark Office (2011), "The USPTO Trade mark Casefile Dataset (1884-2010)" and Center for Measuring University Performance data. Note: The complement to 100% is represented by institutions without any IP.

is a dichotomous variable denoting whether university i is a public ($control_i = 0$) or a private one ($control_i = 1$); age_i mirrors university i's age in 2006, *i.e.* number of years since establishment; $stud2006_i$ refers to the total number of students enrolled in the fall 2006 period (in thousands); and med_school_i denotes the presence of a medical school. Finally, uni_state is a discrete variable accounting for the number of Universities located in the State where university i is located.

A second group of variables focuses on the university's research activities. The variable $res\_fund\_per\_stu_{it}$ – calculated as the total amount of funds (in thousand dollars) that university i invested in research at time t (*i.e.* in year t) divided by the number of students enrolled – mirrors the overall intensity of research activities in the university, whereas $fedfund\_share_{it}$, denotes the share of university i's research expenditure financed by the federal government in year t. $N\_researchareas_i$

Table 4.9: Variables' names and contents

Variable	**Description**
tm_{it}	Number of trade marks applied for by university *i* at time *t*
$control_i$	Dichotomous variable denoting university ownership: 1= private; 0 = public
age_i	Age is the number of years from establishment of university *i* until 2006
$stud2006_i$	Number of students enrolled in university *i* in fall 2006 (in thousands)
med_school_i	Dichotomous variable denoting the presence of a medical school: 1 = yes; 0 = no
uni_state_i	Number of universities in the state
$res\_fund\_per\_stu_{it}$	Ratio of the research expenditures of university *i* at time *t* (in thousand dollars, at constant values) on the number of students in 2006
$fedfund\_share_{it}$	Share of university *i*'s research expenditures financed by federal government at time *t*
$n\_researchareas_i$	Number of disciplines federal funds are allocated to in university *i* (see § 4.2)
$engineering_i$, … , $social\ sciences_i$	Proportion of federal research funds allocated to each discipline (see § 4.2)
$patgrant_{it}$	Number of patents granted to university *i* and applied for at time *t*
$patapp_{it}$	Number of patents applied for by university *i* at time *t*
$before1997tm_i$	Total number of trade marks applied for by university *i* before 1997

is a count variable ranging from zero to nine, denoting the number of scientific fields in which university i received federal funds for research activities in 2004, as an indication of the diversity of the research activities conducted in the university. Nine variables then account for the intensity of federal research funds across disciplines. The value of these variables ranges from zero to one, in a stepwise fashion[17] (see Section 4.4.2 for more details). We also investigate the link with patenting activities. Two distinct measures relating to patents are used: $patapp_{it}$ denotes the number of patents applied for by institution i at time t ; whereas $patgrant_{it}$ refers to the number of patents granted to institution i and applied for at time t . Finally, since trade marks are likely to be a persistent activity, we include a time invariant discrete variable indicating the total number of trade marks applied for by university i at the onset of our observation period ($before1997tm_i$). Summary descriptive statistics on the variables used in the analysis are provided in Appendix 4.E.

[17]Possible values are 0, 0.11, 0.12, 0.37, 0.62, 0.85, 1, corresponding respectively to "mixed", "low", "moderate", "strong", "heavy" and "all" research intensity in each of the disciplines considered.

Some of the variables appear to be strongly correlated among each other, as can be seen from Table 4.10. This is the case, for instance, for the number of students, which appears to be very much linked to the number of patents granted or applied for, the stock of trade marks in 1997, and the type of ownership (*i.e.* being private or public). Estimates nevertheless prove not to be significantly affected by the inclusion or exclusion of these highly correlated variables - in terms of either significance or sign of regressors.

Table 4.10: Pairwise correlation matrix

	tm	control	age	stud2006	med_school	uni_state	res_fund_per_stu	fedfund_share	n_researchareas	patgrant	patapp	before1997tm
Tm	1											
control		1										
age	0.15*	0.22*	1									
stud2006	0.32*	-0.31*	0.06*	1								
med_school	0.21*		0.13*	0.17*	1							
uni_state		0.21*	-0.05*	0.03	-0.04*	1						
res_fund_per_stu			-0.05*	-0.07*		0.09*	1					
fedfund_share		0.10*		-0.09*	0.11*			1				
n_researchareas	0.04*	-0.03*	0.05*	0.16*	-0.07*	-0.05*	-0.03	-0.06*	1			
patgrant	0.33*		0.15*	0.59*	0.24*	0.07*			0.05*	1		
patapp	0.27*		0.13*	0.48*	0.20*	0.06*		0.03	0.04*	0.75*	1	
before1997tm	0.51*	-0.03*	0.18*	0.35*	0.19*				0.11*	0.41*	0.34*	1

Note: correlation coefficients displayed if significance level ≥ 0.10;
Legend: * = significance level ≥ 0.01

Given that we only have a few time varying regressors available, the analysis relies on pooled cross section estimates. Our dependent variable, the number of trade mark applications in year t, is a non-negative integer, *i.e.* a count variable. The natural starting point for an analysis of count data is the Poisson distribution and the Poisson model. However, our variable does not seem to verify the property of equidispersion associated to the Poisson distribution, as its variance tends to be seven to eleven time superior to its mean over the years (see Table 4.5). Thus we also considered the negative binomial specification, which is one possible way to account for overdispersion. Besides, our dependent variable shows a high proportion of zero values. Until 2004, the third quartile of the trade mark variable was equal to 0. Two different reasons might actually explain the fact that universities do not apply for trade marks: either the university did not have the opportunity to do so, or it did not attempt at all, for example if no one in the personnel of the university is familiar with the trade mark legislation system. This is likely to result in an over-representation of zeros in the data. Therefore, we also consider Zero-Inflated Poisson (ZIP) and Zero-Inflated Negative Binomial specifications, accounting for the prevalence of zeros observed in the data. ZIP and ZINB regressions split the process modelling the outcome as zero or nonzero: a logit model first predicts whether or not the dependent variable is zero - in our case, whether university i is likely to have at least one trade mark in time t; a Poisson/Negative Binomial model then predicts the counts for those universities for which the dependent variable is likely to be positive (see Long 1997 and Greene 2008 for a discussion of zero-modified count models).

For each type of model considered, three regressions are run, a first one relying only on institutional and research funding variables among the explanatory variables, and the two other ones taking into account patenting activity, relying either on all patent applications or only on patents granted. For those three types of regressions, the four count data specifications mentioned above were estimated. We then relied on log-likelihood function and on information criteria in order to compare the goodness of fit of the different models (see Table 4.11). In all cases, the various information criteria[18] considered favour the ZINB model, which is thus the one that we retained for all regressions, the results of which are displayed here, in Table 4.12. For each regression, the results are presented in two parts. The first column (*i.e.* the one on the left hand side) corresponds to the Negative Binomial part of the model, whereas the results of the Logit zero inflated estimates are reported

[18]Information criteria correspond to log-likelihood criteria with degrees of freedom adjustment. They account for the trade-off between model accuracy and parsimony, by introducing a penalty term for the number of parameters included in the model. Two standard criteria are Akaike's information criteria (AIC) and Schwarz's Bayesian information criteria (BIC). The penalty term for the number of parameters is larger in BIC than in AIC. In both cases, the preferred model is the one with the lowest AIC/BIC value.

in the second column. Let us note that positive coefficients in the "inflate" part imply a higher chance of zeros, *i.e.* of not applying for trade marks. In the analysis that follows, we mainly focus on the sign and significance of the coefficients, rather than on their size. To further simplify the analysis, we show the sign of significant coefficients in Table 4.13 below.

Table 4.11: Information Criteria associated to the different models

		Poisson	Neg Bin	ZIP	ZINB	*Prefers*
Regression 1 (no patent variable)	Log likelihood	-7747.773	-5138.632	-5650.558	-4806.011	*ZINB*
	AIC	15553.55	10337.26	11417.12	9730.022	*ZINB*
	BIC	15737.71	10527.78	11785.44	10104.7	*ZINB*
Regression 2 (including *patapp*)	Log likelihood	-7724.275	-5138.294	-5640.4	-4772.996	*ZINB*
	AIC	15508.55	10338.59	11400.8	9667.991	*ZINB*
	BIC	15699.06	10535.45	11781.83	10055.37	*ZINB*
Regression 3 (including *patgrant*)	Log likelihood	-7728.255	-5137.705	-5636.908	-4759.344	*ZINB*
	AIC	15516.51	10337.41	11393.82	9640.689	*ZINB*
	BIC	15707.02	10534.27	11774.84	10028.07	*ZINB*

As could be expected, private universities prove to be more entrepreneurial in nature, and exhibit a stronger likelihood to register a trade mark. Bigger universities, as well as those with medical schools also tend to register more trade marks. Age does not seem to play a role in trade marking activity, which may be due to the fact that most universities included in the sample are relatively old, and already well established (the value of the tenth percentile is 43 years old). Trade mark registration nevertheless appears to be persistent, as the stock of trade marks applied for before our observation period positively relates to trade mark applications during the period 1997-2007. The estimations also suggest that the smaller the number of universities located in a certain state, the more likely they are to register trade marks. This somewhat counter-intuitive result - as it would be reasonable to expect that competition at the local level would increase the need for universities to differentiate themselves from their competitors, possibly using trade marks - may mirror the necessity of launching new initiatives and of being more dynamics in order to attract funds or students.

As far as research activities are concerned, trade marking activities as a whole do not appear to be significantly correlated with the intensity of research expen-

Table 4.12: Regression results

	(1)		(2)		(3)	
	NegBin	Logit	NegBin	Logit	NegBin	Logit
patapp			-0.002	-0.229		
			(1.70)*	(4.70)***		
patgrant					-0.001	-0.259
					(0.58)	(5.86)***
res_fund_per_stu	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.82)	(1.21)	(0.19)	(0.20)	(1.12)	(0.81)
fedfund_share	0.445	-0.068	0.482	0.054	0.453	0.038
	(2.08)**	(0.20)	(2.28)**	(0.16)	(2.14)**	(0.12)
before1997tm	0.014	-0.221	0.014	-0.162	0.014	-0.131
	(10.79)***	(7.06)***	(11.13)***	(6.73)***	(10.93)***	(5.84)***
control	0.240	-1.079	0.242	-1.093	0.229	-1.171
	(2.57)**	(5.66)***	(2.61)***	(5.58)***	(2.46)**	(5.77)***
age	-0.000	-0.000	-0.000	-0.001	-0.000	-0.002
	(0.30)	(0.18)	(0.52)	(0.83)	(0.57)	(0.99)
stud2006	0.010	-0.069	0.011	-0.070	0.010	-0.076
	(4.37)***	(6.31)***	(4.43)***	(6.26)***	(3.50)***	(6.33)***
med_school	0.242	-0.885	0.270	-0.469	0.296	-0.103
	(2.46)**	(3.97)***	(2.81)***	(2.07)**	(3.12)***	(0.43)
uni_state	-0.004	0.015	-0.004	0.014	-0.005	0.012
	(1.52)	(3.18)***	(1.61)	(3.04)***	(1.86)*	(2.52)**
n_researchareas	0.022	0.033	0.029	0.087	0.032	0.090
	(0.69)	(0.41)	(0.95)	(1.12)	(1.02)	(1.18)
engineering	-0.128	-0.007	-0.160	-0.184	-0.212	-0.301
	(0.47)	(0.02)	(0.59)	(0.41)	(0.77)	(0.65)
environmentalsciences	-0.778	-0.605	-0.929	-1.046	-0.955	-1.300
	(2.21)**	(1.12)	(2.71)***	(1.93)*	(2.78)***	(2.37)**
lifesciences	-0.046	0.085	-0.105	-0.249	-0.160	-0.501
	(0.22)	(0.23)	(0.52)	(0.69)	(0.79)	(1.36)
othersciences	-1.485	-1.430	-1.678	-2.086	-1.646	-2.217
	(1.91)*	(1.26)	(2.15)**	(1.67)*	(2.11)**	(1.81)*
physicalsciences	0.105	0.274	0.134	0.069	0.146	-0.102
	(0.30)	(0.58)	(0.39)	(0.15)	(0.43)	(0.23)
psychology	-1.098	-0.415	-1.161	-0.956	-1.118	-1.193
	(2.48)**	(0.54)	(2.60)***	(1.26)	(2.45)**	(1.57)
computersciences	0.988	0.356	0.915	-0.147	0.948	-0.332
	(2.29)**	(0.49)	(2.15)**	(0.21)	(2.21)**	(0.46)
mathematicalsciences	-4.705	-4.958	-4.835	-6.014	-4.810	-6.310
	(4.66)***	(2.11)**	(4.75)***	(2.37)**	(4.72)***	(2.47)**
socialsciences	1.190	0.073	1.091	-0.273	0.979	-0.344
	(1.51)	(0.10)	(1.44)	(0.37)	(1.29)	(0.44)
Constant	-0.204	2.881	-0.202	2.883	-0.159	3.437
	(0.82)	(5.73)***	(0.81)	(5.82)***	(0.65)	(6.59)***
Dummy years	Yes	Yes	Yes	Yes	Yes	Yes
Ln(alpha)	0.186		0.153		0.178	
	(2.65)***		(2.35)**		(2.84)***	
N	4232		4232		4232	
Log pseudo-likelihood	-4,806.01		-4,773.00		-4,759.34	

Notes: t-statistics are given within parentheses. * p<0.1; ** p<0.05; *** p<0.01

Table 4.13: Regressions results: sign of significant coefficients

	(1)		(2)		(3)	
	NegBin	Logit	NegBin	Logit	NegBin	Logit
Patapp			-	-		
patgrant						-
res_fund_per_stu						
fedfund_share	+		+		+	
before1997tm	+	-	+	-	+	-
Control	+	-	+	-	+	-
Age						
Stud	+	-	+	-	+	-
med_school	+	-	+	-	+	
uni_state		+		+	-	+
n_researchareas						
engineering						
environmentalsciences	-		-	-	-	-
lifesciences						
othersciences	-		-	-	-	-
physicalsciences						
psychology	-		-		-	
computersciences	+		+		+	
mathematicalsciences	-	-	-	-	-	-
socialsciences						

Note: Sign displayed for p<0.1

diture. However, they tend to be positively related to the share of federal funds received, which suggests that trade marks might sometimes be used as a signalling tool to receive federal funds. Indeed government funding, more than other types of funding, are often associated to specific goals and outcomes, that generally condition the renewal of the grants. They are thus likely to be related to the creation of new research centres or programs that may lead to new trade mark registrations. In terms of research areas, our results suggest that a stronger focus on computer sciences leads to observing more trade mark activity. The link with patents, on the other hand, appears to be ambiguous. We find that the likelihood of trade mark registration, independently of the number of applications, positively relates to patenting activities - both applications and grants - whereas the number of trade mark applications tends to be negatively related to patent applications, and is not significantly related to granted patents.

In order to get further insights into the different logics which may drive the registration of trade marks by universities, we refined the above analysis by distinguishing different categories of trade marks, and sought to analyse whether the determinants differ according to the category considered. Two groups of trade marks were identified, based on the information on classes of products designated in the trade mark application. The first group corresponds to trade marks with at least one class of product likely to be related to the research activity (namely classes 1, 5, 9, 10, 31, 35, 42, or 44), as explained in Subsection 4.4.4, whereas the other group corresponds to trade marks which do not designate any of those classes of products. The previous models were estimated separately on those two categories of trade marks. The signs of the coefficients obtained are presented in Table 4.14. Complete regression results are presented in Appendix 4.F.

In terms of basic institutional characteristics, such as size, age, being a private or a public institution, or the presence or not of a medical school, the two categories of trade marks seem to be associated to the same type of university characteristics. Both types of trade marking activity are also significantly and positively related to the past use of trade marks, and tend to be negatively related to the number of

Table 4.14: Regressions results on the two different categories of trade marks: sign of significant coefficients

	TM with classes related to research						TM without classes related to research					
	(1)		(2)		(3)		(4)		(5)		(6)	
	NegBin	Logit	NegBin	Logit	NegBin	Logit	NegBin	Logit	NegBin	Logit	NegBin	Logit
Patapp				-					-	-		
patgrant					+	-					-	-
res_fund_per_stu	+		+								-	
fedfund_share	+		+		+						+	
before1997tm	+	-	+	-	+	-	+	-	+	-	+	-
Control	+		+			-		-		-	+	-
Age												
Stud	+	-	+	-		-	+	-	+	-	+	-
med_school	+	-	+	-	+				+		+	
uni_state	-		-		-			+		+		+
n_researchareas												
engineering												
environmentalsciences				-		-	-		-		-	
lifesciences												
othersciences	+		+		+		-		-		-	-
physicalsciences	-		-									
psychology	-	-	-	-	-	-			-		-	
computersciences	+		+		+							
mathematicalsciences	-		-	-	-	-	-	-	-	-	-	-
socialsciences	+	+	+		+	+						

Note: Sign displayed for p<0.1

universities present in the state.

As far as the research activities are concerned, by contrast, our result suggest that trade marks registered in classes of products seemingly associated to research activities are actually positively related to the research funds received by the university (positive and significant coefficient obtained in the first two models), whereas the other trade marks do not seem to be positively related to research funding and are even found to be slightly negatively related to them. The latter result might point towards the existence of alternative strategies inside universities, which might either specialize in research activities, or alternatively choose to invest in the protection of their reputation as educational institutions. Trade marks with classes seemingly related to research activities also tend to be positively correlated with patenting activities, which suggest that the two types of IPRs are used jointly rather than as substitutes to each other. The coefficient obtained for all patent applications is only significant in the logistic regression, whereas when restricting to granted patents, the coefficients are significant for both parts of the model. This suggests that universities apply for trade marks when they have obtained a patent protection rather than in the early stage of the invention development.

Regarding research areas, trade marks with classes seemingly related to research activities tend to be more strongly associated to certain sectors than other trade marks. They are particularly strongly associated to computer sciences – which may mirror the fact that many universities develop their own software as part of their research activities, software that are likely to be commercialized to actors in the area –, and to other sciences. For some other disciplines such as psychology and social sciences, the results of our estimations suggest that the relationship with this type of trade marks is not straightforward, as the coefficient obtained in the logit regression and those obtained in the negative binomial regressions point toward opposite effects. We can note that trade marks may positively relate to research areas where outputs are likely to be patentable, (*e.g.* computer sciences, software being patentable under US legislation), as well as to research areas presumably not associated to patent activities (*e.g.* social sciences). In a further step, it would be interesting to analyse the possible complementary or substitute relationship between the use of patents and trade marks in the various areas of academic research.

4.6 Conclusion

In this last chapter, we investigated trade marking activity in the context of a specific innovative actor, namely universities. Of the many analyses focusing on universities' third function, none seems to address trade mark registration by academic institutions. We conversely believe that universities may rely on trade marks to signal, protect or better exploit some of their key intangible assets. Through trade marks universities may in fact legally protect their reputation, market their current and prospect activities, and better appropriate and sell their innovative output.

Our study is, to the best of our knowledge, the first to address this gap in the academic entrepreneurship literature. It does so by investigating whether and to what extent universities in the United States use trade marks; how trade mark registration relates to patenting by academic institutions; and the way some university specific variables contribute to explaining university trade marks. The analysis relies on a novel dataset containing information about university characteristics and their IPR activities over the period 1997-2007.

We find trade mark activities by universities to be positively correlated with the number of students enrolled, the presence of medical schools, the share of federal funds received, and being a private institution, and negatively correlated with the number of universities located in the same State. Based on the classes of products in which trade marks are registered, it is possible to identify different categories of academic trade marks relating to different strategies. Some trade marks may be used to protect the general reputation of the university, whereas others tend to relate to merchandising activities. A last group of trade marks appears to be related to research activities and outputs. Regarding this last type of trade marks, they tend to be positively associated to patents, but they are also used in research areas where outputs are not patentable. The discussion about the type of relationships possibly linking trade marks to patents thus remains very much open. Future research might want to address the "one to many" or "many to many" IP link, as well as the timing that characterizes trade mark registration vis-à-vis patent application, in order to shed light on the possible existence of complementarities or substitution effects. Another issue deserving investigation is whether and - if so - to what extent, the relationship trade marks-patents is influenced by the quality of the innovations patented.

A way to further refine our greenfield exploration would be to acquire precise and time varying data about some key within-university characteristics, like the number of students, the number of graduates and the amount of money spent in research by each department. The Universities in our sample are very well known to differ *e.g.* in the relative importance of their departments, their national ranking, and their organization, and these might have consequences on IPR use and strategies (see Bercovitz *et al.* 2001 in this respect). Finally, this last chapter proposed an analysis of trade marks in the context of an actor with various potential objectives and activities. Trade marking activity in this case takes different forms, which coexist and are likely to interact. This is likely to apply to a certain extent to any type of actor. The protection of general reputation might relate to the protection of specific assets or products. Those different strategies are relatively difficult to disentangle in the case of firms. In the case of universities, by contrast, the different activities conducted are relatively clear-cut, so that it is easier to identify different forms of trade marking activities. The investigation of academic trade marking activities may therefore constitute a fruitful field of investigation, not only regarding academic entrepreneurship activities, but also to contribute to the understanding of the multiple stakes of trade mark strategies.

4.7 Appendices

Appendix 4.A Examples of university trade marks related to research activity (in alphabetical order)

ACSI, University of Michigan: The American Customer Satisfaction Index (ACSI) is an economic indicator measuring the satisfaction of consumers in the U.S., based on both customer interviewing and econometric modelling. The project was started in 1994 by researchers at the National Quality Research Center, a research unit within the University of Michigan, in cooperation with partners at the American Society for Quality in Milwaukee, Wisconsin, and CFI Group in Ann Arbor. In December 1995, "ACSI" was deposited as a trade mark at USPTO by the Michigan University. It is registered in class 35, referring more precisely to "business and market research and analysis services, namely, the research and periodic measurement, publication and distribution to others of customer evaluation of the quality of goods and services purchased in the United States in major industry sectors". In 2009, a private company was formed called "American Customer Satisfaction Index" based in Ann Arbor, Michigan. The index is now produced by this company and no longer by the University of Michigan, although Claes Fornell, who was and still is the principal researcher behind the ACSI, remains a professor at the university. (For more information: http://www.theacsi.org/index.php)

Bioglass, University of Florida: Bioglass is a biomaterial that was developed at the University of Florida in the end of the 1960. During the years of the Vietnam war, Larry Hench, material engineer at the University of Florida, started research on the possible use of glass as a prosthesis material for the soldiers who had limbs amputated. This research, which received funding from the U.S. Army Medical R&D Command, led to the creation of Bioglass®. Bioglass®, initially used for bone regeneration, later proved to have multiple useful applications for clinical use, notably in periodontics (PerioGlas®). "Bioglass" was deposited as a trade mark by the University of Florida, registered at USPTO in August 1982 in classes 10 (referring to "Biologically Active Glass and Biologically Active Glass-

Coated or Laminated Ceramic or Metal, Formed into Bone Screws, Rods and Pins and Other Dental and Surgical Implants"), 9 (referring to "Laboratory Equipment-Namely, Biologically Active Glass and Glass-Coated or Laminated Tissue Culture Discs"), and class 42 (referring to "Services-Namely, Biomedical Engineering Services-Namely, Designing and Fabricating Biologically Active Glass and Biologically Active Glass-Coated or Laminated Ceramic or Metallic Dental and Surgical Implants"). (For more information: http://new.novabone.com/history.html)

Brainmap, University of Texas: BrainMap is an online database of published functional neuro-imaging experiments, created and developed at the Research Imaging Institute of the University of Texas Health Science Center San Antonio (UTHSCSA). Its aim is to provide a tool to share methods and results of studies in specific research domains, such as language, memory, attention, emotion, and perception. "Brainmap" was deposited as a trade mark by the University of Texas at USPTO first in class 9 in November 1995 (referring to a "computer software for use in the field of human neuroscience, namely, software for creating digitized representations of the human brain"), later in class 16 in March 2004 (referring to "printed educational materials, namely testing booklets in the field of self-assessment and thinking skills"), and lastly in December 2006 in class 44 (referring to a service "providing an online computer database in the field of neurology and brain function; providing a database in the field of neurology and brain function that also allows inputting and collection of data and information for research purposes"). (For more information on http://brainmap.org/)

COEUS, Massachusetts Institute of Technology: Coeus is an electronic research administration system for award management, developed by the Massachusetts Institute of Technology (MIT) in the early 1990s. Its purpose is to assist the research community for grant proposals and pre- and post-award management. "Coeus" was registered as a trade mark at USPTO by the MIT in July 1997 in class 9 (referring to "computer software that manages sponsored programs databases and provides for the electronic transfer and management of research grant proposals and data by any method, ie CD ROM, diskettes, magnetic tape, or downloadable from a remote site, and related documentation”). (For more information: http://osp.mit.edu/coeus/)

Loom and Powerloom, University of Southern California: Loom and Power loom are knowledge representation languages for constructing intelligent applications, developed by researchers in the Artificial Intelligence research group at the University of Southern California’s Information Sciences Institute. “Loom” and “Powerloom” are two registered trade marks at USPTO owned by the University of Southern California, both filed in July 2003, and both in class 9 (referring to “computer software and downloadable computer software, namely, computer program modules and data files that encode knowledge and ontologies for exploitation by artificial intelligence and other automated reasoning applications; downloadable electronic user manuals therefore, and electronic user manuals therefore recorded on computer media”). (For more information: http://www.isi.edu/isd/LOOM/)

Octave, Carnegie Mellon: Octave (Operationally Critical Threat, Asset, and Vulnerability EvaluationSM) corresponds to a set of methods and tools for risk-based information security strategic assessment and planning. It was developed by the Carnegie Mellon Software Engineering Institute and launched in the beginning of years 2000s. The trade mark “Octave” was deposited by the Carnegie Mellon University in March 2002 in 3 different classes 35, 16 and 41, referring respectively to “business consulting services in the field of information security, risk evaluation and risk management”, “printed publications, namely books and reports in the field of information security, risk evaluation and risk management”, and to “education and training services, namely group workshops and self-paced classes, and cd-rom presentations, in the field of information security, risk evaluation and risk management”. (For more information: http://www.cert.org/octave/)

OMIM, Johns Hopkins University: Online Mendelian Inheritance in Man (OMIM) is a timely compendium of human genes and genetic phenotypes, intended for use by researchers, advanced students and other professionals concerned with genetic disorders. This database was initiated in the early 1960s by Dr. Victor A. McKusick. It was initially a catalog of Mendelian traits and disorders, entitled Mendelian

Inheritance in Man (MIM). Several book editions of MIM were published later on, and the online version, OMIM, was created in 1985 by a collaboration between the National Library of Medicine and the William H. Welch Medical Library at Johns Hopkins. "OMIM" is a trade mark deposited by John Hopkins University at USPTO in December 2001 in class 44 (described as a service "Providing health related information, namely, information via an online medium regarding Mendelian related inheritance"). (For more information: http://www.omim.org/)

Spacewatch, University of Arizona: Spacewatch is a project founded in 1980 by Tom Gehrels and McMillan at the University of Arizona's Lunar and Planetary Laboratory. Its purpose is to explore the various populations of small objects in the solar system, and study the statistics of asteroids and comets in order to investigate the dynamical evolution of the solar system. It is besides involved in finding potential targets for interplanetary spacecraft missions, as well as objects that might present a hazard to the Earth. The trade mark "Spacewatch" was deposited at USPTO by the University of Arizona in July 2000. It is protected in class 41 and 42, referring respectively to "educational research, namely, research in the field of discovering, identifying, investigating and monitoring asteroids and comets; development and dissemination of methodology and educational materials for others in the field of discovering, identifying, investigating and monitoring asteroids and comets" and to "scientific research; research in the field of identifying, investigating and monitoring asteroids and comets". (For more information: http://spacewatch.lpl.arizona.edu/)

Appendix 4.B Universities' main characteristics, 1997 – 2007

	year	N obs.	Total funds received		Share of federal funds		Medical school	Age		Students in 2006 (in 1000)		Share of graduate students		Number of universities in State	
			Mean	Sd	Mean	Sd		Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd
Overall sample	1997		63,829	132,270.37	58%	0.23	18%								
	1998		68,561	138,995.88	58%	0.23	19%								
	1999		74,447	148,808.17	58%	0.24	18%								
	2000		77,003	159,349.60	57%	0.24	18%								
	2001		77,932	165,267.89	58%	0.24	19%								
	2002	621	77,210	167,263.73	59%	0.23	19%	105.9	49.36	12	14.63	27%	0.25	22.3	15.53
	2003		75,275	170,660.76	60%	0.23	18%								
	2004		79,511	172,162.75	62%	0.23	18%								
	2005		77,167	175,211.13	62%	0.22	18%								
	2006		81,656	176,785.26	62%	0.22	18%								
	2007		162,504	370,335.96	61%	0.22	18%								
Public universities	1997		62,753	144,902.65	55%	0.22	19%								
	1998		67,265	151,957.05	55%	0.22	19%								
	1999		72,549	163,059.31	55%	0.23	19%								
	2000		75,068	172,840.22	55%	0.23	19%								
	2001		75,817	178,664.38	56%	0.23	19%								
	2002	369	76,340	182,485.71	57%	0.23	19%	97	46.71	16	16.76	24%	0.21	19.6	14.46
	2003		76,427	189,153.40	59%	0.22	19%								
	2004		79,466	187,391.35	60%	0.23	19%								
	2005		76,655	191,491.30	62%	0.21	19%								
	2006		78,373	187,863.42	61%	0.21	19%								
	2007		165,352	407,669.27	60%	0.21	18%								
Private universities	1997		65,342	112,580.29	62%	0.23	18%								
	1998		70,434	118,249.00	62%	0.24	18%								
	1999		77,261	125,193.88	62%	0.25	18%								
	2000		79,892	137,230.12	62%	0.25	18%								
	2001		81,212	142,509.52	62%	0.24	18%								
	2002	252	78,532	141,583.00	62%	0.23	18%	119	50.31	6	6.94	34%	0.3	26.3	16.2
	2003		73,516	138,255.91	63%	0.24	18%								
	2004		79,581	146,368.46	64%	0.24	18%								
	2005		77,968	146,787.88	63%	0.24	18%								
	2006		87,046	157,379.45	65%	0.22	18%								
	2007		158,026	303,660.14	63%	0.24	18%								

Source: Author's own compilation on Center for Measuring University Performance data (2011)

Appendix 4.C Examples of academic trade marks in the various classes relating to the output of the university's research (name of the trade mark and description of the products covered)

class	description	Examples		
		Word Mark	Applicant	Description
1	Chemical products	ADEASY	Johns Hopkins University, The	Biological materials, namely DNA vectors used to produce recombinant adenoviruses for scientific and medical research;
		PANTHERSKIN	Florida International University	Corrosion and fire inhibiting chemicals for use in the manufacture of steel structures, transport vehicles and industrial machinery
5	Pharmaceutical products	CHICAGO BCG VACCINE	University of Illinois	Bacillus calmette guerin vaccine;
		DEUTRANE	University of Iowa	Inhalational anesthetics for surgical use
9	Computer softwares	3D-AUTOLAYOUT	Carnegie Mellon University	Computer programs for solving three-dimensional layout and design problems
		ACAPELLA	University of Washington	DNA and protein sample analysis instrumentation for research purpose
		MAMMO-FAX	University of Pittsburgh	Hardware and software for use in analyzing mammograms and transmitting them by telefacsimile
		SWIMSOUND	Virginia Commonwealth University	Waterproof apparatus for listening to radios or mp3 players via bone conduction during recreational and competitive swimming, or while bicycling, jogging or hiking in rain or high-moisture environments
10	Medical apparatus	ELECTROGENE	University of Pennsylvania	Electronic medical apparatus used in the treatment of arthritis and other cartilage-related diseases and cartilage damage, for human and veterinary use
		SMART DRAIN	Alfred E. Mann Institute for Biomedical Engineering at the University of Southern California	Surgical drain with optical fibers for viewing tissue conditions, that do not feature microprocessors, computing capabilities or electronic control capabilities;
31	Plants and seeds, organic products	ACALYPHA BOURBON STREET	University of Georgia	Live plants, namely, Acalypha godseffiana plants;
		CROSBREED	Rutgers, The State University of New Jersey	Disease-resistant oysters
		ORGENIC	Auburn University	Living animals, namely transgenic animals; transgenic catfish
35	Business management, business services, Advertising	DEMONTECH	DePaul University	Business consultation services in the field of start-up high technology businesses; consultation in the field of human resources and employee recruitment
		FLORIDA SCAN	Florida State University	Forecasting information concerning the economic condition of the state of Florida
		NASA TECHLINK	Montana State University	Business consultation services, namely, technology transfer assistance, technology transfer agreement formation assistance, technology licensing assistance and business assistance in areas of technology commercialization, planning and strategic marketing
36	Finance, Insurance, Real estate	CARNEGIE MELLON CYLAB	Carnegie Mellon University	Consultation and research for others in the field of risk management
		CREIGHTON PORTFOLIO INDEX	Creighton University	Financial research and information services; Financial consulting services, namely, expert analysis in finance
42	Research services	HUMAN CAPITAL LAB	Bellevue University	Research and development and consultation related thereto in the field of human capital investment and management;
		MINE-TO-MILL	University of Queensland	Engineering consultancy services; consultancy services relating to the extraction, handling, refining and processing of ores, metals and minerals;
		SHARPBRAIN	University of South Carolina	Research and development of products that enable senior citizens to maintain intellectual activity, brain health, and memory in order to facilitate independent living
		SPEED RX	University of Vermont and State Agriculture College	Laboratory services, namely, predicting the speed and efficacy of blood-clotting agents
		UNHCEMS	University of New Hampshire	Providing an online computer database in the field of chemical and environmental management;
44	Medical services	... ON THEIR WAY	The Vanderbilt University	Health care services; hospital services; and medical services;
		COMPLETELIFE	Indiana University	Psychological counseling; dietary and nutritional guidance; music therapy for physical, psychological and cognitive purposes; massage; and oncology pharmacy consulting
		TRAUMA BURN CENTER	University of Michigan	Medical services, namely, patient care and medical research

Source: U.S. Patent & Trade mark Office (2011), "The USPTO Trade mark Casefile Dataset (1884-2010)"

Appendix 4.D Top 50 academic applicants of patents and trade marks (1997-2007)

Patents		Trade marks		Trade marks in classes 1, 5, 9, 10, 35, 42, 44	
University of California	2962	University of Pennsylvania	169	University of Pennsylvania	75
Massachusetts Institute of Technology	1075	University of Texas - Austin	164	University of Chicago	46
California Institute of Technology	887	Georgia State University	162	University of Texas - Austin	45
University of Texas - Austin	821	Georgia Institute of Technology	162	University of Washington - Seattle	33
Stanford University	747	University of Central Florida	120	University of California	33
University of Wisconsin - Madison	732	University of California	117	Carnegie Mellon University	32
Johns Hopkins University	674	Harvard University	105	Harvard University	29
University of Michigan - Ann Arbor	597	Tulane University	91	Colorado State University	28
University of Florida	469	University of Washington - Seattle	82	Vanderbilt University	25
Cornell University	439	University of Wisconsin - Madison	78	Johns Hopkins University	23
Columbia University	405	Rice University	76	Oregon Health & Science University	23
Harvard University	396	University of Chicago	74	University of Central Florida	21
University of Washington - Seattle	379	Carnegie Mellon University	71	University of Michigan - Ann Arbor	21
Georgia Institute of Technology	374	Ohio State University - Columbus	70	University of Southern California	21
University of Illinois - Urbana-Champaign	372	Rutgers the State Univ. of NJ - New Brunswick	69	Georgia Institute of Technology	17
University of Pennsylvania	362	University of Pittsburgh - Pittsburgh	68	Georgia State University	17
Michigan State University	339	Vanderbilt University	66	University of Illinois - Urbana-Champaign	16
Duke University	336	University of Florida	65	University of North Dakota	15
Pennsylvania State University - University Park	310	University of Michigan - Ann Arbor	64	Yale University	15
North Carolina State University	265	Auburn University	61	Duke University	15
New York University	264	Florida International University	61	Tulane University	14
University of Utah	228	University of Southern California	59	Ohio State University - Columbus	14
Princeton University	222	University of Nebraska - Lincoln	57	Georgetown University	13
University of South Florida	211	University of Illinois - Urbana-Champaign	52	University of Nebraska - Lincoln	12
Purdue University - West Lafayette	208	Syracuse University	51	Stanford University	12
University of North Carolina - Chapel Hill	204	Brigham Young University - Provo	51	University of Rochester	12
Northwestern University	202	University of Akron - Akron	48	University of Florida	12
University of Chicago	201	Arizona State University - Tempe	48	Auburn University	11
University of Iowa	195	Johns Hopkins University	47	University of Arkansas - Little Rock	11
Yale University	192	American University	43	University of Colorado - Boulder	11
Rice University	190	University of Hawaii	42	Brigham Young University - Provo	11
Ohio State University - Columbus	180	Dartmouth College	42	University of New Hampshire - Durham	10
Rutgers the State University of NJ - New Brunswick	174	Skidmore College	41	Cornell University	10
University of Rochester	169	University of Oklahoma - Norman	40	Indiana University - Bloomington	10
Texas A&M University	168	University of Arkansas - Little Rock	40	Baylor College of Medicine	10
University of Massachusetts - Boston	162	Yale University	40	Wake Forest University	9
Baylor College of Medicine	147	University of Missouri - Columbia	38	University of Iowa	9
University of Arkansas - Little Rock	146	Northwestern University	36	University of South Carolina - Columbia	9
Emory University	145	Baylor College of Medicine	36	University of Missouri - Columbia	9
University of Kentucky	142	Indiana University - Bloomington	36	Arizona State University - Tempe	8
University of Maryland - College Park	139	Duke University	35	Rutgers the State Univ. of NJ - New Brunswick	8
University at Albany	138	West Virginia University	35	University of Utah	8
Vanderbilt University	136	Case Western Reserve University	34	Columbia University	8
University of Central Florida	132	Drexel University	34	Washington University in St. Louis	8
Carnegie Mellon University	128	University of New Mexico - Albuquerque	34	University of Alabama - Birmingham	8
University of Missouri - Columbia	127	University of South Dakota	33	University of Akron - Akron	8
Washington University in St. Louis	126	Tufts University	32	Northwestern University	8
University of Colorado - Boulder	122	University of Iowa	32	University of Maryland - Baltimore	7
University of Virginia	118	Oregon Health & Science University	32	Medical College of Wisconsin	7
Iowa State University	117	Univ. of North Carolina - Chapel Hill	32	Medical University of South Carolina	7

Source: Author's own compilation on OECD (2011), Patent Database, U.S. Patent & Trade mark Office (2011), "The USPTO Trade mark Casefile Dataset (1884-2010)" and Center for Measuring University Performance data.

Appendix 4.E Descriptive statistics of the variables used in the regression

	N	Mean	Std. Dev.	Min	Max
IPR activity					
tm_{it}	4232	1.289	3.269377	0	45
$patgrant_{it}$	4232	8.055	27.63593	0	549
$patapp_{it}$	4232	5.315	22.6084	0	518
$before1997tm_i$	4232	8.571	18.47701	0	165
Institutional characteristics					
$control_i$	4232	0.390	0.487888	0	1
age_i	4232	124.805	50.25637	12	370
$stud2006_i$	4232	14.630	15.51242	0.108	207.9
med_school_i	4232	0.236	0.424856	0	1
uni_state_i	4232	23.653	15.84987	1	54
Research funds					
$res\_fund\_per\_stu_{it}$	4232	15528.92	130489.3	5.775	5915297
$fedfund\_share_{it}$	4232	0.569	0.208192	0	1
Research areas					
$n\_researchareas_i$	4232	1.534	1.27826	0	9
engineering	4232	0.087	0.198927	0	1
environmentalsciences	4232	0.045	0.145623	0	0.85
lifesciences	4232	0.403	0.345709	0	1
othersciences	4232	0.013	0.081831	0	1
physicalsciences	4232	0.084	0.192567	0	1
psychology	4232	0.024	0.110908	0	0.85
computersciences	4232	0.015	0.0875	0	0.85
mathematicalsciences	4232	0.010	0.064616	0	0.85
socialsciences	4232	0.015	0.084434	0	0.85
Number of observations in the sample across years					
1997	371				
1998	361				
1999	355				
2000	378				
2001	384				
2002	390				
2003	411				
2004	381				
2005	401				
2006	391				
2007	409				

Appendix 4.F Results of the regressions on trade marks with classes related to research activities

	(1)		(2)		(3)	
	NegBin	Logit	NegBin	Logit	NegBin	Logit
patapp			0.000	-0.368		
			(0.29)	(3.90)***		
patgrant					0.004	-0.356
					(2.64)***	(5.32)***
res_fund_per_stu	0.000	0.000	0.000	0.000	0.000	0.000
	(2.84)***	(0.08)	(1.85)*	(0.87)	(0.85)	(0.36)
fedfund_share	0.642	-0.179	0.746	0.129	0.624	0.103
	(2.14)**	(0.29)	(2.49)**	(0.23)	(2.07)**	(0.17)
before1997tm	0.013	-0.273	0.012	-0.140	0.012	-0.096
	(8.04)***	(4.71)***	(8.24)***	(4.05)***	(8.04)***	(2.45)**
control	0.253	-0.380	0.219	-0.446	0.157	-0.545
	(1.99)**	(1.22)	(1.75)*	(1.51)	(1.28)	(1.84)*
age	0.001	0.000	0.000	-0.002	0.000	-0.003
	(0.99)	(0.03)	(0.51)	(0.67)	(0.33)	(1.25)
stud2006	0.010	-0.063	0.008	-0.054	0.002	-0.071
	(4.03)***	(3.93)***	(2.96)***	(3.80)***	(0.52)	(4.22)***
med_school	0.269	-1.614	0.229	-1.141	0.316	-0.461
	(1.91)*	(4.52)***	(1.74)*	(3.50)***	(2.47)**	(1.34)
uni_state	-0.008	0.005	-0.008	0.002	-0.009	-0.002
	(2.19)**	(0.69)	(2.36)**	(0.22)	(2.75)***	(0.20)
nb_researchareas	-0.050	-0.141	-0.019	0.057	-0.019	0.076
	(0.85)	(0.74)	(0.33)	(0.39)	(0.34)	(0.53)
engineering	0.160	0.435	0.054	-0.054	-0.008	-0.349
	(0.41)	(0.53)	(0.14)	(0.07)	(0.02)	(0.44)
environmentalsciences	-0.268	-1.013	-0.579	-1.817	-0.478	-2.192
	(0.50)	(1.12)	(1.12)	(2.18)**	(0.93)	(2.59)***
lifesciences	0.263	0.011	0.266	-0.291	0.214	-0.874
	(0.92)	(0.02)	(0.99)	(0.49)	(0.81)	(1.42)
othersciences	3.566	3.068	3.534	2.431	3.575	2.055
	(1.84)*	(1.39)	(1.86)*	(1.18)	(1.86)*	(1.02)
physicalsciences	-1.101	-0.307	-0.881	-0.157	-0.826	-0.276
	(1.97)**	(0.30)	(1.65)*	(0.17)	(1.53)	(0.29)
psychology	-4.042	-5.696	-4.502	-8.044	-4.531	-11.459
	(3.84)***	(1.86)*	(4.78)***	(2.44)**	(5.10)***	(2.52)**
computersciences	2.565	1.205	2.374	0.031	2.598	0.292
	(4.59)***	(0.95)	(4.49)***	(0.03)	(4.83)***	(0.25)
mathematicalsciences	-8.214	-8.203	-8.753	-10.348	-8.482	-11.203
	(3.08)***	(1.40)	(3.34)***	(1.83)*	(3.38)***	(1.89)*
socialsciences	4.438	3.034	3.796	2.820	3.928	4.985
	(2.60)***	(2.08)**	(2.36)**	(1.57)	(2.59)***	(1.76)*
Constant	-1.423	3.544	-1.181	3.242	-1.126	4.317
	(4.29)***	(4.23)***	(3.53)***	(4.17)***	(3.58)***	(5.00)***
Dummy years	Yes	Yes	Yes	Yes	Yes	Yes
Ln alpha	0.236		0.133		0.171	
	(2.31)**		(1.32)		(1.78)*	
N	4232		4232		4232	
Log likelihood	-2,588.96		-2,553.37		-2,536.71	

Notes: t-statistics are given within parentheses. * p<0.1; ** p<0.05; *** p<0.01

Appendix 4.F (Continued) Results of the regressions on trade marks with classes related to research activities

	(4)		(5)		(6)	
	NegBin	Logit	NegBin	Logit	NegBin	Logit
patapp			-0.003	-0.142		
			(2.16)**	(4.08)***		
patgrant					-0.004	-0.191
					(2.67)***	(4.77)***
res_fund_per_stu	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(1.63)	(1.32)	(1.54)	(0.90)	(1.86)*	(1.04)
fedfund_share	0.316	-0.003	0.389	0.165	0.433	0.208
	(1.19)	(0.01)	(1.49)	(0.42)	(1.65)*	(0.52)
before1997tm	0.012	-0.171	0.013	-0.147	0.014	-0.136
	(8.52)***	(6.55)***	(9.02)***	(5.90)***	(9.19)***	(5.54)***
control	0.097	-1.486	0.144	-1.465	0.191	-1.507
	(0.84)	(6.73)***	(1.25)	(6.36)***	(1.66)*	(6.16)***
age	-0.000	0.001	-0.001	-0.001	-0.001	-0.001
	(0.59)	(0.49)	(0.91)	(0.38)	(0.84)	(0.43)
stud2006	0.007	-0.079	0.010	-0.081	0.014	-0.083
	(2.93)***	(6.39)***	(3.42)***	(6.19)***	(3.88)***	(5.58)***
med_school	0.166	-0.376	0.216	0.029	0.224	0.288
	(1.38)	(1.54)	(1.83)*	(0.11)	(1.93)*	(1.01)
uni_state	-0.000	0.021	0.000	0.023	-0.001	0.021
	(0.11)	(3.91)***	(0.02)	(4.18)***	(0.24)	(3.66)***
nb_researchareas	0.031	0.016	0.035	0.071	0.033	0.077
	(0.86)	(0.17)	(0.97)	(0.78)	(0.90)	(0.83)
engineering	-0.229	0.025	-0.229	-0.110	-0.200	-0.120
	(0.68)	(0.05)	(0.67)	(0.21)	(0.58)	(0.22)
environmentalsciences	-1.097	-0.627	-1.131	-0.904	-1.113	-1.107
	(2.54)**	(0.98)	(2.65)***	(1.40)	(2.58)***	(1.64)
lifesciences	-0.172	0.296	-0.234	-0.078	-0.251	-0.283
	(0.66)	(0.69)	(0.92)	(0.18)	(0.99)	(0.63)
othersciences	-1.675	-1.546	-1.785	-2.112	-1.737	-2.325
	(1.93)*	(1.24)	(2.08)**	(1.58)	(2.03)**	(1.69)*
physicalsciences	0.186	0.223	0.253	0.090	0.383	0.019
	(0.43)	(0.42)	(0.60)	(0.17)	(0.90)	(0.03)
psychology	-0.792	-0.285	-0.908	-0.875	-0.925	-1.154
	(1.57)	(0.36)	(1.79)*	(1.06)	(1.80)*	(1.35)
computersciences	-0.254	-0.514	-0.340	-0.941	-0.308	-1.164
	(0.49)	(0.60)	(0.65)	(1.08)	(0.58)	(1.27)
mathematicalsciences	-4.180	-3.956	-4.317	-5.052	-4.275	-5.573
	(3.72)***	(1.76)*	(3.91)***	(2.07)**	(3.91)***	(2.22)**
socialsciences	0.906	-0.170	0.991	-0.380	1.053	-0.405
	(1.01)	(0.19)	(1.13)	(0.45)	(1.20)	(0.47)
Constant	-0.294	2.827	-0.426	2.825	-0.606	3.046
	(0.99)	(4.93)***	(1.39)	(4.85)***	(2.02)**	(4.90)***
Dummy years	Yes	Yes	Yes	Yes	Yes	Yes
Ln alpha	0.428		0.445		0.489	
	(5.25)***		(5.99)***		(6.87)***	
N	4232		4232		4232	
Log likelihood	-3,911.52		-3,894.72		-3,885.97	

Notes: t-statistics are given within parentheses. * p<0.1; ** p<0.05; *** p<0.01

CONCLUSION

> *Over the past six years [...], global corporations have leaped on the brand-wagon with what can only be described as a religious fervour. Never again would the corporate world stoop to praying at the altar of the commodity market. From now on they would worship only graven media images. Or to quote Tom Peters, the brand man himself: "Brand! Brand!! Brand!!! That's the message... for the late 90's and beyond" [in Peters 1997, p.337].*
>
> — Naomi Klein, *No Logo* (2000)

At the turn of the twenty-first century, Naomi Klein argued in her best-seller book *No Logo* that the main focus of modern companies now lies in the marketing of their brands, increasingly overriding all the other aspects of the production and commercialisation of products. Brands, and their corollary signs trade marks, indeed constitute a crucial asset for firms. Through them firms can get known and build a reputation on a large scale. Trade marks enable the consumers to differentiate between competitive offerings and possibly to develop loyalty towards one preferred brand, which enables the firm to charge higher prices and maintain higher margins. Trade mark applications world wide have been booming since the last three decades. Whereas in 1985 the number of trade mark applications worldwide was comparable to patent applications – respectively 950 and 920 thousands –, it is now nearly twice as high – 3.66 millions trade mark applications versus 1.97 millions for patents in 2010[19]. Trade marks and brands, for better or for worse, may then well be at the heart of modern economies.

However, despite their importance in economic life, trade marks and trade mark data have long been neglected in the economic literature, contrasting with the larger attention paid to patents. One of the reasons may be that trade marks do not speak for themselves. By nature, they are signs used to mediate information or representations on a product. Unlike patents which, by definition, refer to technological progress, the only condition for the registration of trade marks is the novelty of the sign itself, so that, essentially, they may be described as empty nutshells. Trade mark data mostly take on meaning when they are related to other types of data concerning the firm, from which it may be possible to infer the strategy and motivations underlying the trade mark deposit.

The main question that this thesis addressed consisted in assessing and understanding how trade marks are related to innovative activities. Over the last decade a number of studies have raised the idea that trade marks could be used as an indicator of innovation, complementing the information brought by traditional indicators such as patents or R&D expenditure. Several empirical studies sought to verify that there is indeed a correlation between trade marks and other variables of innovative activity, such as patents or innovation. Yet the mechanisms explaining this link were rarely explicitly analysed. This thesis aimed at filling this gap by investigating which role trade marks strategies play in the activity of innovative actors.

A major challenge in this analysis was to disentangle the effect of the IPR and the effect of the underlying assets. For innovators it is one issue to invest in marketing and branding assets to increase the visibility and attractiveness of their innovations, and it is another issue to decide whether or not to protect their brand through IPR. Both decisions are not equivalent and may both have an impact on profit. What is observed in trade mark data are precisely the decisions to acquire IPR protection. This motivated the approach chosen in this thesis, which consisted

[19] WIPO Statistics database, December 2011

in describing specifically the potential effects of trade mark protection and in investigating how trade marks are likely to be integrated in the protection strategies of innovators.

In a first step we built a formal model comparing the effect of trade mark protection for innovative firms and for non-innovative firms. This model sticks to the legal definition of trade marks and considers that they prevent other parties from creating confusion on the origin of the product and thus benefiting from the trade mark owner's reputation. This reputation is built in a dynamic framework through cumulative advertising expenditure. Our model compares the respective effect of filing a trade mark on the inter-temporal profits of an innovating firm and of an imitating one, competing in a Cournot duopoly framework. We find trade mark registration to be always more beneficial for the innovative firm than for the imitating one. The justification is that trade marks enable the innovative firm to pre-empt a dominant position on the market by securing the loyalty of its early customers, so that beyond brand protection they help appropriate the benefits of innovation. This implies that for a same cost of registration, innovating firms are more likely to register trade marks than their competitors, which corroborates the link between trade marks and innovation. Our model also predicts for which types of innovation the link with trade mark is likely to be relevant: innovations which are at the interface of the market, which are valued *per se* by consumers and likely to be advertised, primarily product and marketing innovations.

We tested those results empirically through a systematic assessment of the link between trade marks and different types of innovation across sectors. Consistently with our theoretical model and by contrast with most previous studies, the sense of causality stated in our empirical analysis goes from innovation to trade mark, as our assumption is that firms register trade marks to appropriate the benefits of their innovation. We find that trade marks are significantly positively linked to product and marketing innovation whereas insignificant or negative relationship is found with other types of innovation, which corroborates the predictions of our theoretical model. We also find that the link between trade marks and product innovation holds when controlling for patenting activity, and when taking into account possible endogeneity effects due to reverse causalities. This tends to confirm that trade mark data could bring additional information on innovation, beyond the information brought by patent data, especially on innovations without or with low technological content. Those types of innovations tend to gain importance in advanced economies, particularly with the growing weight of service sectors; this is likely to constitute, considering the results of our analysis, one explanation of the relative rise in trade mark applications compared to patents over the last decades.

When differentiating the analysis by categories of sectors, we found that the effect of product innovation on trade mark use - when controlling for patents and for endogeneity issues - is significant in all sectors except in high-tech manufacturing sectors. This result could be either due to the fact that in those sectors trade marks do not tend to be used in relation to product innovations, or the fact that most of those innovations are also patented, so that trade marks would not be related to product innovation beyond patented ones. To investigate this point further, our second question consisted in analysing the relationship between patents and trade marks and how both interact in the protection strategy of the firm.

For this we extended the framework of the previous theoretical model, taking into account the possibility for the innovating firm to register a patent or not. Registering a patent is schematically assumed to give a monopoly position on the innovation, which is otherwise immediately imitated by competitors. During the patent period, firms face therefore no competition, so that no confusion is possible on the origin of the product. This implies a substitution effect between patent and trade mark as means to protect innovation. Besides this effect is counterbalanced by a complementary effect, which comes from the fact that the trade mark extends the reputational benefits of the monopoly period beyond the expiration of the patent. Depending on the characteristics of the market, we find that either the substitution or the complementary effect can be predominant.

Those findings are also supported by an empirical analysis assessing the interrelated effects of trade mark and patent use on firms' market value. The analysis disentangles the effect of IPR and of underlying assets and looks at the specific effects of various IPR protection strategies: patent or not and/or trade mark or not. We find that in pharmaceutical and chemical industries patent and trade mark use tends to be complementary, whereas in micro-electronics sectors they tend to be substitutes. So in the same line as Teece (1986), stating that the benefits of innovation depend on whether the context in which firms operate allows for the possibility of using different complementary assets, our analysis goes a step further and states that the complementarity relationship between the various assets is itself dependent on the context of the market. Those results may explain why in some sectors trade marks are more strongly related to innovation than in others. In sectors such as micro-electronics where patents constitute the most crucial means of protection, the link between trade mark use and innovation is likely to be weaker. This link is by contrast likely to be stronger in sectors, such as many services, where the protection through patents is not possible, or else in sectors, such as pharmaceuticals, where patent protection is available and tends to be reinforced by trade mark protection.

In sum, the findings of the second and third chapters corroborate the existence of a relationship between trade marks and innovative activity, but the strength of this relationship is not constant and differs across sectors. This result is likely to have implications both for researchers and for practitioners. It is in the interest of the latter to gauge the potential benefits of using trade mark protection in relation to innovation according to the characteristics of their market and to adapt their IPR strategy accordingly. Our analyses also imply that trade mark-based statistics and analyses about innovation should as far as possible take sector characteristics into account. The incentives to use different combinations of IPRs are not even across sectors and markets. This should be considered when using patents and trade marks as proxies of innovative activity or of technological and market assets.

Then, if trade marks play a role in innovative activities, we may assume that it is not only true for firms but also for other innovative actors. We therefore sought to investigate patterns of trade mark use of another type of actor likely to innovate, namely academic institutions. This topic tends to be overlooked in the existing literature on academic entrepreneurship, which rather focuses on university patents. Our exploratory analysis shows that universities do use trade marks, and that they increasingly use them in relation to their research activities. University trade marks take different forms: some are used to protect the general reputation of the university, others relate to merchandising activities, and others point to research activities and outputs. The latter, contrary to the others, tend to be significantly and positively related to the amount of research funds received by the universities.

This has implications both in the field of academic entrepreneurship analyses and regarding our understanding of trade mark activities. Trade marks are likely to play a part in academic entrepreneurship activities. Investigating this role, especially the potential impact they have on the valuation of the patents owned by the university, or on their research outcomes, would constitute interesting research questions. Moreover academic trade marks may contribute to gain insights on the multiple stakes of trade mark strategies. Those different stakes are easier to identify in the case of universities than in the case of firms, as the former tend to register the trade marks corresponding to different strategies in different classes of products. Yet the fact that different types of trade marks, used for different purposes, may coexist and interact is relevant also to other types of actors, so that the analyses on academic trade marks may help refine our analyses of the role of trade marks in entrepreneurship activities in general.

More generally, the analyses presented in this thesis constituted only a first step in analysing the relationship between trade mark protection and innovative activities. Contrary to patents, which are the object of a prolific literature, addressing several lines of analyses (*e.g.* patent citations or strategic use of patents), this topic is relatively unexplored. We aimed at starting to bridge this gap. A number of issues are unaddressed in this thesis, which would contribute to refining and extending our analyses. A first way to refine the analyses would be to take into account different levels of substitutability between innovations, and to look at how trade marks contribute to product differentiation. Then, as suggested in the fourth chapter, taking into account various trade mark strategies and analysing their interrelated effect on innovation and performance could constitute a fruitful field for future research. Analysing the one-to-one or one-to-many relationship between trade marks and products could constitute a first step in this line of study. The timing of trade marks in the life-cycles of firms and products would also be worth investigating. In this regard further panel data analyses would be useful to address more precisely dynamic effects in the link between trade marks and innovative activities. More than indicators of actual, successful innovations, trade marks can be seen as an indicator of expected market opportunities. The registration of a trade mark is often the first step in the creation of a business, so that trade marks are likely to constitute a very early indicator of economic activity.

Further research is also needed in order to be able to build meaningful indicators based on trade mark data. In Annex, we describe various issues regarding cross-country comparability, sectoral categorisation and heterogeneous value of trade marks, all those issues would need further investigations. Beyond the need for statistical methodologies to build aggregate indicators of trade marks, those issues are themselves likely to raise interesting questions, regarding international strategies of trade mark protection, the fact that firms may look for trade mark protection in product classes outside their sectors of activities, or the use of trade marks for strategic purposes. All those specific strategies are likely to have an impact on the performance of the actors who use them.

Finally, our empirical analyses were all restricted to the firm or the institution level. It would be interesting to change levels of analysis. First one can seek to refine the analysis in investigating the link trade mark-innovation at the product level. This would lead to analysing how different trade mark strategies relate to innovation and to performance. This implies to find appropriate data to be able to relate IPRs at the product or innovation level. It would also be interesting to adopt a macro-level of analysis, and to examine if trade marks tend to stimulate innovation or not. As they help appropriate the benefits of innovation, trade marks may increase the incentives for firms to innovate, but they also constitute barriers to entry, so that the aggregate effect on innovative activity would need to be investigated.

Overall, our analyses suggest that intellectual property protection is likely to play a key role in the benefits of innovations. Economic actors do not confine themselves to innovating; they also actively protect their innovations. We showed that trade marks constitute in their own right a means - for firms and also for other innovative actors - to protect innovations, and that the frontier with patent protection is not clear-cut as both tend to interact in the benefits gained from innovation. The different ways in which they are used and how they integrate in the overall strategy of firms is an area which certainly deserves further investigation.

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ANNEX: METHODOLOGICAL AND STATISTICAL ISSUES REGARDING THE CONSTRUCTION OF INDICATORS BASED ON TRADE MARK DATA

Throughout this thesis we showed that trade marks are likely to be related to various types of innovative activities. On may thus seek to use trade mark data to appraise those innovative activities and build new trade mark-based innovation indicators. However various issues have to be taken into account in the construction of trade mark-based indicators. Among those issues are the cross-country comparability of trade mark data, their categorization by industrial sectors, and the heterogeneous value of trade marks. In the following, we describe the nature of those various problems and we propose some methods that can possibly be used to overcome them.

Cross-country comparisons of trade marking activity

Different levels of applications may be considered to assess a country's trade marking activity. Trade mark applicants may choose to register their trade mark in their national office to be protected on their domestic market, but if they choose to go international, they have to register their trade mark in the offices of the countries in which they want to implement it[20]. The Madrid system, established in 1891, facilitates the registration of trade marks in multiple jurisdictions (see Chapter 1), offering the possibility to acquire protection in several countries by filing only one application in one jurisdiction with one set of fees. It is also possible to register a trade mark with validity throughout the European Community as a whole, with the OHIM (see Chapter 1). CTM apply indivisibly across all European Union member states. This system has nevertheless not replaced national trade mark registration systems, which continue to operate in parallel.

Most trade mark applicants tend to register primarily in their home countries: if we look at trade mark applications by country of residence of the applicant at the OHIM, the USPTO and the JPO (Figure A.1), we observe that the number of applications for domestic applicants is always much higher in their home offices than in foreign offices[21]. In general, trade mark applicants start with their home markets and later, possibly, go international, which implies an important "home-bias" in trade mark applications statistics.

This constitutes a problem for international comparability of trade mark-based statistics. If one looks at the repartition of the applications by origin in one office, the figures for the host country (such as filings from US applicants at the USPTO) and for other countries are not comparable. To make cross-country comparisons on trade mark counts, one must either focus on data from international offices, or combine statistics from various offices.

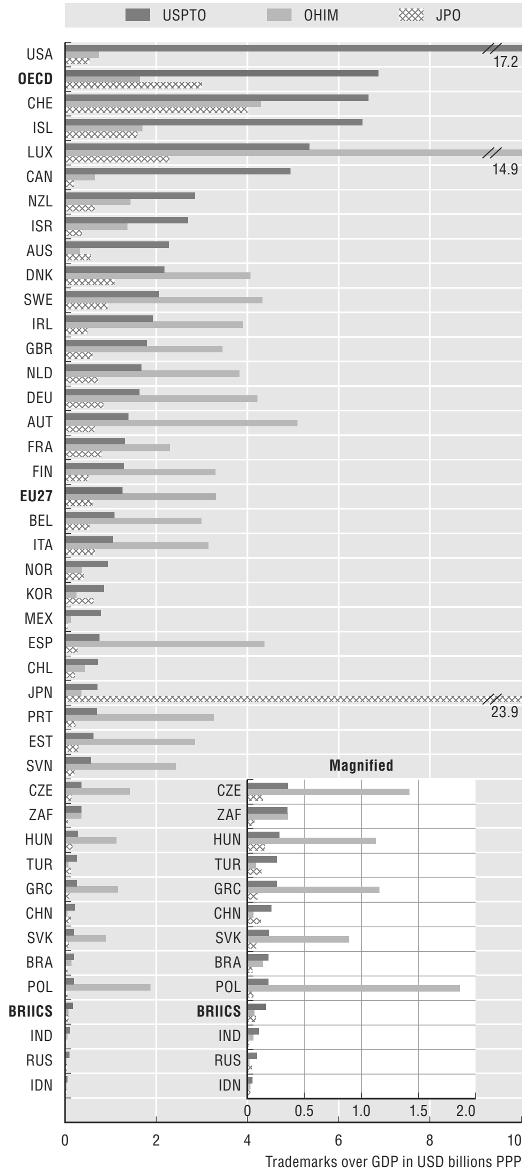
First it is possible to compare the various European countries with each other, considering trade mark applications in OHIM. Yet this does not make it possible to compare European countries with foreign countries.

For the latter comparisons, various methodologies may be considered. One

[20]Trade mark right is indeed subject to the territoriality condition, see Chapter 1

[21]In 2007-2009, the number of applications from US applicants at the USPTO was 23 times higher than at the OHIM, and 32 times higher than at the JPO. Japanese applications at the JPO were 34 times more numerous than at the USPTO, and 67 times more numerous than at the OHIM. As far as the OHIM is concerned, the domestic bias appears to be relatively less marked, which may be explained by the fact that Community trade marks are international trade marks, thus less related to the local market. Yet European applications at the OHIM were still almost three times more numerous than at the USPTO, and almost 6 times more numerous than at the JPO.

Figure A.1: Trade mark applications at JPO, OHIM and USPTO, 2007-09 average



Source: OECD (2011) Science, Technology and Industry Scoreboard, based on US Patent and Trade mark Office (2011), "The USPTO Trade mark Casefile Dataset (1884-2010)" ; OHIM Community Trade mark Database; CTM Download, April 2011; JPO (2008-10), Annual Reports; OECD, National Accounts Database, June 2011; and IMF, World Economic Outlook Database, June 2011. Notes: the graph presents average numbers of trade mark applications at the various offices over the period 2007-2009, expressed as a ratio to GDP. Counts are presented according to the application date and the address of the applicant. Countries are ordered according to USPTO figures.

methodology consists in comparing total levels of trade mark applications in the different national intellectual property offices. This is for example the methodology followed for the trade mark indicators provided by the World Bank (see World Bank 2012). However the figures may not be comparable as trade mark legislations tend to vary significantly from one country to another (see Chapter 1). In addition to the differences in registration costs, there may be qualitative differences, such as between single-class[22] or multi-class systems, or between Common law and registration systems. All those differences are likely to have a significant impact on the levels of trade mark applications.

Another possibility to compare levels of trade marking activity across countries is to look at international applications under the Madrid Protocol, which may provide an overall assessment of trade marking activity abroad. However, some major countries, like Canada, Brazil, India or Mexico are not yet part of the Madrid system[23]. Moreover, the propensity to use the international procedure varies across countries. For example, the United States joined it only recently (in November 2003), so that their level of Madrid applications is relatively low.

Then one may try to apply a methodology which was previously used for patent indicators (see OECD 2009a, p.71), which would consist in building families of trade mark applications according to the priority date of the applications, and to work at the level of "triadic trade marks", that is trade marks registered at the OHIM, the USPTO and the JPO. Yet many trade marks are strongly associated to a specific national market and have no international vocation, especially since trade marks are strongly related to language and other cultural aspects. For example, a same product can be protected by different unrelated trade marks across countries (*e.g.* Danone is known as Dannon in the United States, Taillefine is known as "Vitalinea" in Spain, "Light & Fit" in the US). Therefore we may lose significant information by considering only trade marks which are invariant across several offices.

[22]Single-class systems require a separate application for each class of product. This is for example the case in China.

[23]As of 13 July 2012, there were 87 member States in the Madrid Union.

We may thus prefer an alternative method for international comparison of trade marking activity, which consists in considering the repartition of the applications in a given set of national offices, and apply a correction for the home-bias, by re-estimating the number of applications from the home country based on its relative weight in foreign offices[24]. As an illustration, we detail here the underlying method used in the 2009 *OECD Science, technology and industry Scoreboard* for the calculation of "cross-border trade marks", relying on trade mark applications data at the OHIM, the USPTO and the JPO. Table A.1: represents the number of applications in 2006 in the three major offices (in column) by origin (in line):

Table A.1: Applications at the USPTO, the OHIM and the JPO in 2006 by origin

		Trademark Office		
		USPTO	OHIM	JPO
Origin of Applicant	US	233 312	12 699	8 160
	European	19 467	53 417	9 598
	Japanese	3 158	1 735	111 754

Source: OHIM and JPO annual reports, year 2006-2007, WIPO statistical database for USPTO figures.

For each office, it is possible to compare the numbers of applications from foreign countries between them, but they cannot be compared with the numbers of applications from residents of the country (in grey), because of the home-bias. It is however possible to estimate a figure of the resident applications corrected from the domestic bias, based on the data from other offices. The number of resident applications in one office can be estimated by the proportion of applications of the country in the other offices times the size of the considered office, *i.e.* the total number of applications.

For example, if we consider the OHIM trade mark applications, the number of resident applications may be re-estimated based on the proportion of European applications in the foreign office, according to the following formula:

[24]This type of methodology is used for cross country comparisons of trade marking activity in OECD (2009b, 2011) *Science, Technology and Industry Scoreboard.*

- Based on the USPTO repartition of applications :

$$\widehat{EU_{OHIM}} = EU_{USPTO} \times \frac{\overline{OHIM}}{\overline{USPTO}},$$

where EU_{USPTO} is the number of applications from European applicants at the USPTO, $\overline{OHIM}$ is the total number of applications at the OHIM, and $\overline{USPTO}$ is the total number of applications at the USPTO.

- Based on the JPO repartition:

$$\widehat{EU_{OHIM}} = EU_{JPO} \times \frac{\overline{OHIM}}{\overline{JPO}},$$

where EU_{JPO} is the number of applications from European applicants at the JPO, and $\overline{JPO}$ is the total number of applications at the JPO.

This method is statistically relevant if the figures are robust, that is if the proportion of applications of the considered country relative to the other is stable across the two foreign offices: if the share of country A relative to country B among deposits of country C is close to the share of country A relative to country C in country B, divided by the share of country B relative to country C in country A. This condition is not verified with the figures of the matrix above. Indeed in terms of number of trade mark applications we have the following relations:

- (1) in the JPO: $US_{JPO} = 0.85 \times EU_{JPO}$
- (2) in the USPTO: $EU_{USPTO} = 6.16 \times JP_{USPTO}$
- (3) in the OHIM: $US_{OHIM} = 7.32 \times JP_{OHIM}$

If the relations were consistent with each other, the relation (3) would be:

- $US_{OHIM} = 0.85 \times 6.16 \times JP_{OHIM} = 5.24 \times JP_{OHIM}$

The Japanese applications are proportionally more numerous at the USPTO than at the OHIM. This is due to the fact that, as for patents, Japanese trade mark applicants in Europe tend to use relatively more national procedures than the OHIM.

We have then to take into account direct filings at national offices in Europe. If we compute the previous matrix replacing the numbers of applications at the OHIM by the addition of the applications at the OHIM and in the 25 national offices of Europe[25], we obtain the following matrix:

Table A.2: Applications at the USPTO, the JPO, the OHIM and European national trade mark offices in 2006 by origin

		Trademark Office		
		USPTO	**OHIM + E.U. national offices**	JPO
Origin of Applicant	US	233 312	**26 021**	8 160
	European	19 467	**534 195**	9 598
	Japanese	3 158	**5 027**	111 754

Sources: OHIM and JPO annual reports, year 2006-2007, WIPO statistics database (2008) for USPTO and EU national offices figures

The relationship (3) then becomes:

- (4) in the OHIM + E.U. nat. off.: $US_{OHIM+EU\,nat.off.} = 5.18 \times JPO_{OHIM+EU\,nat.off.}$

Relation (4) is consistent with relations (1) and (2), so that the figures are stable across offices when we consider both the OHIM and the European national offices. It is then possible to apply the above method to correct the home-bias from the data of the various offices, which would make the figures concerning the geographical origin of the applications comparable between each other. On the basis of the figures above, and without having applied further corrections, one would say that the level of trade mark activity by American companies is slightly inferior to the level of European companies, both being more than five times higher than the level of Japanese companies.

Classifying trade marks by industry

In the previous chapters of this thesis, we showed that the relevance of trade marks to inform about innovative activities is likely to vary from one sector to

[25]The European Union counts one national trade mark office in each of the 27 countries, except Benelux which has one office for three countries.

another (see Chapters 2 and 3). It may then be preferable to restrict to specific sectors when using trade marks as an indicator of innovation. In this perspective, it is important to be able to categorize trade mark applications by sectors of economic activities.

As already mentioned, trade marks are registered for one or several classes of products (see Chapter 1). The protection associated to the trade mark concerns only the products of the classes for which it is registered. The registration fees are increasing with the number of classes that are designated. Most offices now apply the International Classification of Goods and Services for the purpose of registering trade marks, established in 1957 by the Nice Agreement, comprising 45 distinct classes. From a statistical point of view, this system of classes enables the analysis of the repartition of the trade marks across the types of products to which they refer.

First, information on Nice classes may be used to study the repartition between goods and services trade marks. Indeed the Nice classification is explicitly divided between classes relating to goods (class 1-34) and classes relating to services (class 35-45). Yet the home-bias also affects the comparability of countries concerning the share of good-related and service-related trade marks. Services being less exported than goods, the proportion of trade marks relating to services is higher for domestic applications than for foreign ones. When looking at country specialization towards manufacturing or service activities based on trade mark data, as for the comparisons of overall levels of trade marking activity, it is then necessary to combine data from various offices. One might for example choose to rely on applications at one specific office to evaluate countries' specialization profile, except for the host country, for which applications at a foreign office should be considered. This method makes it possible to improve international comparability, as for all countries it considers the repartition of the applications in a foreign office. However, it minimizes the share of service trade marks, which are less likely to be commercialized abroad. One might alternatively compare the share of trade marks related to goods and/or to services in resident applications at each national office.

Although this might also be affected by variations in legal systems and procedures across countries, the impact is likely to be lower when analysing repartitions across classes of products than when considering overall levels of activities.

At a more detailed level of analysis, one may seek to establish a general correspondence between classes of goods and services and industrial sectors. However, the Nice classification is not equivalent to the classifications used traditionally for economic activities (such as NACE[26] or ISIC[27]). Contrary to the latter classifications, which follow a hierarchical structure with different levels of detail, the Nice classification is non-hierarchical and Nice classes tend to be highly aggregated (for example, class 5 regroups among others food for baby, dental wax and herbicides). Moreover, the trade mark classification has been built with a focus on demand, the customers' side, whereas industry classifications focus on the firms' side, on supply. Therefore it is not straightforward to establish a correspondence between the sectors to which firms belong and the classes in which they register trade marks. Despite those issues, several attempts have been made to establish a qualitative correspondence between classes of the Nice classification and industrial classifications. For example, Gauch and Schmoch (2009) identified eight categories of technological-oriented product trade mark fields (Chemistry, Pharmacy, Metal Products, Machinery, Electronics, Medical Technology, Electrical Devices and Vehicles) and eight categories of service-oriented trade mark fields (Management, Finance, Repair, Telecommunications, Transport, Material Treatment, Entertainment and Other Services), based on the main focus of the classes content. They also sought to identify more precisely trade marks relating to ICT services, based on the Nice classes and the keywords provided in the description of products and services contained in trade mark applications[28]. We may also mention WIPO (2012), which grouped the 45 Nice Classification classes into ten categories (Agriculture, Business, Chemicals, Clothing, Construction, Health, Household equipment, Leisure

[26]Statistical classification of economic activities in the European Community

[27]International Standard Industrial Classification

[28]Beside the designation of Nice classes, trade mark applications may contain a list of keywords describing the products and services concerned by the trade mark, which may help shorten the examination process.

and Education, Research and Technology, and Transportation). Further analyses would be needed to test and refine those correspondences through an empirical approach, for example relying on trade mark data matched with firm-level data, identifying the probability of firms in each sector to register trade marks in the different Nice classes.

Finally, we may notice that trade mark-based analyses might give another perspective on the economic activities of firms. Indeed, sector classification do not always make it possible to understand the complexity of firms' activities. Many firms classified in manufacturing sectors for example tend to be also involved in service activities, and vice-versa. Looking at the classes of products contained in firms' trade mark applications might help to describe more accurately the types of activities they are involved in.

Heterogeneous value of trade marks

Issue of non-used trade marks

An issue that should be taken into account in the analysis of trade mark data is that not all registered trade marks are actually used on the market. Indeed the deposit of a trade mark can be associated to various strategies. It can on the one hand be used in order to signal and effectively sell the products on the market. But on the other hand, many companies file marks that they do not use directly. This can correspond to various strategies. In some cases, firms prior to deciding on a new brand may want to protect several options, and then only ultimately choose one. Besides, some firms may register trade marks only for strategic purposes, without the intent to use them. They may do so in order to block the competitors from using certain names or signs – various descriptive names are deposited in order to limit the possibilities of the competitors, or in order to get licensing rents. They may also do so in order to prevent the tarnishing of a brand image (*e.g.* the firm Red Bull deposited a high number of trade marks containing the word "bull"). This issue of non-used trade marks was the object of a recent report by Graevenitz *et al.* (2012) on trade mark "cluttering", which is defined as arising when "firms hold trade marks that are overly broad or unused raising costs for later applicants". The report distinguishes three different types of mechanisms leading to cluttering: applying for more classes than needed, applying for several marks for one product, or applying for marks by anticipation of a broadening of the product range. In any case, this may be an issue especially when considering trade marks as an indicator of innovation, as this increases the distance between what is observed in trade mark registrations and what actually occurs on the market.

We may try to appraise this phenomenon and to detect those non-used trade marks. This is made possible by the requirement of actual use, which stipulates that trade marks that are not used continuously during a certain period are deemed abandoned (see Chapter1). We can check that this clause has an important impact on trade marks registered at the USPTO. In the USPTO the trade marks have to be used continuously for six years after the date of registration. Six years after the registration, the trade mark owner must file declarations with the USPTO showing genuine use of the trade mark, if not the trade mark is cancelled[29]. A majority of trade marks registered at the USPTO do not survive after this duration.

Table A.3 presents the proportion (in %) of trade marks registered at the USPTO between 1987 and 2007 which are still pending or which died each year after registration. The lines correspond to the dates of registration, and the columns to the date of cancellation or abandonment of trade marks. For each registration year, the years with the highest level of cancellation or abandonment have been highlighted.

We observe that the impact of the clause of actual use is quite important. On the

[29]Section 8 of the Lanham Act states that : "Each registration shall remain in force for 10 years, except that the registration of any mark shall be cancelled by the Director for failure to comply with the [following] provisions (...). During the 1-year period immediately preceding the end of the applicable time period [6 years for registrations issued pursuant to the provisions of the Lanham Act], the owner of the registration shall pay the prescribed fee and file in the Patent and Trade mark Office: (1) An affidavit setting forth those goods or services recited in the registration on or in connection with which the mark is in use in commerce and such number of specimens or facsimiles showing current use of the mark as may be required by the Director; or (2) an affidavit setting forth those goods or services recited in the registration on or in connection with which the mark is not in use in commerce and showing that any such non-use is due to special circumstances which excuse such non-use and is not due to any intention to abandon the mark."

Table A.3: Survival rate of registered trade marks at USPTO between 1987 and 2007, in %

		Cancellation or abandonment date																				
Registration date	Still valid in 2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987
2007	99.97	0.03																				
2006	99.87	0.10	0.03																			
2005	99.75	0.10	0.11	0.03																		
2004	99.66	0.10	0.13	0.09	0.02																	
2003	99.63	0.09	0.09	0.10	0.07	0.03																
2002	99.51	0.13	0.10	0.07	0.08	0.07	0.03															
2001	87.81	11.59	0.13	0.09	0.07	0.09	0.07	0.02														
2000	45.56	38.49	14.85	0.09	0.10	0.09	0.09	0.09	0.01													
1999	45.89	0.14	40.48	11.95	0.10	0.12	0.10	0.08	0.09	0.01												
1998	44.40	0.09	0.31	41.46	12.53	0.13	0.12	0.10	0.11	0.08	0.02											
1997	41.19	3.00	0.10	0.34	42.95	11.28	0.12	0.09	0.09	0.10	0.07	0.02										
1996	30.00	10.72	3.55	0.19	0.14	40.95	12.49	0.10	0.13	0.08	0.09	0.09	0.03									
1995	29.76	0.10	11.85	3.33	0.04	0.15	52.77	0.19	0.13	0.08	0.08	0.13	0.08	0.03								
1994	29.52	0.04	0.10	12.44	3.87	0.05	2.38	49.52	0.26	0.11	0.09	0.09	0.14	0.10	0.02							
1993	30.00	0.04	0.04	0.11	12.90	3.74	0.31	2.38	31.98	16.66	0.09	0.10	0.10	0.12	0.07	0.01						
1992	30.17	0.11	0.01	0.02	0.13	14.43	2.50	0.06	0.37	32.29	18.45	0.13	0.12	0.10	0.09	0.07	0.01					
1991	30.00	0.04	0.02	0.01	0.02	0.09	16.19	0.06	0.05	0.09	27.26	24.80	0.14	0.13	0.10	0.10	0.17	0.02				
1990	28.76	0.06	0.01	0.01	0.03	0.05	0.55	14.77	0.02	0.04	0.13	24.59	29.67	0.13	0.11	0.11	0.15	0.12	0.03			
1989	41.32	0.04	0.08	0.05	0.03	0.04	0.07	0.66	1.31	0.02	0.05	0.39	28.94	26.14	0.11	0.10	0.15	0.10	0.14	0.01		
1988	43.15	0.08	0.09	0.07	0.04	0.05	0.04	0.08	0.04	0.04	0.03	0.12	0.33	28.65	26.26	0.11	0.15	0.09	0.18	0.11	0.03	
1987	37.14	5.64	0.06	0.08	0.05	0.05	0.06	0.05	0.04	0.02	0.03	0.05	0.06	0.32	30.40	24.72	0.14	0.11	0.13	0.15	0.09	0.02

Source: Author's own calculations based on US Patent and Trade mark Office data Trade mark BIB (Cassis) 2008.

whole around 55% of trade marks die six or seven years after registration. It should be noted that the trade mark owner benefits from a grace period of six months after the six years, which can explain why most applications die seven and not six years after registration (this may also be due to the delays in the cancellation procedure). This proportion is very stable over time. Besides, a relatively high proportion (about 15%) of trade marks die 10 or 11 years after registration; this corresponds to trade marks that were not renewed. Yet the proportion of trade marks dying after ten years is relatively low compared to those dying after six or seven years.

This type of analysis may help appraise and filter non-used trade marks. However it does not apply to all the trade mark systems. Although the clause of actual use is present in almost every jurisdiction, its impact is not always as significant as it is for American trade marks. In the OHIM for example (where the term of cancellation for non-used is three years), around 0.1% of Community trade marks registered in one year are cancelled every year. There is no particular peak after three or four years, which means that the clause of actual use has no significant impact. The main explanation is that unlike in the USPTO system, the cancellation procedure based on non-use is not automatic for Community Trade marks. In the US, the trade mark owner must periodically file declarations with the USPTO showing genuine use of the trade mark, if not the trade mark is cancelled automatically. By contrast, in the EU, the trade mark owner is not obliged to file declarations. Some third party has to come along and apply to cancel the trade mark based on non-use. Hence some Community Trade marks have never been used and remain registered. This variation in the procedure explains why the clause of actual use has no significant impact on European trade marks whereas it has on American ones. Nevertheless the history of OHIM trade marks is quite short, and we may assume that behaviours are susceptible to evolve when the system becomes more mature (notably when the competition on trade marks will become more important; for now only relatively strong brands are registered at the OHIM, which are difficult to attack).

Possible methods for assessing trade mark value

The issue of non-used trade marks is only one aspect of the value of trade marks. As in the case of patents, trade marks tend to be very heterogeneous from one trade mark to the other (Sandner 2009a). Many trade marks correspond to marketing or product campaigns that have failed. On the contrary, few trade marks have effectively a very high value for the firm. One of the main indicators used to assess the value of patents is the number of citations received by the patent, be it forward (see for example Trajtenberg 1990), or backward citations (Harhoff *et al.* 2003). This is not applicable to trade marks, which do not contain citations, so that other methodologies have to be considered to appraise trade mark value.

Sandner (2009a) proposes a number of indicators which may reflect trade mark value, based on information contained in the trade mark application document. Those indicators are the number of Nice classes (trade mark breadth), claimed seniorities (indicating the familiarity of the consumers with the trade mark), oppositions lodged against competitors (reflecting the intensity with which the trade mark is protected, see also Graevenitz 2007), and oppositions received from rivals (reflecting the assessment by third parties of the trade mark's potential value). Among those four indicators, Sandner (2009a) shows that the first three tend to relate positively to the market value of the firm, whereas the last one is not found to have a significant impact. To those indicators, we can add another approach to evaluate trade mark value, proposed by Graevenitz and Sandner (2009), consisting in using citations of the trade mark on the search engine Google, in the same way as patent citations are used to evaluate patent value. Citations of the trade mark on Google constitute a very broad indicator of the "impact" of trade mark, as reflected in various sources (customers review, press, bug reports). Those various methods may help refine trade mark-based indicators to be used in economic analyses, capturing the variation in their value. Finally, those various indicators could be combined in composite indicators of trade mark value.

The statistical methodologies presented in this annex aim at overcoming various issues pertaining to the comparability and interpretability of aggregate indicators based on trade mark data. We may conclude in mentioning that all the issues considered constitute a line of analysis in themselves. It may indeed be interesting, beyond the search for methodologies to increase comparability, to focus specifically on the strategies adopted by trade mark applicants in terms of targeted countries or markets, industrial sectors, and strategic use of trade mark applications. These focuses are likely to convey valuable information on the different types of use of trade marks in economic activities.

RÉSUMÉ EN FRANÇAIS - STRATÉGIES DE MARQUES ET ACTIVITÉS INNOVANTES

L'objet de cette thèse de doctorat est d'analyser le lien entre dépôts de marques et activité innovante et, ce faisant, d'évaluer les possibilités d'utiliser les marques comme indicateur d'innovation et notamment d'innovation à faible contenu technologique. Ces dernières, importantes en particulier dans les secteurs de services, sont susceptibles d'avoir un impact sur la croissance économique. Leur mesure est actuellement très limitée, les indicateurs traditionnels d'innovation comme la R-D ou les brevets se référant principalement aux innovations technologiques. Les enquêtes sur l'innovation, quant à elles, se limitent généralement à des données surtout qualitatives (l'entreprise a-t-elle réalisé tel ou tel type d'innovation, oui/non) et, en outre elles ne sont pas disponibles pour tous les pays. Ainsi, pour mesurer les innovations à faible contenu technologique il est nécessaire de se tourner vers d'autres sources.

Les marques constituent une source d'information potentielle. De même que les brevets, les données de dépôts de marques ont été enregistrées régulièrement et systématiquement depuis des décennies dans un grand nombre de pays, et sont généralement publiquement accessibles à partir de bases de données électroniques. De plus, les marques ont un large périmètre d'application. Elles sont présentes dans tous les secteurs d'activité économique, des secteurs manufacturiers de haute technologie aux secteurs à faible contenu technologique ou encore dans les services. Cependant, d'un point de vue juridique, l'enregistrement d'une marque ne requiert pas la nouveauté du produit lui-même ou d'une de ses caractéristiques. Le seul critère pour enregistrer une nouvelle marque est la nouveauté du signe lui-même pour identifier le produit. A priori, il n'y a pas de lien direct, essentiel, entre les marques et l'innovation, comme c'est le cas par exemple pour les brevets. Il est donc nécessaire de tester l'existence d'un tel lien et d'analyser les mécanismes qui pourraient l'expliquer.

Dans cette optique, notre recherche s'intéresse aux questions suivantes :

- Les dépôts de marques sont ils reliés à l'activité innovante et, le cas échéant, quels sont les mécanismes qui pourraient expliquer cette relation ?
- Comment les marques interagissent-elles avec d'autres droits de propriété intellectuelle (DPI) et comment cela affecte-t-il leur relation avec l'innovation ?
- Les schémas d'utilisation des marques diffèrent-ils selon les firmes et selon les secteurs et comment cela impacte-il la possibilité de construire des indicateurs d'innovation basés sur les données de marques ?

Nous cherchons à répondre à ces diverses questions d'une part à travers une approche conceptuelle et théorique et d'autre part au moyen d'analyses empiriques quantitatives.

Le premier chapitre pose les bases de l'analyse, en définissant les marques et en présentant un état des lieux de la littérature sur le sujet, plus particulièrement sur le lien entre marques et innovation. Du point de vue strictement juridique une marque consiste en un signe quelconque permettant d'identifier l'origine d'un produit. L'enregistrement d'une nouvelle marque n'est pas nécessairement associé à une innovation. Cependant, plusieurs pans de la littérature suggèrent que les marques sont susceptibles d'avoir un rôle dans le processus d'innovation. D'une part les marques permettent d'informer les consommateurs sur les produits et éventuellement de signaler leur nouveauté ; d'autre part, plusieurs auteurs mentionnent l'importance-clé des marques comme barrière à l'entrée aux concurrents potentiels sur un marché. Elles permettent aux firmes de préempter une position dominante en fidélisant leur clientèle. Déposer une marque est alors un moyen parmi d'autres pour les firmes de s'approprier les bénéfices de leur innovation.

Plusieurs études empiriques récentes ont cherché à montrer qu'il existe en effet une corrélation entre marques et activité innovante. À partir de données d'enquêtes auprès des firmes, ces études montrent l'existence d'une relation positive entre les dépôts de marques et diverses variables d'innovation telles que les brevets ou la part du chiffre d'affaires associé aux nouveaux produits. Selon ces études, les marques pourraient donc être utilisées comme indicateur d'innovation en complément des indicateurs traditionnels tels que les brevets. Cependant à ce stade, l'utilisation de données brutes de marques constituerait un indicateur biaisé de l'activité d'innovation. Il est probable que les comportements de dépôts de marques et leurs déterminants varient d'un secteur à l'autre et d'une entreprise à l'autre. Pour déterminer dans quels cas et selon quelle méthode les marques peuvent servir pour mesurer l'innovation, il convient donc d'analyser plus précisément leurs modes d'utilisation par les entreprises et les mécanismes qui les relient à l'activité innovante.

Les second et troisième chapitres constituent le cœur de notre analyse, où nous nous proposons de vérifier et d'expliquer le lien entre marque et innovation.

Dans le second chapitre, nous cherchons à analyser les comportements de dépôt de marques au niveau des firmes et à déterminer s'ils sont liés à leur activité innovante. L'étude repose sur une base de données construite à cet effet, rendant compte de l'activité de dépôts de DPI des entreprises françaises, base obtenue en appariant les données de firmes de la base ORBIS© avec les données de DPI aux niveaux national et européen. Ces données ont par ailleurs été appariées avec les résultats français de l'Enquête Communautaire sur l'Innovation 2008 de manière à obtenir des informations sur l'activité innovante des firmes.

Dans un premier temps, nous cherchons à modéliser de manière théorique l'impact de la protection d'une innovation par une marque. L'hypothèse retenue dans notre modèle consiste à dire que la marque permet à la firme d'empêcher ses compétiteurs de créer une confusion sur la source du produit, confusion qui leur permettrait de profiter de la réputation acquise par la firme. Dans ce cadre, nous montrons que le bénéfice généré par le dépôt de marque est toujours plus important pour les firmes innovantes que pour les autres firmes, car il leur permet de s'approprier entièrement la réputation construite durant leur période de monopole. Nous déduisons de ce modèle que les marques sont susceptibles d'être liées aux innovations qui se trouvent à l'interface du marché, celles que le consommateur est susceptible de valoriser et qui font l'objet de publicité, en premier lieu les innovations de produit ou de marketing.

Au travers d'une analyse empirique, nous montrons que les marques sont significativement et positivement corrélées aux innovations de produit et de marketing telles que reportées dans l'Enquête Communautaire sur l'Innovation. Le lien entre utilisation de marques et innovation de produit reste significatif en contrôlant pour les dépôts de brevets, ce qui laisse penser que les données de marques peuvent constituer une source d'information complémentaire pour ce type d'innovation. En différenciant les résultats par catégories de secteurs, nous trouvons que les marques sont significativement reliées aux innovations de produits au-delà des innovations brevetées dans tous les secteurs sauf dans les secteurs manufacturiers de haute technologie. Notre étude tend donc à montrer que l'utilisation des marques en relation avec l'innovation dépend des secteurs et du type d'innovation considérés, et particulièrement de la possibilité ou non de breveter l'innovation. Ce résultat suggère la présence d'effets d'interaction entre marques et brevets, effets que nous nous proposons d'examiner dans le troisième chapitre.

Le troisième chapitre se concentre sur l'interrelation entre les protections liées à l'innovation apportées respectivement par la marque et par le brevet. Nous cherchons à déterminer si ces deux types de DPI sont complémentaires ou substituts. Plusieurs papiers dans la littérature précédente ont cherché à étudier les complémentarités entre marques et brevets. Mais ils ne distinguent généralement pas l'impact des DPI de l'impact des actifs sous-jacents associés à ces DPI. Nous nous intéressons pour notre part précisément à l'apport de la protection par la marque et par le brevet, et à leur interdépendance intrinsèque. Notre modèle théorique reprend le cadre d'analyse utilisé dans le deuxième chapitre, où les marques permettent aux firmes de s'approprier leur réputation construite par les dépenses de publicité. Les brevets, quant à eux, sont supposés donner à la firme un monopole temporaire sur son innovation. Nous évaluons les profits générés par l'innovation dans le cas où la firme dépose une marque, un brevet, les deux conjointement ou aucun des deux. Nous cherchons ensuite à déterminer si les deux types de DPI sont complémentaires, c'est-à-dire si l'utilisation de l'un augmente le bénéfice lié à l'utilisation de l'autre. Pour cela nous faisons appel au concept de supermodularité, qui permet d'analyser la complémentarité entre variables discrètes. Les résultats du modèle tendent à montrer que la relation entre marque et brevet n'est pas univoque. Selon le taux de dépréciation et le niveau d'appropriabilité des dépenses de publicité, les deux types de DPI peuvent apparaître ou bien complémentaires, ou substituts.

Ces résultats sont par ailleurs illustrés par une analyse empirique, consistant à évaluer l'impact des différentes stratégies de DPI sur la valeur de marché des firmes et à tester sur cette base l'hypothèse de supermodularité. L'échantillon retenu pour les estimations contient les firmes françaises cotées en bourses présentes dans la base ORBIS©, soit plusieurs centaines d'observations. Les résultats de l'étude empirique montrent que la relation entre brevets et marques dépend des secteurs : dans le secteur des produits pharmaceutiques et chimiques, où le niveau d'appropriabilité de la publicité et son taux de dépréciation ont tendance à être faibles, l'hypothèse de complémentarité tend à être vérifiée, tandis que dans les secteurs des produits informatiques et électroniques et de l'équipement électrique, reposant sur des technologies de pointe difficilement imitables, marques et brevets tendent à être substituables. De manière générale, cette étude suggère que la relation de complémentarité ou de substituabilité entre brevets et marques dépend de différentes caractéristiques du marché. Dans le prolongement de Teece (1986), qui établit que les profits de l'innovation dépendent des possibilités de la firme d'utiliser des actifs complémentaires, il apparaît que la relation entre les différents actifs elle-même dépend du contexte dans laquelle la firme évolue.

Les chapitres précédents se concentrent sur le lien entre marques et activité innovante des firmes. Or les firmes ne sont pas les seules institutions susceptibles d'innover, ni les seules institutions susceptibles de déposer des marques. Dans le quatrième et dernier chapitre, nous nous proposons de déplacer le cadre des analyses précédentes sur un autre type d'institution potentiellement innovante : les universités. Depuis l'adoption du Bayh-Dole Act aux Etats-Unis en 1980, de nombreux chercheurs se sont attachés à analyser la "troisième fonction" des universités, c'est à dire les activités entrepreneuriales et de développement économique. Cependant alors que les dépôts et les licences de brevets des universités ont été extensivement étudiés, le sujet des marques académiques reste, à notre connaissance, inexploré. Or les universités, au même titre que les firmes, sont susceptibles d'utiliser l'échantillon complet des DPI à leur disposition, notamment les marques : celles-ci peuvent leur être utile à la fois pour protéger leur réputation globale en tant qu'institution éducative et pour promouvoir leurs différentes activités de recherche ou d'enseignement, en cours ou en projet. Nous cherchons alors à examiner dans quelle mesure les universités déposent des marques et quelles peuvent être les logiques sous-jacentes à cette activité : sont elles spécifiques aux institutions académiques ou sont-elles transposables à d'autres types d'acteurs ?

L'analyse repose sur une base de données de plus de 600 universités américaines combinant, par appariement semi-automatique, données sur les universités publiées par le "Center for Measuring University Performance" (MUP) et données de DPI (marques et brevets déposées à l'USPTO). A partir de ces données nous montrons que les dépôts de marque sont une activité non négligeable des universités et qui connaît un accroissement continu en volume depuis les trois dernières décennies. Les universités déposent des marques non seulement pour protéger leur nom et leur réputation générale, mais aussi de plus en plus en relation avec le produit de leurs activités de recherche. En ce qui concerne les possibles facteurs explicatifs, l'estimation de modèles économétriques montre une corrélation positive robuste entre le nombre de dépôts de marques par l'université et le nombre d'étudiants, la présence d'une faculté de médecine, la part des financement de source fédérale, ou bien encore le fait d'être une institution privée plutôt que publique. Nous observons par ailleurs une corrélation négative avec le nombre d'universités présentes dans l'Etat, ce qui traduit une utilisation des marques par les universités dans une logique de signalement plutôt que pour se différencier des universités concurrentes. A partir de l'information sur les classes de produits dans lesquelles la marque est déposée, nous identifions différentes catégories de marques académiques, associées à différentes stratégies. Certaines marques sont susceptibles d'être utilisées pour protéger la réputation globale de l'université, tandis que d'autres ont trait aux activités de merchandising, et d'autres apparaissent reliées aux activités de recherche de l'université. En ce qui concerne ce dernier type of marques, nous trouvons que leur utilisation est positivement corrélée à l'utilisation de brevets, mais elles sont également utilisées dans des domaines de recherches où les produits ne sont vraisemblablement pas brevetables. Aussi, la question du type de relations entre marques et brevets académiques reste ouverte. A travers ces différents résultats, il apparaît que les marques peuvent constituer un actif-clé de signalement des universités, notamment de leurs activités de recherche.

Sur la base des travaux précédents, les marques semblent pouvoir refléter les activités d'innovation, notamment d'innovation à faible contenu technologique pour lesquels on manque d'indicateurs quantitatifs. En appendice de la thèse, nous abordons un certain nombre de considérations méthodologiques et statistiques concernant la construction d'indicateurs d'innovation basés sur des données de marques agrégées, examinant notamment les possibilités d'effectuer des comparaisons internationales et inter-sectorielles.

ABSTRACT

This thesis aims at explaining the link between trade mark use and innovative activities. The first chapter describes the main legal aspects of trade marks and reviews existing literature in economics and management relating to them. The second chapter analyses how and why firms use trade marks and how they integrate them in their innovative activities. Through a theoretical and empirical approach, we show that trade marks are used in relation to innovations which are at the interface of the market, mainly product and marketing innovations. They are particularly related to innovations with low technological content, for which other means of protection are not available. The third chapter then studies the interrelated effect of trade marks and patents in the protection of innovation. We show that depending on market characteristics, they may complement or substitute each other. In the fourth and final chapter, we explore the patterns of trade mark use by academic institutions, and investigate how these relate to their research activities.

Keywords : Innovation, Intellectual Property Rights, Trade marks, Patents, Complementarity, Academic entrepreneurship.
JEL classification : D23, I23, K29, L2, O30, O32, O34

RÉSUMÉ (COURT)

L'objet de cette thèse est d'expliquer le lien entre utilisation de marques et activités innovantes. Le premier chapitre décrit les principaux aspects juridiques des marques et passe en revue la littérature en économie et gestion s'y rapportant. Le second chapitre analyse comment et pourquoi les entreprises utilisent les marques et comment celles-ci s'intègrent dans leurs activités innovantes. À travers une approche théorique et empirique, nous montrons que les marques sont utilisées en lien avec les innovations prenant place à l'interface du marché, principalement les innovations de produit et de marketing. Elles sont particulièrement reliées aux innovations à faible contenu technologique, pour lesquelles les autres moyens de protection ne sont pas adaptés. Le troisième chapitre étudie les interactions entre marques et brevets dans la protection de l'innovation. Nous montrons que selon les caractéristiques du marché ils peuvent se complémenter ou se substituer l'un à l'autre. Dans le dernier chapitre, nous explorons les schémas d'utilisation de marques par les institutions académiques et leur lien avec les activités de recherche de ces institutions.

Mots-clés : Droits de Propriété Intellectuelle, Marques, Brevets, Complémentarité, Entrepreneuriat académique.
Classification JEL : D23, I23, K29, L2, O30, O32, O34