THREE ESSAYS ON INTELLECTUAL PROPERTY AND THE MANAGERIAL ASPECTS OF ITS PROTECTION AND EXPLOITATION

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ABSTRACT

This thesis presents three essays on intellectual property and the managerial aspect of its protection end exploitation.

The *first essay* provides a systematic review of the empirical trademark literature with the goal to develop a framework that brings together different research streams. Despite its relative youth, this field of scholarly inquiry has already accumulated a critical mass of contributions that allow us to draw initial conclusions about the trademark lifecycle and its multifaceted impact on organisational functioning. Based on a systematic review of 64 academic papers containing some elements of empirical trademark analysis, five broad research areas have been identified, namely: the determinants of trademark deposits; the role of trademarks in differentiating product offerings; the relationship between trademarks and innovation activities; the strategic use of trademarks; and the impact of trademarks on firm performance. Overall, the analysis reveals that the performance-based perspective currently dominates the research landscape, with studies on trademark deposits and the trademark-innovation link to follow. At the same time, there is still relatively little known about the micro-foundations of a firm's trademarking behaviour; the complementary use of trademarks and other intellectual property rights, including its effect on value transference; and the performance implications of different trademark strategies. This essay accounts for these and other findings to outline directions for future research.

The *second essay* focuses on the managerial aspects of intellectual property strategy. Often scholars refer to intellectual property protection as an auxiliary concept that assists in building up or proving an argument about the innovation process. By contrast, this research focuses on intellectual property strategy per se, placing specific emphasis on its managerial dimension. It adopts the upper echelons approach to examine the extent to which CEO characteristics contribute towards the variance in patent and trademark applications. Guided by the resource-based view of the firm, it suggests three areas of resource expertise – legal, scientific, and business – each of which is likely to have a distinct influence on how the chief executive perceives and subsequently responds to intellectual property issues. This proposition is further extended by incorporating the possession of general skills and the moderating role of proactive personality in the overall conceptual framework. The empirical analysis of a sample of 848 CEOs in 261 U.S. publicly-traded companies over the period 1992-2013 generally confirms the contention that executive characteristics are an important determinant for predicting the outcomes of intellectual property strategy. As such, the study reinforces the ongoing academic debate on the need to account for the managerial aspect when considering the strategic decision processes.

The *third essay* offers an extensive analysis of how executive demography affects differentiation strategy. Previous studies of competitive strategy have provided some support for aligning CEO personality traits with product differentiation. This essay suggests further refinement of these findings and extends them by considering a wider range of managerial characteristics proposed in subsequent research. By integrating the upper echelons perspective with the hierarchical view of strategy, this work also draws attention to channels through which chief executives influence organisational outcomes. It particularly argues that along with direct involvement, decisions made by the CEO regarding corporate strategy will affect the extent of product differentiation, too. The empirical testing is based on a sample of 821 chief executives in 259 U.S. publicly traded companies over the period 1992-2013. Using trademarks to measure product differentiability, this research has demonstrated that executive tenure, age, education, functional experience, monetary incentives, CEO duality, and the founder and owner statuses – all this is statistically significant for explaining variations in differentiation strategy across companies, even after when firm and industry-specific effects are controlled for. Furthermore, it has also been shown that chief executives leverage different characteristics, depending on the type of involvement and the strategy level at which they make decisions. By confirming CEO biases that guide product differentiation, this research also contributes to the broader discussion on the importance of accounting for human interpretation in the strategy making process.

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LIST OF PUBLICATIONS

The following is a list of my publications both related to and arising from the research carried out for this PhD:

Nasirov, S., Li, C., and Thompson, S. (2015) CEOs and product differentiation: How managerial ability affects trademark registrations. In: Newcastle University, **30th Annual Conference of the British Academy of Management**, Newcastle-upon-Tyne, UK 6-8 September, 2016.

Nasirov, S., Li, C., and Thompson, S. (2015) CEOs and intellectual property: How managerial ability affects trademark registrations. In: The University of Bordeaux, **DRUID Academy Conference 2016**, Bordeaux, France 13-15 January, 2016.

Other conferences attended:

06/2017 **7th NIE Doctoral Student Colloquium**
Loughborough, UK

06/2017 **2nd BAM Corporate Governance Early Career Researchers Conference**
Nottingham, UK

03/2017 **Strategic Management Society Special Conference**
Milan, Italy

09/2016 **11th Annual Conference of the EPIP Association**
Oxford, UK

06/2016 **6th NIE Doctoral Student Colloquium**
Nottingham, UK

06/2016 **Midlands Regional Doctoral Colloquium 2016**
Birmingham, UK

06/2016 **1st BAM Corporate Governance Early Career Researchers Conference**
Manchester, UK

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

Benelux	Belgium, the Netherlands, and Luxembourg
CAO	Chief Administrative Officer
CCO	Chief Commercial Officer
CEO	Chief Executive Officer
CFO	Chief Financial Officer
COO	Chief Operating Officer
DPMA	German Patent and Trade Mark Office
EPO	European Patent Office
GDP	Gross Domestic Products
HR	Human Resources
INAPI	National Institute of Industrial Property, Chile
INPI	Portuguese Patent and Trademark Office
INPI France	National Institute of Industrial Property, France
IP	Intellectual property
IPO	Intellectual Property Office of the United Kingdom
IT	Information Technologies
JD	Juris Doctor
JPO	Japanese Patent Office
MBA	Master of Business Administration
OECD	Organisation for Economic Co-operation and Development
OHIM	Office for Harmonization in the Internal Market
PhD	Doctor of Philosophy
R&D	Research and Development
ROA	Return on Assets
SEC	U.S. Securities and Exchange Commission
SIC	Standard Industrial Classification
TFP	Total Factor Productivity
U.K.	United Kingdom
U.S.	United States
U.S.C.	United States Code
USD	United States Dollar
USPTO	United States Patent and Trademark Office
VC	Venture Capital
WIPO	World Intellectual Property Organisation

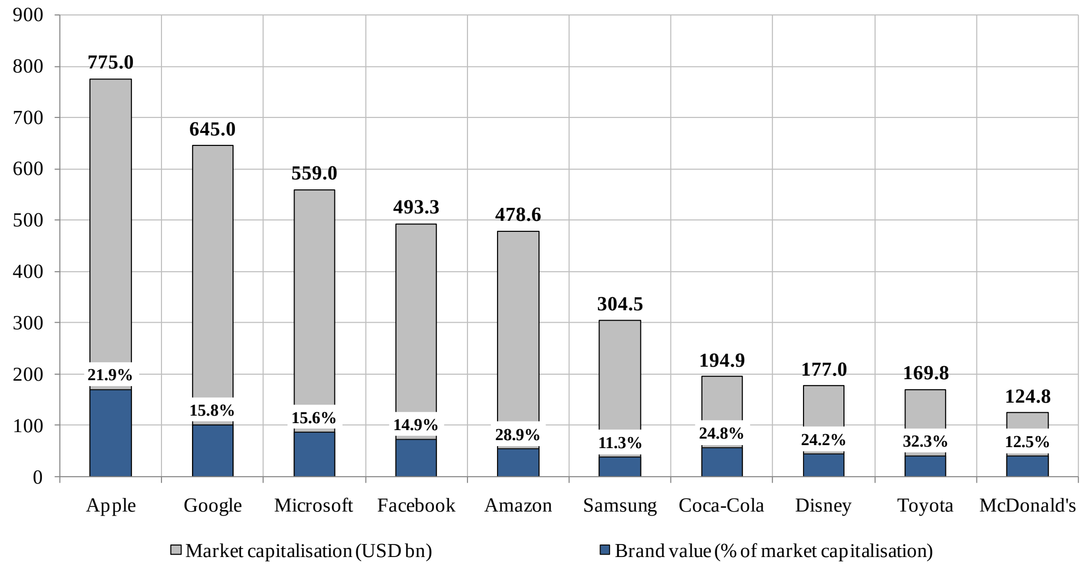
CHAPTER 1. INTRODUCTION

1.1. RESEARCH MOTIVATION

Over the past few decades, the literature on intellectual property has expanded considerably, with the focus steadily shifting from theoretical to empirical studies. There are various reasons for this tendency, of which one is the ongoing effort of government officials to pursue evidence-based policy making and, hence, the need to have a better understanding of how intellectual property can affect economic and social development (WIPO, 2009). Second, on the side of the business sector, the attitude towards intellectual property rights as an instrument for threatening competitors has started giving way to the idea that they should be an integral part of organisational strategy (Al-Aali and Teece, 2013). As a result, there has been a surge of interest in examining systems and methods for their efficient management. Finally, one must also not ignore the fact that the elimination of certain legal and technical barriers has allowed a wider range of researchers to have access to intellectual property statistics and make their own contribution to this field (Graham *et al.*, 2013).

But let us for the moment take a closer look at the business sector. There is a wealth of case studies showing how companies can benefit from their intellectual property. Perhaps one of the most famous examples is the adoption by IBM Corporation of the patent licensing strategy, when the company radically revised its approach to the use of intellectual property rights and eventually boosted the revenue from royalty payments from USD 30m in 1990 to USD 1bn in 2003 (Rivette and Kline, 2000). Another notable example is AstraZeneca – this company has long been extremely successful in competing with generic drug manufacturers by transferring reputational aspects of patents, which have a limited lifespan, to trademarks (Conley *et al.*, 2013). Moreover, brands per se have become a critical source of revenue for many companies, largely owing to their ability to ensure premium pricing and stable demand from loyal customers. Given the impact on company value that brands have (see Figure 1.1), their protection and wise management are thus seen to be necessary for firms' survival and competitiveness in the marketplace.

Figure 1.1. Top 10 most valuable brands in the world



Sources: Forbes Magazine; The New York Stock Exchange; Korea Exchange; the author's own calculations. Note that for each company, market capitalisation is as of August 1st, 2017.

As simple as it might sound, not every company is actually capable of taking full advantage of its intellectual property, let alone turning it into one of the core business competences. The question then arises: what determines the success or failure in each case? To date, the absolute majority of studies on intellectual property have been dedicated to scrutinising industry and firm-specific factors (e.g., Block *et al.*, 2015; Cohen *et al.*, 2000; Hall and Ziedonis, 2001; Hanel, 2006; Jensen and Webster, 2006). However, there is another potentially insightful dimension that has been relatively underrepresented in the literature – we refer here to the role of corporate leaders, their attitudes, values and perceptions, in controlling, governing, and exploiting intellectual property. Despite some anecdotal reports (e.g., Fisher and Oberholzer-Gee, 2013; Reitzig, 2007; Rivette and Kline, 2000) recent empirical evidence (e.g., Balsmeier and Buchwald, 2014; Galasso and Simcoe, 2011; Hirshleifer *et al.*, 2012; Wu *et al.*, 2005) suggesting that this relationship is likely to exist, there is still a lack of systematic and consistent research which would illuminate the effects of senior executives on intellectual property issues.

In an effort to address this gap, this thesis examines the link between observable managerial characteristics and unobservable cognitions, values, and perceptions with the aim to understand the influence chief executives have on organisational processes and outcomes. Its specific interest lies in situating the managerial perspective with respect to the protection of intellectual property and its deployment to differentiate product offerings. For example, it seeks to answer such questions as: what demographic factors can affect a chief executive's perception of intellectual property rights? Does the chief executive have similar attitudes towards intellectual property protection at different stages of the new product development process? When it comes to the introduction of a product in the marketplace, what are the traits that the CEO can leverage in order to facilitate or impede differentiation strategy? And more generally, is there any reason to believe that chief executives can be at all responsible for business and functional strategies?

It should also be noted that while referring to intellectual property rights at large, this thesis draws predominantly on trademark analysis. The use of trademark data in empirical research is still a fairly new and unexplored area, yet first results have been promising, suggesting that trademarks can be a valid indicator of innovation and product differentiation activities (e.g., Bosworth and Rogers, 2001; Greenhalgh and Rogers, 2006b; Mangàni, 2007; Mendonça *et al.*, 2004). Along with the methodological opportunities these statistics provide, the choice to concentrate on trademarks is motivated by several other reasons. First of all, among all formal methods of intellectual property protection, trademarks seem to have the tightest association with top managers in the sense that "[i]mportant trademark decisions other than strictly legal interpretations usually rest with top management" (Cohen, 1986:61). Second, as it has already been mentioned, every company has goodwill to protect; hence, trademarks should be relevant to a wider range of firms in different industries, thereby allowing for the generalisation of the results. Finally, unlike patents, trademarks are cheaper to acquire, and once being registered, this intellectual property right usually does not require engaging in costly litigation and enforcement processes.

1.2. DATA AND METHODS

From data collection ...

One of the major challenges for empirical researchers specialising in intellectual property issues consists in linking patent and trademark statistics to firm-level information. The problem usually relates to the fact that "a large number of observations in each dataset need to be merged in the absence of a common identifying code" (Thoma *et al.*, 2010:3). Often, the only plausible solution is to compare inventor, assignee, owner, and company names to establish the link. This method, however, entails certain difficulties: for example, name heterogeneity arising from inconsistent abbreviations, typographical errors, variations in naming, or spelling mistakes is likely to result in a non-negligible number of unmatched or erroneously matched observations. Therefore, it is generally advised to perform name harmonisation and consolidation before proceeding to the matching procedure.

In this research, we use a longitudinal panel dataset of more than 250 U.S. publicly traded companies for the period 1992-2013 that contains patent, trademark, financial, and managerial information. The dataset was created by combining data from multiple sources, including:

- OECD HAN Database and OECD Patent Quality Indicators Database, for patent registrations;
- USPTO Trademark Case Files Dataset for trademark introductions, applications, and registrations;
- Standard & Poor's Compustat North America Dataset for firm financial statistics and industry aggregates;
- Standard & Poor's Execucomp Dataset for information about executive ownership and compensation;
- Marquis Who's Who directories; the Bloomberg database; the BoardEx database; companies' SEC filings, press releases, and official web-sites; and CEOs' LinkedIn profiles, university yearbooks, and obituaries, for demographic characteristics of chief executives.

Before linking these datasets, we had to eliminate name heterogeneity existing in some of them. We followed the harmonisation procedure designed by Magerman *et al.* (2011) and performed character and punctuation cleaning, legal form indication treatment, common company word removal, and spelling variation adjustment. Once harmonised, all names were subsequently consolidated by first identifying a unique token in each of them and then searching for this token in the full set of names. Finally, we used a mixture of approximate search heuristics, the edit distance method, and the token algorithm to link firm names from different datasets (Raffo and Lhuillery, 2009). When accepting a match, we also controlled for firm location – that is, country, state, city, and address – to minimise the chance of having false positives.

... to data analysis

In empirical economics, the situation when the dependent variable is the result of a count data process is fairly common. Specific examples may include the number of crimes in a location, the length of stay in a hospital, or the number of student dropouts. Clearly, the number of patents and trademarks applied for and received by a company also fits this profile. To analyse count data, researchers often choose to first normalise them and then to use the ordinary least squares method to obtain parameter estimates. However, a superior approach would be to estimate either Poisson or negative binomial models, which are specifically designed to handle this type of data (Allison, 2009). The choice between the two models is usually guided by whether overdispersion is observed in the data or not, with the negative binomial model being able to treat it.

When examining the managerial aspects of intellectual property and differentiation strategies, we followed Allison and Waterman (2002) and estimated an unconditional negative binomial model with directly introduced fixed effects – as their analysis suggests, such an approach yields consistent parameter estimates, especially in long panels. As such, our econometric strategy slightly diverges from what can sometimes be seen in the intellectual property literature. More specifically, we did not employ the fixed effects negative binomial model proposed by Hausman *et al*. (1984) and based on the conditional likelihood method because of the criticism that this model is unable to control for all stable covariates and, therefore, may lead to erroneous results (see Guimarães, 2008). Furthermore, to better capture the decision-making process related to differentiation strategy, we made some extra adjustments and built the negative binomial model in the hurdle specification (Mullahy, 1986). The basic idea here is to interpret the first stage as reflecting the chief executive's decision on accessing (by means of trademarking) a new product market, whereas the second stage – on the extent of product differentiation in this market.

A note on the method used for the identification of empirical trademark studies

The ultimate goal of our review was to develop an integrated framework that would bring together various streams of the empirical trademark literature. In order to do this, we first had to select articles for review, which task was accomplished by carrying out a systematic search procedure (e.g., Becheikh *et al.*, 2006). We started with identifying the keywords to look for as well as some outlets to exclude from further analysis. After filtering out all non-empirical studies, we were left with the initial set of 566 papers which required a more detailed examination. It should be noted that the field we focus on is in its infancy; therefore, we were unable to rely on a journal's impact factor or reputation to guide our selection process as valuable contributions could still appear even in relatively lower ranked journals. So, instead, we read through abstracts, introductions, and methodology sections of all these papers to ensure that only relevant empirical studies were selected. We also looked through the reference lists of the already selected publications and augmented the sample with papers not identified at previous stages. Overall, our procedure resulted in 64 academic articles to review.

1.3. CONTRIBUTIONS

This research offers a number of contributions, both theoretical and empirical. Here, we will highlight some of the key ones.

In the *first essay*, we make an early attempt to develop an integrated framework that brings together different research streams of the empirical trademark literature. As such, we supplement the existing reviews that usually consider a broader range of intellectual property issues (e.g., Candelin-Palmqvist *et al.*, 2013; Hanel, 2006) with a systematic and, what is perhaps even more important, focused analysis of papers using trademark statistics. Unlike previous reviews of this literature (e.g., Mendonça *et al.*, 2004; Schautschick and Greenhalgh, 2016), we do not confine our interest to a particular academic discipline, such as economics. Instead, we scrutinise findings and observations from management and business studies, thus providing a more holistic perspective on trademark activities in organisations. Finally, our essay also identifies some general areas around which most of the empirical trademark work has been concentrated, shows how these areas are related to each other, and proposes avenues for future research that should ultimately improve our understanding of organisational trademarking.

In the *second essay*, we propose a conceptual framework that helps us understand the role of a chief executive's cognitive bases and values in governing the protection of intangible assets. With this research, we first contribute to the literature on intellectual property rights (e.g., Block *et al.*, 2015; Gallié and Legros, 2012; Greenhalgh and Longland, 2005; Helmers and Rogers, 2010; Jensen and Webster, 2006; Sandner, 2009) by showing that managerial characteristics tend to be an important determinant of a company's patent and trademark activities. Another contribution is made to the existing literature on intellectual property management (e.g., Al-Aali and Teece, 2013; Conley *et al.*, 2013; Fisher and Oberholzer-Gee, 2013; Reitzig, 2007; Rivette and Kleine, 2000): here, our results indicate that formal methods of protection are utilised by chief executives selectively, with special preference being given to patents. Based on this finding, we further argue that such attitude may actually undermine the efficiency of complementarity and value transference strategies. Finally, our study adds to the growing literature on the relationship between trademarks and innovation (e.g., Flikkema *et al.*, 2014; Gotsch and Hipp, 2012; Mendonça *et al.*, 2004; Schmoch, 2003) by suggesting to rely on the legal basis for filing a trademark application in order to identify innovation-related trademarks.

Additionally, this essay also makes several methodological contributions. First, it comes up with the idea of CEO orientations – such as legal, scientific, and business – and describes an approach to capturing each of them. Second, it uses award-based statistics to identify proactive personality; in doing so, it draws on the observation that individual proactivity is positively related to the need for achievement. And third, as we have already mentioned, it proposes a method to reveal innovation-related trademarks. More specifically, it focuses on the time lag between the moment when a trademark is introduced in the marketplace and the moment when the application to protect it is filed. This method is based on the intuition that trademarks with a longer time lag are less relevant to the protection of new product identity and more – to the protection of acquired reputation.

In the *third essay*, we study the effect of executive characteristics on a company's differentiation strategy and, thereby, aim to contribute to the literature in several ways. First, we attempt to address the criticism that upper echelons theory is the black box because it tells us little about "the psychological and social processes that mediate between executives' demography on the one hand and their behaviors on the other" (Hambrick, 2007:335). So, instead of invoking the concepts of dominant coalitions and power in order to justify top managers' direct involvement in the planning and implementation of business and functional strategies, we provide more concrete reasons for why chief executives may eventually accept some degree of responsibility for product differentiation. As such, we bridge this stream of literature with research in strategic marketing, where this phenomenon is referred to as the divergence between the locus of strategy and the locus of decision making (see Day, 1992; Varadarajan and Clark, 1994; Webster, 1992). Furthermore, we link upper echelons theory to the hierarchical view of strategy and particularly its argument about cross-level strategic interdependencies (see Hofer, 1975; Hofer and Schendel, 1980; Vancil and Lorange, 1975) to demonstrate that CEOs may also have an impact on product differentiation indirectly by making decisions on corporate strategy issues. Next, this essay contributes to the management literature on competitive strategies (e.g., Beal and Yasai-Ardekani, 2000; Govindarajan, 1989; Gupta and Govindarajan, 1984) by concentrating on a wider range of personality traits as well as by putting the analysis into the context of large corporations where the relationship in question is less apparent. Our specific interest in product differentiation complements previous studies that examine the managerial dimension of the new product development process, yet mainly at earlier, pre-market introduction stages (e.g., Barker and Mueller, 2002; Kor, 2006; Wu *et al.*, 2005). Finally, by viewing trademarks as a means of product differentiation, we also contribute to the corresponding intellectual property literature (e.g., Crass and Schwiebacher, 2017; Mangàni, 2007; Semadeni, 2006).

As for the methodological contributions this essay makes, we should first highlight the development of two new classification systems: one can be used to match university degrees to broad subject areas, whereas the other – to match post names to functional areas. Second, the essay points to the diversity of institutional experience as yet another factor that may affect top managers' decisions in strategic situations and develops a measure to capture it, which includes such components as the number of industries and companies chief executives worked in during their professional careers and also their military, civil service, and academic experiences. And third, it suggests a method for distinguishing trademarks introduced in new product markets from trademarks introduced in the markets where the company currently operates.

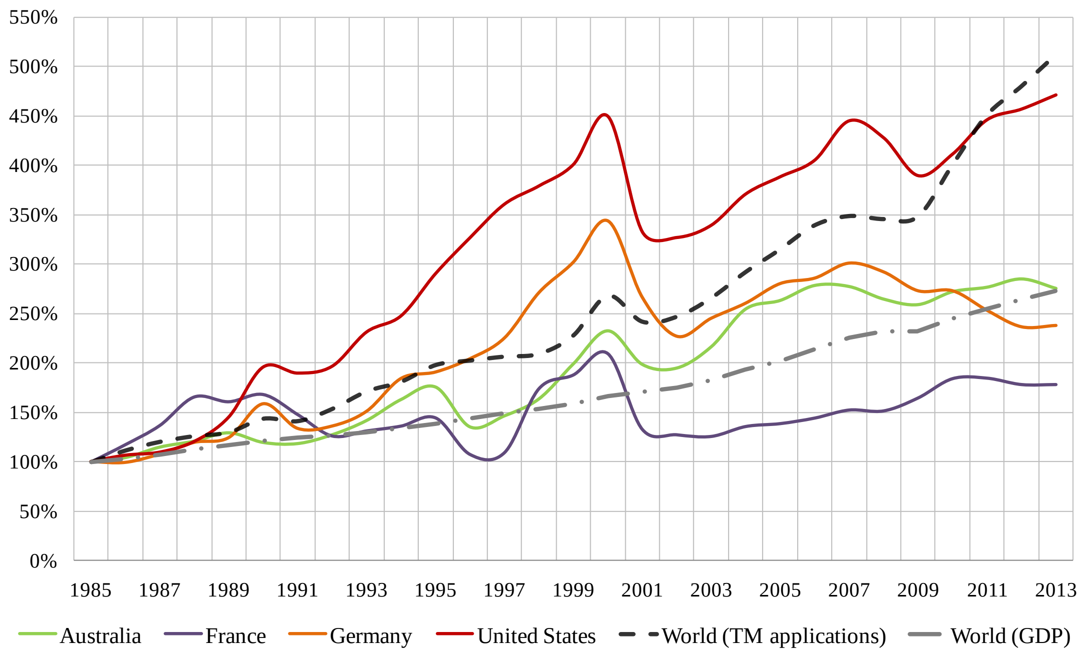
At a more general level, the last two essays contribute to the long-standing choice determinism debate (Astley and Van de Ven, 1983; Bourgeois, 1984; Hitt and Tyler, 1991; Hrebiniak and Joyce, 1985) by confirming that organisational outcomes can be partially predicted by the values and cognitive bases of chief executives. Here, it needs to be noted that many scholars, especially those working in population ecology or industrial economics, tend to perceive the managerial role as inactive or, at most, reactive. As the argument goes, organisational change occurs in response to various shocks in the external environment; hence, the function of managers boils down to simply confronting these shocks by adjusting organisational structure. In turn, these essays demonstrate that chief executives are not just passive onlookers – their personal characteristics do affect the decision-making process and, as such, have a significant impact on strategic choices and performance levels.

CHAPTER 2. THE USE OF TRADEMARKS IN EMPIRICAL RESEARCH: TOWARDS AN INTEGRATED FRAMEWORK

2.1. INTRODUCTION

Over the last few decades, the empirical analysis of intellectual property has been a thriving area, although the focus has been almost exclusively on patents and their contribution to technological progress. At the same time, recent changes in the economic structure have led both academics and policymakers to reconsider the toolbox of indicators they are currently using and search for new measures that would let them identify, monitor, and evaluate previously neglected processes and practices. A fine example in this regard is the growing importance of services in the modern productive system and, hence, the need to have a more accurate account of innovation activities taking place there (see Barras, 1986; Gallouj and Weinstein, 1997). Since service sectors are usually associated with a weaker flow of R&D investment and patent applications, if at all, conventional methods have a limited explanatory power and are likely to result in underestimating the actual extent of their innovation effort. So, among the available alternatives, the choice eventually fell on trademarks due to their widespread use across various industries, relevance to different organisation types, and close association with the new product development process (Mendonça *et al.*, 2004; Schmoch, 2003). In fact, this interest has been further reinforced by the increasing popularity of trademark protection among a variety of organisations in different countries (see Figure 2.1).

Figure 2.1. The dynamics of trademark applications in selected countries



Sources: The World Intellectual Property Organisation (for trademark applications); The World Bank (for the world GDP growth rate). Note that 1985 is set to 100%.

Although empirical trademark studies remain at an early stage of development, a critical mass of papers have already been accumulated that can be used to draw some initial conclusions about trademark activities and their effect on organisational functioning. So, the aim of this work is to identify the basic literature using trademark statistics, systematically review it, and create an integrated framework that brings together different research streams. To anticipate the results of our analysis, we find that all the empirical research on trademarks can be grouped into five broad categories, namely: the determinants of trademark filings; the role of trademarks in product differentiation; the link between trademark and innovation activities; the strategic use of trademarks; and the impact of trademarks on firm performance. So far, considerable attention has been devoted to the evaluation of how trademarks may impact on company value, productivity, and profitability. In line with the aforementioned need for new innovation measures, the relevance of trademarks to innovation processes has been carefully scrutinised, too. However, there are areas that still deserve further exploration: for example, little is known about intraorganisational factors governing trademark activities; studies that would look at trademarking in developing countries are fairly rare; and more work should be done to address methodological inconsistencies to allow for a better comparability of results. As for contributions to the literature, this research broadens the analysis presented in previous reviews (e.g., Mendonça *et al.*, 2004; Schautschick and Greenhalgh, 2016) by looking at the fields that are adjacent to economics, including marketing and management. Such an approach allows us to provide a more holistic perspective on trademark activities in organisations and stimulate cross-disciplinary learning. This work also adds to the existing reviews on intellectual property rights (e.g., Candelin-Palmqvist *et al.*, 2013; Hanel, 2006) by placing a specific focus on trademarks.

The rest of this paper is organised as follows. Section 2.2 provides some background information on trademarks and examines the rationale for their legal protection. Section 2.3 describes the method used to identify the basic trademark literature and also presents the bibliographical patterns which can be observed in the selected publications. Section 2.4 contains a detailed analysis of each empirical paper and links it to the broader stream of research. Section 2.5 concludes with a discussion of implications for future research.

2.2. BACKGROUND INFORMATION ON TRADEMARKS AND THE ECONOMIC RATIONALE FOR THEIR PROTECTION

2.2.1. A brief overview of the U.S. trademark system[1]

A trademark is any symbol, word, or other device used to identify and distinguish goods or services of one party from those of another (Blackett, 1998).[2] Trademark protection, in turn, entails that the company is granted an exclusive right to use its goodwill embodied in the mark in order to minimise the extent of unfair trade practices, such as deception, misleading advertising, or product mislabelling (McClure, 1979). This is also advantageous for consumers because the law explicitly prohibits the use of marks that create the likelihood of confusion in the marketplace, cause a mistake, or deceive regarding the source of the products to which they are affixed, thereby ensuring some degree of uniformity and, under certain circumstances, quality in purchased products. A salient characteristic of trademark protection is that its legal basis is formed up of "a series of legal materials emanating from common law, the federal government, and variations established by the state" (Cohen, 1986:62), which all together constitute part of the law of unfair competition.[3] As such, a trademark itself should not be viewed as a conventional property right because the right associated with the mark arises only through its actual use in commerce (Besen and Raskind, 1991; LaFrance, 2005).[4]

All trademarks can be grouped into five categories each of which reflects the degree of inherent distinctiveness and, therefore, corresponds to the level of protection afforded them (Cohen, 1986):

- *fanciful marks* are purposely designed to operate as trademarks, without any pre-existing meaning;

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[1] It should be noted that certain aspects of trademark and related intellectual property laws vary on a country basis. For expositional purposes, the theoretical part of this study is devoted to the U.S. trademark system; thus, the U.S. law is hereinafter referenced and reviewed.

[2] The word "trademark" usually acts as an umbrella term and may equally denote service marks, certification marks, collective marks, collective membership marks, or trade dresses (Mims, 1984; Tancs, 2009). It has also become common practice to consider the words "trademark" and "mark" as synonyms. So, these terms will be used interchangeably in the course of this work.

[3] This is in contrast to patents and copyrights whose protection is guaranteed by the U.S. Constitution. At the same time, trademark protection at the federal level is governed by The Federal Trademark Act of 1946, also known as The Lanham Act. The act not only establishes a set of rules on which the federal trademark registration system has to base itself, but also supplements common law with more precise definitions (Cohen, 1986).

[4] The Trademark Law Revision Act of 1988 expanded the grounds on which registration could be granted. It introduced a provision that along with commercial use, a trademark may be eligible for registration also when the registrant can demonstrate a bona fide intent to use it in commerce.

- *arbitrary marks* have an innate meaning but are used in such a way as to avoid consumer confusion;
- *suggestive marks* subtly appeal to some features of the product;
- *descriptive marks* directly refer to at least one of the product's characteristics; and
- *generic marks* convey immediate information about the category to which the product belongs.[5]

The former three classes are normally entitled to the strongest protection, whereas generic terms tend to remain in the public domain. Descriptive terms are not eligible for protection unless they have "acquired distinctiveness through secondary meaning" (Jacoby, 2001:1029).[6] Additionally, the law also explicitly bars the registration of any trademark that consists of or comprises immoral, deceptive, or scandalous matter.

Despite the need to follow a separate registration procedure to apply for federal protection, both registered and non-registered marks are still protected. Trademarks not yet registered with the U.S. Patent and Trademark Office (USPTO) or even not eligible for federal registration can still enjoy a certain degree of legal protection under common law as so-called technical trademarks (Cohen, 1986). In this case, trademark rights are allocated on the first-to-use basis and retained through suing competitors for infringing the mark. However, federal registration grants benefits not available to marks existing under common law, such as nationwide constructive notice of the trademark owner's claim; prima facie evidence of the validity and ownership of the mark; the owner's exclusive right, obtained and maintained under certain conditions, to use the trademark in commerce; access to the federal enforcement system, and penalties against infringement; and the import ban on goods bearing infringing marks (Blankenship, 2001). Finally, once the trademark is registered, it can be renewed indefinitely for further periods of ten years as long as the registration complies with the procedures prescribed by the trademark legislation, and the mark is both distinctive and still used in commerce.

2.2.2. The economic rationale for trademark protection

According to McClure (1979), much of the debate about the necessity to use trademarks as an instrument for intervening into the market is based on the two competing

[5] A special class of so-called "famous marks" has been introduced by The Federal Trademark Dilution Act of 1995, which created a federal cause of action to prevent unauthorised use, trading upon the goodwill, and dilution of the distinctive quality of such marks. This act was largely replaced by The Trademark Dilution Revision Act of 2006.

[6] In certain cases, courts may apply the functionality doctrine. It allows "competitors to copy functional features of a product, even if the features have secondary meaning, unless the features are protected by patent or copyright" (Mims, 1984:645).

ideas – altruism and individualism. In practical terms, it leads to the question of whether there can ever be a balance between protecting individual rights and encouraging market competition. This conceptual puzzle is usually described as the opposition between the anti-trademark Harvard school and the pro-trademark Chicago school, with the latter currently dominating the policy landscape (Swann, 2014). It should be mentioned, however, that the major source of contradiction between these schools is much more fundamental and, as Posner (1979) puts it, largely related to the difference in approaches to studying industrial organisation. While the Harvard school is more inclined to employ natural observations, the Chicago school is an active proponent of general economic theory and, particularly, price theory. Both of these methods have their limitations and underlying assumptions, thus often leading to incompatible conclusions. In what follows, we will consider in more detail some of the key arguments each of these schools has to offer.

Although trademark law had come under strong criticism long before the 1930s,[7] the economic rationale for abandoning trademark protection was originally devised by Harvard economist Edward Chamberlin in his famous book "*The theory of monopolistic competition: A re-orientation of the theory of value*" published in 1933. To Chamberlin (1933), trademarks are a central element of monopolistic competition, which argument is in stark contrast to the opinion prevailing at that time that they are part of the essentially competitive regime. As his argument goes, trademark protection gives the producer an opportunity to use advertising and other marketing methods to foster product differentiation and achieve brand loyalty, although this seems to be artificial in the situation when products are functionally identical. By utilising trademarks, producers can benefit from a monopolistic position in the market enabling them to earn monopoly rents and suppress competition. On the demand side, this strategy leads to higher consumer prices due to irrational brand premium; while on the supply side, it undermines competition by providing the ground for creating oligopolies or even monopolies, with corresponding barriers to market entry (Bain, 1956; Comanor and Wilson, 1967). Recognising that, Brown (1948:1195) concludes that Chamberlin effectively rejects the product differentiation function of trademarks because "the public interest would be best served by permitting unlimited confusion through imitation, so that it would be almost impossible to accomplish advertising differentiation".

At the same time, the generally negative stance on advertising activities expressed by Chamberlin (1933) should be attenuated by noting that advertising is not homogeneous and normally consists of persuasive and informative elements (Brown, 1948; Kaldor, 1950).

[7] In 1879, the U.S. Supreme Court abolished the Federal Trademark Act, which was then declared unconstitutional. This episode can be seen as one of the most serious attacks on trademark law in U.S. history (McClure, 1979).

By denying the former part, Chamberlin (1933) thereby dismisses the dilution doctrine that is entirely based on the idea of persuasive values and their role in the formation of business goodwill (see Schechter, 1927). Furthermore, if there is no informative component, consumers would have to invest a great deal of effort in gathering relevant information on goods and services offered by various producers. Informative advertising, however, should be taken with a precaution because one may cast doubt on its ability to generate reliable information in terms of product quality assurance. The producer may instead create "the illusion of a guarantee without in fact making more than the minimum warranty of merchantable quality" (Brown, 1948:1186). So, a real challenge for all stakeholders is to ensure that "[c]ommunication free of confusion [... is] fostered only for sellers who give and buyers who seek information" (Brown, 1948:1198).

Given that the active position of the Harvard school with respect to the adverse economic effects of trademarks had, at some point, resulted in an attempt of policymakers to limit the scope of trademark protection, a counterattack was mounted by the Chicago school (Swann, 2014). In their seminal paper, Landes and Posner (1987) promote the idea that trademarks should be valued because they perform a number of functions beneficial to society. For example, the simplest problem trademarks can easily solve is economising on words: that is, rather than describing a product as a set of its characteristics, consumers can just use its trademarked name. The authors vividly demonstrate this by looking at the coffee brand "Sanka", which otherwise should have been referred to as "the decaffeinated coffee made by General Foods" (Landes and Posner, 1987:268-269). Clearly, without trademarks, buyers would have to invest much effort in memorising all this information. Landes and Posner (1987) also note that the economising function can be effectively implemented only when the uniqueness of a trademark is enforced.

Another advantage of using trademarks mentioned by Landes and Posner (1987) consists in their ability to reduce consumer search costs. Given that products are different in terms of quality and variety, consumers have to spend their time and money on trying to identify those goods and services that they truly need among the assortment offered in the marketplace. The producer's reputation embodied in the trademark can make this task much easier. By signalling product quality or variety, trademarks can reduce search costs and, at the same time, create incentives for the producer of a trademarked good to "maintain a consistent quality over time and across consumers" (Landes and Posner, 1987:269). If the product's quality does not meet the expectations of its consumers, they can easily punish the producer by reducing future purchases. But are there other incentives for producers to maintain product quality? For a consumer, the overall price of any good or service can be calculated as the sum of its price as well as search costs. By reducing search costs, trademarks thus enable the producer to charge a higher price for their products, provided that the gross price remains unchanged, and enjoy higher profits. So, it can be concluded that "[i]n a world of imperfect information, it may be entirely rational for consumers to pay a higher price for the brand they are used to, as they save the time of researching whether other products would equally satisfy them" (Swann, 2014:1139).

Finally, another argument in favour of trademarks is related to one of the market failure problems. According to Economides (1988), all goods and services can be classified into two categories – experience products and infrequently consumed products. Regardless of the classification, all products have observable and unobservable characteristics that may be valued by consumers differently. Since the producer is more knowledgeable about their product, it creates asymmetric information in the marketplace. As a result, "[i]n the absence of trademarks, faced with the choice between goods which look identical, the consumer will only by chance pick the one with the desirable unobservable qualities" (Economides, 1988:526). In turn, producers will be willing to produce products with the cheapest unobservable qualities, and this does not serve the best interests of the consumer. Therefore, trademarks help identify unobservable features of products, making the consumer's choice clearer and discouraging the producer from adverse behaviour.

2.3. THE IDENTIFICATION OF THE LITERATURE

2.3.1. Methodology

The principal objective of this work is to develop an integrated framework that brings together different streams of the empirical trademark literature. In order to do this, we first identified a broad sample of studies that examine trademark-related issues. Using the Business Source Premier database, we searched for such terms as "trademark" and "service mark" in the title, abstract, and key words of all indexed papers. We then limited the number of papers for review by excluding non-empirical research as well as articles published in law journals because it is highly unlikely that they would employ statistical analysis.[8] Finally, we retained only those studies that were published as full-length articles in peer-reviewed journals in English. The above procedure left us with a superset of 566 papers explicitly referring to trademarks (see Table 2.1). Unlike previous reviews on a similar topic (e.g., Candelin-Palmqvist *et al.*, 2012), we were unable to rely on a journal's impact factor or quality to narrow down the search because the empirical analysis of trademark data is still in its infancy, so even significant contributions can appear in relatively low ranked outlets.

Table 2.1. The selection of articles for review

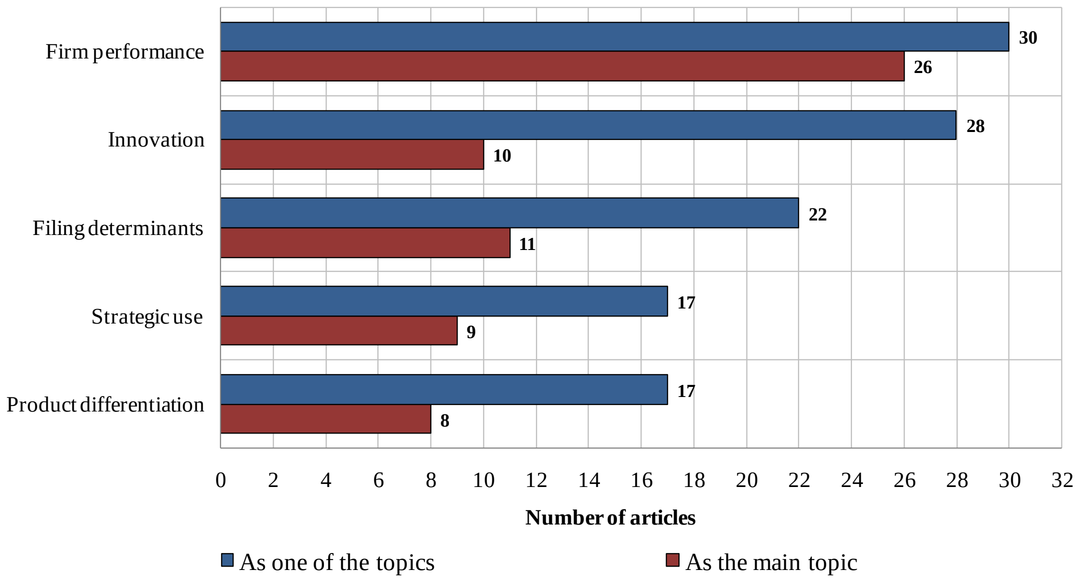
Stage no.	Key word(s)	Operation	Search field(s)	Result
1	trade mark; trademark; service mark	Contain either of these words	TI: title AB: abstract SU: subject terms	25,675
2	law; legal; legislation; tax	Exclude either of these words	SO: publication name	24,126
3	empirical; model; statistics; survey	Contain either of these words	TX: all text	4,035
4	academic journals	-	Source types	586
5	English	-	Language	566

Every article was subsequently reviewed to establish whether it met the inclusion criteria or not. First of all, we filtered out a significant number of papers that appeared in the original list because of the expression "United States Patent and Trademark Office" being present in the abstract or among the subject terms, whereas the papers per se were on topics

[8] A notable exception is Heald and Brauneis's (2011) study of trademark dilution.

unrelated to trademark analysis. Some studies pointed to trademarks while talking about the concepts of dilution, infringement, and licensing, as well as assessing a company's brand strategy; since the absolute majority of them were not empirical, they were excluded from our review, too. With our initial search, we also retrieved several conceptual papers that focused primarily on classification issues, intellectual property management, or presented a new dataset (e.g., Conley *et al.*, 2013; Hipp and Grupp, 2005) – these papers were dropped, although we still referred to them and elaborated on their ideas in corresponding sections. To make sure that all valuable contributions were accounted for, we supplemented the search results with articles identified in other review papers (e.g., Mendonça *et al.*, 2004; Schautschick and Greenhalgh, 2016) and in the reference lists of the already selected empirical trademark studies. Overall, our screening generated a sample of 64 papers, which were used as a basis for this review. One of the major drawbacks of our approach, however, is that it largely misses out government reports, book chapters, working papers, and conference proceedings. This concern was addressed, to an extent, of course, by adding a table that briefly summarises some of such contributions, with the most critical ones being further mentioned in the review part.

Figure 2.2. A summary of research streams in the empirical trademark literature



It needs to be noted that one paper can contribute to multiple research streams. Recognising that, we propose to look at two indicators: (i) *blue bars* show the number of articles in a field for which this field is one of the discussed topics; and (ii) *red bars* show the number of articles in a field for which this field is the main topic of discussion. Clearly, "firm performance" is likely to be a research topic on its own, while the remaining areas are mostly discussed along with some other topics.

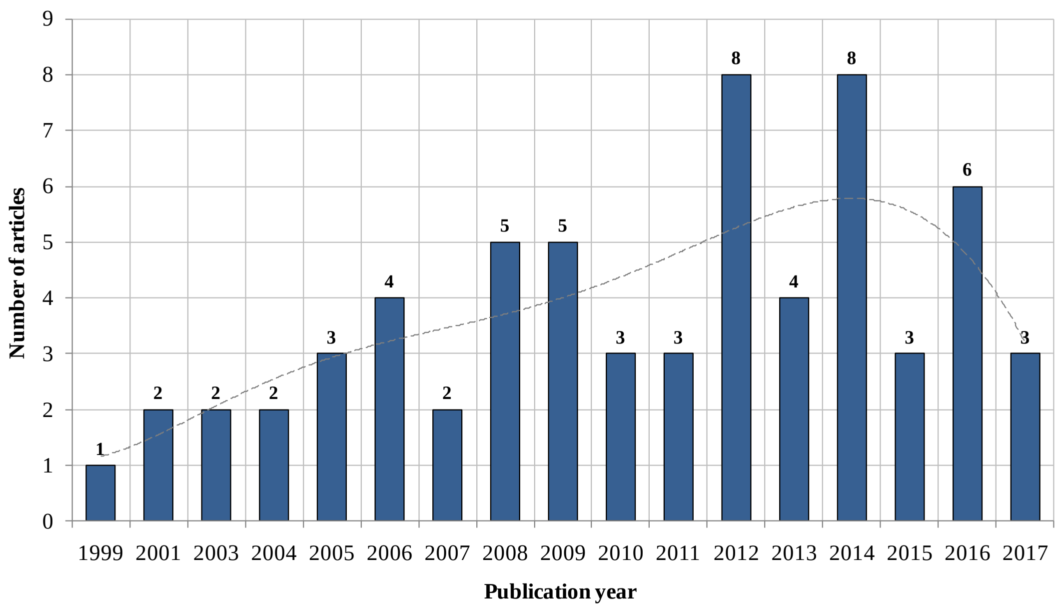
We completed the literature identification stage by classifying each article into one or more groups, depending on the perspective taken towards trademarks. Overall, five major groups were identified, namely: 30 articles assess performance implications of trademarking;

28 studies exploit the link between trademark and innovation activities; 22 papers attempt to identify the determinants of trademark deposits; 17 works explore the strategic use of trademarks; and in 17 publications, the authors refer to trademarks in the context of product differentiation (see Figure 2.2). Before proceeding to an in-depth analysis of each category, we should consider some stylised facts about publishing empirical trademark research.

2.3.2. A descriptive analysis of the empirical trademark literature

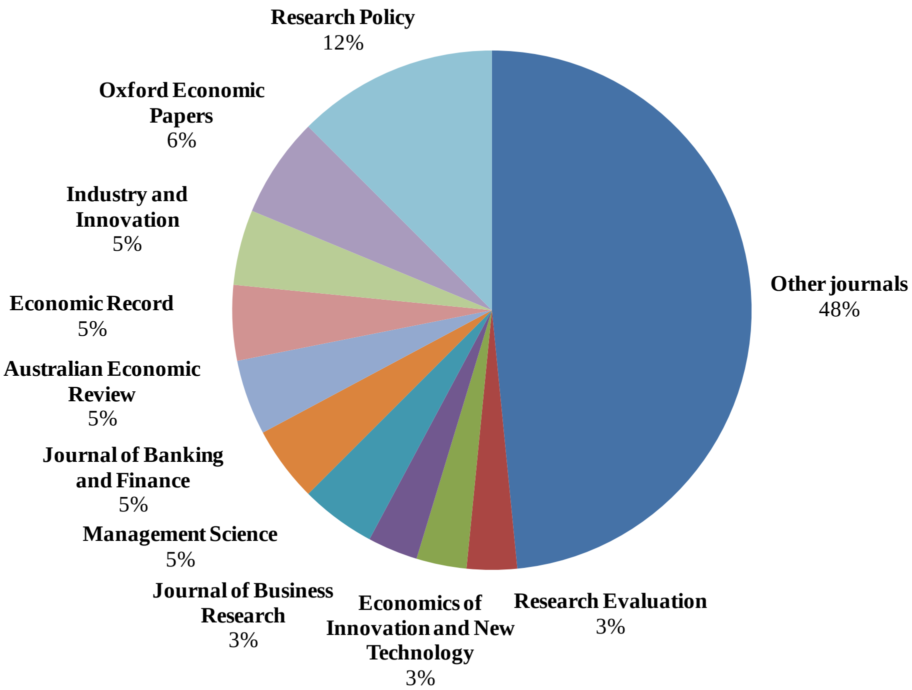
Figure 2.3 indicates that scholars had shown little interest in empirical trademark research before 2000s. Arguably, the earliest known study that utilised trademark statistics in a systematic way was the paper by Allegrezza and Guarda-Rauchs (1999), which attempted to identify the determinants of trademark filings and also explored a potential link between trademark activities and corporate innovation. Since then, there has been continuous growth in the use of trademark data that reached its maximum in 2012 when eight papers were published. There are many reasons behind this, including a significant effort directed by policymakers towards a better understanding of the impact that intellectual property has on economy and society (WIPO, 2013). The validity of this argument can be supported by looking at the recent proliferation of policy documents and reports touching upon trademark issues (see Table 2.A.6). Trademark analysis also seems to be a useful tool for studying non-technological innovation, such as business model innovation, marketing innovation, and innovation in services (Hipp and Grupp, 2005; Mendonça *et al.*, 2004). Finally, the greater attractiveness of trademarks for empirical researchers can further be attributed to substantial improvements in the availability of trademark statistics achieved by removing certain barriers previously limiting access to this type of information (Graham *et al.*, 2013).

Figure 2.3. The number of articles per publication year



Evidently, *Research Policy* comes out as the most popular outlet for academic studies that make use of trademark data (see Figure 2.4). This journal was, in fact, among the first leading social science journals that pointed to the value of trademark statistics for improving our knowledge of corporate innovation and intellectual property strategies. *Oxford Economic Papers* is the second most popular outlet, although this result is mainly due to a special issue published in 2013 and entirely dedicated to innovation and intellectual property topics. Other named journals have a fairly equal percentage share, having two-to-three trademark-related papers accepted for publication over the last two decades. In total, 41 journals have published at least one empirical trademark paper – such journal diversity may reflect the broader appeal of trademark statistics, including its general applicability to research in economics, business, and management. Moreover, the recent tendency among top-tier outlets across all major fields to accept articles utilising trademark analysis is likely to indicate that this empirical perspective has gained academic credibility, which is necessary to ensure and maintain a high quality of research.

Figure 2.4. The composition of articles by publishing journal



A number of useful insights can be drawn from the country emphasis in the selected publications. As it can be seen from Figure 2.5, the vast majority of the empirical trademark literature concentrates on developed economies, with studies confined to the U.S. institutional context currently dominating the research landscape. The fact that the U.S. has attracted so much scholarly attention is hardly surprising, given the size and importance of its market to the world economy, as well as the long and rich history of intellectual property protection in this country (Candelin-Palmqvist *et al.*, 2012). It should further be noted that the geographical dimension warrants special consideration because of its close relationship with the way in which intellectual property systems are governed. Our analysis particularly suggests that most of these works revolve around countries with the common law system (e.g., the U.S., the U.K., and Australia), while continental law countries (e.g., Germany, Benelux states, and Spain) tend to have a fairly small share. Finally, cross-country comparisons are also popular in trademark analysis – they are often related to an attempt to identify the determinants of trademark filings in different countries and examine the role of trademark protection in international trade.

Figure 2.5. The geographical scope of empirical trademark research

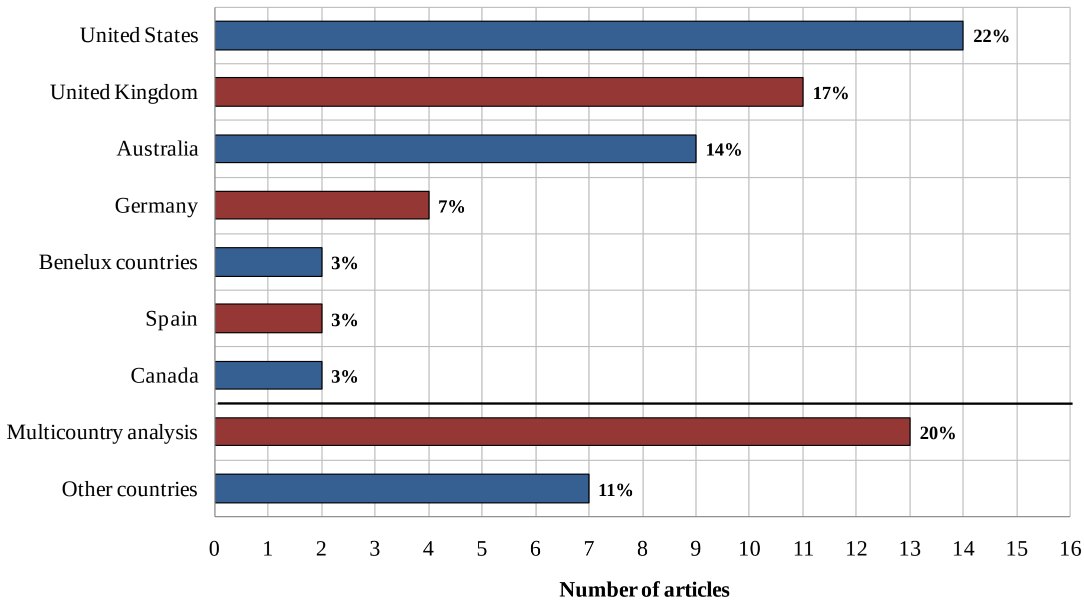
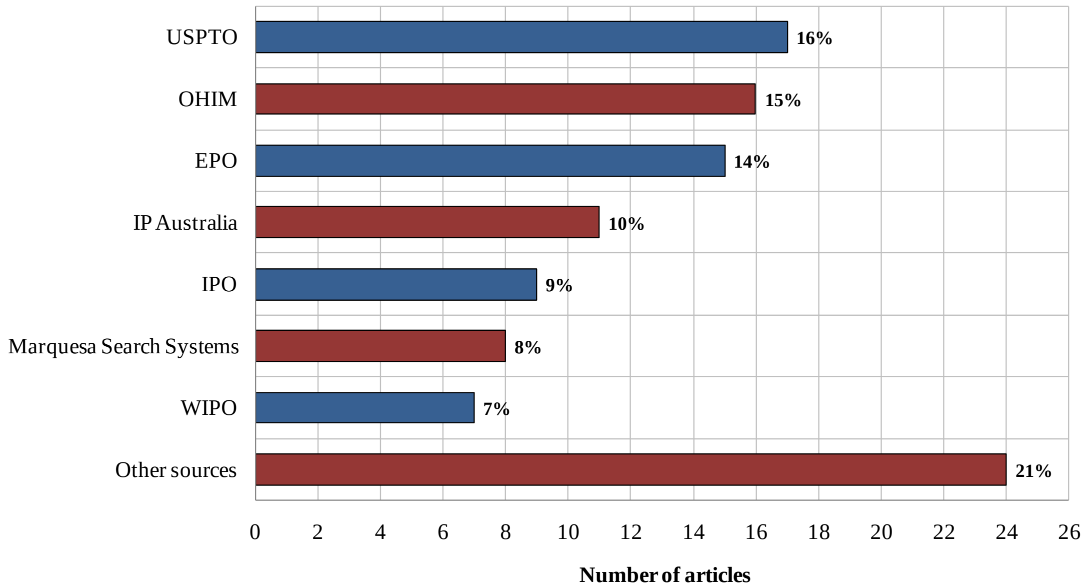


Figure 2.6 presents the key sources of trademark statistics. The results are largely consistent with what we have already observed for the geographical distribution of trademark studies, with the USPTO being the most popular provider of such information. Furthermore, there is a good reason to believe that the Office will maintain its leading position in the future, in part owing to the ongoing plan to continue disclosing intellectual property data in a form convenient for public access and academic research.[9] Another important supplier of trademark statistics to mention is IP Australia – the Australian government agency responsible for administering intellectual property rights. In this case, we

[9] It should be noted that the USPTO is legally responsible for the dissemination of intellectual property information to the general public (35 U.S.C. §2). In order to keep up with this task, the Office has recently introduced a new research agenda that aims to unveil the relationship between intellectual property and economic growth. As such, for the first time they have disclosed detailed administrative data regarding trademark examination, registration, and assignment processes (see Graham *et al.*, 2013; Marco *et al.*, 2014).

have a fine example of a productive collaboration between academia and the government sector because at least one of the authors of each paper that utilised trademark statistics from IP Australia pointed to their affiliation with the University of Melbourne, where the Agency established the Intellectual Property Research Institute of Australia in 2002. Finally, the need for cross-country comparisons has resulted in the use of the trademark statistics collected by supranational institutions, including the World Intellectual Property Organisation, the European Patent Office, and the Office for Harmonisation in the Internal Market. When taken together, their share in providing statistical information for empirical trademark research far exceeds 30%.

Figure 2.6. Major sources of trademark statistics



Note that since one article can draw on multiple sources of trademark information, the total number of articles here is higher than the total number of reviewed articles.

To date, the most cited article that employs trademark statistics is the work by Bosworth and Rogers (2001), which estimates the private returns from investing in intangible assets in Australia (see Table 2.2). Moreover, the performance perspective that includes such topics as market value, profitability, and firm survival, tends to be the most popular area in the empirical trademark literature, with six out of the top 10 publications addressing it in one or another way. Other highly cited articles make use of trademark statistics to capture corporate innovation and strategic activities. As for publishing journals, *Research Policy* clearly dominates the top 10 list, thus once again establishing itself as a major outlet for this type of work. And to conclude, we can also point to Australia as the most popular setting among the top cited papers; however, the time factor should be taken into account here because these are also one of the oldest papers in our sample.

Table 2.2. Top 10 most cited articles that use trademark statistics

Number of citations	Author(s)	Article name	Journal	Year
290	Bosworth, D.; Rogers, M.	Market value, R&D and intellectual property: An empirical analysis of large Australian firms	Economic Record	2001
251	Mendonça, S.; Pereira, T.S.; Godinho, M.M.	Trademarks as an indicator of innovation and industrial change	Research Policy	2004
204	Greenhalgh, C.; Rogers, M.	The value of innovation: The interaction of competition, R&D and IP	Research Policy	2006
202	Amara, N.; Landry, R.; Traoré, N.	Managing the protection of innovations in knowledge-intensive business services	Research Policy	2008
137	Sandner, P.G.; Block, J.	The market value of R&D, patents, and trademarks	Research Policy	2011
113	Krasnikov, A.; Mishra, S.; Orozco, D.	Evaluating the financial impact of branding using trademarks: A framework and empirical evidence	Journal of Marketing	2009
110	Schmoch, U.	Service marks as novel innovation indicator	Research Evaluation	2003
101	Feeny, S.; Rogers, M.	Innovation and performance: Benchmarking Australian firms	Australian Economic Review	2003
101	Buddelmeyer, H.; Jensen, P.H.; Webster, E.	Innovation and the determinants of company survival	Oxford Economic Papers	2010
96	Semadeni, M.; Anderson, B.S.	The follower's dilemma: Innovation and imitation in the professional services industry	Academy of Management Journal	2010

The number of citations for each article was retrieved from Google Scholar.

2.4. A REVIEW OF EMPIRICAL TRADEMARK RESEARCH

2.4.1. The determinants of trademark deposits

General background. In economic theory, a company's decision to file a trademark application is usually explained by referring to the cost-benefit analysis. That is, a trademark should be registered only if the expected value of its registration exceeds the opportunity cost of the registration procedure (Economides, 1988; Mendonça *et al.*, 2004). However, empirical trademark research suggests that such a decision goes far beyond mere cost-benefit considerations and largely depends on the interaction between external and internal environments. *External environment* is determined by different forces acting outside the company and their influence on the company's adaptation process. Its structure is complex and consists of several interrelated layers, including the industries and region in which the company operates; it may also extend across national borders and multiple jurisdictions. A practical impact of external environment on the company's propensity to trademark is likely to manifest itself in substantial discrepancies in trademark deposits among economic sectors, countries, and agglomerations of states. As for *internal environment*, it denotes the composition of managerial, organisational, and work practices that affect organisational functioning. A detailed analysis of these practices aims at revealing critical dimensions along which companies, even from the same industry, may still differ with respect to trademark activities they pursue. For example, the availability of financial resources can impose a constraint on the intensity of trademark applications, whereas the internal policy to ensure full-fledged protection of intangible capital – facilitate them.

The effect of external environment on trademark deposits

Literature review. According to Baroncelli *et al.* (2005), the distribution of trademark ownership among countries is uneven and tends to be highly skewed towards companies from advanced, market-based economies, which altogether account for the great majority of trademark registrations. To explain these disparities, the authors suggest considering the link between brand reputation and trademarking behaviour. As the argument goes, companies from developing countries are much more constrained in the ability to export products to foreign markets because their brands have not gained enough recognition among potential customers, mainly owing to the lack of information regarding product quality, past business practices, and commercial performance. This eventually leads to a poor visibility of such companies in international trade, with a negative effect on the number of trademarks they have to first introduce and then formally protect. Developing countries, in turn, may impose discriminatory measures against overseas applicants to reduce the competitive pressure foreign producers put on domestic companies, especially when the quality of products manufactured by local companies is similar to that of outsiders (Baroncelli *et al.*, 2007).

Mangàni (2006) extends the above findings by showing that recently, there has been a noticeable increase in the use of service marks. He argues that multiple factors can contribute to this dynamics, among which "[t]he structural change of economies, higher tradability of services, technological evolution, greater attention to product differentiation and processes of market liberalization and privatisation" are perceived to be the most relevant ones (Mangàni, 2006:257). His particular attention, however, is directed to the reduction of personal contacts between producers and consumers in the provision of services caused by technological developments: in this case, the heavy reliance on service marks may reflect an additional need for signalling the origin and quality to remote customers. Jensen and Webster (2004) make a similar observation about the growth of trademark activities in service sectors when analysing the recent trademark boom in Australia; yet, the authors are more inclined to associate it with substantial changes in the legislation, eventually permitting the registration of service marks. Furthermore, such factors as a shift in consumer demand for greater variety and quality, and the introduction of the Madrid Protocol that has affected trademarking in companies involved in international trade also deserve a special mention.

In contrast to some of the above findings, Herz and Mejer (2016) offer a much simpler explanation of the significant increase in national trademark applications observed over the past decades, at least when it comes to developed countries. Their analysis departs from the basic fact that "trademark filing fees have been steadily decreasing and converging across countries in Europe" (Herz and Mejer, 2016:1039). Using econometric techniques, they then calculate the sensitivity of trademarking behaviour to fee changes, which is equal to a 10.45% decrease in trademark applications following a 10% increase in the filing fee. Based on these estimations, they decompose the dynamics of trademark applications at 20 European offices over the last 20 years and conclude that it is largely driven by the fee adjustment process. It is worth additionally noting that their highest point estimate is potentially able to fully explain all the recently recorded increases in the number of trademark deposits.

Turning to the forces acting within an industry, Allegrezza and Guarda-Rauchs (1999) suggest that a company's propensity to trademark depends on market characteristics, such as the level of competitiveness, which effect is channelled via the monitoring of rivals' behaviour and especially of their ability to engage in product imitation. Similarly, Gallié and Legros (2012) demonstrate that the probability of using a trademark for the sake of protection varies and is greater for larger companies operating in more competitive markets. As for industry affiliation, their study indicates that companies in the manufacturing sector apply for fewer trademarks, unless they produce consumer goods. Based on an analysis of start-ups' decision on whether to file their initial intellectual property right in the form of a patent or trademark, De Vries *et al.* (2017) also come to the conclusion that industry factors matter. In particular, companies prioritise trademark protection when they face intense market competition or directly interact with final consumers. For such companies securing a unique selling position through trademark registration becomes part of the strategy for accessing the target market. The authors further report that receiving venture capital investment before the application date represents yet another reason for the decision to give preference to trademarks. Their interpretation of this association relies on the supposed willingness of venture capitalists to introduce a product in the marketplace as early as possible; hence, having a brand name legally protected seems to be essential before proceeding to the commercialisation stage.

The effect of internal environment on trademark deposits

Literature review. There are also a number of papers that attempt to detail intra-organisational factors influencing the extent of trademark activities. For example, Allegrezza and Guarda-Rauchs (1999) point to firm size, export orientation, and the attention of decision makers paid to trademark protection as one of the key factors that have a positive impact on trademark deposits. Jensen and Webster (2006), in turn, argue that firm size can well predict the intensity with which companies utilise various appropriability regimes. Among other things, their analysis shows that due to stronger innovation performance, small companies are more likely to apply for trademark protection than large corporations. Moreover, such companies tend to place a greater emphasis on intellectual property protection, including through trademark registrations, frequently owing to a lack of trust they have when transacting with external parties. To assess the extent to which the production process affects a firm's trademarking behaviour, Gao and Hitt (2012) propose to look at investments in information technologies. The conceptual framework they have developed is based on the assumption that technological advances can substantially lower the cost of offering greater product variety, with a corresponding effect on trademark applications and holdings. Their empirical analysis supports the idea that the amount of capital invested in information technologies has a positive relationship with the size of a firm's trademark portfolio; as for its relationship with trademark filings, it is also positive and potentially reflects an increased rate of new product introduction. To address the need for accurate accounting of intangibles, de Rassenfosse (2017) seeks to understand whether the level of investments in brand equity can be seen as a valid input measure of the demand for trademark rights. His analysis of 32 mostly developed countries reveals that advertising and market research expenditures have a significantly positive impact on trademark production.

Finally, a study by Block *et al.* (2015) is particularly interesting in this literature stream because it makes an early attempt to capture the complexity of motives behind a firm's decision to apply for a trademark. In doing so, the authors draw on survey data from 600 small and medium enterprises in innovative industries and derive three major trademarking motives – protection, marketing, and exchange. By using cluster analysis, these motives are then combined into four groups, depending on which one the firm chooses to prioritise: trademark sceptics; marketing-focused trademarking companies; marketing and protection-focused trademarking companies; and trademark advocates. Along with visible differences in trademarking behaviour existing across these groups, the authors also acknowledge the company's affiliation with the service sector, its reliance on innovation activities, external knowledge, and financial capital as further sources of group idiosyncrasies.

Other determinants of trademark deposits

Literature review. In addition to examining the determinants of trademark deposits in the private sector, there is new research entirely dedicated to trademark protection in academic institutions (see Squicciarini *et al.*, 2012). Focusing on 621 U.S. universities, this research demonstrates that the number of enrolled students, the share of graduate students, the presence of a medical school, the amount of federal funding, the private status, and the intensity of patent activities – all this is positively associated with the number of trademark applications; at the same time, higher concentration of universities in the state reduces the propensity of a focal university to register a trademark. In fact, it may well be that networking with academic institutions also facilitates trademark activities undertaken by private companies. According to Doh and Kim (2014), small and medium enterprises in South Korea tend to apply for more trademarks if they have an established relationship with universities, which may reflect, among other things, the importance of technological and financial support available to regional companies through this particular channel. Their analysis additionally suggests that the number of R&D personnel negatively affects trademark registrations, although the authors do not elaborate on this finding.

2.4.2. Trademarks and product differentiation

General background. The predominant function of a trademark is to distinguish goods and services of one party from those of another. In order to avoid consumer confusion, formal protection can thus be afforded only to those marks that efficiently perform the differentiation function. An important issue here refers to the extent to which trademark data capture, for example, the *quality dimension of product differentiation*. According to Landes and Posner (1987:270), "[t]he value of a trademark is the saving in [consumer] search costs made possible by the information or reputation that the trademark conveys or embodies about the brand". However, companies would have little incentive to invest in activities related to brand promotion, unless there was a legal guarantee that a third party would be limited in its ability to imitate the brand and, as such, free-ride on the brand owner's reputation, thereby destroying the informational capital carried by a trademark. So, formal protection coupled with significant reputation-building expenditures is likely to lead the producer to maintain the quality level of products because the alternative is to incur reputational damage. It can then be deduced that the higher is the value of a trademark, the stronger will be the company's incentive to protect it so as to avoid financial losses associated with its infringement. Against this background, one can predict that "high quality producers have greater incentives to deposit their trademarks in several markets, both at a national and international level" (Mangàni, 2007:618).

Product differentiation in international trade

Literature review. A few studies have utilised trademark statistics to analyse variety and quality patterns in international trade. Fink *et al.* (2005:96), for example, examine data on trademark activities in more than one hundred countries and reveal that "the number of newly registered trademarks depends on the worldwide volume of exports from the source country in a particular industry". Other factors that can potentially influence trademark filings include economic and linguistic proximities between countries participating in international trade as well as their membership in the Madrid Protocol. Overall, the authors conclude that "richer countries tend to import products of higher quality and greater brand differentiation", with the effect being more pronounced in consumer goods and trademark-intensive industries (Fink *et al.*, 2005:100). It should also be noted that the empirical strategy in this work is based on the assumption that a company's propensity to protect a trademark is associated with both product quality and the extent of brand differentiation. Fairly similar results were obtained by Mangàni (2007), who shows that trademark deposits are positively correlated with the size and wealth of an economy. Moreover, after decomposing the overall trademark entries into extensive, intensive, quantity, and quality margins, he reveals that country variations in trademark applications are mainly driven by differences in quantity within markets, while the quality effect turns out to be fairly negligible. Finally, a work by Baroncelli *et al.* (2007) looks at the discrimination against foreign trademark applicants as a potential barrier to imports. The starting point of this study is the observation that there are developing countries where the ratio of trademark registrations to applications is much higher for national applicants compared to foreigners. They then derive a theoretical model that attempts to explain these discrepancies by focusing on the product quality competition between domestic and foreign companies. Using the statistical analysis of trademark activities in China, Hong Kong, India, and South Africa, they find some signs of protectionist behaviour, especially in the situations when imported products are of similar quality to the ones produced locally.

Competitive positioning

Literature review. Several empirical papers have studied a company's competitive positioning vis-à-vis its rivals. More specifically, Semadeni (2006) focuses on service mark applications filed by management consulting companies in order to examine the competitive positioning of themselves as well as their service offerings. He reads through the description of each mark to determine its specialisation and innovation characteristics, which information is then used to calculate dyadic distances between mark pairs. His results suggest that companies attempt to differentiate themselves away from their immediate competitors, while still locating their services closer to similar services of other companies. Furthermore, positioning preferences very much depend on the age and size of a focal company: that is, older companies tend to reduce the competitive overlap with younger companies, which is in stark contrast to larger companies that prefer to enhance it. Another interesting observation this study has to offer is related to the positioning of prospective services – upon their introduction, all market players seek to establish an association with them. In a subsequent study, Semadeni and Anderson (2010) employ a similar analytical framework to assess a company's decision on whether to imitate or not a new offering, given environmental uncertainty and information asymmetries. Among multiple findings they present in this study, two are worth a special mention: on the one hand, the probability of imitation increases when the company perceives the innovating competitor as having the superior knowledge of the market; on the other hand, a highly innovative offering is less likely to be imitated because of the uncertainty and risks it is surrounded with. In turn, Crass and Schwiebacher (2017) argue that companies value trademark protection for its ability to reduce the likelihood of product substitution. Based on an analysis of the 2011 German Innovation Survey, they conclude that for service sector companies, the use of trademark protection per se is positively associated with a more product-differentiated environment. However, this effect is observed only when a company introduces product innovations which are new to the market, otherwise it fades away. The authors interpret these results in favour of the role of trademark protection in ensuring horizontal differentiation and enhancing the company's ability to appropriate rents from innovation activities. As for service sector companies that adopt imitation strategy, the portfolios of trademarks they have accumulated have a positive impact on the extent of product differentiation, thus suggesting differentiation through brand proliferation.

Historical studies of product differentiation

Literature review. There are a couple of works that employ trademark statistics to explore differentiation issues in a historical context. One of them is a paper by Llonch-Casanovas (2012) that examines the development of the Catalan knitwear industry over a period of 100 years. It particularly demonstrates that business location was among the most significant factors influencing a company's differentiation activities. When companies operated within industrial districts, with their atmosphere of rivalry and imitation, they had to facilitate differentiation by creating new brands and, hence, registering more trademarks. However, the survival of these brands very much depended on district characteristics, including the industrial structure and product specialisation as its key determinants. In turn, da Silva Lopes and Guimaraes (2014) look at the development of British dominance in light consumer goods industries over the period 1876-1914. Their analysis shows that technological and marketing innovations – originated either in the U.K. or abroad – laid a basis for the creation of sustained competitiveness in the selected industries; and the existence of intellectual property protection ensured that entrepreneurs were able to keep monopoly rents for subsequent years. Moreover, investing in new product development and branding allowed companies to expand their market share and to enjoy economies of scale, with trademark protection as a principal element in making this happen.

2.4.3. Trademarks as an indicator of innovation activities

General background. Unlike patents, trademarks should not necessarily be associated with a new good or service to warrant a registration, let alone to be introduced in the marketplace. Hence, the question arises: to what extent does trademarking behaviour correspond to innovation activities? To date, the literature has come up with two broad approaches to justifying the existence of the trademark-innovation link. The *theoretical method* appeals to the signalling function of a trademark (Landes and Posner, 1987) to argue that companies introduce new trademarks in order to increase consumer awareness of a new product variety in the marketplace. Following changes in consumer tastes, the producer may, for example, choose to design a new trademark for a newly developed product "that comes closer to the new tastes, while continuing to produce the old product" (Economides, 1988:530). However, with this argument alone, it is difficult to accurately assess the actual extent of the relationship in question, especially considering that companies may decide to leverage their existing brands – and, as such, acquired reputation – even for newly developed goods and services, thus causing fluctuations in the trademark flow regardless of innovation activities.

So, a possible alternative is to rely on the *empirical method* that employs correlation analysis and uses it along with widely accepted indicators of innovation, such as R&D expenditure or patenting, to see whether trademark statistics behave in a similar manner or not. The intuition here is that trademarks represent an output of the new product development process, which typically consists of research, development, and commercialisation phases (Jensen and Webster, 2009). Therefore, with an appropriate lag structure, the flow of trademarks is likely to match the level of preceding innovative activities in a company. Another variant of this method is to employ surveys and other available means to first distinguish innovative companies from the rest and then see if, on average, they introduce more trademarks. There are certain limitations associated with this method as well, including the fact that the actual introduction of a new trademark may not always coincide in time with filing a trademark application; and in services, companies rarely engage in patenting or extensive research activities, hence affording fewer opportunities for using correlation analysis.

The use of service marks and innovation in the service sector

Literature review. Allegrezza and Guarda-Rauchs (1999) are among the first who have presented empirical evidence regarding a potential link between innovation and trademark activities. They examine more than 2,500 small and medium enterprises in Benelux countries and come to a conclusion that a company's R&D expenditures are positively related to trademark deposits. Since then, considerable effort has been directed towards testing and verifying this link, especially in service sectors where the need to assess the extent of innovation activities seems to be particularly acute. For example, Schmoch (2003) places a special focus on service marks and shows that their use is significantly correlated with the share of turnover due to sales of new goods and services; as it turns out, the observed effect is much more pronounced in knowledge-intensive services. In another study, Schmoch and Gauch (2009) adopt an international perspective into the quantitative analysis of innovation activities by using trademark statistics. Among other things, they suggest that "the use of community trademarks proves to be insufficient for valid statistical analyses; international registrations combined with community trademarks should be used instead" (Schmoch and Gauch, 2009:323). In turn, Gotsch and Hipp (2012) demonstrate that although trademarks are generally a suitable indicator of innovation in knowledge-intensive services at large, their explanatory power is considerably greater for product innovations. This is broadly consistent with their subsequent study reporting that the protection of new goods and services is the most important motive for filing a trademark application (see Gotsch and Hipp, 2014).

Links to other indicators of innovation

Literature review. An analysis of trademark use by Portuguese companies performed by Mendonça *et al.* (2004:1401) extends the above findings further by revealing that "high-technology sectors, which use more patents, also make a more intensive use of trademarks", thereby pointing to an association between the two and, as such, the link of trademark filings to innovation activities. Similarly, Hall *et al.* (2013) demonstrate that a company's trademark activities are closely associated with patenting. Based on this and other results, they conclude that companies which are active in formal intellectual property protection attempt to exploit all the mechanisms available to ensure its full integrity. In addition, Hanel (2008) demonstrates that companies that have received R&D subsidies from the government are associated with more trademark applications; moreover, the use of patents and also trademarks seems to be mandatory for a successful innovation strategy. At the same time, after examining individual trademarks and their correspondence to new product launches, Malmberg (2005) shows that unlike the pharmaceutical industry where trademarks are tied to the number of new products, electromechanical and automotive sectors seem to be far less reliant on trademark activities when marketing innovative output. In turn, Gallié and Legros (2012) suggest that trademark applications are more likely in companies which are involved in the development of new production or distribution methods. To evaluate the relationship between innovation proxies, Jensen and Webster (2009) use both statistical and survey-based measures of innovation. Similar to other studies, they have identified a positive relationship between R&D expenditures and trademark filings, with the effect being especially pronounced in service sectors. What is perhaps more interesting is that trademarks perform well when it comes to capturing innovation activities in the manufacturing industry. This conclusion is based on the fact that companies directly classifying themselves as innovative are associated with more trademark deposits. Their analysis additionally suggests that trademarks are particularly better at capturing product and marketing innovations. By combining information on trademark registrations and new products announcements, Flikkema *et al.* (2014) also confirm that most trademarks refer to innovation activities. According to their results, of two trademark categories – related to service delivery innovation and to innovative offering, the latter group is likely to be combined with other intellectual property rights.

Overall, we can conclude that the absolute majority of studies have generally agreed on that trademark statistics should be seen as a valuable source of information about a company's innovation activities. However, the efficiency of this indicator very much depends on a number of different factors, among which industry characteristics tend to prevail. Another point to make regarding the measure efficiency is related to innovation type: being a predominantly consumer-directed instrument, trademarks therefore have a significantly higher potential for capturing the extent of product and marketing innovations than other types of innovation.

2.4.4. Trademarks and their strategic use

General background. When introducing a new trademark, the company usually attempts to address two sorts of issues. On the one hand, different trademarks owned by the same company can be somehow interrelated. This interrelation is likely to be rooted in the company's brand strategy, which has three generic types – corporate branding, a house of brands, and mixed branding (Rao *et al.*, 2004). Clearly, given the strategy type the company adopts, there will be variations not only in the number of newly introduced trademarks, but also in the potential costs and benefits that the chosen strategy brings to the company. On the other hand, trademark activities, especially when they follow the appropriation motive, can have a close association with other intellectual property rights. As Teece (1986) once famously suggested, a company's ability to profit from innovation over time largely depends on whether it can establish a prior position in complementarity assets as well as the characteristics of the appropriability regime in which it operates. From this perspective, the strategic use of trademarks may consist in pursuing value transference, with shifting "the advantages of technical or performance-based customer benefits (originally reserved in patents or copyrights) to trademarks" (Conley *et al.*, 2013).

Trademarks in relation to each other

Literature review. A pioneering, albeit not well cited, study by Sandner (2009:1257) argues that "[c]ompany trademark portfolios are not loose agglomerations of trademarks but, instead, contain complex structures that coherently protect a company's brand, which may extend across multiple products, product categories, and services". To identify these structures, which are referred to as trademark families, the author decomposes trademark portfolios of 2,289 companies by examining the characters, words, and syllables contained in each trademark. Overall, he reveals two strategic options a brand manager faces when introducing a new trademark – either to start a new brand or to continue developing the existing brand. Should the latter option be selected, there are further alternatives to decide on, including whether to cover a different facet of the existing brand (hedging); to update the existing brand so that it still maintains its differentiation potential (modernising); or to leverage information capital embodied in the existing brand (extending). In a subsequent work, Block *et al.* (2014b) use the above classification to assess financial implications of trademarking strategies. Their results suggest that there are clear differences in the valuation of trademark families by financial markets, namely: "[w]hile financial markets place a premium on brand-developing trademarks [...], they do not value brand-creating trademarks and hedging trademarking strategies" (Block *et al.*, 2014b:167). Furthermore, trademarking strategies that are based on brand modernisation or extension tend to have a positive impact on firm value, too. As the authors put it, advertising efficiency associated with brand extension increases the chances of a company to succeed with launching a new product or entering a new market; yet, brand modernisation is valued because of its role in maintaining the strength and attractiveness to consumers of the company's existing brands.

Another aspect of strategic trademarking refers to so-called trademark cluttering. According to von Graevenitz *et al.* (2012:5), "cluttered trade mark registers [... are] registers containing such a large number of unused or overly broad trade marks, that the costs of creating and registering new marks substantially increase for other applicants". It should be noted that there are many reasons, and they are not necessarily related to fraudulent or deceptive practices, why certain trademarking strategies cause the cluttering effect. For example, trademark applications may be filed in more product classes than needed; companies applying for more trademarks genuinely anticipate an extension of their product lines and, therefore, attempt to secure certain names associated with existing brands beforehand; as well as multiple trademark applications can also be due to name regulation in such industries as pharmaceuticals. As for the latter, von Graevenitz (2013) gives a detailed account of this phenomenon by using enlargement of the European Union as a natural experiment to examine the effect of cluttering on trademarking in the pharmaceutical sector. His results demonstrate that regulatory uncertainty may provoke a significant increase in companies' propensity to trademark invented names which they will unlikely to use. This behaviour is largely caused by the fear that some of these names may be rejected by the regulator to prevent medication error due to confusing or overly similar names in other jurisdictions, thus leaving companies with no registered trademarks at all. Additionally, he provides monetary estimates of the cost effect stemming from the surplus of invented names: his conservative assumption for the lower bound lies in the range between USD 21m and USD 49m per year. In turn, Fink *et al.* (2014:3) consider a sister concept to trademark cluttering – trademark squatting, which "describes a situation in which a company or individual registers a trademark that protects a good, service, or trading name of another company". This strategy is likely to be especially harmful for companies that operate across national borders because squatters can substantially delay their foreign market entry. What is perhaps more insightful in this respect is the strategic response companies develop to minimise or even avoid trademark squatting. Using data on trademark oppositions, Fink *et al.* (2014) show that, once having experienced squatting, brand owners inflate trademark filings by registering a disproportionately large number of new trademarks in areas which are not directly related to their current business activities.

Trademarks in relation to other intellectual property rights

Literature review. There are also several papers that point to the complementarity existing between trademarks and other appropriability regimes. Unlike prior research that pointed to the substitutability aspect of some protection mechanisms, Graham and Somaya (2006) attempt to verify the hypothesis that intellectual property rights actually complement each other. After examining patent, copyright, and trademark litigation statistics on the top 100 U.S. packaged software companies, they confirm that companies use trademarks and copyrights as complements. Furthermore, they also show that this effect is mainly driven by the attention paid by top managers to intellectual property issues as well as by organisational resources that can be utilised across different protection areas. A work by Munari and Santoni (2009) provides additional empirical evidence to support the complementarity hypothesis. Their analysis of 425 small and medium enterprises in Italy shows that companies tend to favour a joint use of patents and trademarks; moreover, those companies that complement patents with trademarks perform better than those without intellectual property rights. Amara *et al.* (2008) extend these findings further to the case of the joint use of formal and informal protection methods. Their analysis of 2,625 innovative service establishments in Canada demonstrates that "trademarks are complementary to patents, copyrights, and confidentiality agreements [..., while being] independent from secrecy, complexity of designs, and lead-time advantages" (Amara *et al.*, 2008:1541). They conclude that companies do not perceive intellectual property protection as a collection of isolated instruments; instead, corporate managers attempt to exploit synergies stemming from different protection methods to secure innovative output. Gallié and Legros (2012), in turn, demonstrate that trademark protection is negatively correlated with – or is a substitute to – each non-statutory method and especially with lead-time advantages. But what can influence the company's decision to complement one protection method with another? Using data on patent and trademark activities in French companies, a study by Llerena and Millot (2013) attempts to provide an answer. It identifies significant differences across economic sectors, namely: patents and trademarks complement each other in chemical and pharmaceutical sectors, while acting as substitutes in high-tech business sectors. The joint use of patents and trademarks is largely due to the advertising factor, with high advertising spillovers and a low advertising depreciation rate leading to patents and trademarks being used as complements.

Trademarks and entrepreneurial activities

Literature review. The use of trademarks is sometimes considered in relation to entrepreneurial activities. For example, a work by Lechner *et al.* (2016) suggests that vertical disintegration is likely to result in the separation of brands from upstream activities. As such, this may create entrepreneurial opportunities in terms of selling, acquiring, and reselling brands via market transactions. By looking at trademark assignments in the U.S. manufacturing sector, the authors confirm the above hypothesis as well as point to the positive relationship between the degree of vertical disintegration and the size of the market for brands. In turn, Goel *et al.* (2016) argue that formal and informal entrepreneurs can benefit from knowledge spillovers associated with intellectual property rights. Using trademarks to capture the flows of innovative, yet non-patentable knowledge, the authors demonstrate that an increase in trademark applications has a positive and statistically significant effect on formal entrepreneurship; however, the effect turns insignificant when informal entrepreneurs are focused on. It is also found that the spatial effect of trademark applications is negative, thus indicating that "neighboring trademarks are based on country-specific norms and traditions that generally do not transfer well across borders" (Goel *et al.*, 2016:306).

Trademark lifecycle

Literature review. There are studies that look at the trademark lifecycle and its determinants. By employing U.S. trademark statistics, Millot (2009) shows that the absolute majority of marks die six-to-seven years after the registration date simply because the owner fails to confirm that the trademark is still in commercial use. A large share of marks is then unable to survive the ten-to-eleven-year period when the owner is legally obliged to renew the mark registration. Against this background, Gao and Hitt (2012) argue that significant improvements in information technologies have resulted in more frequent updates in product lines. Therefore, companies with higher information technologies capital may actually be associated with a shorter trademark lifecycle. Using the Australia retail grocery industry as an exemplary setting, Jensen and Webster (2008), in turn, demonstrate that trademark age is positively related to consumer demand. However, this is effective only up to a point – if the company fails to keep up with investment in branding activities to match ever changing consumer preferences, a decline in consumer loyalty will result in inability to leverage it. A work by Melnyk *et al.* (2014) provides insights into what affects trademark prolongations. They examine 2,911 trademarks in the U.S. software security industry and come to a conclusion that larger and more innovative companies often terminate their trademarks earlier; at the same time, older companies are more likely to opt for the prolongation of a trademark. As for trademark characteristics, trademark age and the number of product classes in which it is registered both increase the probability of prolongation.

2.4.5. Trademarks and organisational performance

Market value gains from trademarking

General background. The strategic value of intangible resources consists in their ability to contribute towards sustaining a company's competitive position; given that, it needs to be accounted for and, ideally, also included in shareholders' funds (Hall, 1992). However, the question arises: what exactly can the source of such value be? As far as trademarks are concerned, their close association with the reputation of the underlying product or producer – and, as such, a significant power to influence consumer choice – seems to be a plausible answer (Landes and Posner, 1987). This power can be gained through advertising, product quality, servicing, and other methods which aim to first induce consumer loyalty and then transform it into higher sales and the willingness to pay a premium for the branded product, thereby allowing the company to obtain greater profits (Chamberlin, 1933). Although most of the mark's value is inseparable from the product to which it is affixed, some trademarks can have value of their own and, hence, should themselves be seen as a legitimate good (Economides, 1988; Landes and Posner, 1987). It is also true that the value of a trademark exists as long as there is some sort of formal protection; if not, competitors will have a strong incentive to imitate the trademark and, by deliberately provoking consumer confusion, appropriate some of the benefits associated with it (Landes and Posner, 1987).

A commonly used approach to estimating the private returns to trademark activities is based on linking the valuation placed by the financial market on a company's total assets to its trademark applications or holdings (Bosworth and Rogers, 2001; Hall, 1999). As the argument goes, when determining the company's value, financial markets consider not only the tangible assets that appear on its balance sheet, but also intangible assets, such as R&D expenditures, patents, and trademarks. Therefore, the following valuation function can be specified (Griliches, 1981):

$$V = q \cdot (A + K)^{\sigma},$$

where V is the current market value of the company; A is the current value of tangible assets (on the balance sheet); K is the current value of intangible, or knowledge, assets (off the balance sheet); q is the current market valuation coefficient of the company's assets that reflects its differential risk and monopoly position; and σ is a coefficient that reflects the possibility of non-constant returns to scale. If trademarks are treated as an asset that is symmetrical to other knowledge assets then their value can be incorporated in the formula simply by augmenting K with it (Sandner and Block, 2011).

Literature review (see Table 2.3 for a summary of the results). In the paper by Bosworth and Rogers (2001), the authors apply the above method to estimate returns to innovation activities in large Australian companies. This work is among the first that looks beyond R&D spending and patents, and also points to trademarks and designs as an additional source of the company's market value. Despite a solid theoretical grounding, the results obtained by the authors are fairly ambiguous: that is, they are unable to find any statistically significant evidence to support the argument that the intensity of trademark applications influences market value if the full sample is considered. At the same time, a positive association between trademark activities and market value emerges when the sample is limited to non-manufacturing companies. Furthermore, the authors' estimates suggest that "a trade mark application has a private value of less than half that of a patent application" (Bosworth and Rogers, 2001:331), but without knowing the cost structure on which each of these instruments relies, no definitive conclusion can be made regarding their overall value efficiency. Similar findings are demonstrated by Feeny and Rogers (2003) when they construct an index to compare the innovation potential of Australian companies. In order to obtain the weight for each intangible asset and then use it to aggregate the assets into a single index, the authors measure the average impact of R&D expenditures, patents, trademarks, and designs, on the company's market value. As before, they reveal that the economic effect of trademark intensity is not statistically different from zero.

Greenhalgh and Rogers (2006a) conduct a more detail investigation of sectoral disparities observed in the market valuation of trademark activities. Using U.K. intellectual property statistics, they come to a conclusion that a more intensive use of trademarks in service sectors yields a higher stock market premium. And this result stands in stark contrast to transport, communication, utilities, and manufacturing industries – even though the popularity of trademarks there is still high, they have no sizable impact on the value that the financial market places on companies in these sectors. In turn, a study by Greenhalgh and Rogers (2006b) examines returns to innovation activities in U.K. companies that belong to Pavitt technological sectors. Their findings indicate that the intensity of trademark applications positively affects market valuation across all Pavitt sectors, except for the information intensive sector where this effect turns out to be negative. They also mention that for the full sample, "higher market share boosts the stock market's valuation of trade marking, but within the Pavitt sectors there are some that follow this result [...], whereas others have the converse relationship" (Greenhalgh and Rogers, 2006b:576-577). Finally, Greenhalgh and Rogers (2012) corroborate these results by revealing a greater influence that trademark activities in the past period have on the current market value, with service sector companies enjoying a much large effect than those operating in the manufacturing sector. As for trademark intensity in a given year, its relationship with market value is curvilinear, which effectively implies diminishing returns from adding an extra trademark to the existing portfolio. The authors additionally report that a higher level of trademark intensity in the industry tends to boost the focal company's market value, albeit this rule does not apply to service sectors. It seems that such an industry effect is associated with both an increasing pressure for laggards to innovate, as they face a significant risk of losing their market share, and the optimism with which investors evaluate the ability of those companies to close the gap with more innovative competitors.

A more careful explication of how a rival's product innovation and new advertising may affect the focal company's market value is offered by Fosfuri and Giarratana (2009). Their research is particular concerned with the competition between Pepsi and Coca-Cola in the carbonated soft drink market over the period 1999-2003. They rely on new product announcements to measure product innovation, whereas new advertising is proxied by the number of trademark filings. First of all, their results are generally in line with past findings pointing to the positive impact a company's innovation and trademark activities have on its valuation by the financial market. What is perhaps more interesting is that a new trademark filed by a rival also increases the capitalisation of the focal company. As the authors put it, new advertising tends to attract new customers and, as such, boosts total demand, whereas the distribution of market shares stays unaffected. By contrast, a new product released by a rival reduces the market value of the focal company because product innovation triggers the reallocation of market shares in favour of the innovator.

In turn, Sandner and Block (2011) approach the valuation problem from a slightly different end. They particularly argue that trademarks are not homogeneous and can be distinguished with respect to their own value; as such, these differences have to be accounted for when assessing returns to trademark activities. The authors come up with four indicators that are potentially capable of capturing trademark value, namely: (1) trademark breadth, or the number of product classes covered by a mark; (2) trademark seniority, or the number of marks registered in other jurisdictions; (3) trademark oppositions brought by an applicant; and (4) trademark oppositions received by an applicant. Overall, their multi-country analysis reveals that financial markets assign a higher value to companies with larger trademark portfolios. However, when a trademark's own value is considered, higher returns are associated with more senior trademarks as well as those trademarks for which the owner filed an opposition against another company. The authors thus conclude that "[b]y filing an own trademark or an opposition against a rival's trademark, firms show to the financial markets that they are eager to protect their marketing investments [..., and stock] markets seem to value such activity" (Sandner and Block, 2011:983).

Another research that deserves a special mention is a study by Krasnikov *et al.* (2009), where the authors make an early attempt to understand the extent to which financial returns to trademark activities may depend on the brand strategy associated with each trademark. The authors come up with a classification according to which trademarks are different in their aim to enhance either consumer awareness of or association with the underlying brand. As the argument goes, the former group of trademarks is valued because it enables the company to distinguish itself from other competing brands, whereas the latter – because it helps the company to manipulate its consumers' brand-related attitudes. Their analysis of 108 U.S. companies from 14 industries suggests that the existing stock of brand-association trademarks increases the company's future Tobin's q and stock returns. At the same time, the stock of brand-identification trademarks built up by the company during the previous period is found to significantly reduce the current positive impact of brand-association trademarks on Tobin's q and stock returns. According to the authors, a possible explanation for such a negative effect is that "the brand-awareness efforts of firms attract more individual investors to their stocks, thereby attenuating the stock returns and Tobin's q value of such firms" (Krasnikov *et al.*, 2009:163).

Trademarks are also shown to be a useful signalling mechanism that companies can employ in their communication with potential investors, especially in situations with high uncertainty and large information asymmetries. For example, Block *et al.* (2014a:540) examine trademark activities in U.S. start-up companies and come to a conclusion that "[t]he number of trademarks and the breadth of their applications [...] provide additional information regarding the scope and direction of start-ups' marketing strategies". So, when making their investment decisions, venture capitalists include this information into the final valuation of a start-up. However, the strength of the signalling effect declines over the venture cycle: as soon as more tangible information about the start-up's operation becomes available, venture capitalists prefer instead to rely on it for guiding their further investment strategy. In a subsequent work, Zhou *et al.* (2016) demonstrate that combining trademarks with patents can help start-ups to attract a larger amount of venture capital than when just one of these instruments is used. The reason behind such a synergistic effect is that along with the enhanced protection of intellectual property, having both patents and trademarks registered also indicates the start-up's innovation potential and its firm intention to proceed with the commercialisation of a new product. As in the prior study, the signalling effect appears to influence venture capitalists' decision making inasmuch as no other valuable information is available, and tends to fade away in later funding rounds.

Finally, there are two studies that provide insights into the market valuation of trademark activities in specific industries. To start with, there is a work by González-Pedraz and Mayordomo (2012) that makes an attempt to estimate financial returns to trademarking in the U.S. commercial banking sector. Among other things, the authors report a lower value assigned by the financial market to banks with a diverse trademark portfolio. Moreover, banks that maintain a stock of relatively young trademarks tend to be valued higher and are likely to improve their valuation further if decide to substitute older trademarks with younger ones. The event analysis they also conducted reveals abnormal returns or losses around the date when a trademark is introduced or cancelled, respectively. In turn, Aksoy-Yurdagul (2015) addresses the problem of value appropriation existing in the open-source software sector. He points out that a company's ability to reap financial benefits associated with commercialising open-source products very much depends on its stock of software patents and trademarks. Using data on 70 largest software producers, he shows that a larger stock of software trademarks has a negative effect on the relationship between the company's open-source product portfolio and market value. This outcome is consistent with his initial hypothesis that developing a strong software brand may not be fully compatible with the open-source business model because investing in related marketing activities is unlikely to result in higher cash flows in the future and, if pursued, will be viewed by the financial market in negative light.

Productivity gains from trademarking

General background. Another commonly used approach to quantifying economic returns to trademark activities is by linking them to total factor productivity (Hall, 1999). According to Duygun *et al.* (2016), the rationale behind this relationship is largely based on the ability of a trademark to stimulate consumer demand. In turn, the company can respond to an increase in demand by selecting one of the following options: first of all, it may choose to use up some of its excess capacity and, by doing this, improve operational efficiency. If there is no spare capacity left, the company may decide to expand inputs – this is likely to increase the scale of production, with a corresponding effect on the returns to scale. Finally, the company may also adopt a new technology that enables it to produce more output, while keeping inputs at the same or even lower level. Duygun *et al.* (2016:S71) note that the "relationship between trademarking activity, technical change and eventually TFP growth can be particularly relevant to firms which tend to invest more in the development of innovative production technologies and therefore tend to be the technological leaders in their industry". Overall, these actions will ultimately lead to the growth in total factor productivity.

Table 2.3. A summary of the results on market value gains from trademarking

Paper	Country	Dependent variable	Trademark-based measure	Effect range	Significance level
Bosworth and Rogers (2001)	Australia	Log of market value	Trademarks/ tangible assets	0.605-0.786	N.S.
Feeny and Rogers (2003)	Australia	Log of market value	Trademarks/ tangible assets	0.942-1.132	N.S.
Greenhalgh and Rogers (2006b)	U.K.	Log of market value	Trademarks/ total assets	0.073 *(for full sample)*	N.S.
Fosfuri and Giarratana (2009)	U.S.	Tobin's q	Number of trademarks	Rival: 0.576 Firm: 3.244	Rival: 5% Firm: 5%
		Market share	Number of trademarks	Rival: 0.726 Firm: 0.614	Rival: N.S. Firm: N.S.
		Total demand	Number of trademarks	Rival: 0.015-0.022 Firm: 0.064-1.783	Rival: 5% Firm: 5%
Krasnikov *et al.* (2009)*	U.S.	Tobin's q	Stock of trademarks	BI: 0.007 BI*BA: -0.0001	BI: 5% BI*BA: 5%
		Stock returns	Stock of trademarks	BI: 0.003 BI*BA: -0.0001	BI: 5% BI*BA: 5%
Sandner and Block (2011)	Multiple countries	Tobin's q	Trademark stock/ marketing assets	11.368-13.504	1%
González-Pedraz and Mayordomo (2012)	U.S.	Tobin's q	Trademark stock/ total employees	Linear: -10.417 Quad.: 627.764	Linear: 1% Quad.: 10%
Greenhalgh and Rogers (2012)**	U.K.	Log of market value/ tangible assets	Trademark dummy	UM: 0.221 CM: 0.316 UM+CM: 0.396 *(for full sample)*	UM: 1% CM: 1% UM+CM: 1%
			Trademarks/ tangible assets	UM: 0.049 CM: 0.006 *(for full sample)*	UM: N.S. CM: N.S.
Block *et al.* (2014a)	U.S.	Log of start-up valuation	Number of trademarks	Dummy: 0.223 Linear: 0.033 Quad.: -0.0001	Dummy: 1% Linear: 1% Quad.: 1%
			Number of trademark classes	Linear: 0.165 Quad.: -0.015	Linear: 1% Quad.: 1%
Aksoy-Yurdagul (2015)	Fortune Global 500	Tobin's q	Stock of trademarks	0.027	N.S.
Zhou *et al.* (2016)***	U.S.	Log of amount of VC funding	Trademark dummy	AR: 0.238 IR: 0.118 LR: 0.413	AR: 5% IR: N.S. LR: 10%

* BI refers to brand-identification trademarks; BA refers to brand-awareness trademarks. ** UM refers to UK trademarks; CM refers to community trademarks. *** AR refers to all funding rounds; IR refers to the initial funding round; LR refers to the later funding round. N.S. stands for "not significant".

In order to estimate the effect of productivity gains due to trademarking on the company's total output, the Cobb-Douglas production function can be utilised (see Greenhalgh and Rogers, 2012):

$$Y = A \cdot L^{\alpha} \cdot K^{\beta},$$

where Y is total output; L is the stock of labour; K is the stock of tangible capital; A is total factor productivity; and α and β are the output elasticities of labour and capital, respectively. Then the effect of trademarks as well as other intangible assets can be incorporated as follows:

$$A = f(R, P, HK, IT, TM),$$

where A is total factor productivity; R is the stock of R&D expenditures; P is the stock of patents; HK is the stock of human capital; IT is the stock of information technology; and TM is the stock of trademarks. Greenhalgh and Longland (2005) show that the stock measures of R&D expenditures, patents, and trademarks can be replaced with flow measures when the rate of depreciation is very high.

Literature review (see Table 2.4 for a summary of the results). Turning to empirical studies, a work by Greenhalgh and Longland (2005) demonstrates that the intensity of trademark applications has a positive effect on the company's net output. However, this effect is mainly driven by low-tech companies, whereas there is no direct evidence of productivity gains from trademark activities in the high-tech sector. Along with short-lived benefits of intellectual property protection, this may also indicate that "firms, especially those in the most dynamic sectors, have to keep innovating in order to preserve their productivity ranking in relation to their competitors" (Greenhalgh and Longland, 2005:308). Similarly, a study by Greenhalgh and Rogers (2012) reveals that companies can enjoy a large value-added premium at present if they applied for a trademark in the past period, with the effect being generally higher for companies in the service sector. Moreover, the authors also report a strongly non-linear effect of trademark intensity on value added; taking into account a similar pattern for market value, they conclude that "stock markets are well informed about the gains to firms from their trade mark activity" (Greenhalgh and Rogers, 2012:65). Finally, it appears that the dynamism of trademark activities in an industry has a detrimental impact on the focal company's value added, which may be associated with a Schumpeterian competition through innovation.

Unlike the above cross-sectoral studies, Duygun *et al.* (2016) focus on the effect of trademark activities on the productivity of commercial banks in the U.K. Their analysis is based on a metafrontier framework that, among other things, allows the authors to decompose total factor productivity growth into "changes of efficiency, technical change and scale change for each group of commercial banks as well as the whole sector" (Duygun *et al.*, 2016:S78). Their results reveal substantial differences between trademarking and non-trademarking banks in terms of their overall productivity and the factors that underpin it. That is, before the 2007-2009 financial crisis the productivity growth in trademarking banks was mainly supported by changes in technical efficiency; however, the technological progress took place only in a small number of such banks, while other trademarking banks were unable to catch up with the metafrontier. At the same time, the trend clearly reversed in 2009, with the productivity growth in trademarking banks being now negative. The authors explain the observed effect by a dramatic reduction in lending, which has also pushed some banks to revisit their scale efficiency. By contrast, the productivity of non-trademarking banks showed no signs of significant growth in the pre-crisis period and started improving just after the crisis' most cute phase. It seems that having exploited the major gains associated with the scale efficiency model, these banks have eventually turned their attention to new technologies as a source of productivity growth.

Table 2.4. A summary of the results on productivity gains from trademarking

Paper	Country	Dependent variable	Trademark-based measure	Effect range	Significance level
Greenhalgh and Longland (2005)	U.K.	Log of added value	Trademark stock/ total employees	2.540-4.200 *(for full sample)*	10%
Greenhalgh and Rogers (2012)*	U.K.	Log of added value	Trademark dummy	UM: 0.107 CM: 0.083 UM+CM: 0.274 *(for full sample)*	UM: 1% CM: 5% UM+CM: 1%
			Trademarks/ tangible assets	UM: 0.246 CM: -0.009 *(for full sample)*	UM: N.S. CM: N.S.

* UM refers to UK trademarks; CM refers to community trademarks. N.S. stands for "not significant".

Profitability gains from trademarking

General background. There are three perspectives from which the association of trademark activities with a company's profitability can be considered. First of all, by differentiating its product offering from that of competitors, a company may induce brand loyalty and, under certain conditions, charge customers a price premium for its goods and services (Chamberlin, 1933; Landes and Posner, 1987). Along with customer-related effects, trademark activities are also likely to influence the competitive regime existing in the marketplace: for example, they are often used to create barriers to market entry, which, in turn, are expected to lead to higher industry concentration (Bain, 1956). And as practice shows, the chances are that in more concentrated industries, incumbents will eventually adhere to collusive behaviour, with collusive prices and abnormal profits as its most notable manifestations (Griffith *et al.*, 2011). Finally, there is a perspective that looks at trademarks in terms of their presumed link to the new product development process (Duygun *et al.*, 2013; Greenhalgh and Rogers, 2012). Provided that the link holds, trademarks can then be employed to measure the effect of the Schumpeterian competition on a company's cost and profit efficiency because it is believed that such a competitive regime facilitates constant revisions of production methods in order to improve the overall firm performance.

Literature review (see Table 2.5 for a summary of the results). While trying to understand what may cause abnormal profits to emerge and persist over time, Griffith *et al.* (2011) suggest focusing on intangible resources: they particularly argue that along with tangible capital, these resources should also be accounted for to obtain more accurate profit estimates. The analysis they conducted by using Australian intellectual property statistics indicates that patent and trademark stocks have a positive and significant impact on a company's profit earning potential, thus supporting the authors' original idea regarding the need for the intangible capital-adjusted measure of profits. At the same time, neither patents nor marketing practices and branding seem to be important for explaining abnormal profits as those are mainly driven by industry collusion and a company's abuse of its market power. Similarly, Krasnikov *et al.* (2009) demonstrate that the existing stock of brand-association trademarks has a positive effect on future return on assets. Future cash flows are also shown to be positively influenced, including a substantial reduction in their variability. In turn, a study by Marco-Lajara *et al.* (2016:4560) draws specific attention to the role of trademarks in ensuring profitability in the hotel industry, which is largely due to their tight association with hotel reputation.

Additionally, there is a series of studies that evaluate profitability gains from trademark activities in the banking sector. In their first work, Duygun *et al.* (2013) approach the profit efficiency problem by looking at how banks compete through product innovation, which, as they argue, has been of not lesser importance for bank profitability than price competition. Their results generally confirm the idea that trademarking banks are more profit efficient compared to non-trademarking ones. However, the relationship between the industry-wide trademark intensity and a bank's profit efficiency is shown to be curvilinear. That is, launching a new product by one bank is likely to increase cost inefficiencies in the sector as it challenges the market shares of other banks. The downward pressure on profit efficiency caused by cost revisions will, in turn, subside only with an increase in industry competition. In a subsequent study, Duygun *et al.* (2014:507) reveal that trademarking and non-trademarking banks share the same cost and profit frontier, "although there exists some circumstantial evidence that the assumption of a common alternative profit frontier may be rejected for the period before 2008". They also re-confirm that trademarking banks are more profit efficient, although there is a group of banks that have a potential to benefit from trademark activities but cannot do it, presumably due to a lack of innovation activities.

Table 2.5. A summary of the results on profitability gains from trademarking

Paper	Country	Dependent variable	Trademark-based measure	Effect range	Significance level
Krasnikov *et al.* (2009)*	U.S.	Cash flows	Stock of trademarks	BI: 7.820 BI*BA: 0.019	BI: 5% BI*BA: 5%
		Cash flow variability	Stock of trademarks	BI: -0.044 BI*BA: 0.001	BI: 5% BI*BA: N.S.
		Return on assets	Stock of trademarks	BI: 0.051 BI*BA: -0.0004	BI: 5% BI*BA: N.S.
Griffiths *et al.* (2011)	Australia	Gross profit	Stock of trademarks (days)	0.070	10%
Marco-Lajara *et al.* (2016)	Spain	Operating income/roo m	Trademark dummy	0.005	1%

* BI denotes brand-identification trademarks; BA denotes brand-awareness trademarks. N.S. stands for "not significant".

The impact of trademark activities on firm survival

General background. According to Schumpeter (1943:84), innovation is among the chief reasons for why companies survive as it "strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives". An economic explanation for the existence of the exposed relationship often refers to the fact that in order to survive, a company needs to achieve the minimum efficiency scale, of course, provided that scale economies play a crucial role in the company's ability to compete in the market (Audretsch, 1991). One way to do this is by fostering innovative activities that stimulate company growth and, eventually, result in attaining the necessary level of production. As Audretsch (1991:444) puts it, "[t]hose firms which successfully innovate can expect future sales growth, while those that face only dim prospects of innovating are more likely to exit from the industry". Incumbent companies, in turn, have to continuously innovate because it reduces the threat of disruption emerging technologies may bring about (Cefis and Marsili, 2005). However, it needs to be remembered that innovation activities are inherently risky and may themselves become a source of financial distress and then market exit (Buddelmeyer *et al.*, 2010). The diversification of product-market portfolio is another way for the company to increase its chances of survival (Srinivasan *et al.*, 2008). When serving several industries, the company may not only hedge its exposure to demand shocks in a particular product market, but also benefit from economies of scale in marketing activities.

At the same time, Srinivasan *et al.* (2008) continue, lower riskiness and the existing access to multiple markets can increase the company's visibility to potential acquirers.

Literature review. To investigate differences in survival patterns between new and incumbent companies in Australia, Jensen *et al.* (2008) choose to concentrate on patent and trademark applications – these are used to proxy high and low-risk innovation, respectively. As expected, the analysis largely supports the proposition that innovation activities can significantly increase the probability of firm survival. In more specific terms, trademark applications are shown to be positively associated with the likelihood that the company stays in the market, regardless of whether a new or incumbent company is being considered. A similar effect is observed for trademark holdings; yet, its magnitude for new firms is twice as large, thereby suggesting that "low-risk innovation capital is more important for new firms than incumbents" (Jensen *et al.*, 2008:443). In a subsequent work, Buddelmeyer *et al.* (2010) argue that failing to account for the degree of uncertainty pertaining to each innovation measure is likely to preclude researchers from fully capturing firm survival patterns. Having this in mind, their results are still highly consistent with what was discussed before and demonstrate that the hazard rate is significantly lower for companies that file more trademark applications as well as hold larger trademark portfolios. Recognising that trademarking mainly reflects new-to-the-company innovations, the authors conclude that "the innovative activity associated with the launch of a trade mark is less risky than radically innovative activity" captured by a patent (Buddelmeyer *et al.*, 2010:281). Finally, Helmers and Rogers (2010) generally confirm prior findings when looking at a cohort of almost 162,000 British companies. Their study reveals that patent and trademark activities increase the chances of a new company to survive in the market. They also show that survival is more difficult for companies that operate in trademark-intensive industries, which may indicate the importance of product differentiation for maintaining the competitive edge in such sectors.

In turn, Srinivasan *et al.* (2008) make an attempt to relate the survival chances of new companies in the U.S. high-tech industry to the diversity of their product-market portfolios. Unlike previous research, these authors focus on different options a company may face when leaving the market, including dissolution or acquisition. Furthermore, they also examine if the use of strategic resources – in this case, patents and trademarks – together with product-market diversification can enhance the company's fit with the external environment and, as such, affect its survival. The general conclusion to draw from their analysis is that "the diversity of product-market portfolio, itself, confers no advantage or disadvantage to a new high tech firm. Rather, it is important for the firm to align its product-market strategies with the appropriate assets [...] to improve its chances of survival or acquisition" (Srinivasan *et al.*, 2008). For example, no matter what exit option the company is subject to, having more trademarks enables it to survive for a longer period. This outcome supports the role of trademarks, and marketing assets in general, in improving the level and speed of cash flows, as well as highlights their potential ability to signal the company's growth strategy and, therefore, attitude towards acquisition. When a diverse product-market portfolio is matched by a larger number of trademarks, the company's exit by dissolution tends to be still delayed, while its exit by acquisition – hastened. The latter effect may suggest that such companies are perceived by rivals as a desirable target to take over.

Finally, Huang *et al.* (2013) look at the survival problem from a somewhat different perspective. More specifically, the authors try to understand how companies that decide to enter markets complementary to a proprietary platform can keep their returns to innovation from being appropriated by the platform owner. They focus on two types of protection mechanisms: on the one hand, intellectual property rights, such as patents and copyrights; and on the other hand, downstream capabilities – those are proxied by trademarks and consulting services. The results of their analysis suggest that an independent software vendor with a larger stock of intellectual property rights as well as with stronger downstream capabilities is more likely to join the partnership with a software platform provider. Furthermore, weaker the vendor's downstream capabilities are, stronger the influence of intellectual property rights on the probability of partnership is. Overall, the authors conclude that "[p]latforms will be less likely to grow in settings with little formal means of IP protection and, in particular, where patent and copyright protection is weak. They will be relatively more successful when [... independent vendors] are more effectively able to secure returns from their innovations through patents, copyrights, and downstream capabilities" (Huang *et al.*, 2013:119).

Other performance-related implications of trademarking

Literature review. In addition, a few studies were identified that did not fully fit any of the above categories but still contained some valuable insights regarding performance implications of trademark activities. For example, Helmers and Rogers (2011) examine high- and medium-tech start-ups in the U.K. and report that the decision to apply for a trademark is associated with subsequent asset growth. They interpret this finding as evidence that "trade-marking firms are better at marketing their innovations which directly translates into higher growth" (Helmers and Rogers, 2011:1024). An analysis of small and medium enterprises operating in the Italian fashion industry conducted by Agostini *et al.* (2015), in turn, reveals that corporate trademarks have a positive and significant effect on sales performance. This effect tends to be persistent over time, with the benefits of trademark activities lasting for up to three years from the moment of registration. Interestingly, they find no contribution of product trademarks to the sales performance of a company. Such result seems to be consistent with the idea of a shorter product lifecycle in the fashion industry and, hence, a greater effort that needs to be directed at building a strong corporate brand rather than many product brands.

Trademarks are also found to have a strong impact on wages and income. Greenhalgh and Longland (2001) demonstrate that registering a new trademark is one of the key determinants of wage rises; however, there is a three-year lag before the actual effect can be observed. The authors argue that improvements in long-term profitability largely depend on the ability of a company to innovate and capture the resulting returns. So, upon the successful market introduction of a new product, which can be deduced by scrutinising trademark activities, some excess profit stemming from its sales is expected to be shared with employees through the process of wage bargaining. A work by Azomahoua and Diene (2012) considers trademarks in terms of their potential to capture certain types of innovation, especially in developing countries where other intellectual property instruments can be less accessible. Among other things, their findings show that income polarisation in African countries is significantly affected by innovation activities, but the effect very much depends on innovation origin and type. That is, they report a stronger impact on income polarisation of trademarks compared to patents when innovation is originated in the home country, while the opposite is true for non-resident innovation.

2.5. DIRECTIONS FOR FUTURE RESEARCH

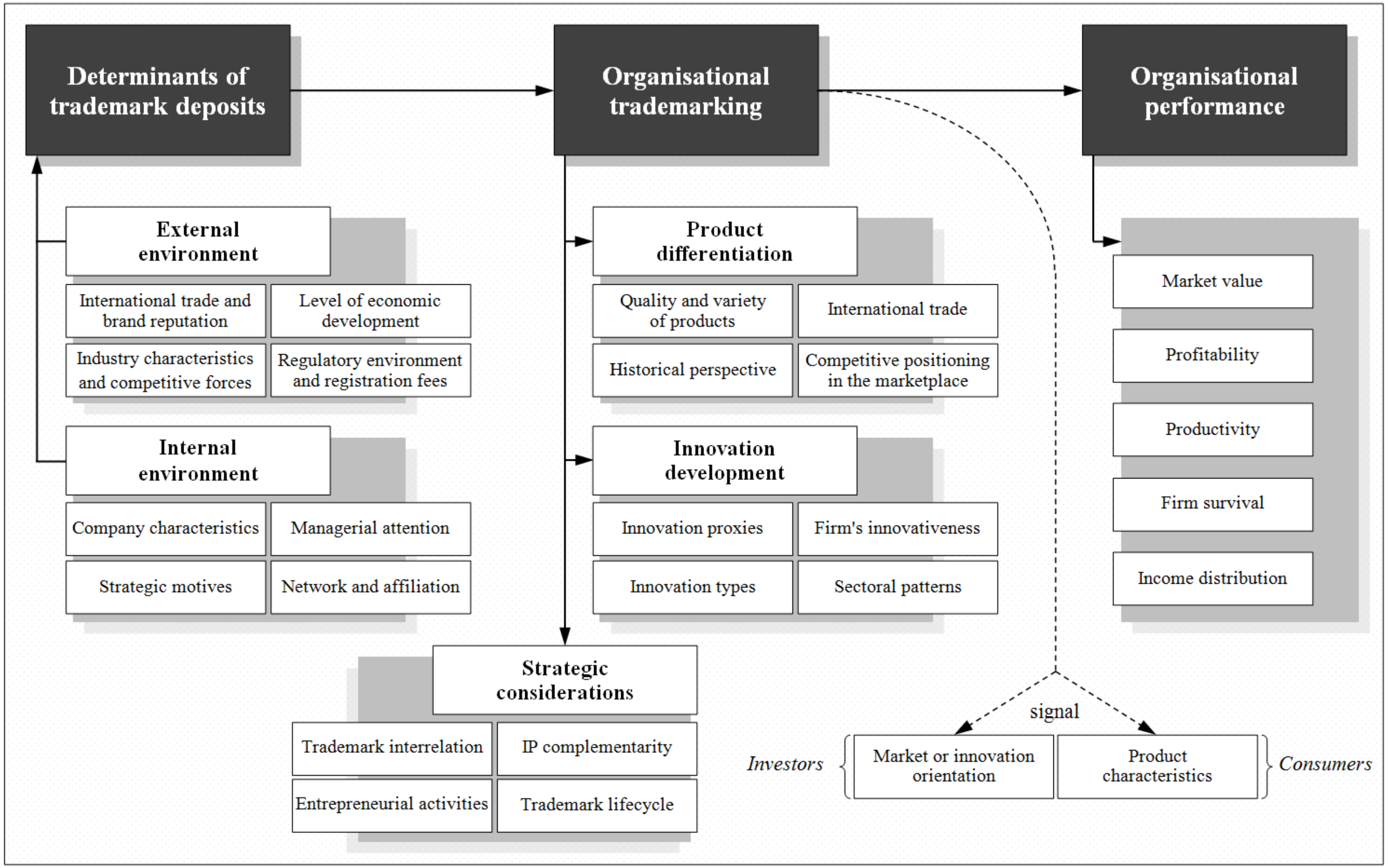
The purpose of this work has been to review the empirical literature relying on trademark statistics in order to develop a conceptual framework that brings together different research streams. First, we identified the basic sample of papers that used trademark analysis while examining some economic or business issues. Each of these papers was then classified into one of five categories, including filing determinants, product differentiation, innovation, strategic use, and firm performance. Finally, we conducted a detailed review of the selected papers and also made an attempt to position each of them with respect to other studies in the same literature stream. As a result, we have created an integrated framework that provides scholars with a better understanding of the current scope of empirical trademark research as well as helps them navigate themselves through its different areas (see Figure 2.7). In what follows, we will highlight several topics which, in our opinion, are worth further exploration.

The determinants of trademark activities

Our review suggests that when examining trademark activities, the absolute majority of authors choose to focus on either macro, country-wide factors or on industry and firm-specific aspects. At the same time, there has been growing evidence, especially in the context of the business and management literature, that intraorganisational forces also have a strong impact on how intellectual property is developed, protected, and deployed. For example, the review paper by Becheikh *et al.* (2006) points to the managerial perspective as being potentially useful to evaluate a company's intellectual property activities. Similarly, Hanel (2006:895) argues that intellectual property issues become "a daily preoccupation of CEOs in many industries". Other works have also emphasised the leading role of senior executives in facilitating the integrated management of intellectual property, its contribution towards forming and sustaining a company's competitive position (e.g., Al-Aali and Teece, 2013; Fisher and Oberholzer-Gee, 2013; Reitzig, 2007). Despite all these clues, there has been a general lack of research that would move the field from discussing anecdotal evidence about managerial engagement in patent and trademark activities to a systematic empirical analysis of the presumed relationship, including its effects on organisational functioning.[10] This observation is particularly relevant to trademark studies: to our knowledge, there are only two empirical papers that have explicitly explored the managerial side of trademarking (see Faurel *et al.*, 2016; Graham and Somaya, 2006). Thus, more research should be carried out to investigate the role of corporate leaders and other internal factors, such as structure and culture, in determining a company's trademarking behaviour.

[10] Some notable exceptions include Balsmeier and Buchwald (2014), Galasso and Simcoe (2011), Hirshleifer *et al.* (2012), and Wu *et al.* (2005).

Figure 2.7. An integrated framework that brings together different streams of the empirical trademark literature



The heterogeneity of trademark types

One of the advantages of looking at different scientific fields within a single review paper is that this approach enables us to identify opportunities for cross-disciplinary learning. From what we have seen so far, it is clear that economic studies largely ignore the fact that the trademark flow tends to be heterogeneous. A rare exception to this rule is the work by Sandner and Block (2011), who hold that trademarks differ in terms of their internal value and propose a range of indicators capturing these differences. At the same time, marketing scholars are generally more aware of various trademark types and actively exploit them to examine brand strategy issues. Krasnikov *et al.* (2009), for example, suggest classifying all trademarks into two broad categories – trademarks that reflect a company's efforts to build brand awareness among consumers and trademarks that favour brand associations. In turn, Agostini *et al.* (2015) distinguish between corporate and product-related trademarks, with the former group aiming to induce customer loyalty towards the whole company. Finally, Block *et al.* (2014b) show that trademarks can be either independent or belong to a trademark family. What all this evidence suggests is that in order to obtain more robust results that also better match real life situations, researchers should, when it is possible, account for potential irregularities in the trademark flow, let alone try to incorporate them in hypothesis testing.

The link between advertising and trademark activities

Despite de Rassenfosse's (2017) work, systematic empirical studies that would focus on the link between a company's advertising and trademark activities are still relatively rare, especially when it comes to firm-level analysis. Meanwhile, as Fosfuri and Giarratana (2009) suggest, trademarks represent an important step in new advertising campaigns and, as such, should be regarded as a valid indicator of new advertising output. As their argument goes, by intensifying advertising activities, companies can enhance the ability of a trademark to attract new customers, with a corresponding positive effect on the company's market share. In mature product markets, advertising can assist companies with maintaining brand loyalty, which, in turn, is associated with a more inelastic demand. Overall, it appears that when advertising and trademark activities are coordinated, companies are likely to enjoy greater power in creating a differentiation advantage. Therefore, future empirical research should examine advertising in relation to a company's trademarking (or, broadly speaking, branding) strategy, including their combined effect on consumer behaviour across different markets.

A wider geographical coverage

To date, only a handful of empirical trademark studies have been devoted to developing countries, which is fairly surprising given the growing importance of their economic activities to the rest of the world. This tendency, however, is not new to intellectual property research, where just a quarter of all publications are concerned with a non-U.S. or Europe context (see Candelin-Palmqvist *et al.*, 2012). Such a profound interest in developed countries may in part be justified by the greater availability and quality of their trademark data. So, once there are any breakthroughs on this front, it would be useful to gather more information about, for example, the perception of trademark protection by companies in those countries, with corresponding implications for their strategic behaviour; whether trademark valuation is significantly affected by a weaker regime of intellectual property protection pertaining to developing economies; and also what policy changes are necessary to ease the access to the protection system for different companies. Furthermore, as we have already mentioned, the geographical dimension often serves as a reliable proxy for a country's legal system. To clarify why it is so important to pay attention to the country-specific institutional context, we should refer to the U.S. trademark system, which is jointly governed by common law, the federal legislation, and other legal acts established by the states (Cohen, 1986). With that in mind, a number of questions may arise, including how strong would the incentive for a company to apply for and maintain a trademark registration be, given that all marks are still protected under common law? What is the extent to which registration costs affect a company's trademarking behaviour in this case? Do these costs impact on the incentive to trademark for small companies compared to their larger rivals?

Methodological inconsistencies

Our review suggests that scholars tend to examine trademarks at different points of their lifecycle. For example, it has been argued that trademark applications can accurately capture new product launches, thus making them a suitable instrument for studying the Schumpeterian process of competition through innovation (Greenhalgh and Rogers, 2012). Yet, not all authors actually clarify whether those applications were eventually successful or rejected due to an invalid claim, opposition, or any other procedural reason. There are also works that do not draw a clear distinction between trademark applications and registrations, simply assuming that the lag between filing for trademark protection and its actual granting is insignificant. Meanwhile, as Graham *et al.* (2013) report, the average time to issuance for different U.S. trademark types can range from 0.5 to 2.5 years; but when the registration is not mandatory for legal protection, it may take more than five years for a company to have its trademark registered after the introduction in the marketplace. As for trademark stocks, there are scholars who view them as an indicator of product differentiation (Greenhalgh and Rogers, 2012). At the same time, stock and flow measures can be interchangeable when intangible assets are depreciated at a high rate (Greenhalgh and Longland, 2005). Given these inconsistencies, more research is needed to revise the existing methodology in order to enhance the validity and comparability of findings derived from trademark statistics.

Access to trademark data

It has already been noted that one of the reasons for why empirical trademark studies are still in their infancy is because detailed trademark data are relatively difficult to obtain, unlike, for example, patents, which have been in the extensive scientific use for several decades. Moreover, a meaningful analysis of trademarks is further complicated by the need to link them to company-level financial information – and this is not a trivial task, given that there is no unique identifier to combine different datasets together (see Helmers *et al.*, 2011). At the same time, certain improvements have recently been made that have increased the attractiveness of trademark statistics for empirical analysis. First of all, detailed trademark administrative data in the format convenient for scientific research have been released in the public domain by the USPTO (see Graham *et al.*, 2013). The data provide a detailed account of trademark activities in the U.S. for more than a century, including useful insights into the prosecution process. Future studies should utilise these data to examine, among other things, a company's intentions when filing a new trademark application; some critical points of the registration process and their role in estimating trademark value; the trademark lifecycle and its relationship with the underlying business strategies; and the extent of a company's diversification activities. Another source of relevant statistics is the USPTO's dataset on trademark assignments, which "contains detailed information on 786,931 assignments and other transactions recorded at the USPTO between 1952 and 2013" (Marco *et al.*, 2014:4). Researchers using this dataset may find it appealing to address the topics that are related to trademark valuation, including monetary benefits stemming from a company's reputation; the dynamics of the market for brands and its determinants; and the use of trademarks as a collateral asset. Finally, there is also an initiative to produce intellectual property statistics jointly pursued by the European Commission's Joint Research Centre and the Organisation for Economic Co-operation and Development (see Dernis *et al.*, 2015). Their database containing intellectual property bundles for the top 2,000 corporate R&D performers worldwide can facilitate research activities on such topics as trademark filing strategies; the complementarity between patents and trademarks; and the transfer of the value originated in patents to trademarks (for the latter, see Conley *et al.*, 2013).

APPENDIX 2.A. SUMMARY TABLES

Table 2.A.1. An overview of papers on the determinants of trademark deposits

Paper	Geographical scope	Period	Sample description	Sources of IP statistics	Summary of main findings regarding trademarks
The effect of external environment on trademark deposits					
Baroncelli *et al.* (2005)	Multi-country analysis	1994-1998	~100 countries	WIPO	The ownership of trademarks is asymmetric. The majority of trademarks in the world are registered by companies from industrialised countries. Companies in developing countries are more likely to differentiate themselves by investing in brands, not in new technologies. A larger number of companies in developing countries may benefit from a stronger enforcement of trademarks rather than from a stronger enforcement of patents.
De Vries *et al.* (2017)	U.S.	1998-2007	4,703 companies	USPTO	A start-up company is more likely to file an initial intellectual property right in the form of a trademark rather than a patent if (i) it operates in a less concentrated market; (ii) it is active in business-to-consumer markets, not business-to-business markets; and (iii) it is backed by venture capitalists.
Herz and Mejer (2016)	Multi-country analysis	1993-2011	22 EU countries	OHIM	National trademark filings are price-sensitive, namely: a substantial proportion of the rise in filing numbers can be explained by lower fees. Trademark filings at national offices in Europe became more elastic after the mid-1990s because the European Community Trademark became available as an attractive alternative to national filings in 1996 and increased the price-sensitivity of applicants.
Jensen and Webster (2004)	Australia	1906-2002	Australian companies	IP Australia	Trademark filings are associated to (i) more inventive companies; (ii) the growth of the service sector; (iii) the consumer side shift in demand for more product quality and variety; (iv) globalisation; and (v) industry based microeconomic reforms.

Mangàni (2006)	Multi-country analysis	1995-2006	110 countries	OHIM, IP Australia, Italian Office for Patents and Trademarks	The growth in service mark deposits is associated with (i) the structural change of economies; (ii) higher tradability of services; (iii) technological evolution; (iv) greater attention to product differentiation; (v) processes of market liberalisation and privatisation; and (vi) the reduction of human intermediation in the provision of services.
The effect of internal environment on trademark deposits					
Allegrezza and Guarda-Rauchs (1999)	Benelux countries	1999	~2,500 companies	Benelux Office for Intellectual Property	Trademark deposits are positively related to (i) firm size; (ii) the intensity with which companies monitor their rivals; (iii) the company's evaluation of a rival's ability to imitate its products; (iv) the share of exports in total revenue; (v) the importance assigned to trademark protection by decision makers; and (vi) the intensity of R&D expenditure.
Block *et al.* (2015)	U.S.	2012	600 companies	Online Survey	Small and medium enterprises are guided by three motives when filling a trademark application: (i) protection, (ii) marketing, and (iii) exchange. These motives can be combined with each other so that companies form trademarking clusters of (i) trademark advocates, (ii) marketing-focused companies, (iii) marketing- plus protection-focused companies, or (iv) trademark sceptics. Each cluster is associated with different industry- and firm-level characteristics.
de Rassenfosse (2017)	Multi-country analysis	1980-2010	32 countries	WIPO, Benelux Office for Intellectual Property	Trademark applications can be predicted by assessing a company's brand equity investment.
Gao and Hitt (2012)	Fortune 1000 manufacturing firms	1987-1997	116 companies	USPTO	Information technologies contribute towards higher trademark holdings. Companies with more capital related to information technologies apply for more new trademarks and retire existing trademarks more quickly, thus shortening the trademark life cycle.
Jensen and Webster (2006)	Australia	1989-2001	490 observations	IP Australia	Small and medium enterprises are more likely to apply for trademarks, given their innovative potential, than large corporations.

Other determinants of trademark deposits					
Doh and Kim (2014)	South Korea	2004-2009	47 companies	Korea Intellectual Property Rights Information Service	The number of trademarks registered by small and medium enterprises in South Korea is (i) negatively related to the number of R&D personnel; and (ii) positively related to a company's networking with universities.
Squicciarini *et al.* (2012)	U.S.	1997-2007	621 universities	USPTO, EPO	Trademark activities pursued by academic institutions are positively related to (i) the number of students enrolled; (ii) the share of graduate students; (iii) the presence of a medical school; (iv) the share of federal funds received; (v) the private institution status; and (vi) patent applications or grants. However, they are negatively related to the number of universities located in the same state.

Note that one article can take more than one perspective. To avoid repetitions, this table presents only the articles for which the aforementioned perspective is deemed to be the most fundamental.

Table 2.A.2. An overview of papers on the use of trademarks as an indicator of product differentiation

Paper	Geographical scope	Period	Sample description	Sources of IP statistics	Summary of main findings regarding trademarks
Product differentiation in international trade					
Baroncelli *et al.* (2007)	China, Hong Kong, India, South Africa	1994-1998	4 countries	WIPO	In some developing countries, the ratio of trademark registrations to applications is much higher for national than for foreign applicants, which is consistent with the idea of discrimination against foreign companies. Incentives to discriminate are stronger when foreign companies produce products that are close in quality to the goods produced by domestic companies. Discretion and discrimination in the trademark registration process can sometimes be used as a protectionist tool.
Fink *et al.* (2005)	Multi-country analysis	1994-1998	~100 countries	WIPO	Higher quality and brand differentiation positively affect exports to rich country markets. This effect is especially pronounced in consumer goods and trademark-intensive sectors, but small or nonexistent for some intermediate goods sectors. The number of newly registered trademarks depends on the worldwide volume of exports from the source country in a particular industry. Registrations are more likely to take place in less distant economies, in countries where the same language is spoken, and among countries that participate in the Madrid system. Fluctuations in the total volume of imports and the per capita GDP do not significantly affect the volume of trademark registrations.
Mangàni (2007)	Multi-country analysis	2003	~120 countries	OHIM	Trademark deposits have a positive correlation with the size and wealth of economies. The contribution of trademark variety in justifying the higher deposits of larger and richer economies can be decomposed in extensive and intensive margins, with the latter accounting for more trademark entries. In turn, the decomposition of the intensive margin shows that the quantity margin dominates the quality margin. The quality effect is mostly explained by the level of economic development.

Competitive positioning					
Crass and Schwiebacher (2017)	Germany	2011	4,453 companies	German Innovation Survey	In service sectors, the use of trademarks increases the probability that the company's products and services will not be easily substituted by competitors. This product differentiation effect of trademarks is observed for companies with new-to-the-market product innovation, but not for companies without product innovation, thereby suggesting that trademarks supplement the appropriation of product innovation rents in services. The number of trademarks demonstrates the product differentiation effect for service companies with imitative new-to-the-firm product innovation, which indicates differentiation due to proliferating product variants. As for companies in the manufacturing sector, trademarks do not show any conclusive product differentiation effect.
Semadeni (2006)	U.S.	1989-1999	50 management consulting companies	USPTO	Management consulting companies pursue various service positioning strategies: (i) although companies position their marks near to similar marks from other companies, the companies themselves located distant from other similar firms; (ii) the older the focal company, the further from other companies it will position, and the older the other company, the nearer to it the focal company will position; (iii) the larger the focal company, the nearer to other companies it will position, and the larger the other company, the further from it the focal company will position; and (iv) the focal company locates its prospective services near the marks of other companies, and the focal companies locates its marks near to the prospective services of other companies.
Semadeni and Anderson (2010)	U.S.	1989-1999	50 management consulting companies	USPTO	Companies whose decision makers contemplate imitation are likely to consider (i) competitors with a history of innovation and (ii) competitors with highly related offerings as having superior information about market conditions, thus being more likely to imitate an innovation of those competitors. A prospective imitator is likely to doubt the efficacy of highly innovative offerings and will tend to forgo imitation, trusting in their own internal information superiority. However, as time elapses, the level of imitation decreases at an increasing rate; furthermore, past imitation tends to be a good predictor of future imitation.

Historical studies of product differentiation

da Silva Lopes and Guimaraes (2014)	U.K.	1876-1914	Light consumer goods industries	IPO	During the 1876-1914 period, Britain developed important innovations, which enabled the creation of sustained competitiveness in light consumer goods industries. These innovations were either marketing-based, technologically based, or a combination of the two. Factors often regarded as explaining British economic decline in heavy industries had no impact on the development of light consumer goods industries, instead encouraging their fast growth in this period.
Llonch-Casanovas (2012)	Spain	1865-1996	Knitwear industry	Spanish Office of Patents and Trademarks	More trademarks were created in Spain's two main knitwear districts than in other areas. The imitation and rivalry characteristic of industrial districts favoured the proliferation of trademarks and encouraged companies to diversify their products through the creation of new brands. The success of the brands was uneven and depended on the industrial structure in each district and the kind of product specialisation. Not only were the industrial districts an important factor in brand creation, but brand consolidation was decisive in raising levels of competitiveness in knitwear districts in Spain.

Note that one article can take more than one perspective. To avoid repetitions, this table presents only the articles for which the aforementioned perspective is deemed to be the most fundamental.

Table 2.A.3. An overview of papers on the use of trademarks as an indicator of innovation

Paper	Geographical scope	Period	Sample description	Sources of IP statistics	Summary of main findings regarding trademarks
The use of service marks and innovation in the service sector					
Gotsch and Hipp (2012)	Germany	2009	278 companies	Online Survey	The interrelation between trademark registrations and innovation success is stronger in knowledge-intensive (business) services. The power of trademark registrations to explain innovation activities is higher for product innovations.
Gotsch and Hipp (2014)	Germany	2009	278 companies	Online Survey	The use of trademarks for intellectual property protection has a positive effect on innovation success. The protection of new products and services is the most important motive for registering a trademark. Trademarks represent an adequate indicator of new service innovations in knowledge-intensive business services.
Schmoch (2003)	Germany	2001	377 companies	Centre of European Economic Research	Service marks represent a suitable indicator of innovation activities in knowledge-intensive services. They demonstrate a positive correlation with the share of turnover achieved with new products and services.
Schmoch and Gauch (2009)	Multi-country analysis	1990-2008	12 countries	Questel Orbit	Service marks represent a suitable instrument for the quantitative analysis of innovation activities in services. The use of community trademarks proves to be insufficient for a valid statistical analysis; instead, international registrations combined with community trademarks should be employed.
Links to other indicators of innovation					
Flikkema *et al.* (2014)	Benelux countries	2007-2008	660 companies	Benelux Office for Intellectual Property	The motives for trademark registration are linked to the reference to innovation, but service and product innovation show different results. Trademarks registered to signal strategic change and build brand equity refer to service delivery innovation. In turn, trademarks registered to protect intellectual property refer to technological product innovation, along with the motive of signalling strategic change. Trademarks used to signal innovative offers are usually filed close to market introduction, without combining them with other intellectual property rights. This is especially common for trademarks related to service innovation.

Hall *et al.* (2013)	U.K.	1998-2006	8,577 companies	IPO, EPO, OHIM	Patentees are more likely to be product innovators rather than process innovators, more likely to use trademarks, and they are larger, slightly more likely to export, and to be part of a business group. The fact that those companies that choose to patent also tend to have trademarks may suggest that some companies like to use formal intellectual property protection of all kinds, whereas others do not. Having trademarks also has an additional positive impact on new-to-the-market innovative sales.
Hanel (2008)	Canada	1997-1999	5,220 companies	Statistics Canada Survey of Innovation	Trademarks represent a means to enhance a company's reputation. Companies that introduce imitative innovations are likely to use technology patented by other companies and their trademarks. Using patents and also trademarks is an integral part of a successful innovation strategy, which consists of performing regularly R&D financed in part by government subsidies and grants, introducing world first product innovations and exporting.
Jensen and Webster (2009)	Australia	2001-2007	1,400 firm-level observations	IP Australia	The performance of trademarks as an indicator of innovation is best for manufacturing companies and for companies undertaking product innovations. The correlation between R&D expenditure and trademark applications is higher for service sector companies than for manufacturing companies.
Mendonça *et al.* (2004)	Multi-country analysis	1996-2002	15 EU countries, including Portugal	OHIM, INPI	There is a positive correlation between the use of patents and the use of trademarks, thus suggesting that trademark analysis can contribute to capturing relevant aspects of innovation phenomena and the process of industrial change. Trademark data can serve the purpose of acting as a partial output indicator of innovations introduced into the goods and services markets and, therefore, be used as an empirical yardstick for measuring overall changes in the patterns of economic activity.

Note that one article can take more than one perspective. To avoid repetitions, this table presents only the articles for which the aforementioned perspective is deemed to be the most fundamental.

Table 2.A.4. An overview of papers on trademark-based strategies

Paper	Geographical scope	Period	Sample description	Sources of IP statistics	Summary of main findings regarding trademarks
Trademarks in relation to each other					
Block *et al.* (2014b)	Multi-country analysis	2004	1,735 companies	OHIM	Many companies use trademark families to protect their brands. Such trademark families are formed through different filing strategies. It appears that financial markets differentiate in their valuation of trademark families. In particular, financial markets value only those trademarks that develop existing brands, while they do not value the creation of new trademarks.
Sandner (2009)	Multi-country analysis	1996-2004	2,289 companies	OHIM	Trademark portfolios are not loose agglomerations of independent trademarks. Instead, groups of trademarks within a portfolio exist so that the trademarks within such groups jointly protect the brands of a company. Company trademark portfolios are developed by following different strategies, including (i) creating, (ii) hedging, (iii) modernizing, and (iv) extending brands.
von Graevenitz (2013)	E.U.	1997-2010	597,450 application events	OHIM	Trademark registers are not always immune against congestion effects. Enlargement of the European Union had a significant and quantitatively important effect on the incentive of pharmaceutical companies to clutter trade mark registers with trademarks they are unlikely to use.
Trademarks in relation to other intellectual property rights					
Amara *et al.* (2008)	Canada	2003	2,625 establishments	Statistics Canada Innovation Survey	Patents, registration of design patterns, trademarks, secrecy, and lead-time advantages over competitors constitute legal and informal methods that are used jointly. More specifically, trademarks are complementary to patents, copyrights, and confidentiality agreements, while being independent from secrecy, complexity of designs, and lead-time advantages. R&D intensity is positively associated with patents, trademarks, complexity of designs, and lead-time advantages, with the highest coefficient in the case of secrecy. External knowledge-sharing with research organizations has a positive and significant effect on the likelihood of choosing trademarks, copyrights, and secrecy, with the highest coefficient in the case of copyrights.

Gallié and Legros (2012)	France	2001-2004	3,547 companies with an intellectual property right	Community Innovation Survey	Trademarks are the most commonly used means of intellectual property protection, followed by lead-time advantages and patents. The probability of using trademarks as a means of protection is positively affected by the development of innovation in production methods and innovation in methods of logistics, or in the supply or distribution of raw materials, goods or services. This probability increases when companies are large and operate in the market with few competitors. The probability of using trademarks is negatively affected by companies in industry, except for the consumer goods sector. The strategy of using trademarks is closely linked to the sector in which the company operates. Trademarks are negatively correlated with every non-statutory mechanism, including lead-time advantage.
Trademarks and entrepreneurial activities					
Goel *et al.* (2016)	Multicountry analysis	2001-2010	52 countries	World Development Indicators	Increases in trademark applications have a positive and significant effect on formal entrepreneurship. The spatial effects of trademark applications are negative, thus suggesting that neighbouring trademarks are based on country-specific norms and traditions that generally do not transfer well across borders. The effects of trademark applications on informal entrepreneurship are insignificant, and this is also true for the related spatial effect. So, knowledge flows from trademark applications are (i) to formal entrepreneurship; and (ii) absent in the case of informal entrepreneurship.
Lechner *et al.* (2016)	U.S.	1975-2005	Manufacturing industry	USPTO	Brands are sold, acquired, and resold through trademark transactions. There is a positive relationship between the degree of industry vertical disintegration and the size of market for brands. The existence of a substantial market of brands can be seen as a signal for the existence of entrepreneurial behavior.
Trademark lifecycle					
Jensen and Webster (2008)	Australia	2002-2005	92 brands	IP Australia	Each additional year of existence of a trademark enhances consumer demand. However, this only holds up to a point: after a time, further longevity diminishes demand. This is consistent with the idea that consumer loyalty may have diminishing returns: as companies fail to continually update or reinvest in the brands or as consumer preferences change, brands may no longer be able to leverage off consumer knowledge of their product. This may explain why many old brands reach a certain point where they are re-launched in order to compete with new entrants to the product market.

Melnyk *et al.* (2014)	U.S.	1993-2000	87 companies in the software security industry	USPTO	A company's culture of origin has a systematic effect on the type of trademarks it is more likely to prolong and on the length of the prolongation. Specifically, larger and more innovative companies terminate their trademarks earlier. The age of the trademark, the number of categories where a particular trademark is present, and the age of the company increase the likelihood of a trademark's prolongation.

Note that one article can take more than one perspective. To avoid repetitions, this table presents only the articles for which the aforementioned perspective is deemed to be the most fundamental.

Table 2.A.5. An overview of papers on performance implications of trademark activities

Paper	Geographical scope	Period	Sample description	Sources of IP statistics	Summary of main findings regarding trademarks
Market value gains from trademarking					
Aksoy-Yurdagul (2015)	Fortune Global 500 List	2003-2009	70 companies	USPTO	Software patent stocks positively affect the relationship between a company's open source software product portfolio and its value, while software trademark stocks have a negative effect on this relationship. An optimal portfolio of intellectual property rights for companies that want to reap more benefits from their open source software is the one with a large stock of software patents and a relatively small stock of software trademarks.
Block *et al.* (2014a)	U.S.	1998-2007	2,341 companies	USPTO, EPO	Trademarks can predict venture capitalists' valuation of start-ups. Along with protection value, trademarks also have signalling value by indicating a start-up's market orientation. The number of trademarks and the breadth of their applications (i) provide additional information about the scope and direction of the start-up's marketing strategy; and (ii) have an inverted U-shaped relationship with the financial valuation of the start-up by venture capitalists. The signalling value of trademarks decreases over the venture cycle; when more tangible factors become available, the venture capitalist gains deeper insight into the start-up and begins to exert influence on its strategies.
Bosworth and Rogers (2001)	Australia	1994-1996	60-120 companies	IP Australia	For the full sample, there is little evidence that trademark activities have any significant association with market value. However, for non-manufacturing companies, a higher intensity of trademark applications is positively associated with market value. It should also be noted that a trademark application has a private value of less than half that of a patent application.
Feeny and Rogers (2003)	Australia	1995-1998	249-369 companies	IP Australia	On average, innovation leads to an increase in firm performance. Companies vary in their ability to capture the returns to innovation. R&D spending and patenting are important determinants of the company's market value, while the trademark intensity and design intensity have no significant effect.

Fosfuri and Giarratana (2009)	U.S.	1999-2003	Coca-Cola and Pepsi	USPTO	The focal company's product innovation and filed trademarks have a positive effect on its market value. Yet, the introduction of a new product by the rival decreases the market value of the focal company, while a new filed trademark increases it. The effect of the rival's trademark filings on the focal company's market value is channelled through total demand, and the new product innovation effect has a direct impact on the distribution of market shares.
González-Pedraz and Mayordomo (2012)	U.S.	1996-2006	16 commercial bank	USPTO	The ratio of market value to total assets is lower for more diverse trademark portfolios. There is an optimal level of the trademark stock such that a reduction below this level negatively affects the bank's market value, whereas an increase above it improves the valuation. Maintaining a relatively young stock of trademarks has a positive effect on market value. Not only should the stock of live trademarks be young, but cancelled trademarks should be the oldest in the portfolio to improve the market value. There is also a positive/negative abnormal return around the date of the introduction/cancellation of a trademark.
Greenhalgh and Rogers (2006b)	U.K.	1989-2002	619 companies	IPO, EPO, Marquesa Search Systems	Trademark activities are associated with higher market value in almost all the Pavitt sectors. For the full sample, higher market share boosts the stock market's valuation of trademarking. Within the Pavitt sectors, there are some that follow this result, while others have the converse relationship. These conflicting results across sectors indicate that the market's valuation of trade mark activity in its interaction with market power is complex.
Greenhalgh and Rogers (2012)	U.K.	1996-2000	1,600 companies	Oxford IP Research Centre	Trademarks are a useful indicator of innovation, which leads to gains in market valuation and higher total factor productivity for innovative companies. Stock markets are efficient in estimating the likely benefits associated with a company's own trademark activity. Yet, the relationship between trademarks and market value exhibits non-linear patterns. The news about trademark activity creates greater differences in valuation ratios between companies in services than in manufacturing. Greater trade mark activity by competitors reduces net output of companies, but raises their stock market value. There is a large value-added premium for companies that applied for trade marks in the previous year.

Krasnikov *et al.* (2009)	U.S.	1995-2005	108 companies	USPTO	Efforts aimed to build brand awareness and associations among consumers have significant financial implications for companies. More specifically, brand-association trademarks positively affect firm cash flows, Tobin's q, ROA, and stock returns, as well as help reduce the variability of future cash flows. Yet, an increase in consumer brand awareness diminishes the positive effects of brand-association trademarks on stock returns and Tobin's q.
Sandner and Block (2011)	Multicountry analysis	1996-2002	1,216 companies	EPO, OHIM	Trademarks are valued by the stock market: that is, investors assign a higher value to companies with larger trademark portfolios. Well established trademarks are valued higher, as do those trademarks that are vigorously defended by their owners. Yet, broader trademarks have no association with a higher economic value. Attacks by rivals should also not be interpreted as a confirmation of the potential value of a trademark. Trademark activities of small and medium enterprises are home-biased. Those trademarks that are rooted in earlier trademark rights of other jurisdictions are of higher value.
Zhou *et al.* (2016)	U.S.	2000-2012	299 companies	USPTO, EPO	Trademark applications have a positive effect on the received amount of venture capital. This indicates that trademarks can act as a signal of market access and marketing capabilities. Trademarks have not only a direct effect on venture capital financing, but also a complementary effect with patents. Start-ups that apply for both patents and trademarks receive more venture capital than do those that apply for only one of the two. The complementarity between patents and trademarks exists only in initial funding rounds as it stresses a start-up's both technology and marketing capabilities.
Productivity gains from trademarking					
Duygun *et al.* (2016)	U.K.	2005-2013	330 banks	IPO, OHIM	The total factor productivity has grown among trademarking banks up to the start of the financial crisis but the trend has since reversed. Both trademarking and non-trademarking banks were catching up with the meta-frontier up to the financial crisis, though the drivers of this process differed between these groups. After the financial crisis, improvements in technology have been driven by a small number of non-trademarking banks. A large section of the commercial banking sector has not been able to overcome the effects of the financial crisis.

Greenhalgh and Longland (2005)	U.K.	1988-1994	740 companies	Marquesa Search Systems	Trademarks are also associated with gains in value added. It is the intensity of the flow of trademark acquisitions relative to the number of employees which is important for keeping ahead of the crowd, not the accumulated long run stock of trademarks acting in a more persistent way. The underlying cause may refer to the quality of the human capital engaged in generating the continuous flow of innovations. Trademarks have an impact for low-tech companies but are not significant for high-tech companies.
Profitability gains from trademarking					
Duygun *et al.* (2013)	U.K.	2001-2012	20 banks	IPO, Marquesa Search Systems	Trademarks can be used to proxy the intensity of new product competition. However, it takes four years for the effect of competition through product innovation to show an impact on profit efficiency. There is an inverse U-shaped relationship between the trademark intensity in the commercial banking sector and the average profit efficiency in the sector. Holding a trademark may make a bank more profit efficient than those which do not have a trademark. The net impact of new product competition on cost and profit efficiency in the banking sector is though negative in the sense that overall both cost and profit inefficiency increase following an increase in the intensity of competition.
Duygun *et al.* (2014)	U.K.	2001-2013	213 observations	IPO, OHIM	Older and larger banks are more likely to file an application for trademarks. The number of trademarks filed by other commercial banks is associated with a bank's propensity to trademark. Banks that have previously filed a trademark application are less likely to apply for a new one. There is a common cost and alternative profit frontier for trademarking and non-trademarking banks, albeit some evidence suggests that it is not the case for the alternative profit frontier for the period before 2008. Trademarking banks are more profit efficient than non-trademarking banks, while there is no significant difference between the cost efficiency scores of trademarking and non-trademarking banks.
Griffiths *et al.* (2011)	Australia	1990-2006	2,689 companies	IP Australia	Accounting for unmeasured intangible assets matters for the estimation of profits. The effect of patent and trademark stocks on the profit rate is large and positive, thus suggesting that these measures can capture the profit earning potential of companies.

Marco-Lajara *et al.* (2016)	Spain	2009-2013	2,003 companies in the hotel industry	Sistema de Análisis de Balances Ibéricos	Knowledge stemming from a hotel's employees and also the value of registered trademarks prevail over R&D expenditure for hotel profitability. Trademarks are a valuable asset for hotel profits insofar as they act as the most important "presentation card" for tourists to visit the establishment.
The impact of trademark activities on firm survival					
Buddelmeyer *et al.* (2010)	Australia	1997-2003	299,038 companies	IP Australia	Companies with more of both trademark applications and stocks have a lower hazard rate. As trademarks reflect new-to-the-company innovations, this may indicate that the innovative activity associated with the launch of a trademark is less risky than the radically innovative activity captured by a patent.
Helmers and Rogers (2010)	U.K.	2001-2005	161,857 companies	IPO, EPO, Marquesa Search Systems	The number of trademark applications is associated with a lower probability of firm exit. A higher share of trademark active companies in an industry has a positive association with firm exit. Trademarking is associated with a lower probability of firm exit in almost all sectors.
Huang *et al.* (2013)	U.S.	1996-2004	1,220 companies in the software industry	USPTO	Independent software vendors (i) with a greater stock of formal intellectual property rights, such as patents and copyrights, and (ii) with stronger downstream capabilities, as proxied by trademarks and software consulting services, are more inclined to join a proprietary platform and to do so earlier. The effects of intellectual property rights on the probability of partnership are greater (i) when an independent software vendor has weak downstream capabilities or (ii) when the threat of imitation is greater, such as when the markets served by the independent software vendor are growing quickly.
Jensen *et al.* (2008)	Australia	1997-2005	261,510 companies	IP Australia	Trademark applications, which reflect low-risk innovation investments, increase the likelihood of survival for both new and incumbent companies. A similar effect is observed for trademark stocks, capturing low-risk innovation capital. Unlike incumbents, the stock of low-risk capital is the major source of comparative advantage for new companies.
Srinivasan *et al.* (2008)	U.S.	1993-2002	1,435 companies in the high-tech industry	USPTO	The number of trademarks delays a company's exit by dissolution and acquisition. The diversity of product-market portfolio combined with a larger number of trademarks (i) delays a company's exit by dissolution, and (ii) hastens a company's exit by acquisition.

Other performance-related implications of trademarking					
Greenhalgh and Longland (2001)	U.K.	1986-1995	~700 companies	IPO, EPO, USPTO, WIPO	The impact of intangible assets on wages and jobs is beneficial for workers. New trademarks are significant in raising wages, although there is a time lag between acquiring trademarks and awarding wage gains. Companies with a large historic stock of older trademarks are generally paying less. The relative strength of trademarks in consumer goods sectors and the corresponding weakness of patents in producer goods sectors suggest that companies earn relatively more profit from the former than the latter.
Helmers and Rogers (2011)	U.K.	2000-2005	7,038 companies	IPO, EPO, Marquesa Search Systems	Trademark activities are significantly associated with subsequent asset growth, thus suggesting that trademark-active companies are better at marketing their innovations which directly translates into higher growth.
Azomahoua and Diene (2012)	Multicountry analysis	1960-2008	34 countries	World Bank Africa Database	In African countries, trademarks are more accessible and, thus, are likely to be an indicator of innovation activities. Residential trademarks have a greater effect on income polarisation than residential patents; yet, if innovation is non-residential then patents outperform trademarks. Unexpected shocks that affect patents will have a permanent effect on income polarisation, whereas the effect of unexpected shocks that impact trademarks is transitory.
Agostini *et al.* (2015)	Italy	2008-2012	133 companies in the fashion industry	Italian Office for Patents and Trademarks	Corporate trademarks and marketing expenses have a positive association with the sales performance of small and medium enterprises, while the effect of product trademarks is not significant. Corporate trademarks and product trademarks show a lower correlation, suggesting that this is unlikely that small and medium enterprises would hold both corporate and product trademarks. Trademarks registration and marketing expenses preserve their benefits in subsequent years and also show a cumulative effect over time.

Note that one article can take more than one perspective. To avoid repetitions, this table presents only the articles for which the aforementioned perspective is deemed to be the most fundamental.

Table 2.A.6. An overview of other contributions to empirical trademark research

Paper	Brief description	Geographical coverage	Period	Source of IP data
Working papers and conference proceedings				
Castaldi (2016)	The relationship between trademark portfolios and economic performance	Multi-country analysis	2005-2012	USPTO, OHIM
Castaldi and Giarratana (2011)	The determinants of firm performance in professional services	U.S.	2000-2009	USPTO
Crass (2014a)	Firm characteristics and their role in driving trademark registrations	Germany	2010	OHIM, DPMA
Crass (2014b)	The role of brand use in the commercial success of product innovations	Germany	2010	OHIM, DPMA
Crass and Schwiebacher (2013)	The effect of trademarks on product imitability and substitutability	Germany	2010	Mannheim Innovation Panel
Crass *et al.* (2016)	The effect of investment in brand equity on firm financial performance	Germany	2010	OHIM, EPO, DPMA
de Rassenfosse (2015)	The fee elasticity of demand for international trademarks	Multi-country analysis	2004-2013	WIPO
Faurel *et al.* (2016)	The impact of CEO pay incentives on new product development	U.S.	1993-2011	USPTO
Fink *et al.* (2014)	Trademark squatting and its effect on a company's strategic behaviour	Chile	1991-2010	INAPI
Flikkema *et al.* (2010)	The extent to which new trademarks refer to innovations	Benelux countries	2007-2008	Benelux IP Office
Flikkema *et al.* (2015)	The link between trademark and innovation activities	Benelux countries	2009	OHIM, EPO, Benelux IP Office
Gambardella and Giarratana (2006)	The effect of downstream assets on new product launches	U.S.	1993-2000	USPTO
Graham and Somaya (2006)	The complementarity between intellectual property rights	U.S.	1985-1999	Federal Judicial Centre

Heath and Mace (2017)	The effect of trademark protection on firm profits and strategy	U.S.	1982-2005	USPTO
Llerena and Millot (2013)	The complementarity between patents and trademarks	France	1998-2007	OHIM, INPI France
Mainwaring *et al.* (2004)	Determinants of trademark deposits and regional disparities	UK, Ireland	1983-2001	IPO
Malmberg (2005)	The use of trademarks as an indicator of new-to-the-firm innovations	Sweden	1935-2000	PRV Svensk Varumärkestid-ning
Millot (2009)	Statistical properties of trademarks and the link to innovation activities	Multi-country analysis	1884-2007	USPTO, OHIM, JPO
Millot (2011)	Companies' trademarking behaviour, a link to innovation	France, Germany	1999-2006	INPI France, DPMA, OHIM, EPO
Munari and Santoni (2009)	The complementarity between patents, trademarks, and designs	Italy	2004-2007	EPO, OHIM, Italian IP Office
von Graevenitz (2009)	The defence of trademarks through oppositions	Multi-country analysis	1996-2004	OHIM
Book chapters				
Duguid *et al.* (2010)	The role of trademarks in economic development and international trade	France, U.K, U.S.	1870-1970	Various historical sources
Greenhalgh and Rogers (2006a)	The market value of trademarks	U.K.	1996-2000	IPO, OHIM
Greenhalgh and Rogers (2008)	Determinants of trademark deposits	U.K.	1996-2000	Marquesa Search Systems
Griffiths and Webster (2006)	The market value of trademarks	Australia	1989-2002	IP Australia
Reports				
Farooqui *et al.* (2011)	Investment in knowledge capital and its contribution to growth	U.K.	1990-2008	Community Innovation Survey
Greenhalgh *et al.* (2011)	The link between trademark activities and firm performance	U.K.	2000-2006	IPO, OHIM

Helmers and Schautschick (2013)	The use of various intellectual property rights for one product	U.K.	2002-2009	IPO, EPO, OHIM
Helmers *et al.* (2013)	The link between intellectual property and firm performance	U.K.	2002-2009	IPO, EPO, OHIM
von Graevenitz *et al.* (2012)	The problem of "cluttering" of trademark registers	U.K.	2000-2007	IPO, OHIM, WIPO
WIPO (2013)	The role of trademarks in protecting brands and brand strategy	Multi-country analysis	1974-2011	WIPO
Dataset descriptions				
Dernis H. *et al.* (2015)	Intellectual property bundles of world top corporate R&D investors	Multi-country analysis	2010-2012	EC JRC, OECD
Graham *et al.* (2013)	Trademark case files dataset	U.S.	1870-2012	USPTO
Marco *et al.* (2014)	Trademark assignment dataset	U.S.	1952-2013	USPTO

CHAPTER 3. THE ROLE OF CEO CHARACTERISTICS IN GOVERNING INTELLECTUAL PROPERTY PROTECTION: WHAT CAN U.S. PATENT AND TRADEMARK STATISTICS TELL US?

3.1. INTRODUCTION

By adopting the upper echelons approach (Carpenter *et al.*, 2004; Hambrick, 2007; Hambrick and Mason, 1984), this research examines the extent to which a company's decision to formally protect its intellectual property is associated with variations in CEO characteristics. The original idea stems from the business literature where several authors have called for a new generation of chief executives whose profound understanding of the strategic value of intellectual property rights enables their companies to secure competitive advantages and solidify a market leadership position (see Fisher and Oberholzer-Gee, 2013; Reitzig, 2007; Rivette and Kline, 2000). However, another justification for the existence of such a link can be drawn from the resource-based view of the firm (Barney, 1991; Penrose, 1959; Rumelt, 1984; Wernerfelt, 1984). According to it, not only "the resources with which a particular firm is accustomed to working will shape the productive services its management is capable of rendering [...], but also the experience of management will affect the productive services that all its other resources are capable of rendering" (Penrose, 1959:5). Recognising intellectual property as one of the company's most valuable resources, we can then qualify this line of reasoning further to derive at least two practical implications for our analysis. First, managerial characteristics are likely to be significant for guiding the firm's intellectual property strategy; and second, the previous experience of senior executives needs to be focused on because of its importance in dealing with this strategy, its constituting elements, and other adjacent activities. In fact, a similar conclusion has been reached by several studies in the strategic management literature reporting that the salient characteristics of senior managers influence the innovation process and its core elements (e.g., Barker and Mueller, 2002; Daellenbach *et al.*, 1999; Galasso and Simcoe, 2011; Kor, 2006; Wu *et al.*, 2005). So, it would be natural to expect that the CEO, as the most powerful actor in the organisation (Hambrick and Mason, 1984),[1] and their cognitive bases and values should also be guiding the decisions that have an impact intellectual property protection. However, there is a surprising lack of systematic empirical evidence on this matter – the gap we seek to bridge.

We examine executive characteristics in the form of individual orientations, which effectively represent a combination of formal knowledge, skills, and professional experience obtained by an individual over their lifetime. The general argument goes that certain types of individuals are better at recognising the pros and cons of intellectual property protection and, hence, tend to make more informed decisions regarding its direction than their less informed colleagues. Our study also concentrates on the proactivity dimension of CEO personality. This trait is used to address the aspect of intellectual property strategy that relates to strict timing constraints placed on the company's right to claim incontestable protection for its creative output (Hall *et al.*, 2014; von Graevenitz, 2013). To account for the variations in managerial perception with respect to different intellectual property rights, we employ U.S. patent and trademark statistics. Assuming for the moment that innovation development is a linear process (Nelson, 1959), our empirical analysis then moves along its timeline and first considers the developmental stage: here, we use the stream of patent registrations to capture the company's effort to protect its inventive output. In turn, trademark data are examined to clarify intellectual property activities at the commercialisation and product lifecycle stages. We particularly argue that the protection of new product identity is reflected in the flow of trademarks filed on the "intent to use in commerce" basis; at the same time, filing a trademark on the "use in commerce" basis indicates the protection of the reputation acquired by the product over its time in the marketplace.

This study makes several important contributions to the body of knowledge. First, it adds to the existing literature on intellectual property rights (e.g., Block *et al.*, 2015; Gallié and Legros, 2012; Jensen and Webster, 2006; Sandner, 2009) by drawing attention to executive characteristics and their predictive power in explaining variation in patent and

[1] This view can, however, be criticised for making "an implicit assumption on the distribution of power at the top", whereas the actual distribution of power among senior managers varies across organisations and may depend on a number of factors, other than the position (Finkelstein, 1992:531). We will address this issue later in our analysis.

trademark deposits. Another contribution is made to the literature on intellectual property management (e.g., Al-Aali and Teece, 2013; Reitzig, 2007; Rivette and Kleine, 2000): it is particularly suggested that corporate leaders tend to utilise formal protection selectively, with relatively more attention being paid to patents than trademarks. The study also adds to the emerging literature on the trademark-innovation link (e.g., Flikkema *et al.*, 2014; Gotsch and Hipp, 2012; Mendonça *et al.*, 2004; Schmoch, 2003) by considering the legal basis for filing a trademark application as an attribute that can help identify trademarks resulting from an innovation or, more broadly, new product development process. Finally, this work informs the long-standing choice determinism debate (e.g., Bourgeois, 1984; Hitt and Tyler, 1991; Hrebiniak and Joyce, 1985) by showing that organisational outcomes are likely to be constrained by the personality characteristics of chief executives.

The remainder of the essay is organised as follows. Section 3.2 addresses both perception-related and organisational aspects of the CEO's attention to intellectual property strategy, as well as formulates research hypotheses. Section 3.3 describes the data and method used in this study. Section 3.4 presents the results of the statistical analysis, including some robustness checks. Section 3.5 concludes with discussing the study's implications, pointing to its limitations, and offering directions for future research.

3.2. THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

3.2.1. The role of managerial perception in administering intangible resources

When examining the strategic use of intangible resources at large, the managerial perspective holds that the CEO is the only executive who can be responsible for their totality; therefore, their perception of the relative importance of each item influences its acquisition and deployment (Hall, 1992). The reference to the leading role of managerial perception is consistent with the upper echelons analysis, where the cognitive bases and values of chief executives are deemed to be one of the principal factors that determine organisational outcomes, such as strategic choices and performance levels (see Carpenter *et al.*, 2004; Hambrick, 2007; Hambrick and Mason, 1984).[2] Drawing on the bounded rationality concept, the theory particularly maintains that managers vary considerably in their ability to assess all potential outcomes of a strategic situation they face (see Child, 1972; Cyert and March, 1963; March and Simon, 1958). As such, they often act not as fully rational agents but rather in accordance with some personal norms and beliefs that guide their interpretation of how the situation should be handled. So, "if we want to understand why organizations do the things they do, or why they perform the way they do, we must consider the biases and dispositions of their most powerful actors – their top executives" (Hambrick, 2007:334).

While in general adopting the upper echelons approach, it is still relevant to ask what kind of channels and mechanisms can enhance or, conversely, put constraints on managerial perception when dealing with firm resources, including intangibles? While answering this question, we should first recall the resource-based view of the firm and especially its interpretation of strategy making as the constant interaction between managers and the resources at their disposal (Mahoney and Pandian, 1992; Oliver, 1997). Then an apparent way to improve managerial perception can be through expanding resource expertise and competency. According to Sirmon *et al.* (2007:279), resource expertise refers to the proficiency of a manager in identifying, adjusting, integrating, and exploiting the company's resources "to respond to a market opportunity to introduce a new product or service when the demand for it appears". Within this framework, the basic premise consists in recognising that more able executives possess such expertise that makes them better at "converting firms' resources into rent-generating capabilities" (Kor, 2003:707). However, the limited deployment flexibility of some resources along with environmental uncertainty may significantly limit

[2] Surely, this factor acts along with firm history and the social, organisational, and economic contexts of decision making (see Oliver, 1997). This argument will be reviewed in more detail in the methodology section.

the room for manoeuvre (Sirmon *et al.*, 2007; Sirmon *et al.*, 2008). The uncertainty argument is particularly notable here because it implies, among other things, that in highly volatile environments, the prior knowledge and experience obtained by CEOs become even more critical for forming accurate expectations regarding the resource's value-creating potential and for better quantifying the risks associated with the realisations of each and every possible outcome (Schmidt and Keil, 2013). Overall, resource expertise should be regarded as the chief executive's relative cognitive strength, endowing them with the qualities and abilities necessary for better utilising "those resources that allow firms to achieve competitive advantage and superior performance" (Schmidt and Keil, 2013:208; Kraaijenbrink *et al.*, 2010).

Another important factor that can have a strong impact on managerial perception is domain expertise. This term can be defined as a deep understanding of the business environment that includes the company's product specialisation, its competitive and market positions, as well as the industry context (Spreitzer *et al.*, 1997). The complex nature of domain expertise becomes much clearer if one considers the multilevel managerial experience model developed by Kor (2003). Among other things, the model suggests that "managers' historic and tacit knowledge of the firm promotes proper matching of resources and capabilities with opportunities [..., whereas experiential] knowledge of the industry helps managers identify and assess emerging opportunities (e.g., new technologies), design proper strategies, and position new products and services strategically" (Kor, 2003:708-710). The accumulation of domain expertise then enhances the cognitive flexibility of managers and, as a result, makes them better suited for resolving conflicts arising from a possible mismatch between the company's strategic goals and the constraints imposed by external forces, especially in the presence of large information asymmetries (Custódio and Metzger, 2013; Furr *et al.*, 2012; Miller and Friesen, 1983). This leads to a possible conclusion that domain expertise is likely to have a positive association with successful managerial practices, provided that these practices are relevant to and valuable for current and future strategy making (Levy, 2014; Rajagopalan and Datta, 1996). Otherwise, it may set boundaries on the CEO's vision – compared to domain outsiders – by essentially limiting the breadth of their knowledge base, reducing receptivity to change, and eventually encouraging path-dependent behaviour (Furr *et al.*, 2012; Wiersema and Bantel, 1992).

3.2.2. Linking the CEO function to intellectual property strategy

Moving on from the discussion of managerial perception and its influence on firm behaviour at large, we now turn to considering intellectual property under the organisational angle and, more specifically, examine its functional relevance to chief executives (see Figure

3.1). Clearly, the predisposition of CEOs to dealing with intellectual property issues may be stipulated by cognitive compatibility and familiarity. Yet, is there any particular reason to believe that the functional subordination also exists, aside from the ultimate responsibility which Hall (1992) has pointed to? Interestingly enough, the actual extent of executive involvement in intellectual property management has been a matter of ongoing debate (see Al-Aali and Teece, 2013; Fisher and Oberholzer-Gee, 2013; Hanel, 2006). Even Hall (1992) in his study shows that corporate leaders perceive intellectual property rights as one of the least significant intangibles in terms of its contribution to the overall business success, with corresponding implications for the degree of managerial attention. These findings, however, should be reassessed in the light of more recent research showing that approximately a half of senior managers understand the strategic value of intellectual property and genuinely engage in its administration (Wild, 2011). Furthermore, several empirical works reviewing the effect of CEO demography on the firm-level innovation process have utilised patents as one its valid measures, thereby also implicitly assuming the association of intellectual property rights with corporate leaders (e.g., Balsmeier and Buchwald, 2014; Galasso and Simcoe, 2011; Hirshleifer *et al.*, 2012; Wu *et al.*, 2005).

A cursory analysis of the relevant literature offers at least two arguments that support the existence of the link in question. First of all, by being a major decider on how resources should be allocated in the company, chief executives and their preferences may eventually affect the creation, acquisition, and exploitation of intellectual property (Barker and Mueller, 2002; Cazier, 2011; Fahlenbrach, 2009; Faleye *et al.*, 2014). This effect is especially pronounced for the innovation process that "requires making long-term investments in R&D projects that may have a negative impact on more immediate financial statements" (Balkin *et al.*, 2000:1119). Therefore, top managers' attitude towards risk-taking behaviour, their personal goals and concerns, as well as opinion on which new product or technologies to invest in become one of the key determinants shaping the outcomes of this process and, relatedly, the composition of the intellectual property portfolio. The resource allocation perspective also relates to the observation that registering an intellectual property right can be a costly endeavour,[3] thus demanding the CEO to devote much more attention to this type of activity. The other argument focuses on the functional strategies that are inextricably intertwined with intellectual property rights: when such strategies are perceived to be of critical importance for business functioning and sustainability, they will most likely be

[3] von Graevenitz (2013:722) estimates that "each new invented name in pharmaceuticals costs U.S. $25,000 (which is conservative)"; yet, he admits that "[a] significant proportion of this cost arises because applicants cannot easily establish whether marks on the register are used". Furthermore, the cost of patent application and maintenance is often even higher and can reach as much as $100,000 and more (see Hemphill, 2008).

elevated to corporate level decision makers (Fisher and Oberholzer-Gee, 2013; Hanel, 2006; Reitzig, 2004).[4] For example, it has been generally recognised in the marketing literature that the responsibility for important trademark decisions, especially those that are tightly bound to corporate branding and reputation, should reside with the firm's chief executive (Balmer and Gray, 2003; Chun, 2005; Cohen, 1986). Owing to a number of benefits trademarks, or brands more generally, can confer to the company, including higher profit margins, customer loyalty, and competitiveness (see Conley *et al.*, 2013; Keller and Lehmann, 2006), their strategic use cannot be left to the discretion of corporate counsels or marketing managers alone.[5] Instead, chief executives should practice a closer involvement in the planning and implementation of the strategies heavily relying on trademarks and their protection (Conley *et al.*, 2013).

The importance of the CEO's direct involvement in devising intellectual property strategy has been repeatedly emphasised in the business literature. For example, Granstrand's (1999) comprehensive study of international practices in intellectual property management shows that one of the salient characteristics of Japanese corporations, clearly distinguishing them from their Western counterparts, consists in the fact that senior executives there tend to pay much more attention to dealing with intellectual property issues, and such behaviour reflects their actual perception of patents and trademarks as the most efficient mechanism for capturing corporate profits. A subsequent work by Rivette and Kline (2000:63-64) calls for the same approach to be adopted in the U.S. context; it particularly argues that "in today's knowledge economy, intellectual property can no longer be considered simply a legal function. It's about business strategy. And that makes it the responsibility of the chief executive officer". In a similar manner, Reitzig (2004) insists on the necessity to elevate the role of intellectual property strategy in modern organisations from the strictly functional to business and organisational levels. His later study (see Reitzig, 2007) surveys senior executives responsible for intellectual property issues in 34 large corporations from eight different industries between 2003 and 2005. This study's results suggest that despite difficulties to find an optimal approach to dealing with intellectual property at the business-unit level, there is one strategic success factor that dominates and holds for all studied companies – the intimate involvement of corporate management in top-level issues concerning intellectual property and its deployment (Reitzig, 2007).

[4] Bringing intellectual property strategy from the functional level to the attention of corporate leaders exemplifies the divergence between the locus of strategy and the locus of decision making (see Varadarajan and Clark, 1994).

[5] Block *et al.* (2015:1917) note that "[a]lthough a company's reputation is established through brands, not directly through trademarks, marketing and innovation research highlight the pivotal role of trademarks in protecting and establishing the brands that support firms' marketing strategies".

3.2.3. Managerial characteristics and their impact on intellectual property strategy

Resource expertise. The perception-based rationale behind managerial involvement in making decisions on intellectual property strategy requires the plausible assumption that it is likely to occur and, particularly, be effective when the chief executive's knowledge base includes elements on intellectual property per se as well as on how it can be aligned with and add to organisational performance (Aghion and Tirole, 1997; Fisher and Oberholzer-Gee, 2013; Palfrey, 2011). A standard approach widely used by scholars who study human capital consists in treating higher education and other forms of occupational training as potent enhancers for the ability of an individual to acquire, process, and employ specialised knowledge and skills (Becker, 1962; Hatch and Dyer, 2004; Hitt *et al.*, 2001; Katz, 1955). Yet, further analysis reveals that the knowledge built up during the schooling period facilitates the adoption of new information only if there is a certain degree of commonality between the two; otherwise, the individual's professional experience has to be considered as a robust basis for future learning, largely due to its ability to mitigate the disparities that often exist between educational levels and professional needs (Cohen and Levinthal, 1990). With respect to the subject of our study, this line of reasoning effectively presupposes that relevant educational and professional backgrounds can exert a significant amount of influence on how knowledgeable the CEO is about intellectual property protection, thereby guiding their strategic actions through the perception of its merits, demerits, and practical applications.

To account for the complex nature of intellectual property protection, we will focus on its three principal dimensions that should help us better capture the decision making context and also some plausible cognitive bases and values associated with each of them.[6] First of all, intellectual property protection can be regarded as merely a legal instrument permitting the beneficiary to exclude others from making, using, or selling their creative work (e.g., Bently and Sherman, 2014; Hughes, 1988; Peng *et al.*, 2017; Torremans, 2016). As such, the main focus of this perspective is on the isolating mechanism embodied in intellectual property rights and its role in reducing the probability of imitation and other unfair practices that may divert part of the rent stream from the right holder (Rumelt, 1984). By design, any protection regime should attempt to balance out the private gains and social costs of its operation, or economic inefficiencies will occur (Gallini and Scotchmer, 2002). In line with this principle, intellectual property law offers several options each of which depends on the underlying asset and affords to it the limited scope and duration of

[6] This approach is largely consistent with how the literature on intellectual property rights has been organised. An illustrative example is a study by Ziedonis (2008), which presents an exploratory analysis of the most influential academic papers in the field and concludes that they all can be grouped into four generic categories – law, economics, business, and consulting.

protection, as well as determines what constitutes the right's infringement (Hall *et al.*, 2014). Being well aware of these legal subtleties, the asset owner may find it even more appealing to form a portfolio of intellectual property rights by bundling together instruments with complementary characteristics.[7] Should it be the case, the effective period of protection can be significantly extended and will depend on the cumulative features of the portfolio, thereby giving opportunities for the use of intellectual property strategically (Conley *et al.*, 2013; Jensen and Webster, 2009).

If this perspective dominates organisational practice then intellectual property management is mainly perceived in the light of its contribution towards the company's regulatory capability. Among other things, this also implies that CEOs with legal expertise, either due to academic or professional experience, tend to be better prepared for the adoption and maintenance of a suchlike approach. Apparently, they possess the knowledge and skills necessary to manage and even prevent the legal risks associated with intellectual property; to control and reduce its litigation and regulatory costs; and to integrate it in the broader context of compliance and enforcement. However, lawyer CEOs may also become prone to perception biases when judging on positive and negative sides of the methods available for intellectual property protection in a given situation. This attitude can potentially lead to adjusting the decision-making process so that it involves a more careful and, hence, time-demanding consideration of various legal options as well as a use of alternative, often informal protection mechanisms, if feasible and cost-efficient (Hall *et al.*, 2014; Mueller *et al.*, 2013).[8] Some of these predictions have, in fact, received empirical confirmation in the existing literature. For example, DeMott (2005) reports a tendency to diminish the importance of general counsels in those companies where the CEO possesses substantial legal experience, thus indirectly indicating the elevation of some legal tasks and duties to the executive level. Furthermore, Litov *et al.* (2014) suggest that companies with large portfolios of intangible assets especially value a lawyer-director's expertise because of their ability to minimise the chances of corporate litigation. Finally, Henderson *et al.* (2017:26) show that having a chief executive trained in law may "not only reduce the frequency of most types of common

[7] For example, U.S. law stipulates that utility patents should be granted for the term of twenty years (35 U.S.C. §154); design patents – for the term of fourteen years (35 U.S.C. §173); trademarks are protected for as long as they both are used in commerce and comply with associated legal procedures (15 U.S.C. §1058-1059); and copyrights are issued for the term consisting of the life of the author and 70 years after the author's death (17 U.S.C. §302).

[8] To put it differently, such chief executives may slow down the decision-making process by increasing its comprehensiveness on the legal side. This proposition is based on the observation that less comprehensive processes speed up decision making as less information needs to be processed; however, the resulting effect still largely depends on environmental characteristics and the nature of information involved (see Eisenhardt, 1989; Fredrickson, 1984; Fredrickson and Mitchell, 1984).

corporate litigation, but also their severity". At the same time, they found no statistically significant impact of this expertise on the frequency of intellectual property litigation.

Before proceeding to the hypothesis formulation, it is important to point out that the U.S. intellectual property protection system does not require a company to obtain a federal registration of its trademark in order for the mark to be legally protected; so, the company is still able to enjoy basic benefits under common law (see Cohen, 1986; Graham *et al.*, 2013). Therefore, we can anticipate differences in the attitude of lawyer CEOs towards the protection of newly introduced trademarks compared to the trademarks which have been in the marketplace for some time. More specifically, such executives may see little benefit in investing financial resources in protecting a trademark (provided that the formal protection is costly enough) which has been well established and recognised in the marketplace and whose use by the current owner is unlikely to be disputed by competitors. Based on this intuition and the evidence above, the following hypotheses are proposed:

Hypothesis 1 (a): *CEO legal orientation is positively related to the number of patent applications.*

Hypothesis 1 (b): *CEO legal orientation is positively related to the number of innovation-based trademark applications.*

Hypothesis 1 (c): *CEO legal orientation is negatively related to the number of reputation-based trademark applications.*

Second, intellectual property protection can also be viewed as an economic incentive for individuals to engage in inventive activities by ensuring a financial reward to their productive effort (e.g., Dosi, 1988; Greenhalgh and Rogers, 2010; Landes and Posner, 2009; Menell and Scotchmer, 2007; Scotchmer, 2004). Succinctly put, a fundamental problem pertaining to the production of knowledge – or any other creative work – is that once developed, it enters the public domain where it can be relatively easily appropriated by the producer's rivals (Arrow, 1962; Nelson, 1959).[9] One immediate implication of such practice is that whenever the setting is competitive, the stream of R&D investment will be below the socially desirable level, largely owing to the reluctance of an inventor to spend their time and monetary resources on designing an asset which then can be freely accessed by other unrelated parties (Menell and Scotchmer, 2007). To correct this market failure, the state should intervene through, for example, the issuance of intellectual property rights – they effectively grant to the inventor a temporary monopoly that serves as an *ex ante* incentive and enables the inventor to secure private returns to their invention (Besen and Raskind,

[9] In the economic literature, it is commonly referred to as knowledge exhibiting non-excludable and non-rival characteristics (see Stiglitz, 1999).

1991).[10] This outcome is achieved "either by charging through the use of a patent (licensing) or by charging a monopoly price on the product" (Stiglitz, 1999:311); yet, the use of trademarks beyond their original purpose of signalling producer identity and product quality can also results in further rent extraction, especially in service sectors (Mendonça *et al.*, 2004). Furthermore, trademark protection assists in maintaining the integrity of the marketplace because it prohibits "the use of marks associated with particular manufacturers in ways that would cause confusion as to the sources of the goods [... and, therefore, provide more] incentives for firms to invest in activities (including R&D) that improve brand reputation" (Menell and Scotchmer, 2007:1536).

According to the outlined perspective, the successful administration of intellectual property strategy requires senior executives to develop a thorough understanding of the role it plays in enhancing the company's innovation potential. While there may be a diversity of sources to draw this knowledge from, we argue that the proper expertise can be formed following the individual's intimate involvement in science-related discussions, tasks, and projects. To be more precise, the sought-after knowledge and skills can be obtained by studying towards a PhD degree in a field where the intensity of inventive activities is high, such as engineering, technology, or natural sciences (Roach and Sauermann, 2010; Sauermann and Cohen, 2010). Alternatively, working within the academic environment, with its sharp focus on scientific research, or having a professional affiliation with engineering or R&D functions may also contribute towards the perception of intellectual property protection as a key element of innovation development (Barker and Mueller, 2002; Daellenbach *et al.*, 1999; Dietz and Bozeman, 2005).

Previous studies have generally supported this point of view. For example, Kaplan (2008:688) examined 71 telecommunication companies during the period 1982-2001 with the aim to "understand the extent to which CEO attention could help explain heterogeneous firm response to technical change". Her analysis particularly suggests that chief executives with a technical background facilitate patent applications, and this can be explained by their better awareness of the value new technological arenas can generate. Similar results were obtained by Galasso and Simcoe (2011), who controlled for CEO technical education while examining the effect of individual overconfidence on organisational innovation. In turn, Sauermann and Cohen (2010:2149) evaluated 1,707 PhD scientists and came to the conclusion "that researchers' motives matter for innovative performance and that different

[10] Along with providing an incentive for inventive activities, the monopolistic nature of intellectual property rights imposes social costs, including monopoly pricing and slower knowledge diffusion during the period of exclusive rights (Greenhalgh and Longland, 2005). However, the conventional view has been that the cost of incentivising an inventive activity should outweigh the social cost of granting the monopoly.

motives have different effects". More precisely, preferences for intellectual challenge, income, and independence are positively associated with patent applications; however, the desire for responsibility or job security shows a negative association. As for inputs to the innovation process, Daellenbach *et al.* (1999) analysed 57 companies in primary metals and semiconductors industries from 1988 to 1993. They found that chief executives with technical orientation exhibit greater commitment to innovation and, hence, invest more in R&D activities. This is largely consistent with the study's original prediction that the accumulation of technical expertise makes top managers more apt to adopt a favourable stance towards technology initiatives. These results were subsequently confirmed by Barker and Mueller (2002): among other things, their work demonstrates that chief executives with engineering or R&D experience favour more research expenditure, as do those having a degree in science or engineering. Other studies have corroborated the outlined patterns in managerial perception with respect to the innovation process at large (e.g., Datta and Guthrie, 1994; Thomas *et al.*, 1991; Tyler and Steensma, 1998).

Since this perspective puts much emphasis on the generation of new ideas, knowledge, and forms, we will then concentrate here on patents and innovation-based trademarks as the key instruments that can ensure the protection of such output. Therefore, we can conjecture:

Hypothesis 2 (a): *CEO scientific orientation is positively related to the number of patent applications.*

Hypothesis 2 (b): *CEO scientific orientation is positively related to the number of innovation-based trademark applications.*

And third, intellectual property rights can be perceived as a strategic tool that, for example, companies utilise to efficiently communicate with customers, obtain incumbency advantages, as well as shape the market structure (e.g., Al-Aali and Teece, 2013; Andersen, 2004; Davis, 2004; Fisher and Oberholzer-Gee, 2013; Hanel, 2006; Reitzig, 2004). This perspective clearly diverges from the above economic view by admitting the ubiquitous character of intellectual property protection and, as such, seeks to reveal its business and industry-wide implications (Davis, 2004; Ziedonis, 2008). The formation of such a pragmatic approach – and it continues to gain momentum – reflects "a new ecology of competition in which wars once fought for control of markets are now being waged over the exclusive rights to new ideas, innovations, and inventions" (Andersen, 2004; Rivette and Kline, 2000:62). Recognising that, some companies have already made a rather successful attempt not only to integrate intellectual property elements in their corporate strategies, but also to alter the appropriability regime so that it would optimise the value of intangible assets in their portfolios (Fisher and Oberholzer-Gee, 2013; Hanel, 2006; Teece, 1986; Teece, 2006).

On the managerial side, this perspective reveals the necessity for a new generation of CEOs whose profound understanding of the strategic importance of intellectual property rights enables their companies to achieve market leadership and reap the benefits associated with it (Rivette and Kline, 2000). To be even more efficient, such executives should also be capable of adopting a holistic approach to intellectual property protection that, among other things, includes providing extra opportunities to marketing, engineering, and strategy functions, while avoiding a sole focus on its excludability dimension (Conley *et al.*, 2013; Reitzig, 2004).

The presented facts thus lead us to suppose that to comply with such a complex approach to intellectual property protection, chief executives need to have their knowledge bases adjusted so that to incorporate information about how intellectual property can enhance the company's competitiveness and overall performance. As such, we expect that CEOs with a degree in business studies should be better equipped for making the decisions that involve the strategic use of intellectual property protection, since the required knowledge is available in the programme curriculum, especially if we refer to MBA-related courses.[11] The validity of this statement is particularly supported by the observation that "an MBA degree confers a bundle of skills on executives that are sufficiently valuable in the [resource-based view sense ...] to create firm value" (Finkelstein *et al.*, 2009:110). On a more general note, Goldfarb and Xiao (2011) showed that chief executives holding a degree in economics or business studies enter markets with fewer rivals, thus essentially linking this type of knowledge to competitive strategy decisions. As we have already pointed out, professional training can further be complemented or compensated – should it be absent – by the relevant working experience. In this case, we suggest considering marketing or sales functions as potentially fruitful sources of the expertise we are trying to capture.[12] This conclusion is

[11] To verify this statement, we selected 10 universities from which the majority of CEOs in our sample (about 51%) received their MBA degrees, namely: Columbia University, Harvard University, Indiana University Bloomington, New York University, Northwestern University, Stanford University, University of Chicago, University of Houston, University of Michigan, and University of Pennsylvania. We then examined the structure of MBA programmes they offer to determine the courses in the required curriculum which are relevant to intellectual property management. Our results suggest that neither of these programmes contains the course that would explicitly (that is, in its name or description) refer to the subject of interest. Yet, our further analysis suggested that the relevant knowledge can be potentially acquired by studying such core courses as marketing, business strategy, and leadership, or by taking purposely built elective courses. This appears consistent with the study by Segev *et al.* (1999) that provides detailed information on the curriculum structure of 25 leading U.S. business schools in 1993. Obviously, this approach does not take into account curriculum changes that have been implemented over time and resulted in supposedly greater availability of such knowledge for later cohorts. Nevertheless, it still enables us to partly capture the general tendency in this subject area for a given timeframe.

[12] By invoking here marketing or sales (output) functional experience, we effectively assume that it exhibits a similar effect on executives' mindset as having an MBA degree. In other words, such experience may facilitate the strategic use of intellectual property protection, especially when it

largely in line with a study by Gupta and Govindarajan (1984). Based on the analysis of 58 general managers operating at the level of a strategic business unit, they showed that the manager's professional experience in marketing or sales has a positive impact on the effectiveness of the units that intend to increase their market share and achieve superiority over competitors.

So, we can formulate the following hypotheses:

Hypothesis 3 (a): *CEO business orientation is positively related to the number of patent applications.*

Hypothesis 3 (b): *CEO business orientation is positively related to the number of innovation-based trademark applications.*

Hypothesis 3 (c): *CEO business orientation is positively related to the number of reputation-based trademark applications.*

Domain expertise. In this research, we conceptualise the impact of the CEO's domain expertise on intellectual property protection by referring to the generality of their skills and professional experience. According to Murphy and Zabojnik (2004), companies place a much greater emphasis on general managerial ability nowadays than they did a few decades ago.[13] This trend reflects, among many things, the elevation of more problem-solving activities to the upper level; a significant increase in the diversity of functions that CEOs are expected to supervise; as well as the growing complexity of business operations, which creates the need for a well-rounded manager who ensures productive interaction among different stakeholders (see Betzer *et al.*, 2016; Custódio *et al.*, 2013; Ferreira and Sah, 2012). In turn, intellectual property protection represents an area where the communication problem may become especially pronounced. Some anecdotal evidence suggests that along with keen interest in and strategic vision of intellectual property, chief executives who seek to achieve success in its management should also have more general skills and knowledge, such as the recognition of market trends, consumer orientation, and solid expertise in the firm's operations (Rivette and Kline, 2000). Having the ability to share the same language with various functional groups, generalist CEOs can then accept a leading role in integrating intellectual property issues into organisational strategy, thereby reinforcing decisions on market demand by the legal opportunities to exploit the resultant intellectual property (Fisher and Oberholzer-Gee, 2013).

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comes to trademark activities. However, we have to admit that the link between this type of expertise and patent protection is more ambiguous and, as such, is likely to be mediated not by functional subordination or the familiarity derived from day-to-day professional considerations but rather by competitive and market power considerations.

[13] We follow Becker (1962) in defining general skills as being useful in many firms in addition to the one where they were developed. As the same time, special skills have no effect on the individual's productivity in other organisations and, therefore, are of little value outside the source firm.

So far, only a handful of research has actually attempted to examine the diversity of managerial experience and its effect on organisational functioning, including the activities that are usually associated with intellectual property protection. One such example is the work of Custódio *et al.* (2015), who studied the careers of 2,005 executives in 1,464 companies over the period 1993-2003 to identify which managerial skills – general or special – would facilitate corporate innovation. By using patent-based measures to capture the productivity of innovation in an organisation, they showed that companies with generalist CEOs have significantly more patents (and their quality is much higher) compared to those firms where chief executives possess mainly specialised knowledge and skills. A plausible explanation for the observed findings, as the authors put it, is that generalist managers are more apt to pursue new and, therefore, riskier projects because of the awareness that the human capital they have is equally applicable somewhere else should the failure of an innovative project wield a credible threat of dismissal. At the same time, Fisher and Oberholzer-Gee (2013:157) came to a conclusion that companies largely "miss opportunities to create and exploit the value of intellectual property". Their case study analysis attributes such ignorance to the lack of a common framework and even functional silos existing within corporate management as well as to the prevailing opinion that intellectual property issues should be delegated to company lawyers, who are mostly left out from the process of making corporate decision. However, the likelihood of achieving commercial success nowadays is higher for those companies that are able to efficiently link intellectual property activities to the overall business model. The authors thus insist that companies should go beyond traditional organisational structures and adopt a more inclusive approach that allows for "early and continuous interactions between business executives, lawyers, and engineers" (Fisher and Oberholzer-Gee, 2013:175). CEOs with general managerial skills would, according to their reasoning, be more capable of overcoming functional disintegration and building the decision-making framework that puts together various functional competences to deploy intellectual property strategically.

As such, the following hypotheses can be developed:

Hypothesis 4 (a): *CEOs with diverse domain expertise are positively related to the number of patent applications.*

Hypothesis 4 (b): *CEOs with diverse domain expertise are positively related to the number of innovation-based trademark applications.*

Hypothesis 4 (c): *CEOs with diverse domain expertise are positively related to the number of reputation-based trademark applications.*

3.2.4. The interaction effect of managerial characteristics and CEO proactive personality on intellectual property strategy

Following rapid growth in the popularity of formal intellectual property rights (Graham *et al.*, 2013; Hall *et al.*, 2014), the optimal timing for initiating the registration process has become critical to the company's ability not only to secure its competitive position but often to survive in the marketplace. Moreover, neglecting the temporal aspect of intellectual property protection is likely to have an adverse effect on the extent to which organisations can profit from their intangible assets and creativity. For example, it has been suggested that a delay in patent issuance aggravates uncertainty about technological trade, thereby endangering efficiency gains the company would have upon commercialising the invention (Gans *et al.*, 2008). With multiple filings, however, "applicants accelerate grant proceedings for their most valuable patents [... as well as] prolong the battle for such patents if a withdrawal or refusal is imminent" (Harhoff and Wagner, 2009:1969).[14] Time-lagging companies can also suffer from the congestion effect, which is the situation when the desired trademark has already been taken by a rival (von Graevenitz, 2013). This potentially leads to such negative consequences as a reduction in business competitiveness and corporate profits; extra costs and risks associated with the promotion and protection of an alternative brand; and even the company's inability to enter the target market. Overall, as the argument goes, "[c]ompanies that design products first and then search for ways of protecting them face a far narrower set of options" compared to those organisations where the discussion on intellectual property issues is stimulated at an earlier stage of the new product development process (Fisher and Oberholzer-Gee, 2013:175).

Once again invoking Hall's (1992) assertion that chief executives bear ultimate responsibility for the totality of intangible assets, we therefore conjecture that managerial proactiveness should be seen as an important factor that affects the temporal dimension of intellectual property strategy. This proposition is consistent with a more general observation that "effective CEOs are likely to be pro-active with respect to either their environments or the organizations they manage" (House and Singh, 1987:695). But how exactly are proactive individuals different from those who adhere to a more reactive approach to problem solving? According to Crant (2000:43), proactive behaviour can be defined as "taking initiative in improving current circumstances or creating new ones [..., which typically involves] challenging the status quo rather than passively adapting to present conditions". Proactive managers exploit

[14] Firms may also opt to delay patenting an invention to extend the monopoly period (Correia *et al.*, 2014). Yet, this strategy is viable only if certain conditions are met, including low R&D competition, high product market competition, and high patenting costs. Challenging the conventional wisdom that "filing early is better", Kim *et al.* (2016) show that the value of waiting to file a patent application increases under high environmental uncertainty.

asymmetries in the marketplace to obtain first-mover advantage that allows their companies to introduce products or services ahead of the competition, thus achieving earlier brand recognition as well as capturing higher profits (Lumpkin and Dess, 1996; Lyon *et al.*, 2000). As a result, such individuals tend to demonstrate a positive association with personal initiative, innovation and creativity, entrepreneurship, work performance, and professional success (Crant, 2000; Kim *et al.*, 2009; Seibert *et al.*, 2001; Thompson, 2005).

More specifically, previous studies have identified that CEOs with a higher need for achievement pursue broadly focused, marketing-oriented strategies and prefer proactive, analytical decision making (see Miller and Toulouse, 1986a; Miller *et al.*, 1982). Miller and Toulouse (1986b) pointed out that proactiveness, along with risk taking, catalyses commercial success in innovation and helps minimise the chances of strategic stagnation. They also suggested that it "may be associated with more dynamic and ambitious managers who sometimes have spectacular successes – particularly during the early growth phases of their firm's life cycle" (Miller and Toulouse, 1986b:56). In turn, Miller (1983:771) argued that proactiveness represents a distinct characteristic of an entrepreneurial company that "engages in product-market innovation, undertakes somewhat risky ventures, and is first to come up with "proactive" innovations, beating competitors to the punch". However, even in companies where technocrats are deemed to be responsible for the innovation process, he continued, "risk taking and proactiveness are more strongly influenced by the explicitness of product market strategy and the personality of the leader" (Miller, 1983:785). Finally, Parker and Collins (2010) found that the ability of an individual to stimulate innovative and creative activities; to scan the organisation's domain to identify opportunities and threats; and to keep abreast of major trends and developments that may affect corporate performance – all this is positively related to proactive behaviour aiming to change either the internal organisational environment or the organisation's fit with the external environment.

As Bateman and Crant (1993) showed, the proactivity trait is not necessarily related to mental ability. Given that, our approach to revealing the effect of proactiveness on intellectual property strategy will consist in considering its interaction with the four elements of managerial personality. Based on this reasoning, we derive the following hypotheses:

Hypothesis 5 (a): *CEO proactive personality positively moderates the relationship between CEO characteristics and the number of patent applications.*

Hypothesis 5 (b): *CEO proactive personality positively moderates the relationship between CEO characteristics and the number of trademark applications.*

3.3. DATA AND METHODS

3.3.1. Sample and data collection procedure

The preceding hypotheses are tested using a longitudinal sample that includes U.S. publicly-traded companies observed over a 22-year period. A multistage approach was adopted to construct the final panel. We started with linking the Standard & Poor's ExecuComp dataset to the Standard & Poor's Compustat North America dataset. In the merged sample, we retained only those companies that had complete observations for the entire period of interest as well as CEO-related information for each year. As we were working with financial statistics from different years, we also adjusted all monetary variables to constant 2009 U.S. dollars by applying the GDP deflator obtained from the U.S. Bureau of Economic Analysis. Next, we hand-collected CEO demographic data by analysing a variety of sources, including Marquis Who's Who directories; the Bloomberg database; the BoardEx database; firms' SEC filings, press releases, and official web-sites; and CEOs' LinkedIn profiles, university yearbooks, and obituaries. This information was subsequently added to the sample by using the chief executive's full name and employment year to correctly match cumulative indicators.

A separate procedure was conducted to obtain and link the data on patent and trademark applications.[15] First, we extracted trademark statistics from the USPTO Trademark Case Files dataset (Graham *et al.*, 2013). Due to the absence of a unique identifier that would allow us to match this information to the rest of our data, we chose to focus on company names – an approach widely used in research on intellectual property rights (see Thoma *et al*., 2010). More specifically, for each company we determined the most distinguishing element in its name and then searched for this element in the entire trademark dataset, simultaneously controlling for such parameters as country, state, city, and address to minimise false positives (Raffo and Lhuillery, 2009). To further ensure data consistency and comparability, we dropped observations with missing owners, non-U.S. owners (based on both the owner's address and nationality), and the owners who were individuals. The trademarks for which the class type was missing were excluded, too. Although much effort was also given to reducing the number of false negatives, there is still a small chance that changes in a firm's name or non-captured name variations could result in unidentified matches. Yet, it is our contention that this limitation has no significant influence on our ability to capture the company's overall trademarking behaviour. Finally, the sample construction was

[15] It should be noted that in this research, we use filing year for both patent and trademark applications because this method allows us to better trace the link between CEO heterogeneity and the company's decision to formally protect its intellectual property. However, among all applications, we account only for those that were eventually registered in order to avoid capturing the artefacts largely pertaining to the registration process.

completed by essentially replicating the same procedure for patent statistics, which were derived beforehand from the OECD patent-related datasets.[16]

Overall, our final sample comprises 5,742 firm-year observations of 848 CEOs in 261 U.S. publicly traded companies from 39 industries between 1992 and 2013.[17] For these companies we were able to identify 394,201 patent and 44,526 trademark applications – this is approximately 20% and 2% of all applications filed with the USPTO over the designated timeframe, respectively.

3.3.2. Dependent variables

Although intellectual property strategy can take a variety of different forms, here we primarily focus on the company's patent and trademark activities as its most notable manifestations. In doing so, we first calculated the number of patent applications filed by the company in a given year (*invention protection*). This indicator aims to capture the company's ongoing effort to protect its creative output by officially claiming the right to the invention.[18] Our next dependent variable comprises the sum of (i) trademark applications filed under the "intent to use" basis; and (ii) trademark applications filed under the "use" basis, but firstly used in commerce within one year before the date of filing (*new product identity protection*).[19] We constructed it in response to the observation that certain trademarks come

[16] Since the patent statistics necessary for our analyses were dispersed among different databases, we first had to merge them with each other. We started with the OECD HAN database (September 2016 edition), from which the assignee names for every patent application were derived; we then used the application identifier to link each entry to the OECD Patent Quality Indicators database (March 2017 edition; see Squicciarini *et al.*, 2013). The last step was done to obtain an application's filing year as well as to reconfirm that it resulted in the patent grant at some point. Finally, we only selected applications that were submitted to the USPTO, due to comparability reasons.

[17] In this study, we use the Fama-French industrial classification (see Fama and French, 1997). As for the observation period, its lower bound was determined by the data availability on executive compensation in the Standard & Poor's ExecuComp dataset. The upper bound was chosen to minimise selection bias caused by the completeness of the available patent and trademark statistics as well as the discrepancies in time to issuance across different intellectual property rights (see Graham *et al.*, 2013; Hall *et al.*, 2001).

[18] It should be noted that an inventor is always an individual who can subsequently assign his patent rights to a legally formed entity. Furthermore, U.S. patent law used to adhere to the first-to-invent principle, which demanded to award patent rights to the first inventor; in theory, this allowed for some flexibility regarding the actual need to file a patent application. However, with the introduction of The Leahy-Smith America Invents Act in 2011, the U.S. patent system switched to the first-to-file regime, where patent rights are granted to the first person who filed a patent application (for more details on the two systems, see Frost, 1967).

[19] In the U.S., The Trademark Law Revision Act of 1988 expands the grounds on which trademark registrations are permitted. It introduces a provision that a trademark is also eligible for federal protection if the registrant can demonstrate a bona fide intent to use it in commerce. According to USPTO (2014:19), "having a business plan, creating sample products, or performing other initial business activities may reflect a bona fide intent to use the mark". One may argue that some

to existence following the underlying innovation process (see Mendonça *et al.*, 2004); as such, they tend to mimic the company's strategy to secure the brand identity of a newly created good or service. As far as the augmentation is concerned, this was necessary to account for the still innovative nature of those trademarks that had been introduced in the marketplace shortly before seeking federal protection.[20] Finally, we also counted the number of trademark applications filed by the company under the "use" basis and which had been in commercial operation for more than one year before the application date (*acquired reputation protection*). We argue that this variable particularly corresponds to the company's intention to further protect the reputation gained by the product over its lifetime from the potential damages caused by the unfair actions of competitors.

3.3.3. Explanatory variables

Resource expertise. The managerial attitudes towards intellectual property protection devised earlier was captured by concentrating on a range of activities undertaken by chief executives, separately or in combination, that would likely to induce the development of the sought after knowledge, skills, and values. More specifically, *CEO legal orientation* was assessed by a dummy variable that takes the value of one for the chief executive with (i) a degree in legal studies (e.g., law or taxation), and/or (ii) previous professional experience in the legal function (e.g., law or compliance), and zero otherwise. The way this measure is constructed appears to be consistent with previous studies looking at educational and professional backgrounds to identify lawyer CEOs (see Henderson *et al.*, 2017; Lewis *et al.*, 2014; Priest and Krol, 1986). In turn, *CEO scientific orientation* was operationalised as a dummy variable that takes the value of one for the chief executive with (i) a PhD degree in engineering, technology, or natural sciences; (ii) academic research experience; and/or (iii) previous professional experience in the engineering or R&D functions. Finally, *CEO business orientation* was determined based on a dummy variable that takes the value of one for the chief executive with (i) an MBA degree, and/or (ii) previous professional experience in the marketing or sales function.

Domain expertise. To proxy domain expertise – or, more precisely, its diversity – we chose to follow the approach proposed by Custódio *et al.* (2013) and calculated the so-

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trademark applications filed on the "intent to use" basis may correspond to the effort of a newly created firm to protect its brand identity. Sharing this criticism in general, it seems to be less applicable to the companies in our sample due to their long-standing presence in the marketplace.

[20] We tested different cut-off years (e.g., 0, 1, 2, and 3 years since the first use in commerce; see Appendix 3.A, Table 3.A.1); despite these alterations, the results were still largely consistent across all the specifications. We chose to adopt the one-year cut-off method because it allows us both to trace the CEO-trademark link and to capture the trademark's association with the new product development process.

called *general ability index*. The inclusion of this measure in our analysis relates to the necessity to capture "the skills of the CEO that are transferrable across firms and industries, instead of being firm-specific" (Custódio *et al.*, 2013:474). Particularly, it incorporates such elements as (i) the number of industries, (ii) the number of companies, and (iii) the number of positions in which the chief executive worked during their professional careers; as well as (iv) their previous CEO experience at another company. To combine these elements together in a one-dimensional index, we employed principal component analysis (see Appendix 3.B for more details on how the index was compiled). As a result, each executive in our sample was assigned a score derived according to the following formula:

$$GAI_{i,t} = 0.214 * Y_{1,i,t} + 0.594 * Y_{2,i,t} + 0.202 * Y_{3,i,t} + 0.010 * Y_{4,i,t}, \qquad (1)$$

where $Y_{1,i,t}$ is the number of industries CEO_i had worked in until year t; $Y_{2,i,t}$ is the number of companies CEO_i had worked for until year t; $Y_{3,i,t}$ is the number of positions CEO_i had worked in until year t; and $Y_{4,i,t}$ is a dummy variable that takes the value of one for the chief executive with previous experience in the CEO functions at another company, and zero otherwise. Similar to Custódio *et al.* (2013), we classify as generalists those chief executives whose score is above the yearly median, while the rest are deemed to be specialist CEOs.

Proactive personality. The method for identifying proactive CEOs we propose in this study relies on the observation made by Bateman and Crant (1993:107) that "high-proactive individuals would have major achievements of a kind different from those of low-proactive individuals. [...] Some achievements are proactive in the sense that they represent intentional constructive change". This is consistent with the work of Miller and Toulouse (1986a), which showed that chief executives with a higher need for achievement pursue more analytic and proactive strategies. Therefore, we proceeded with examining professional awards, honours, and other achievements and prizes received by each chief executive over their lifetime to reveal proactive individuals. We first divided them into six groups, namely: (i) the awards that emphasise leadership (e.g., "Leadership Award"; "Business Leader of the Year"); (ii) power and influence-related awards (e.g., "World's Most Powerful Business Person"; "Power and Influence Top 50 Hall of Fame"); (iii) the awards that highlight vision and inventiveness (e.g., "Vision for America Award"; "Leadership in Innovation Award"); (iv) position-related awards (e.g., "CEO of the Year"; "Executive of the Year"); (v) professional awards and the awards that emphasise entrepreneurial talent (e.g., "Outstanding Insurance Executive"; "Entrepreneur of the Year"); and (vi) other honours and prizes (e.g., "Lifetime Achievement Award"; "Distinguished Service Award").

Similar to the general ability index, we then utilised principal component analysis to derive the following formula for calculating proactivity scores (see Appendix 3.C for more details on the measure construction):

$$PRO_i = 0.218 * X_{1,i} + 0.082 * X_{2,i} + 0.163 * X_{3,i} + 0.280 * X_{4,i} + 0.236 * X_{5,i} + 0.200 * X_{6,i}, \quad (2)$$

where $X_{1,i}$ is the number of awards received by CEO_i that highlight leadership; $X_{2,i}$ is the number of awards received by CEO_i that highlight power and influence; $X_{3,i}$ is the number of awards received by CEO_i that highlight vision and inventiveness; $X_{4,i}$ is the number of position-related awards received by CEO_i; $X_{5,i}$ is the number of awards received by CEO_i that highlight professional and entrepreneurial achievements; and $X_{6,i}$ is the number of other honours and prizes received by CEO_i.[21] Therefore, we expect CEOs with larger scores to be more proactive with respect to their organisations and outer environments, which should also have an impact on their attitude towards intellectual property protection.

The implicit assumption behind the above measure is that it corresponds to *ex post* public recognition and endorsement of the transformational effects that proactive executives had on their organisations, industries, and society at large. This logic is generally consistent with previous studies on proactive personality and behaviour. For example, the already mentioned work of Bateman and Crant (1993) developed a self-report scale to measure individual proactivity, which was subsequently tested for validity by assessing its relationship with the "Big Five" personality factors, three personality traits, and three criterion measures. The results suggest, *inter alia*, that the proactivity scale demonstrates a strong association with the need for achievement and dominance, as well as with transformational leadership. More importantly, the latter was measured via peer nominations – an approach that essentially represents a simplified version of what we are proposing here. However, it should be noted that a fairly similar method has been widely used for identifying "superstar" CEOs. That is, by treating prestigious business awards as a shock to the CEO status, Malmendier and Tate (2009) showed that award-winning executives subsequently had lower relative performance, demanded higher compensation, and spent more time on activities outside their companies. Although our measure of proactive personality resembles Malmendier and Tate's (2009) indicator, it is far more inclusive. Being relatively unconstrained by the extent of media coverage or the prestige of an award-giving organisation, we make use of a diverse range of awards, prizes and honours that correspond to different sides of the chief executive's proactive personality, thus also altering the interpretation of the index.

[21] Given that the absolute majority of the observations in our dataset have missing values on the award year, we were unable to proceed with the construction of a dynamic index. Instead, we had to settle for a time-invariant measure of individual proactivity. This limitation compels us to admit that the measure may not quite capture the development of the proactive disposition (see Bandura, 1986).

3.3.4. Control variables

Individual-level controls. In line with previous work, we controlled for other managerial factors that could possibly have an impact on intellectual property strategy. Firstly, we included *CEO tenure* to account for the evolution of the chief executive's perception biases and values over their time in office (Finkelstein *et al.*, 2009; Hambrick and Fukutomi, 1991; Miller, 1991). The variable was obtained by taking the difference between the observation year and the year in which the individual was appointed to the CEO position; furthermore, we added its squared term to allow for potential nonlinearities (Wu *et al.*, 2005). To capture the effect of company-specific knowledge and its presumed association with the outcomes of the innovation process at large (Balsmeier and Buchwald, 2014), we distinguished between chief executives who were hired from the outside and those promoted from within. For the former group, we constructed the *external hire* dummy that takes the value of one if the individual was appointed to the CEO position a year or less since joining the company, and zero otherwise (Brick *et al.*, 2006; Gillan *et al.*, 2009). Since the latitude of action afforded to managers significantly depends on internal forces (Hambrick and Finkelstein, 1987; Wangrow *et al.*, 2015), we controlled for the ability of CEOs to influence organisational adaptation. In doing so, we checked whether the chief executive doubled as the board chair or not, and subsequently introduced the *CEO duality* dummy (Galasso and Simcoe, 2011). The level of managerial discretion that stems from having a share in the company's equity was captured by the *CEO ownership* variable, which refers to the percentage stock ownership held by the chief executive (Wu *et al.*, 2005). Finally, we also controlled for the incentive effect that *CEO option pay* may have on decision making by including the natural logarithm of the monetary value of option grants to the chief executive in the observation year (Lerner and Wulf, 2007; Wu and Tu, 2007); as well as for the potential differences existing between men and women in risk perception by adding a *CEO gender* dummy that takes the value of one if the chief executive is male, and zero otherwise (Kruse and Thompson, 2003; Schubert *et al.*, 1999).

Firm-level controls. Our choice of company-specific controls was guided by the empirical studies that have made extensive use of patent and trademark statistics. The *firm size*, operationalised as the logarithm of the total number of employees, was included to account for the critical differences which have been previously observed between large and small companies, especially when it comes to the availability of financial resources; the motives to seek intellectual property protection; and the costs of generating new patents and trademarks (Block *et al.*, 2015; Hall and Ziedonis, 2001). *Firm age* was obtained by subtracting the year to which the company traces its origin from the observation year. This indicator was used to control for the company's accumulated experience in managing intellectual property strategy (Hall and Ziedonis, 2001). Moreover, depending on the phase of the life cycle, companies may change their perception of the value they place on certain intellectual property rights, with a corresponding effect on their creation and acquisition (Block *et al.*, 2015). To capture the allocation of resources among the activities that are tightly intertwined with intellectual property strategy, we initially intended to utilise the statistics on advertising and R&D expenditure. However, the both measures contained a significant number of missing values; so, we instead decided to proceed with an alternative proxy that refers to *selling, general, and administrative expenses* scaled by total assets (Knoeber, 1986). We also augmented the base specification with variables that reflect the company's prior financial performance. Particularly, we added *return on assets* (ROA), which was calculated as the ratio of income before extraordinary items to total assets (to limit outliers, it was winsorized at -1 and +1); as well as *book leverage* that represents the ratio of long-term debt plus current liabilities to total assets (Custódio *et al.*, 2015).

3.3.5. Model formulation and estimation

Before describing the estimation strategy, it is necessary to examine the distributional characteristics of our dependent variables. Since the number of successful patent or trademark applications filed by a company is a count variable, with an abundance of zeros, we can approximate it by using a distribution from the family of discrete probability distributions (Hausman *et al.*, 1984). More specifically, our choice is restricted by either its Poisson or negative binomial forms. The decision as to which distribution to utilise largely depends on whether the equidispersion property holds for the data under consideration or not. To verify this, we performed the test proposed by Cameron and Trivedi (2005) and checked if the conditional variance actually equals the conditional mean. The results of the test provide strong support for the presence of overdispersion in both dependent variables. Therefore, the statistical inference that relies on the Poisson distribution would generate overly optimistic or even erroneous estimates (Cox, 1983; Dean and Lawless, 1989; Paul and Plackett, 1978). Based on this conclusion, we chose to proceed with the negative binomial distribution – it essentially is a generalised version of the Poisson distribution, with a stochastic component included to handle the overdispersion problem (Greene, 2003; Greene, 2008; Hausman *et al.*, 1984).

The probability density function can then be formalised in the following way (adapted from Allison, 2009):

$$f(y_{i,t}) = P(Y_{i,t} = y_{i,t}) = \frac{\Gamma(\theta + y_{i,t})}{\Gamma(\theta)\Gamma(1 + y_{i.t})}\left(\frac{\lambda_{i,t}}{\theta + \lambda_{i,t}}\right)^{y_{i,t}}\left(\frac{\theta}{\theta + \lambda_{i,t}}\right)^{\theta}, \quad (3)$$

where $y_{i,t}$ is the number of patent/trademark applications filed by firm *i* in period *t*; $\lambda_{i,t}$ is the expected value of $y_{i,t}$; θ is the overdispersion indicator; and $\Gamma(\cdot)$ is the gamma function. In turn, the expected value of $y_{i,t}$ can be represented by the log-linear function written as:

$$log\left(\lambda_{i,t}\right) = \mu_t + X^{i}_{j,t-1}\beta_1 + M_{i,t-1}\beta_2 + \zeta_i + \eta_h + \tau_t, \quad (4)$$

where $\lambda_{i.t}$ is the expected number of patent/trademark applications filed by firm *i* in period *t*; μ_t is the intercept which can vary, depending on the observation period; $\mathrm{X}^{\mathrm{i}}_{\mathrm{j,t-1}}$ is the vector of CEO-specific variables and controls for CEO *j* in firm *i* in period *t-1*; $\mathrm{M}_{\mathrm{i,t-1}}$ is the vector of firm-specific controls for firm *i* in period *t-1*; ζ_i denotes unobservable time-invariant firm-specific effects for firm *i*; η_h denotes unobservable time-invariant industry-specific effects for industry *h*; and τ_t denotes year-specific effects to control for unobserved aggregate shocks. All independent variables are lagged by one period to minimise any potential simultaneity bias.[22]

The next decision to make is whether a fixed or random effects specification should be given a priority. On the one hand, the random effects model is considered to be more efficient because it uses fewer degrees of freedom, thus allowing for greater generalisability of the results; yet, it may suffer from the inconsistency caused by the omitted variable problem. On the other hand, the fixed effects model draws on the within-group variation over time and, as a result, generates consistent estimates in the presence of unobserved heterogeneity (Greene, 2003). One way to determine which model is more appropriate, given the data at hand, would be to apply the specification test developed by Hausman (1978). In doing so, we would have to utilise the fixed effects negative binomial model which rests on a conditional likelihood method proposed by Hausman *et al*. (1984). However, the validity of this model has been challenged on the grounds that "the conditional maximum likelihood estimator of the negative binomial with fixed effects does not necessarily remove the individual fixed effects in count panel data" (Allison and Waterman, 2002; Guimarães, 2008:66). This leaves us with no other option to pursue for a formal testing of the model specification when it comes to a suchlike model class.[23] In order to circumvent this problem as well as to address the outlined methodological criticism and to reinforce the robustness of our results, we decided to adopt the unconditional negative binomial model with directly estimated fixed effects (Allison, 2009). But instead of including a dummy variable for every

[22] This can also be interpreted as the period of time required for preparing a formal application before it can be submitted to the USPTO.

[23] Nevertheless, we still decided to experiment with Hausman' (1978) test after modifying our dependent variables via the log transformation. According to its results, the random effects specification should be used for all models because we could not reject the null hypothesis that the difference in coefficients is not systematic.

company in our sample, we used the mean scaling estimator developed by Blundell *et al.* (1999). The main advantage of this approach is that it "relaxes the strict exogeneity assumption and provides consistent estimates under the weaker assumption of predetermined [... regressors], as long as the first moments of the data are stable" (Galasso and Simcoe, 2011:1476). The estimator was calculated as the 5-year pre-sample mean of the number of patent or trademark applications filed by a company, depending on the model. We also experimented with longer pre-sample periods (up to 9 year) but found no significant differences in the obtained results (see Appendix 3.A, Table 3.A.2).

3.4. RESULTS

Tables 3.1 and 3.2 contain the descriptive statistics and the correlation matrix for the study variables, respectively. On average, companies in our sample file around 69 patents to protect inventions; 6 trademarks to protect new product identity; and 2 trademarks to protect acquired reputation. The managerial dimension of the data suggests that the average chief executive stays in office for about 8 years and then moves to another position or retires. In two-thirds of the cases, companies also appoint their CEOs to serve as the board chairman. When there is a turnover in leadership, an internal candidate is likely to be promoted, which is evident from only 16% of the sampled executives having been hired from outside the company. For more than a half of the CEOs, their compensation package includes the value of stock option grants. In turn, owner-managers concentrate mainly in the upper quartile and hold, on average, 2% of the company's equity. Roughly a half of the chief executives in our sample have business orientation. At the same time, legal and scientific orientations are relatively rare, with just around 13% and 20% of the managers included in each of these categories. Finally, correlation coefficients between variables show that CEO tenure is significantly correlated with CEO ownership. To address potential multicollinearity concerns, we calculated the variance inflation factor with the independent variables from our basis models (see Appendix 3.A, Table 3.A.3), and this revealed no obvious problems.

Patent applications. Table 3.3 presents the results of the statistical analysis relating CEO personal traits to the protection of inventions. They offer strong support for the contention that managerial characteristics partially predict the company's patenting behaviour. We have particularly found that chief executives with legal, scientific, and business orientations tend to facilitate patent applications, though the positive effect of having a lawyer CEO is more than twice as large as that of a science or business-oriented manager (Hypotheses 1a, 2a, and 3a are confirmed). Our analysis also shows that chief executives with more general skills favour invention protection (Hypothesis 4a is confirmed), as do more proactive top managers. However, when it comes to the moderating role of individual proactivity, it manifests itself in a somewhat different manner than expected. The results here suggest that for CEOs with legal or business orientation, greater proactiveness lowers the positive impact these background characteristics have on the number of patent applications. Proactiveness in chief executives with a background in scientific research or engineering, in turn, further enhances the protection of inventions (Hypothesis 5a is partially confirmed). As for CEO-level controls, it is worth mentioning that a higher level of CEO ownership dramatically reduces the company's effort to protect its inventive output.

Innovation-based trademark applications. Table 3.4 reports the results of the regression analysis that links CEO characteristics to the protection of new product identity. For this facet of intellectual property strategy, we have revealed that managerial factors have a fairly limited impact. More specifically, it appears that firms managed by chief executives with scientific orientation file fewer trademark applications that protect the identity of new products, although the effect is only marginally significant. At the same time, having a CEO with a legal or business background as well as a generalist manager does not entail any visible changes in this type of intellectual property protection (Hypotheses 1b, 2b, 3b, and 4b are not confirmed). Similar to patent activities, there are positive effects on the number of innovation-based trademark applications stemming from proactive CEOs in general and also from those managers who combine this trait with scientific orientation. In turn, greater proactiveness is likely to reduce the positive impact, albeit not statistically significant, of business orientation on the protection of new product identity, while enhancing the negative impact of having a chief executive with legal expertise (Hypothesis 5b is partially confirmed). Interestingly enough, most of the CEO-induced variation in new product identity protection is explained by differences in executive gender, the level of managerial discretion, and the equity share that managers have in their company. To ensure that our results are not driven by the method we applied to construct the dependent variable, we re-estimated all the empirical models using alternative specifications. For example, we confined the dependent variable to just trademark applications filed on the "intent to use" basis, as well as experimented with the augmentation that accounts not only for applications filed on the "use" basis within one year, but also within two and even three subsequent years (see Appendix 3.A, Table 3.A.1). Evidently, none of these changes was strong enough to affect the final results.

Reputation-based trademark applications. Table 3.5 shows the results of the statistical analysis that assesses the role of managerial characteristics in the protection of acquired reputation. According to it, lawyer CEOs as well as chief executives with a scientific or business background have a negative impact on the number of reputation-based trademarks (Hypothesis 1c is confirmed; Hypothesis 3c is not confirmed), and the positive effect of having a top manager with mainly general skills is not statistically significant (Hypothesis 4c is not confirmed). Similar to the findings for other elements of intellectual property strategy, proactive executives tend to encourage the protection of distinctiveness that brands acquire during their time in the marketplace. Furthermore, greater proactiveness leads to a change in the attitude of scientist CEOs towards reputation protection from negative to positive. As for managers with legal or business orientation, their proactive personality partly offsets the negative influence they have on the number of reputation-based trademarks; yet, its magnitude is not large enough to revert the effect

(Hypothesis 5b is partially confirmed). It should be noted that managerial controls yield valuable results, too. For example, CEO gender constitutes one of the strongest predictors of the variation in the protection of acquired reputation, whereas owner-managers significantly limit this protection, as do chief executives who were hired externally. To clarify whether the patterns we have observed so far are due to the protection of brand identity in newly entered or existing markets, the dependent variable was recalculated to exclude trademark applications filed in new product classes.[24] The results of this analysis closely match our basis estimates, except for scientific orientation which loses its significance when alternative measures are considered (see Appendix 3.A, Table 3.A.4). Therefore, we can conclude that the identified effects originate mainly from trademark activities in existing product markets and are less affected by the company's diversification strategy.

The effect of external environment. The managerial discretion literature holds that along with personal characteristics and internal forces, the industry task environment also plays a critical role in determining the chief executive's latitude of action (see Wangrow *et al.*, 2015). In the context of our study, this implies that the variation in demand for intellectual property protection across economic sectors can actually leave senior managers with fewer options regarding the acquisition and subsequent strategic use of patents and trademarks, let alone the fact that some of these instruments are not actually feasible in certain industries (Greenhalgh and Rogers, 2010). To gain more insight into the moderating effect of external environment, we additionally performed a subsample analysis that examines the role of managerial characteristics in industries with a supposedly different propensity to file a patent or trademark application (see Appendix 3.A, Table 3.A.5). The main conclusion we can draw from this analysis is that CEO cognitive bases and values are still an important predictor of the company's intellectual property strategy. However, in line with the managerial discretion theory, the magnitude, statistical significance, and the direction of the effects of some parameter estimates do depend on industry characteristics. To be more specific, the impact of managerial characteristics on the protection of inventions in high-tech industries is marginal and primarily associated with the positive effect of CEO business orientation on the number of patent applications. Regardless of the industry in which the company operates, the protection of new product identity will still be facilitated by proactive executives. Our findings also show that generalist CEOs favour innovation-based

[24] In doing so, we looked at a three-year period to determine the degree of "newness". That is, we accounted only for the trademark applications that were filed in the product classes used, at least once, in the past three years prior to the application year. For multiclass applications, all product classes had to satisfy this selection criterion. We also experimented with different time periods, including one and two years prior to the application year (see Appendix 3.A, Table 3.A.3). Despite these changes, the results were still very similar to those obtained from the baseline model.

trademark applications in high-tech sectors, as do chief executives with scientific orientation in service industries. Finally, there appears to be no statistically significant effect of executive characteristics on the protection of acquired reputation for companies in the service sector. CEOs with scientific and engineering expertises, in turn, have a positive attitude towards this dimension of intellectual property strategy, yet the effect is statistically insignificant.

3.4.1. Robustness checks

The empirical results presented above suggest that managerial characteristics have a notable impact on intellectual property strategy. To ensure that this conclusion is not sensitive to modifications of the baseline model, we have performed several robustness checks. We started with verifying that the main findings hold when we vary the assumption about the underlying distribution of our dependent variables, as well as in the method we adopt to estimate standard errors. As Table 3.A.6 in Appendix 3.A shows, the results are generally consistent across different specifications, though the models based on the Poisson distribution yield slightly different estimates. We attribute these differences to the overdispersion problem, since the parameter Alpha is much greater than zero. As expected, clustering standard errors at the company level leads to a reduction in the significance level. Alison (2009) also acknowledges this problem when estimating true confidence intervals in unconditional negative binomial models. His proposed solution, which we follow, refers to the adjustment of standard errors by using the outer product of the gradient. The efficiency of this approach is supported by a series of Monte Carlo simulation showing that after applying this correction, "the actual coverage rates [... gets] very close to the nominal 95% confidence intervals for nearly all conditions" (Allison, 2009:64). Furthermore, we verified the suitability of this method for our data by examining the model specification with only firm-level controls and industry fixed effects. The outcomes we have obtained (see Models 1.1, 2.1, and 3.1) are generally in line with previous studies that utilise patent and trademark statistics, thus reinforcing our choice.

A very simplistic interpretation of our results is that CEOs, having certain personality traits, determine intellectual property strategy. Another way of looking at it is to suppose that individuals are drawn to, and advance within, professional settings that provide a better match to their knowledge, skills, and career aspirations (Hambrick, 2007). For example, chief executives with significant experience in intellectual property management might be attracted to companies that make an extensive use of patents and trademarks, thereby exerting a further impact on this strategy. To address the problem of self-selection, we followed a testing method developed by Hirshleifer *et al.* (2012) and restricted our initial sample to the firm-year observations that are associated with longer-tenured chief executives. The basic intuition here is that the chief executive's cognitive bases and values are relatively persistent, unlike intellectual property strategy, which tends to vary over time in response to internal and external pressures. We can then expect that the strength of the matching effect will gradually decline as executive tenure progresses. To verify this, we re-estimated our basis models using different cut-off dates for CEO tenure, ranging from three to five years (see Appendix 3.A, Table 3.A.7). The results of this check indicate that our findings are unlikely to suffer from the endogenous matching of chief executives with certain characteristics to firms that pursue active intellectual property management because the personality traits under consideration are still consistent and significant, no matter how long the CEO has been in office.[25]

Another way to evaluate whether self-selection poses a threat to the validity of our results is to look at the supply of jobs. This approach is based on the assumption that when the labour market is tight, employees have lower chances to find a post that best suits their knowledge and experience, accepting instead an inferior option available at the moment. So, the impact of this choice on organisational functioning is likely to be different compared to a situation when individuals can more fully exploit job-matching opportunities. To make practical use of the outlined approach, we draw on the literature examining the effect of economic conditions on managerial careers and styles (e.g., Kahn, 2010; Schoar and Zuo, 2017). More specifically, we first identify individuals who were appointed to the CEO position during economic recession and then look for any striking differences in intellectual property strategy associated with them, which would potentially indicate the influence of job matching. Similar to the study by Schoar and Zuo (2017), we classify as a recession year those calendar years that either include the trough of a business cycle or fall entirely into a recession period. The data on the U.S. business cycle expansions and contractions were obtained from the National Bureau of Economic Research. Since the statistics were not available for the period after September 2010, we proceeded with using the quarterly GDP figures provided by the U.S. Bureau of Economic Analysis to code calendar years with two or more quarters of declining real GDP as recession years. With only few exceptions related to the effects of CEO business orientation and general skills on the company's trademark activities (see Appendix 3.A, Table 3.A.8), the results are largely consistent across all measures of intellectual property strategy in both recession and non-recession subsamples,

[25] There are two exceptions to this statement that need to be acknowledged. First, the impact of CEO scientific orientation on patent and innovation-based trademark applications becomes insignificant after Year 4 and Year 1, respectively. Second, the impact of CEO market orientation on patent applications becomes insignificant after Year 3. According to the logic of this test, these findings may indicate a gradual decline of the self-selection effect on intellectual property strategy.

thus further reinforcing our conclusion about a weak effect that the endogenous selection might have on our findings.

To address the problem of inertia in strategy adjustment, we tested models with a lagged value of the dependent variable added to the list of controls. Although this method usually results in suppressing the explanatory power of other independent variables (see Achen, 2001), it may still be useful to get some insights into the impact that past intellectual property activities may have on the direction of the current strategy. The analysis confirms that managerial factors continue to be important for determining the company's behaviour in terms of patent and trademark applications (see Appendix 3.A, Table 3.A.9); yet, the level of significance for some variables drops as predicted. Finally, we also experimented with including additional firm and CEO-level controls to capture (i) differences in the company's brand strategy (*Tobin's q*; Rao *et al.*, 2004); (ii) changes in the propensity to patent under the threat of new entries (*capital intensity*; Hall and Ziedonis, 2001); (iii) the potential severity of cash flow shortfalls for creating or acquiring intellectual property rights (*cash holdings*; Custódio *et al.*, 2015); (iv) the accumulation of firm-specific knowledge (*company tenure*; see Finkelstein *et al.*, 2009); (v) the effect of cohort differences on individual cognition and the probability to receive an award (*CEO age*; Hambrick and Mason, 1984); and (vi) the impact of founding executives (*founder CEO*; Gedajlovic *et al.*, 2004). Despite these alterations, our results still hold, therefore suggesting that the findings we have observed are primarily driven by the chief executive's traits (see Appendix 3.A, Tables 3.A.9 and 3.A.10).[26]

[26] To ensure that the approach we have developed to construct the proactivity index does not affect the results of our analysis, we also run separate regressions for each of the index's constituent elements (see Appendix 3.A, Tables 3.A.10 and 3.A.11). Clearly, the by-component analysis tends to be broadly consistent with the outcomes obtained by using the index, which fact additionally reinforces our conclusion regarding the reliability of the proposed proactivity measure.

3.5. DISCUSSION AND CONCLUSIONS

In this study, we have developed a conceptual framework that links managerial characteristics to intellectual property strategy. The framework suggests that a chief executive's individual orientation – such as legal, scientific, or business – as well as general skills and proactiveness have an impact on decisions made by the company to formally protect its inventive output, the identity of newly developed products, and the distinctiveness acquired by existing products. Based on the analysis of patent and trademark applications filed by 261 U.S. publicly traded companies over a twenty-two year period, we have confirmed that the personal characteristics of CEOs are significant in guiding the firm's strategy regarding intellectual property protection (see Table 3.6 for a summary of the results). This conclusion is largely consistent with other applications of the upper echelons approach that make use of intellectual property statistics (e.g., Galasso and Simcoe, 2011; Hirshleifer *et al.*, 2012; Kaplan, 2008; Wu *et al.*, 2005). Unlike these studies, however, our work shifts the focus to intellectual property per se and perceives it as a legitimate object of strategy making, not merely as an outcome of the innovation process. Overall, these results supplement the existing literature by pointing to executive personality as yet another determinant of organisational strategies, along with firm-level factors and the external environment.

As for concrete findings, we have shown that lawyer CEOs facilitate the protection of inventions, while generally disregarding reputation protection. The former observation represents an important addition to our understanding of the new product development process at large. For example, previous studies have indicated that chief executives with a legal background reduce the amount of R&D expenditure, supposedly due to the lack of knowledge about innovation activities (see Barker and Mueller, 2002). At the same time, our results suggest that lawyer CEOs seem to be aware of the necessity of and, perhaps, benefits associated with patent protection – this argument is usually neglected in the literature. The analysis has also revealed that chief executives with legal orientation limit the intensity of reputation-based trademark applications, which fact goes against both the expected managerial behaviour and an implicitly positive stance on federal trademarks taken by this research. We speculate that such an outcome reflects the better knowledge they have about alternative methods that can be invoked to secure brand value, especially in countries with the common law system. Furthermore, lawyer CEOs are likely to be more capable of anticipating negative consequences that the unwary use of intellectual property rights may lead to, thus trying to avoid excessive engagement with formal trademark protection. Nevertheless, the validity of this argument is still unclear because chief executives with legal experience are found to have no statistically significant impact on diminishing litigation risks that stem from intellectual property infringement (see Henderson *et al.*, 2017).

It comes as little surprise that CEO scientific orientation is positively related to the protection of inventions. The type of expertise we are capturing with this construct helps the chief executive develop a better understanding of the value that creative activities can add to the company's innovation potential and, hence, the need to impose some constraints on the ability of other, non-involved parties to benefit from it. What is actually surprising is that the relationship between senior managers with a scientific background and the number of trademark applications turn out to be negative and statistically significant, no matter whether the protection of new product identity or acquired reputation is considered. This may indicate, among other things, that although being capable of recognising the importance of intellectual property protection at earlier stages of the new product development process, such CEOs actually fail to comprehend value transference strategy, which consists in shifting "the advantages of technical or performance-based customer benefits (originally reserved in patents or copyrights) to trademarks" (Conley *et al.*, 2013:104). Previous studies on executive turnover in high-tech businesses also seem to be broadly in line with this conclusion, pointing to a higher market value of start-ups where founder scientist CEOs were replaced with non-founder entrepreneurial executives (see Braguinsky *et al.*, 2010). In order to verify this proposition, a more sophisticated analysis would be required, including some further adjustments of the trademark measure we have used here.

Similar to the above results, the effect of CEO business orientation on the number of patent applications is generally positive, thereby confirming that the skills and knowledge accumulated by such executives tend to enhance their ability to recognise the strategic importance of invention protection for organisational functioning. When considered under the angle of company value and performance, this conclusion complements previous findings showing that, for example, MBA graduates use more sophisticated valuation techniques and adopt more aggressive strategies than those without such a degree (see Bertrand and Schoar, 2003; Graham and Harvey, 2001). At the same time, it also seems to challenge the idea that business orientation, especially if developed during the schooling period, encourages managers "to pursue short term performance at the expense of innovation and asset building" (see Barker and Mueller, 2002; Hambrick and Manson, 1984:201; Miller and Xu, 2017). Additionally, we have revealed that CEOs with a business background do not fully recognise the advantages that federal trademark protection can offer for securing the company's brand value. In certain situations, they even discourage the use of this legal instrument, as it is for the protection of acquired reputation. In doing so, they closely resemble other executive types and, therefore, may miss out an opportunity to strategically leverage trademark protection so that to aggregate "the reputational aspects of each patented invention or copyrighted expression (limited life) in the trademark (indefinite life)" (Conley *et al.*, 2013:104). Having said that, we should also admit that such behaviour can be perfectly rational from the trademark lifecycle point of view (see Melnyk *et al.*, 2014; Millot, 2009), namely: business oriented executives may simply not be willing to invest in the protection of brands which may soon leave the market.

According to Custódio *et al.* (2015:34), chief executives "who gain more human capital through their lifetime work experience promote more innovation in the organizations that they run". We substantiate this contention further by arguing that such managers are also positively related to the protection of inventions. However, when it comes to securing the identity of goods and services in the marketplace, the breadth of the knowledge, skills, and experience CEOs possess has little influence – this is evident from its statistical insignificance in predicting the number of trademark applications. Taken together, these results should be interpreted in terms of the disparities in risk perception between generalist and specialist managers rather than the ability to integrate and facilitate cross-functional communications at the corporate level: as the literature claims, this would be beneficial for the overall intellectual property strategy. Generalist CEOs are also likely to be more inclined to substitute long-term objectives for short- to mid-term ones, knowing that their expertise is on high demand and they can receive a higher pay premium upon switching jobs (Custódio *et al.*, 2013; Murphy and Zábojník, 2004). If this reasoning is correct, they should not be overly concerned with reputation building because it is often a time and resource consuming process, thus paying lesser attention to trademark protection as well. Finally, chief executives whose skills are transferable across companies and industries may simply not have much organisational knowledge to be fully involved in trademark activities. As our results for externally hired executives show, this type of expertise tends to be important for facilitating the protection of acquired reputation.

Another salient point brought about by this study is that managerial traits have a negligible impact on the number of innovation-based trademark applications, which is in sharp contrast to patent protection. One can interpret this as an indication that applying for trademark protection during the market introduction stage of the product lifecycle is a technical procedure decisions on which is largely delegated to legal departments. In turn, we propose to look at this seeming contradiction under the angle of complementarity between various regimes of intellectual property protection (Amara *et al.*, 2008; Chudnovsky, 1983; Munari and Santoni, 2009). According to Graham and Somaya (2006:22), "when managerial attention is focused on [intellectual property] strategy, there likely exist complementary benefits in multiple areas of intellectual property use". So, if there is indeed little understanding about the complementarity aspect of intellectual property rights on the chief executive's side, as our results may suggest, this can cause the company to lose an opportunity to maximise its profits from innovation and, hence, outperform competitors (Teece, 2006). To confirm this proposition, an analysis that links a pool of patents required for producing a product to the corresponding trademark would be desirable.

The main effect of CEO proactive personality on intellectual property strategy turns out to be positive and statistically significant across all protection mechanisms. Such an outcome confirms the basic premise that proactive individuals would intensify intellectual property protection because choosing an optimal moment for filing a patent or trademark application represents yet another aspect of intellectual property strategy, which also determines its effectiveness. However, the results obtained by interacting the proactivity measure with the components of managerial personality are far less straightforward (see Figures 3.2, 3.3, and 3.4). They can be described in terms of two distinct patterns: on the one hand, personal proactivity may enhance the existing impact that perception biases have on intellectual property protection, whether positive or negative. On the other hand, when proactive, some categories of chief executives may completely change their attitude towards protecting intangible assets. For example, it can be seen that proactive CEOs with a scientific background are associated with more patent and trademark filings than their reactive peers, and trademark protection particularly benefits from this. By contrast, proactiveness in lawyer executives as well as in those managers who have business orientation further reduces the extent of intellectual property strategy.

We can offer at least three plausible explanations for the latter effect. First, CEOs with legal or business orientation may be less immune to the so-called superstar curse (see Malmendier and Tate, 2009).[27] It refers to a decline in organisational performance caused by an upward shift in the chief executive's status after receiving an award. There are multiple reasons behind this decline, including a tendency among such executives to demand higher compensation for their service as well as their greater focus on activities outside the company, not on core business responsibilities. Overall, as Malmendier and Tate (2009:1633) frame it, "increases in CEO power in large corporations can exacerbate agency problems, destroying value for the firms' claimholders". Another explanation is related to the switch in attitude towards invention protection caused by greater proactiveness. The decision to reduce the number of patent applications in this case should not necessarily have a negative connotation. Since there is always the patent-secrecy tradeoff, legal or business-oriented proactive executives may prefer to use secrecy instead of patents to protect influential innovations because they envisage that patent disclosure will likely to increase the risk of imitation (Anton and Yao, 1994; Nicholas, 2013). The drop in patent applications may also be associated with the fact that these individuals are less inclined to pursue opportunistic

[27] This argument is partly due to the method we adopted to identify proactive individuals.

patenting strategy, when companies "file a high number of claims and let the examiner figure out the exact invention, thus shifting additional work to the search or examining division and at the same time generating uncertainty among competitors" (see Berger *et al.*, 2012:218).

Finally, another set of insightful observations regarding the influence of executive characteristics on intellectual property protection can be drawn from our control variables (see Table 3.7 for a brief summary). Consistent with the notion of managerial discretion (see Wangrow *et al.*, 2015), the results show that individuals who simultaneously hold CEO and board chair positions in the same company have a positive relationship with intellectual property strategy, although this effect is statistically significant only for trademark protection. There is also some evidence that trademark protection can benefit from long-term objectives pertaining to founder CEOs as well as their profound knowledge of the companies they manage (see Gedajlovic *et al.*, 2004). However, such executives generally disregard patent protection, and this is despite the contention that in companies where a founder is part of the top management team, there are greater opportunities for innovation (see Block *et al.*, 2013). The relationship between the CEO's company tenure and intellectual property strategy has a curvilinear pattern, thereby confirming the "stale in the saddle" effect documented in previous research (see Hambrick and Fukutomi, 1991; Miller, 1991). Finally, we also have to mention that chief executives owning a larger share of the company discourage both patent and trademark applications – a phenomenon that requires further investigation.

3.5.1. Managerial implications

Overall, this research advocates a complex view of intellectual property protection, particularly regarding it as a range of instruments that a company can use to establish its legal right over intangible assets, to secure the cash flows associated with innovative activities, as well as to strengthen its competitive edge. Recognising that, we have identified several individual orientations that are likely to have a significant impact on how chief executives perceive and, subsequently, deploy various protection methods. The empirical analysis of patent and trademark statistics has provided strong support for our theoretical predictions, thereby confirming the effect of managerial perception on organisational outcomes stressed by upper echelons theory (see Carpenter *et al.*, 2004; Hambrick, 2007; Hambrick and Mason, 1984). As such, this work demonstrates that CEO personality represents yet another factor that affects the integrity of the company's intellectual property portfolio and, therefore, should be taken into account during the process of strategic planning and implementation. With the growing value intangible assets bestow on their owners, our findings can thus assist chief executives and other stakeholders in developing a further understanding of how personality traits can affect the legal protection of creative output.

Along with the conventional point to make regarding the need for aligning executive characteristics with organisational strategies, it is important to draw attention to the trade-off companies may actually face even with the same range of interrelated strategies. For example, there is an opinion that CEOs with a degree in business or legal studies lack the skills necessary to pursue and facilitate innovative activities, as well as may exhibit risk-averse behaviour, thus eventually curtailing R&D spending (see Barker and Mueller, 2002). Without assessing the validity of this argument, which may well be true, this leads to the question of what approach should the company adopt to balance out this effect and preserve the positive impact such executives evidently have on, for example, the registration of new patents? A potential solution may be to leverage the human capital incorporated in the top management team (see Kor, 2006). So, this issue deserves closer attention from organisational leadership, especially in companies where innovative activities are critical for the survival in the marketplace.

3.5.2. Study limitations and avenues for future research

We also have to acknowledge that our approach is likely to have several limitations. For example, when linking chief executives to the outcomes of intellectual property strategy, we assumed a one-year gap between the decision to apply for federal protection and the actual moment of submitting the application to the USPTO. Although we have also tested a model specification with contemporaneous effects and found no significant differences (see Appendix 3.A, Table 3.A.13), there is still a chance that the revealed patterns are partially due to inertia related to the speed with which companies adjust their routines, processes, and strategies following leadership turnover (Smith and White, 1987; White *et al.*, 1994). Another limitation concerns the fact that before seeking intellectual property protection, the firm needs to produce an invention, design, or any other creative output. This effectively implies that the relationship tying together chief executives and intellectual property strategy also depends on previous decisions related to the new product development process in its most general form. Other research hence should examine the data assigning the initial resource allocation to the corresponding good or service and, eventually, to an intellectual property right to provide further sought-after insights. Next, although we have captured certain features of corporate governance (such as the effects of CEO duality and executive compensation), more work needs to be done to study input in intellectual property issues from the board of directors and also other top managers, as well as whether corporate governance arrangements have a significant impact on the CEO's ability to pursue this type of strategy. Finally, our sample is restricted to publicly traded companies, thus raising concerns about potential selection bias. We have attempted to address this limitation, at least to a degree, by controlling for firm size; however, researchers may find it appealing to focus on small and medium enterprises to clarify whether top managers in such organisations demonstrate perceptions and attitudes that are different to what we have observed here.

There are also avenues for further research that do not necessarily stem from the limitations of our approach. First of all, our study concentrates on the two most prominent elements of intellectual property protection – patents and trademarks. To obtain a more complete picture, it would be interesting to examine copyrights, industrial designs, and geographical indicators in order to identify executive biases associated with these instruments. Future work should also elucidate the role of managerial preferences and attitudes in guiding the company's choice to switch from formal to alternative, often informal protection methods, such as secrecy, lead time, complexity, and confidentiality (see Hall *et al.*, 2014; Keupp *et al.*, 2009). This can potentially help us understand whether the decision to reduce the number of patent or trademark applications is caused by a managerial preference for informal protection or whether this is just a result of inattention to intellectual property issues from the chief executive's side. It has also been argued that organisational arrangements can make it easier for the company to integrate and successfully execute intellectual property strategy (see Al-Aali and Teece, 2013; Reitzig, 2004). Therefore, the effect of organisational type on the CEO's involvement in intellectual property management warrants more extensive evaluation. Finally, we have shown that the cognitive bases and values of chief executives affect the trajectory of intellectual property strategy. A logical question that follows, deserving further exploration, is does this cause any differences in firm performance, given the value of intangible assets and their importance for organisational operations?

Figure 3.1. A conceptual framework linking CEO characteristics to intellectual property strategy

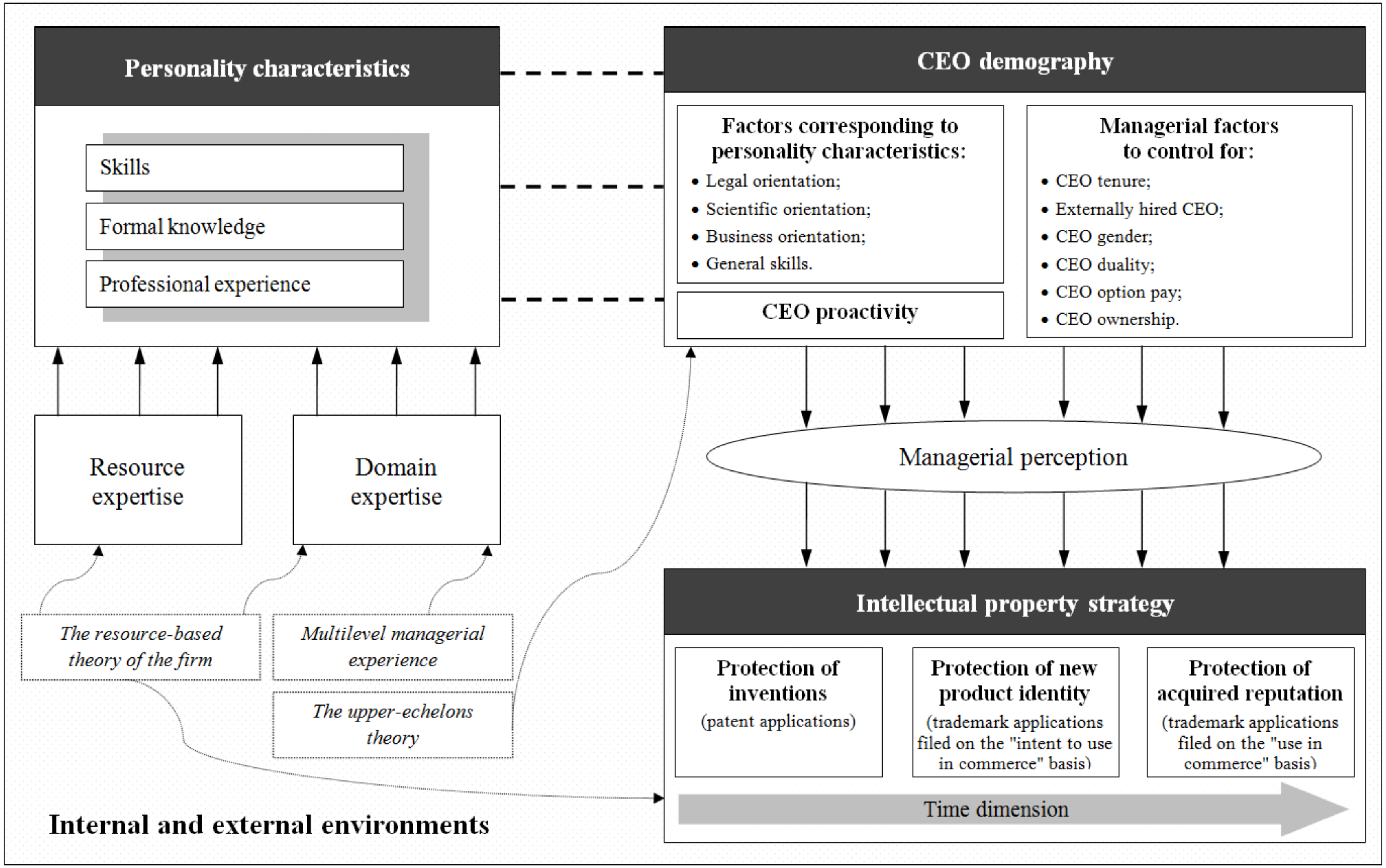


Table 3.1. Descriptive statistics

No.	Variable	Obs.	Mean	SD	Quantiles				
					min	.25	mdn	.75	max
1	Protection of inventions	5,742	68.652	341.149	0.00	0.00	1.00	19.00	8,820.00
2	Protection of new product identity	5,742	6.226	14.726	0.00	0.00	1.00	6.00	272.00
3	Protection of acquired reputation	5,742	1.529	3.709	0.00	0.00	0.00	2.00	75.00
4	Legal orientation	5,742	0.128	0.334	0.00	0.00	0.00	0.00	1.00
5	Scientific orientation	5,742	0.197	0.398	0.00	0.00	0.00	0.00	1.00
6	Business orientation	5,742	0.543	0.498	0.00	0.00	1.00	1.00	1.00
7	General skills	5,742	0.000	1.000	-1.91	-0.71	-0.20	0.47	6.82
8	CEO proactivity	5,742	0.000	1.000	-0.43	-0.43	-0.32	0.04	12.93
9	CEO tenure	5,742	8.236	7.646	0.08	3.00	6.00	10.76	49.03
10	Externally hired CEO	5,742	0.163	0.369	0.00	0.00	0.00	0.00	1.00
11	CEO gender (male)	5,742	0.985	0.122	0.00	1.00	1.00	1.00	1.00
12	CEO duality	5,742	0.658	0.474	0.00	0.00	1.00	1.00	1.00
13	CEO option pay*	5,742	0.869	9.760	-13.82	-13.82	6.64	7.75	13.51
14	CEO ownership	5,742	0.017	0.052	0.00	0.00	0.00	0.01	0.52
15	Firm size*	5,742	9.287	1.552	1.10	8.32	9.31	10.32	13.09
16	Firm age	5,742	83.340	42.397	4.00	48.00	85.00	111.00	229.00
17	ROA	5,742	0.051	0.079	-1.00	0.02	0.05	0.09	0.95
18	Book leverage	5,742	0.234	0.168	0.00	0.12	0.22	0.33	1.45
19	Intensity of commercial expenditures	5,742	0.183	0.180	0.00	0.02	0.15	0.27	1.17

The asterisk denotes the natural logarithm of a variable. Sources and variable definitions are given in Table 3.8.

Table 3.2. Correlations

No.	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Protection of inventions	1.00																		
2	Protection of new product identity	0.17	1.00																	
3	Protection of acquired reputation	0.23	0.47	1.00																
4	Legal orientation	-0.04	-0.08	-0.08	1.00															
5	Scientific orientation	0.01	-0.01	0.00	-0.09	1.00														
6	Business orientation	0.09	0.10	0.06	-0.17	0.00	1.00													
7	General skills	0.03	0.08	0.06	0.14	0.06	0.09	1.00												
8	CEO proactivity	0.15	0.13	0.14	0.14	0.02	0.03	0.08	1.00											
9	CEO tenure	-0.05	-0.07	-0.05	0.05	-0.03	-0.14	-0.01	0.13	1.00										
10	Externally hired CEO	0.02	-0.02	-0.03	-0.03	-0.02	0.06	0.14	-0.06	-0.01	1.00									
11	CEO gender (male)	-0.10	-0.04	-0.02	0.01	-0.03	-0.08	-0.11	-0.03	0.07	-0.01	1.00								
12	CEO duality	0.04	0.05	0.06	0.04	-0.01	-0.02	0.15	0.06	0.25	0.03	0.00	1.00							
13	CEO option pay*	-0.01	0.09	0.05	-0.05	-0.03	0.10	0.04	0.05	-0.16	-0.03	0.01	0.07	1.00						
14	CEO ownership	-0.04	-0.06	-0.06	-0.02	-0.07	-0.13	-0.03	0.03	0.40	-0.01	0.04	0.08	-0.19	1.00					
15	Firm size*	0.26	0.31	0.27	-0.07	0.02	0.12	0.25	0.16	-0.12	-0.08	-0.06	0.13	0.20	-0.11	1.00				
16	Firm age	-0.01	0.09	0.05	0.05	-0.01	0.12	0.22	-0.08	-0.26	-0.05	-0.05	0.10	0.16	-0.21	0.27	1.00			
17	ROA	0.06	0.10	0.11	-0.06	-0.03	0.02	-0.09	0.08	0.03	-0.04	0.02	0.06	0.04	0.06	0.15	-0.08	1.00		
18	Book leverage	-0.02	-0.03	-0.03	0.15	0.02	0.02	0.13	-0.06	-0.13	-0.01	-0.07	0.04	0.02	-0.17	0.06	0.14	-0.16	1.00	
19	Intensity of commercial expenditures	0.02	0.11	0.11	-0.21	-0.10	0.11	-0.14	-0.03	0.07	-0.01	0.00	0.01	0.01	0.13	0.06	-0.25	0.24	-0.26	1.00

The table presents Pearson's pairwise correlations. The asterisk denotes the natural logarithm of a variable. Correlation coefficients above 0.3 are highlighted in red. Sources and variable definitions are given in Table 3.8.

Table 3.3. CEO characteristics and the protection of inventions

Dependent variable: Patent applications $_{i, t}$	Negative binomial models					
	Model 1.1	Model 1.2	Model 1.3	Model 1.4	Model 1.5	Model 1.6
Legal orientation $_{i, j, t-1}$		**1.545***** *(0.158)*	**1.625***** *(0.172)*	**1.570***** *(0.160)*	**1.577***** *(0.160)*	**1.536***** *(0.160)*
Scientific orientation $_{i, j, t-1}$		**1.208*** *(0.092)*	**1.189*** *(0.091)*	**1.191*** *(0.090)*	**1.138†** *(0.085)*	**1.208*** *(0.092)*
Business orientation $_{i, j, t-1}$		**1.202**** *(0.081)*	**1.224**** *(0.083)*	**1.222**** *(0.082)*	**1.260***** *(0.084)*	**1.201**** *(0.081)*
General skills $_{i, j, t-1}$		**1.138***** *(0.041)*	**1.144***** *(0.041)*	**1.128***** *(0.041)*	**1.153***** *(0.040)*	**1.137***** *(0.041)*
CEO proactivity $_{i, j}$		**1.286***** *(0.040)*	**1.418***** *(0.066)*	**1.240***** *(0.038)*	**1.628***** *(0.102)*	**1.284***** *(0.039)*
Legal orientation $_{i, j, t-1}$ × CEO proactivity $_{i, j}$			**0.772***** *(0.058)*			
Scientific orientation $_{i, j, t-1}$ × CEO proactivity $_{i, j}$				**1.234*** *(0.133)*		
Business orientation $_{i, j, t-1}$ × CEO proactivity $_{i, j}$					**0.665***** *(0.049)*	
General skills $_{i, j, t-1}$ × CEO proactivity $_{i, j}$						1.020 *(0.040)*
CEO tenure $_{i, j, t-1}$		0.992 *(0.012)*	0.988 *(0.012)*	0.992 *(0.012)*	0.992 *(0.012)*	0.992 *(0.012)*
CEO tenure^2 $_{i, j, t-1}$		0.9997 *(0.0004)*	0.9998 *(0.0004)*	0.9997 *(0.0004)*	0.9997 *(0.0004)*	0.9997 *(0.0004)*
Externally hired CEO $_{i, j, t-1}$		0.985 *(0.087)*	0.966 *(0.086)*	1.004 *(0.090)*	1.005 *(0.089)*	0.986 *(0.087)*
CEO gender (male) $_{i, j, t-1}$		0.786 *(0.272)*	0.819 *(0.282)*	0.763 *(0.264)*	0.802 *(0.276)*	0.783 *(0.270)*
CEO duality $_{i, j, t-1}$		1.091 *(0.077)*	1.079 *(0.077)*	1.095 *(0.078)*	1.056 *(0.076)*	1.093 *(0.078)*
CEO option pay $_{i, j, t-1}$		0.998 *(0.003)*	0.999 *(0.003)*	0.998 *(0.003)*	0.997 *(0.003)*	0.998 *(0.003)*
CEO ownership $_{i, j, t-1}$		**0.014***** *(0.007)*	**0.012***** *(0.006)*	**0.015***** *(0.008)*	**0.008***** *(0.004)*	**0.015***** *(0.008)*
Firm size $_{i, t-1}$	**2.626***** *(0.061)*	**2.443***** *(0.060)*	**2.443***** *(0.059)*	**2.465***** *(0.061)*	**2.472***** *(0.061)*	**2.440***** *(0.060)*
Firm age $_{i, t-1}$	**0.994***** *(0.001)*	**0.994***** *(0.001)*	**0.994***** *(0.001)*	**0.994***** *(0.001)*	**0.994***** *(0.001)*	**0.994***** *(0.001)*
ROA $_{i, t-1}$	**2.093*** *(0.634)*	**1.809*** *(0.543)*	**1.658†** *(0.497)*	**1.783†** *(0.537)*	**1.643†** *(0.491)*	**1.822*** *(0.548)*
Book leverage $_{i, t-1}$	0.968 *(0.178)*	0.777 *(0.151)*	0.773 *(0.151)*	0.810 *(0.157)*	**0.699†** *(0.135)*	0.790 *(0.157)*
Intensity of commercial expenditures $_{i, t-1}$	**2.337***** *(0.559)*	**2.866***** *(0.690)*	**3.134***** *(0.748)*	**3.141***** *(0.761)*	**2.709***** *(0.647)*	**2.860***** *(0.689)*
Firm fixed effects	BGV	BGV	BGV	BGV	BGV	BGV
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Log likelihood	-15,241.8	-15,143.1	-15,132.9	-15,139.2	-15,115.9	-15,143.0
Pseudo R^2	0.156	0.162	0.162	0.162	0.163	0.162
ln(Alpha)	**0.836*** **	**0.787*****	**0.780*****	**0.784*****	**0.771*****	**0.787*****
Number of observations	5,481	5,481	5,481	5,481	5,481	5,481

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. The dependent variable is measured at time t. Explanatory variables are measured at time t-1. The constant term is omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. Sources and variable definitions are given in Table 3.8.

Table 3.4. CEO characteristics and the protection of new product identity

Dependent variable: Innovation-based trademark applications $_{i, t}$	Negative binomial models					
	Model 2.1	Model 2.2	Model 2.3	Model 2.4	Model 2.5	Model 2.6
Legal orientation $_{i, j, t-1}$		0.925 *(0.063)*	0.945 *(0.065)*	0.934 *(0.064)*	0.917 *(0.063)*	0.924 *(0.063)*
Scientific orientation $_{i, j, t-1}$		**0.899†** *(0.051)*	**0.890*** *(0.050)*	**0.895*** *(0.051)*	**0.866**** *(0.048)*	**0.899†** *(0.051)*
Business orientation $_{i, j, t-1}$		1.004 *(0.044)*	1.011 *(0.044)*	1.012 *(0.044)*	1.003 *(0.043)*	1.004 *(0.044)*
General skills $_{i, j, t-1}$		1.006 *(0.024)*	1.005 *(0.024)*	1.005 *(0.024)*	1.004 *(0.023)*	1.006 *(0.024)*
CEO proactivity $_{i, j}$		**1.123***** *(0.027)*	**1.205***** *(0.044)*	**1.104***** *(0.028)*	**1.399***** *(0.069)*	**1.123***** *(0.027)*
Legal orientation $_{i, j, t-1}$ × CEO proactivity $_{i, j}$			**0.871**** *(0.042)*			
Scientific orientation $_{i, j, t-1}$ × CEO proactivity $_{i, j}$				**1.126†** *(0.073)*		
Business orientation $_{i, j, t-1}$ × CEO proactivity $_{i, j}$					**0.726***** *(0.039)*	
General skills $_{i, j, t-1}$ × CEO proactivity $_{i, j}$						1.003 *(0.028)*
CEO tenure $_{i, j, t-1}$		0.991 *(0.008)*	0.989 *(0.008)*	0.991 *(0.008)*	0.993 *(0.008)*	0.991 *(0.008)*
CEO tenure^2 $_{i, j, t-1}$		1.0001 *(0.0003)*	1.0002 *(0.0003)*	1.0001 *(0.0003)*	1.0000 *(0.0003)*	1.0001 *(0.0003)*
Externally hired CEO $_{i, j, t-1}$		1.044 *(0.062)*	1.039 *(0.061)*	1.050 *(0.062)*	1.050 *(0.061)*	1.044 *(0.062)*
CEO gender (male) $_{i, j, t-1}$		**1.494*** *(0.250)*	**1.570**** *(0.265)*	**1.502*** *(0.251)*	**1.514*** *(0.255)*	**1.495*** *(0.250)*
CEO duality $_{i, j, t-1}$		**1.280***** *(0.063)*	**1.279***** *(0.063)*	**1.282***** *(0.063)*	**1.256***** *(0.061)*	**1.281***** *(0.063)*
CEO option pay $_{i, j, t-1}$		1.001 *(0.002)*	1.001 *(0.002)*	1.001 *(0.002)*	1.001 *(0.002)*	1.001 *(0.002)*
CEO ownership $_{i, j, t-1}$		**0.147***** *(0.069)*	**0.134***** *(0.063)*	**0.149***** *(0.069)*	**0.098***** *(0.047)*	**0.147***** *(0.069)*
Firm size $_{i, t-1}$	**1.477***** *(0.027)*	**1.443***** *(0.028)*	**1.441***** *(0.028)*	**1.446***** *(0.029)*	**1.454***** *(0.029)*	**1.442***** *(0.028)*
Firm age $_{i, t-1}$	**0.997***** *(0.001)*	**0.997***** *(0.001)*	**0.997***** *(0.001)*	**0.997***** *(0.001)*	**0.997***** *(0.001)*	**0.997***** *(0.001)*
ROA $_{i, t-1}$	**3.858***** *(1.154)*	**3.117***** *(0.951)*	**3.028***** *(0.927)*	**3.187***** *(0.969)*	**2.881***** *(0.874)*	**3.125***** *(0.953)*
Book leverage $_{i, t-1}$	**0.502***** *(0.070)*	**0.451***** *(0.064)*	**0.454***** *(0.064)*	**0.458***** *(0.065)*	**0.419***** *(0.058)*	**0.452***** *(0.064)*
Intensity of commercial expenditures $_{i, t-1}$	**3.194***** *(0.519)*	**3.364***** *(0.563)*	**3.439***** *(0.578)*	**3.508***** *(0.593)*	**3.400***** *(0.575)*	**3.364***** *(0.562)*
Firm fixed effects	BGV	BGV	BGV	BGV	BGV	BGV
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Log likelihood	-12,768.2	-12,727.6	-12,722.1	-12,725.6	-12,699.4	-12,727.6
Pseudo R^2	0.109	0.112	0.112	0.112	0.114	0.112
ln(Alpha)	**0.381*****	**0.354*****	**0.350*****	**0.353*****	**0.337*****	**0.354*****
Number of observations	5,481	5,481	5,481	5,481	5,481	5,481

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. The dependent variable is measured at time t. Explanatory variables are measured at time t-1. The constant term is omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. Sources and variable definitions are given in Table 3.8.

Table 3.5. CEO characteristics and the protection of acquired reputation

Dependent variable: Reputation-based trademark applications $_{i, t}$	**Negative binomial models**					
	Model 3.1	Model 3.2	Model 3.3	Model 3.4	Model 3.5	Model 3.6
Legal orientation $_{i, j, t-1}$		**0.643*** *(0.057)*	**0.647*** *(0.057)*	**0.654*** *(0.058)*	**0.647*** *(0.057)*	**0.643*** *(0.057)*
Scientific orientation $_{i, j, t-1}$		**0.898†** *(0.059)*	**0.895†** *(0.059)*	**0.880†** *(0.058)*	**0.868*** *(0.057)*	**0.898†** *(0.059)*
Business orientation $_{i, j, t-1}$		**0.790*** *(0.043)*	**0.792*** *(0.043)*	**0.802*** *(0.044)*	**0.799*** *(0.044)*	**0.790*** *(0.043)*
General skills $_{i, j, t-1}$		1.013 *(0.029)*	1.012 *(0.029)*	1.008 *(0.029)*	1.013 *(0.028)*	1.013 *(0.029)*
CEO proactivity $_{i, j}$		**1.096*** *(0.030)*	**1.113*** *(0.048)*	**1.076**** *(0.028)*	**1.283*** *(0.067)*	**1.096*** *(0.030)*
Legal orientation $_{i, j, t-1}$ × CEO proactivity $_{i, j}$			0.975 *(0.049)*			
Scientific orientation $_{i, j, t-1}$ × CEO proactivity $_{i, j}$				**1.181*** *(0.078)*		
Business orientation $_{i, j, t-1}$ × CEO proactivity $_{i, j}$					**0.819*** *(0.045)*	
General skills $_{i, j, t-1}$ × CEO proactivity $_{i, j}$						0.998 *(0.025)*
CEO tenure $_{i, j, t-1}$		0.995 *(0.010)*	0.994 *(0.010)*	0.994 *(0.010)*	0.995 *(0.010)*	0.995 *(0.010)*
CEO tenure^2 $_{i, j, t-1}$		1.0002 *(0.0003)*	1.0002 *(0.0003)*	1.0002 *(0.0003)*	1.0001 *(0.0003)*	1.0002 *(0.0003)*
Externally hired CEO $_{i, j, t-1}$		**0.834*** *(0.061)*	**0.834*** *(0.061)*	**0.844*** *(0.062)*	**0.840*** *(0.061)*	**0.834*** *(0.061)*
CEO gender (male) $_{i, j, t-1}$		**2.287**** *(0.611)*	**2.304**** *(0.618)*	**2.270**** *(0.606)*	**2.275**** *(0.604)*	**2.287**** *(0.611)*
CEO duality $_{i, j, t-1}$		**1.259*** *(0.076)*	**1.261*** *(0.076)*	**1.270*** *(0.077)*	**1.257*** *(0.076)*	**1.259*** *(0.076)*
CEO option pay $_{i, j, t-1}$		0.9995 *(0.0028)*	0.9995 *(0.0028)*	0.9996 *(0.0028)*	0.9992 *(0.0028)*	0.9995 *(0.0028)*
CEO ownership $_{i, j, t-1}$		**0.050*** *(0.033)*	**0.049*** *(0.032)*	**0.048*** *(0.031)*	**0.043*** *(0.029)*	**0.050*** *(0.033)*
Firm size $_{i, t-1}$	**1.374*** *(0.030)*	**1.327*** *(0.032)*	**1.326*** *(0.032)*	**1.330*** *(0.032)*	**1.333*** *(0.032)*	**1.327*** *(0.032)*
Firm age $_{i, t-1}$	**0.998*** *(0.001)*	**0.998*** *(0.001)*	**0.998*** *(0.001)*	**0.998†** *(0.001)*	**0.998†** *(0.001)*	**0.998*** *(0.001)*
ROA $_{i, t-1}$	**8.507*** *(3.642)*	**8.391*** *(3.655)*	**8.357*** *(3.646)*	**8.827*** *(3.867)*	**7.892*** *(3.444)*	**8.380*** *(3.652)*
Book leverage $_{i, t-1}$	**0.716†** *(0.127)*	**0.725†** *(0.131)*	**0.727†** *(0.131)*	**0.742†** *(0.134)*	**0.701*** *(0.126)*	**0.724†** *(0.131)*
Intensity of commercial expenditures $_{i, t-1}$	**2.080*** *(0.411)*	**2.281*** *(0.474)*	**2.295*** *(0.479)*	**2.406*** *(0.506)*	**2.348*** *(0.493)*	**2.281*** *(0.474)*
Firm fixed effects	BGV	BGV	BGV	BGV	BGV	BGV
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Log likelihood	-7,655.4	-7,603.2	-7,603.1	-7,600.1	-7,595.7	-7,603.2
Pseudo R^2	0.094	0.100	0.100	0.101	0.101	0.100
ln(Alpha)	**0.624***	**0.577***	**0.577***	**0.573***	**0.569***	**0.577***
Number of observations	5,481	5,481	5,481	5,481	5,481	5,481

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. The dependent variable is measured at time t. Explanatory variables are measured at time t-1. The constant term is omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. Sources and variable definitions are given in Table 3.8.

Table 3.6. A summary of hypothesis testing

Hypothesis number	Hypothesis formulation	Predictions	Findings
Hypothesis 1 (a):	CEO legal orientation is positively related to the number of patent applications.	(+)	(+)
Hypothesis 1 (b):	CEO legal orientation is positively related to the number of innovation-based trademark applications.	(+)	N.S.
Hypothesis 1 (c):	CEO legal orientation is negatively related to the number of reputation-based trademark applications.	(-)	(-)
Hypothesis 2 (a):	CEO scientific orientation is positively related to the number of patent applications.	(+)	(+)
Hypothesis 2 (b):	CEO scientific orientation is positively related to the number of innovation-based trademark applications.	(+)	N.S.
Hypothesis 3 (a):	CEO business orientation is positively related to the number of patent applications.	(+)	(+)
Hypothesis 3 (b):	CEO business orientation is positively related to the number of innovation-based trademark applications.	(+)	N.S.
Hypothesis 3 (c):	CEO business orientation is positively related to the number of reputation-based trademark applications.	(+)	(-)
Hypothesis 4 (a):	CEOs with diverse domain expertise are positively related to the number of patent applications.	(+)	(+)
Hypothesis 4 (b):	CEOs with diverse domain expertise are positively related to the number of innovation-based trademark applications.	(+)	N.S.
Hypothesis 4 (c):	CEOs with diverse domain expertise are positively related to the number of reputation-based trademark applications.	(+)	N.S.
Hypothesis 5 (a):	CEO proactive personality positively moderates the relationship between CEO characteristics and the number of patent applications.	(+)	mixed*
Hypothesis 5 (b):	CEO proactive personality positively moderates the relationship between CEO characteristics and the number of trademark applications.	(+)	mixed*

Note: N.S. stands for "not significant". * See Figures 3.2, 3.3, and 3.4 for illustration.

Figure 3.2. Interaction effects of individual proactiveness on the CEO-intellectual property strategy (the protection of inventions)

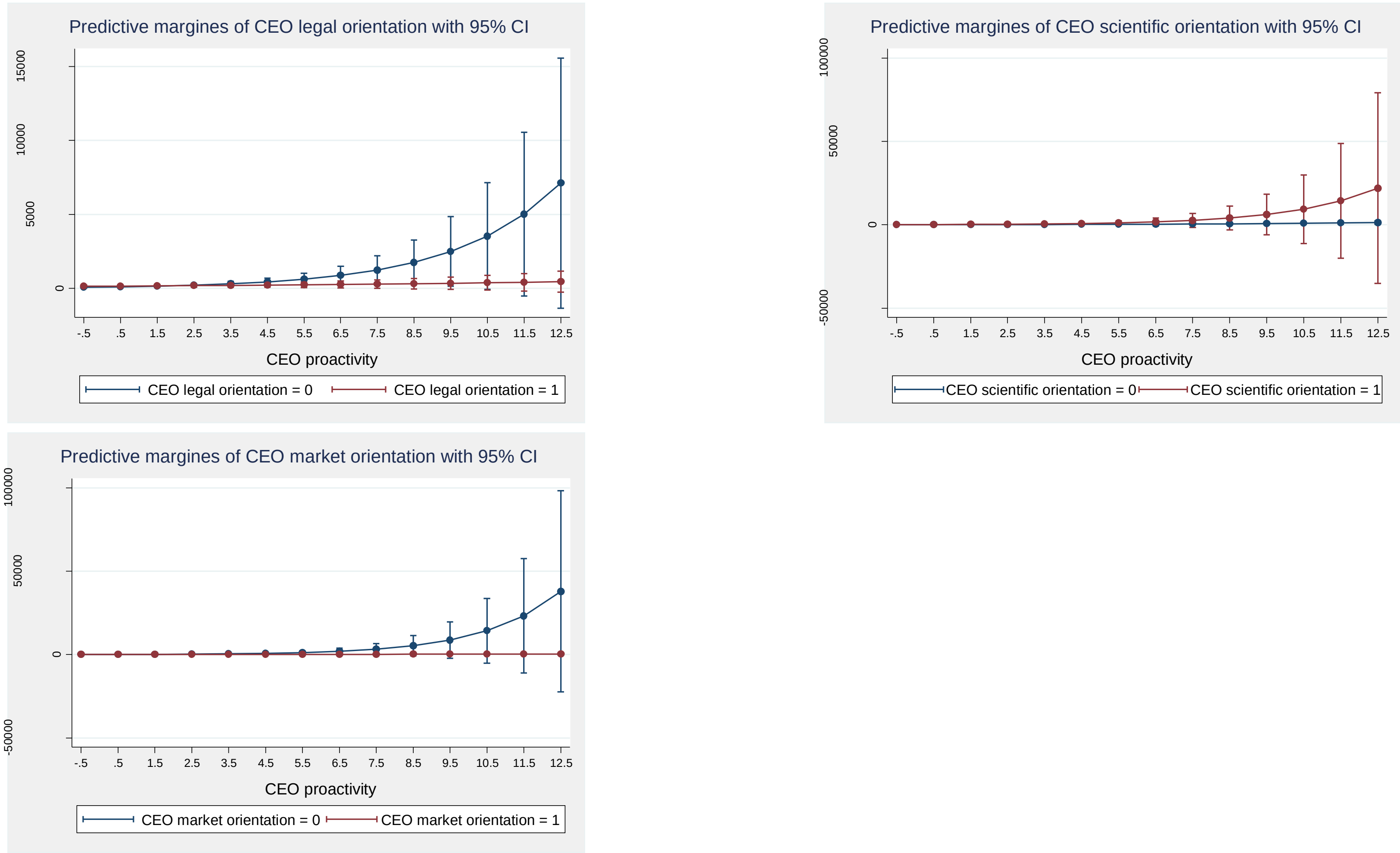


Figure 3.3. Interaction effects of individual proactiveness on the CEO-intellectual property strategy (the protection of new product identity)

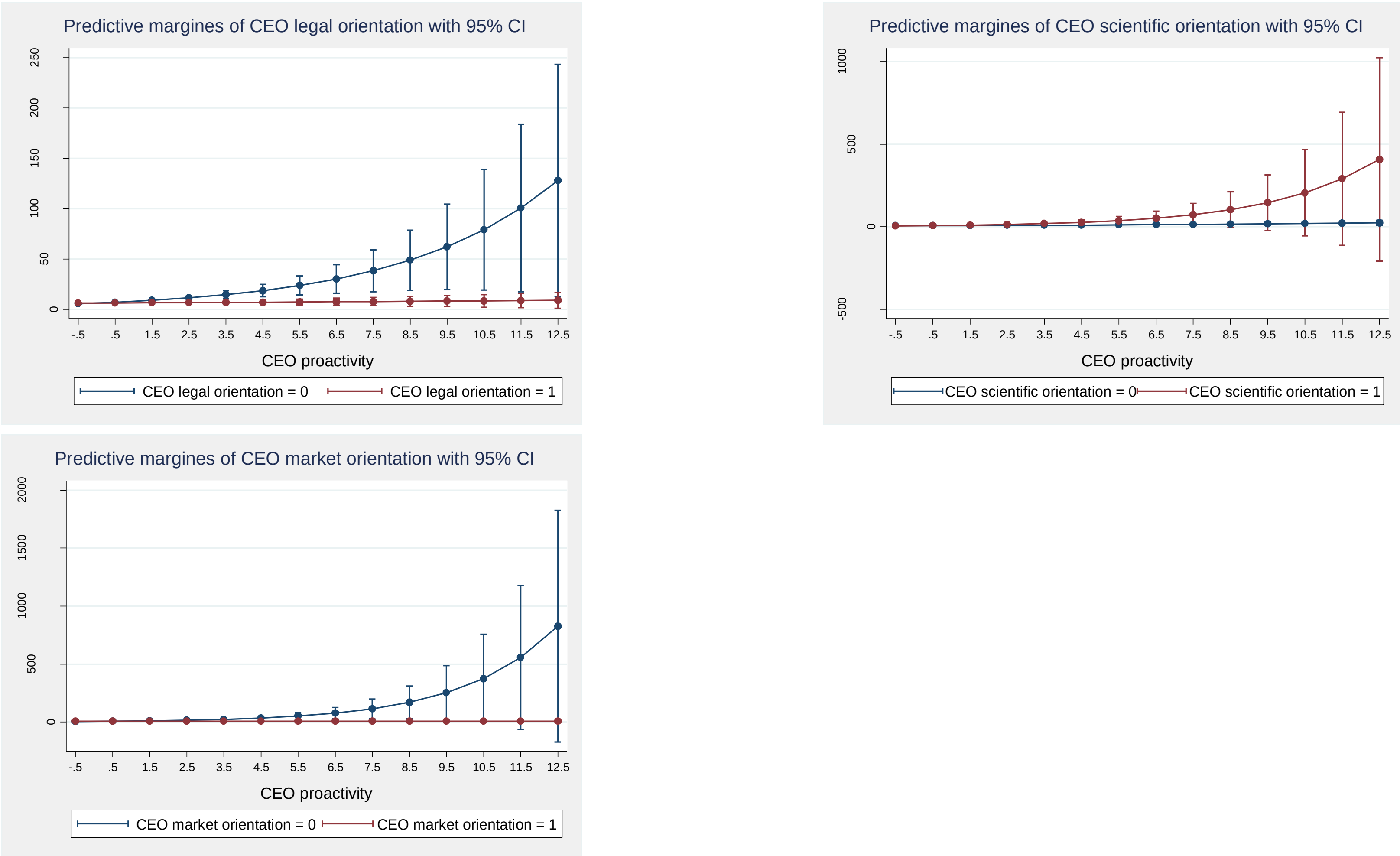
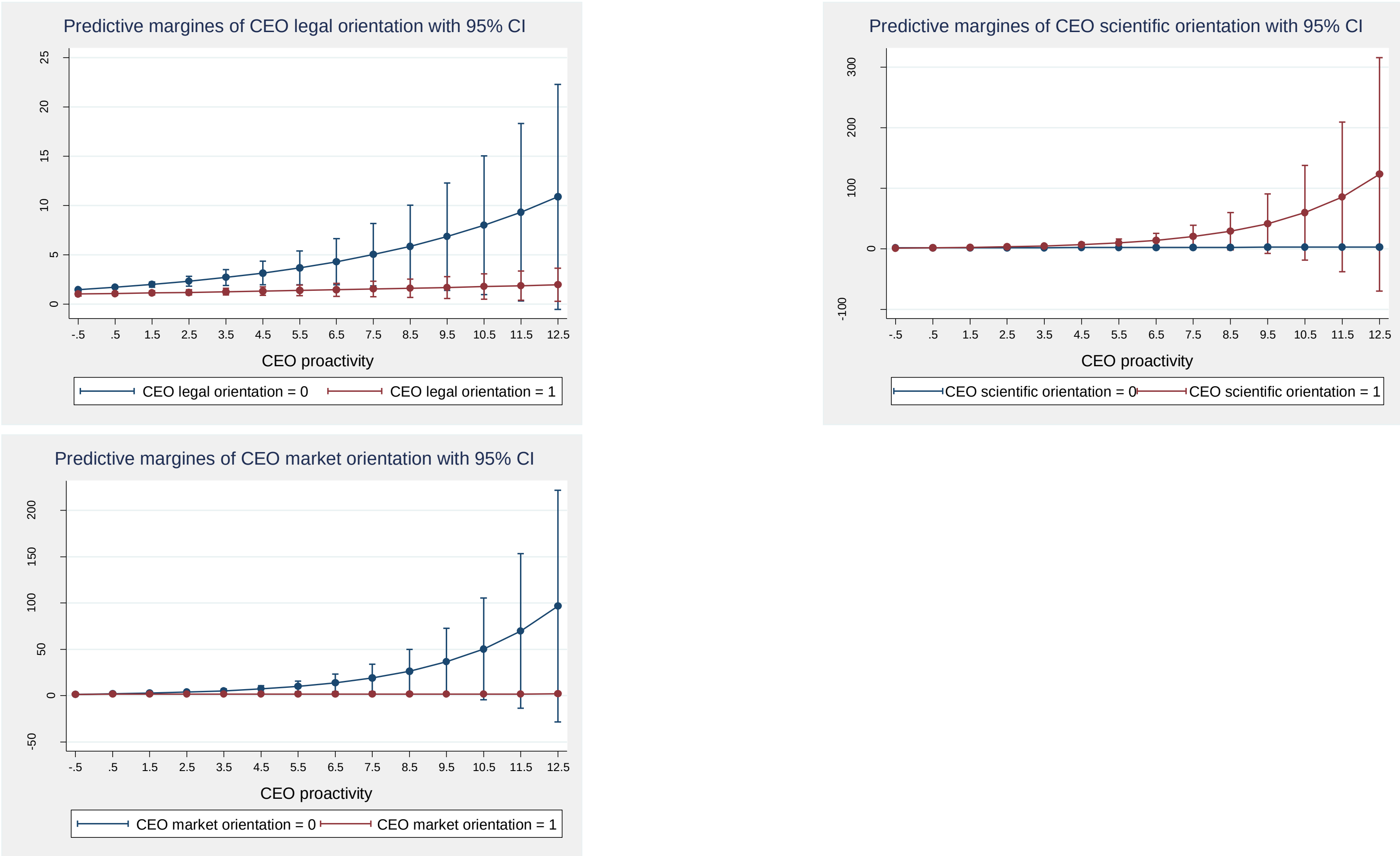


Figure 3.4. Interaction effects of individual proactiveness on the CEO-intellectual property strategy (the protection of acquired reputation)



Note: the interaction effect of individual proactiveness on the CEO-intellectual property strategy for CEO legal orientation is statistically insignificant.

Table 3.7. A summary of the effects of control variables

Control variables	**Dimensions of intellectual property strategy**		
	The protection of inventions *(patent applications)*	**The protection of new product identity** *(innovation-based trademark applications*	**The protection of acquired reputation** *(reputation-based trademark applications)*
Company tenure	inverted U-shaped	inverted U-shaped	inverted U-shaped
CEO tenure	N.S.	N.S.	N.S.
CEO age	N.S.	inverted U-shaped	inverted U-shaped
CEO gender	N.S.	(+)	(+)
Externally hired CEO	N.S.	N.S.	(-)
Founder CEO	(-)	(+)	(+)
CEO duality	N.S.	(+)	(+)
CEO option pay	N.S.	N.S.	N.S.
CEO ownership	(-)	(-)	(-)

Note: N.S. stands for "not significant". The results in this table are based on the econometric analysis from Tables 3.3, 3.4, 3.5, as well as 3.A.10 in Appendix 3.A.

Table 3.8. The description of study variables

Variable name	Description
INTELLECTUAL PROPERTY STRATEGY	
Protection of inventions	The number of patent applications filed by the company with the USPTO, which subsequently resulted in patent grants.
Protection of new product identity	The sum of: • the number of trademark applications filed by the company with the USPTO under the "intent to use" basis, and • the number of trademark applications filed by the company with the USPTO under the "use" basis, but firstly used in commerce within one year before application, which subsequently resulted in trademark grants.
Protection of acquired reputation	The number of trademark applications filed by the company with the USPTO under the "use" basis and used in commerce for more than a year before application, which subsequently resulted in trademark grants.
CEO CHARACTERISTICS	
Legal orientation	A dummy variable that takes the value of one for the chief executive with (1) a degree in legal studies (e.g., law or taxation), and/or (2) professional experience in such functions as law or compliance, and zero otherwise.
Scientific orientation	A dummy variable that takes the value of one for the chief executive with (1) a PhD degree in engineering, technology, or natural sciences; (2) academic research experience; and/or (3) professional experience in such functions as engineering and R&D, and zero otherwise.
Business orientation	A dummy variable that takes the value of one for the chief executive with (1) an MBA degree, and/or (2) professional experience in such functions as marketing or sales, and zero otherwise.
General skills	An index that includes (1) the number of industries; (2) the number of companies; (3) the number of positions; and (4) the CEO experience dummy for each CEO. The chief executives whose index is above the yearly median are classified as mainly possessing general skills (see Appendix 3.B for more details).
Proactivity	An index that includes the number of prizes received by the CEO in the following categories: (1) awards that highlight leadership; (2) awards that highlight power and influence; (3) awards that highlight vision and inventiveness; (4) position-related awards; (5) awards that highlight professional and entrepreneurial achievements; and (6) other honours and prizes (see Appendix 3.C for more details).
CONTROL VARIABLES	
Individual-level characteristics	
CEO tenure	The difference between the year of the observation and the year in which the individual was appointed to the CEO position.

Externally hired CEO	A dummy variable that takes the value of one for the individual who was appointed to the CEO position a year or less since joining the company, and zero otherwise.
CEO gender	A dummy variable that takes the value of one if the individual is male, and zero otherwise.
CEO duality	A dummy variable that takes the value of one if the chief executive also serves as the chairman of the board of directors, and zero otherwise.
CEO option pay	The natural logarithm of the monetary value of option grants to the CEO in the observation year: • ln(0.000001 + OPTION_AWARDS_BLK_VALUE) for pre-2006 data, and • ln(0.000001 + OPTION_AWARDS_FV) otherwise.
CEO ownership	The percentage stock ownership held by the CEO: • SHROWN_TOT_PCT or • SHROWN_TOT * 100/(CSHO * 1000), depending on data availability.
Firm-level characteristics	
Firm size	The natural logarithm of the total number of employees: ln(EMP).
Firm age	The difference between the year of the observation and the year to which the company traces its origins.
ROA	The ratio of income before extraordinary items to total assets: IBCOM/AT.
Book leverage	The ratio of long-term debt plus current liabilities to total assets: (DLTT + DLC)/AT.
Intensity of commercial expenditures	The ratio of selling, general, and administrative expenditures to total assets: XSGA/AT.

Note: we used (i) the OECD HAN database (September 2016 edition) and the OECD Patent Quality Indicators database (March 2017 edition) for patent statistics; (ii) the USPTO Case Files dataset (2015 edition) for trademark statistics; (iii) Marquis Who's Who directories; the Bloomberg database; the BoardEx database; companies' SEC filings, press releases, and official web-sites; and CEOs' LinkedIn profiles, university yearbooks, and obituaries, for CEO demographic characteristics; (iv) the Standard & Poor's ExecuComp dataset for executive ownership and compensation; and (v) the Standard & Poor's Compustat North America dataset for company characteristics.

APPENDIX 3.A. AUXILIARY TABLES

Table 3.A.1. CEO characteristics and the protection of new product identity: Alternative specifications of the dependent variable

Dependent variable: Innovation-based trademark applications $_{i, t}$	**Negative binomial models**			
	DV_ITU	DV_ITU+1	DV_ITU+2	DV_ITU+3
Legal orientation $_{i, j, t-1}$	0.967 *(0.072)*	0.925 *(0.063)*	0.908 *(0.061)*	**0.890†** *(0.060)*
Scientific orientation $_{i, j, t-1}$	**0.900†** *(0.055)*	**0.899†** *(0.051)*	**0.886*** *(0.050)*	**0.889*** *(0.050)*
Business orientation $_{i, j, t-1}$	1.009 *(0.048)*	1.004 *(0.044)*	0.996 *(0.043)*	0.996 *(0.042)*
General skills $_{i, j, t-1}$	0.980 *(0.026)*	1.006 *(0.024)*	1.007 *(0.024)*	1.005 *(0.024)*
CEO proactivity $_{i, j}$	**1.118***** *(0.028)*	**1.123***** *(0.027)*	**1.121***** *(0.027)*	**1.125***** *(0.027)*
CEO controls	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Firm fixed effects	BGV	BGV	BGV	BGV
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Log likelihood	-11,210.4	-12,727.6	-12,944.1	-13,089.4
Pseudo R^2	0.121	0.112	0.111	0.110
ln(Alpha)	**0.482*****	**0.354*****	**0.341*****	**0.336*****
Number of observations	5,481	5,481	5,481	5,481

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. The dependent variable is measured at time t. Explanatory variables are measured at time t-1. The constant term is omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. DV_ITU is the model where innovation-based trademark applications are those filed under the "intent to use" basis. DV_ITU+1 is the model where the number of innovation-based trademark applications is the same as in DV_ITU, plus trademark applications filed under the "use" basis, but firstly used in commerce within one year before the date of filing (as in Model 2.2). DV_ITU+2 is the model where the number of innovation-based trademark applications is the same as in DV_ITU, plus trademark applications filed under the "use" basis, but firstly used in commerce within two years before the date of filing. DV_ITU+3 is the model where the number of innovation-based trademark applications is the same as in DV_ITU, plus trademark applications filed under the "use" basis, but firstly used in commerce within three years before the date of filing. Sources and variable definitions are given in Table 3.8.

Table 3.A.2. The effect of an alternative specification of the mean scaling estimator

	Negative binomial models	
	MSE_BASIS	MSE_ALT_SPEC
DV = Patent applications $_{i, t}$		(based on the specification for Model 1.2)
Legal orientation $_{i, j, t-1}$	**1.545***** *(0.158)*	**1.549***** *(0.158)*
Scientific orientation $_{i, j, t-1}$	**1.208*** *(0.092)*	**1.210*** *(0.092)*
Business orientation $_{i, j, t-1}$	**1.202**** *(0.081)*	**1.197**** *(0.080)*
General skills $_{i, j, t-1}$	**1.138***** *(0.041)*	**1.135***** *(0.041)*
CEO proactivity $_{i, j}$	**1.286***** *(0.040)*	**1.287***** *(0.040)*
Log likelihood	-15,143.1	-15,145.2
Pseudo R^2	0.162	0.162
ln(Alpha)	**0.787*****	**0.788*****
Number of observations	5,481	5,481
DV = Innovation-based trademark applications $_{i, t}$		(based on the specification for Model 2.2)
Legal orientation $_{i, j, t-1}$	0.925 *(0.063)*	0.935 *(0.063)*
Scientific orientation $_{i, j, t-1}$	**0.899†** *(0.051)*	0.918 *(0.052)*
Business orientation $_{i, j, t-1}$	1.004 *(0.044)*	1.016 *(0.044)*
General skills $_{i, j, t-1}$	1.006 *(0.024)*	1.011 *(0.024)*
CEO proactivity $_{i, j}$	**1.123***** *(0.027)*	**1.128***** *(0.027)*
Log likelihood	-12,727.6	-12,729.5
Pseudo R^2	0.112	0.112
ln(Alpha)	**0.354*****	**0.352*****
Number of observations	5,481	5,481
DV = Reputation-based trademark applications $_{i, t}$		(based on the specification for Model 3.2)
Legal orientation $_{i, j, t-1}$	**0.643***** *(0.057)*	**0.651***** *(0.057)*
Scientific orientation $_{i, j, t-1}$	**0.898†** *(0.059)*	0.923 *(0.060)*
Business orientation $_{i, j, t-1}$	**0.790***** *(0.043)*	**0.792***** *(0.043)*
General skills $_{i, j, t-1}$	1.013 *(0.029)*	1.009 *(0.029)*
CEO proactivity $_{i, j}$	**1.096***** *(0.030)*	**1.096***** *(0.030)*
Log likelihood	-7,603.2	-7,596.8
Pseudo R^2	0.100	0.101
ln(Alpha)	**0.577*****	**0.568*****
Number of observations	5,481	5,481

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. Dependent variables are measured at time t. Explanatory variables are measured at time t-1. The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. MSE_BASIS is the model where the mean scaling estimator is based on a 5-year pre-sample period (the basis model). MSE_ALT_SPEC is the model where the mean scaling estimator is based on a 9-year pre-sample period. Sources and variable definitions are given in Table 3.8.

Table 3.A.3. Multicollinearity diagnostics

	VIF	1/VIF
CEO tenure	8.44	0.118
CEO tenure^2	8.15	0.123
Firm age	1.36	0.738
Firm size	1.31	0.762
CEO ownership	1.30	0.772
Intensity of commercial expenditures	1.29	0.774
General skills	1.23	0.814
CEO duality	1.19	0.843
Legal orientation	1.16	0.860
Book leverage	1.16	0.862
ROA	1.12	0.893
CEO proactivity	1.12	0.894
Business orientation	1.11	0.902
CEO option pay	1.11	0.902
Externally hired CEO	1.06	0.946
Scientific orientation	1.04	0.959
CEO gender (male)	1.03	0.975
Mean VIF	2.01	

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

The log-transformed dependent variable (patent applications) is measured at time t. Explanatory variables are measured at time t-1. Parameters are estimated by using the ordinary least squares method. Firm fixed effects, industry fixed effects, and year fixed effects are excluded from the estimation. Sources and variable definitions are given in Table 3.8.

Table 3.A.4. CEO characteristics and the protection of acquired reputation: Alternative specifications of the dependent variable

Dependent variable: Reputation-based trademark applications $_{i, t}$	**Negative binomial models**			
	RP_BASIS	RP_OLD_1Y	RP_OLD_2Y	RP_OLD_3Y
Legal orientation $_{i, j, t-1}$	**0.643***** *(0.057)*	**0.676***** *(0.080)*	**0.658***** *(0.071)*	**0.665***** *(0.068)*
Scientific orientation $_{i, j, t-1}$	**0.898**† *(0.059)*	0.899 *(0.072)*	0.918 *(0.068)*	0.915 *(0.065)*
Business orientation $_{i, j, t-1}$	**0.790***** *(0.043)*	**0.752***** *(0.049)*	**0.770***** *(0.046)*	**0.762***** *(0.045)*
General skills $_{i, j, t-1}$	1.013 *(0.029)*	1.049 *(0.037)*	1.046 *(0.034)*	1.034 *(0.032)*
CEO proactivity $_{i, j}$	**1.096***** *(0.030)*	**1.102**** *(0.037)*	**1.098**** *(0.034)*	**1.095**** *(0.033)*
CEO controls	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Firm fixed effects	BGV	BGV	BGV	BGV
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Log likelihood	-7,603.2	-6,254.7	-6,735.8	-6,950.7
Pseudo R^2	0.100	0.121	0.116	0.114
ln(Alpha)	**0.577*****	**0.799*****	**0.681*****	**0.640*****
Number of observations	5,481	5,481	5,481	5,481

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. The dependent variable is measured at time t. Explanatory variables are measured at time t-1. The constant term is omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. RP_BASIS is the model where reputation-based trademark applications are those filed by the company under the "use" basis and which had been in commercial operation for more than one year before the application date (as in Model 3.2). RP_OLD_1Y is the model where the number of reputation-based trademark applications is the same as in RP_BASIS, except for the trademarks which were filed in the product classes not used in the past year prior to the application year. RP_OLD_2Y is the model where the number of reputation-based trademark applications is the same as in RP_BASIS, except for the trademarks which were filed in the product classes not used in the past two years prior to the application year. RP_OLD_3Y is the model where the number of reputation-based trademark applications is the same as in RP_BASIS, except for the trademarks which were filed in the product classes not used in the past three years prior to the application year. Sources and variable definitions are given in Table 3.8.

Table 3.A.5. CEO characteristics and intellectual property protection in high-tech/service sectors

	Negative binomial models				
	Basis model	High-tech sectors	Non-high-tech sectors	Service sectors	Non-service sectors
DV = Patent applications $_{i, t}$	(based on the specification for Model 1.2)				
Legal orientation $_{i, j, t-1}$	**1.545***** *(0.158)*	0.960 *(0.279)*	**1.632***** *(0.168)*		
Scientific orientation $_{i, j, t-1}$	**1.208*** *(0.092)*	1.040 *(0.178)*	**1.368***** *(0.115)*		
Business orientation $_{i, j, t-1}$	**1.202**** *(0.081)*	**1.286†** *(0.184)*	0.993 *(0.074)*		
General skills $_{i, j, t-1}$	**1.138***** *(0.041)*	1.162 *(0.120)*	**1.096*** *(0.043)*		
CEO proactivity $_{i, j}$	**1.286***** *(0.040)*	1.090 *(0.069)*	**1.262***** *(0.065)*		
Log likelihood	-15,143.1	-5,097.0	-9,762.8		
Pseudo R^2	0.162	0.091	0.182		
ln(Alpha)	**0.787*****	**0.486*****	**0.708*****		
Number of observations	5,481	987	4,494		
DV = Innovation-based trademark applications $_{i, t}$	(based on the specification for Model 2.2)				
Legal orientation $_{i, j, t-1}$	0.925 *(0.063)*	0.966 *(0.154)*	0.958 *(0.077)*	1.004 *(0.178)*	**0.866†** *(0.065)*
Scientific orientation $_{i, j, t-1}$	**0.899†** *(0.051)*	1.122 *(0.117)*	**0.844*** *(0.057)*	**2.105**** *(0.558)*	**0.780***** *(0.047)*
Business orientation $_{i, j, t-1}$	1.004 *(0.044)*	0.947 *(0.090)*	1.043 *(0.053)*	1.070 *(0.113)*	0.987 *(0.048)*
General skills $_{i, j, t-1}$	1.006 *(0.024)*	**1.162*** *(0.084)*	0.992 *(0.026)*	0.901 *(0.064)*	1.037 *(0.028)*
CEO proactivity $_{i, j}$	**1.123***** *(0.027)*	**1.064*** *(0.028)*	**1.158***** *(0.051)*	**1.371***** *(0.089)*	**1.058*** *(0.030)*
Log likelihood	-12,727.6	-2,610.2	-10,035.6	-2,602.0	-10,055.9
Pseudo R^2	0.112	0.124	0.113	0.094	0.122
ln(Alpha)	**0.354*****	**-0.078*****	**0.411*****	**0.324*****	**0.314*****
Number of observations	5,481	987	4,494	1,071	4,410
DV = Reputation-based trademark applications $_{i, t}$	(based on the specification for Model 3.2)				
Legal orientation $_{i, j, t-1}$	**0.643***** *(0.057)*	**0.581*** *(0.139)*	**0.699***** *(0.069)*	0.856 *(0.224)*	**0.599***** *(0.057)*
Scientific orientation $_{i, j, t-1}$	**0.898†** *(0.059)*	1.235 *(0.180)*	**0.805**** *(0.065)*	1.604 *(0.512)*	**0.792***** *(0.056)*
Business orientation $_{i, j, t-1}$	**0.790***** *(0.043)*	**0.528***** *(0.070)*	0.907 *(0.056)*	0.933 *(0.135)*	**0.759***** *(0.047)*
General skills $_{i, j, t-1}$	1.013 *(0.029)*	1.006 *(0.093)*	1.023 *(0.032)*	0.996 *(0.104)*	1.016 *(0.031)*
CEO proactivity $_{i, j}$	**1.096***** *(0.030)*	**1.099**** *(0.035)*	1.083 *(0.060)*	1.121 *(0.098)*	**1.079*** *(0.032)*
Log likelihood	-7,603.2	-1,555.2	-6,000.1	-1,408.8	-6,139.2
Pseudo R2	0.100	0.131	0.096	0.095	0.109
ln(Alpha)	**0.577*****	**0.254*****	**0.609*****	**0.586*****	**0.519*****
Number of observations	5,481	987	4,494	1,071	4,410

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. Dependent variables are measured at time t. Explanatory variables are measured at time t-1. The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. High-tech sectors are determined based on the optimal three-digit SIC code combination proposed by Kile and Phillips (2009). Service sectors refer to the companies with SIC codes in 60-89. Sources and variable definitions are given in Table 3.8.

Table 3.A.6. A comparison of different model specifications

	Poisson, negative binomial, and generalized linear models						
	P_DFLT	P_RBST	NB_DFLT	NB_RBST	NB_PRSN	NB_CLTR	NB_OPG
DV = Patent applications $_{i, t}$				(based on the specification for Model 1.2)			
Legal orientation $_{i, j, t-1}$	**0.793***** *(0.008)*	**0.793*** *(0.082)*	**1.545***** *(0.136)*	**1.545***** *(0.125)*	**1.500***** *(0.118)*	**1.545*** *(0.298)*	**1.545***** *(0.158)*
Scientific orientation $_{i, j, t-1}$	**1.131***** *(0.006)*	**1.131†** *(0.078)*	**1.208**** *(0.078)*	**1.208**** *(0.072)*	**1.176**** *(0.067)*	1.208 *(0.159)*	**1.208*** *(0.092)*
Business orientation $_{i, j, t-1}$	**0.976***** *(0.005)*	0.976 *(0.087)*	**1.202**** *(0.071)*	**1.202***** *(0.067)*	**1.180**** *(0.062)*	1.202 *(0.161)*	**1.202**** *(0.081)*
General skills $_{i, j, t-1}$	**1.029***** *(0.002)*	1.029 *(0.034)*	**1.138***** *(0.038)*	**1.138***** *(0.038)*	**1.139***** *(0.036)*	**1.138†** *(0.083)*	**1.138***** *(0.041)*
CEO proactivity $_{i, j}$	**1.088***** *(0.001)*	**1.088***** *(0.014)*	**1.286***** *(0.044)*	**1.286***** *(0.053)*	**1.269***** *(0.051)*	**1.286†** *(0.169)*	**1.286***** *(0.040)*
Log likelihood	-140,978.7	-140,978.7	-15,143.1	-15,143.1	-15,654.9	-15,143.1	-15,143.1
Pseudo R^2	0.846	0.846	0.162	0.162			0.162
ln(Alpha)			**0.787*****	**0.787*****		**0.787*****	**0.787*****
Number of observations	5,481	5,481	5,481	5,481	5,481	5,481	5,481
DV = Innovation-based trademark applications $_{i, t}$				(based on the specification for Model 2.2)			
Legal orientation $_{i, j, t-1}$	**0.628***** *(0.015)*	**0.628***** *(0.063)*	0.925 *(0.062)*	0.925 *(0.064)*	0.915 *(0.062)*	0.925 *(0.125)*	0.925 *(0.063)*
Scientific orientation $_{i, j, t-1}$	**0.956**** *(0.016)*	0.956 *(0.056)*	**0.899*** *(0.048)*	**0.899*** *(0.048)*	**0.897*** *(0.047)*	0.899 *(0.093)*	**0.899†** *(0.051)*
Business orientation $_{i, j, t-1}$	**0.917***** *(0.012)*	**0.917†** *(0.047)*	1.004 *(0.043)*	1.004 *(0.045)*	1.007 *(0.044)*	1.004 *(0.090)*	1.004 *(0.044)*
General skills $_{i, j, t-1}$	**0.969***** *(0.007)*	0.969 *(0.025)*	1.006 *(0.024)*	1.006 *(0.024)*	1.002 *(0.024)*	1.006 *(0.048)*	1.006 *(0.024)*
CEO proactivity $_{i, j}$	**1.136***** *(0.005)*	**1.136***** *(0.023)*	**1.123***** *(0.026)*	**1.123***** *(0.026)*	**1.122***** *(0.026)*	**1.123†** *(0.078)*	**1.123***** *(0.027)*
Log likelihood	-24,875.8	-24,875.8	-12,727.6	-12,727.6	-12,812.0	-12,727.6	-12,727.6
Pseudo R^2	0.489	0.489	0.112	0.112			0.112
ln(Alpha)			**0.354*****	**0.354*****		**0.354*****	**0.354*****
Number of observations	5,481	5,481	5,481	5,481	5,481	5,481	5,481
DV = Reputation-based trademark applications $_{i, t}$				(based on the specification for Model 3.2)			
Legal orientation $_{i, j, t-1}$	**0.556***** *(0.028)*	**0.556***** *(0.062)*	**0.643***** *(0.057)*	**0.643***** *(0.064)*	**0.644***** *(0.063)*	**0.643**** *(0.087)*	**0.643***** *(0.057)*
Scientific orientation $_{i, j, t-1}$	0.977 *(0.031)*	0.977 *(0.082)*	0.898 *(0.060)*	0.898 *(0.070)*	0.907 *(0.070)*	0.898 *(0.095)*	0.898 *(0.059)*
Business orientation $_{i, j, t-1}$	**0.842***** *(0.022)*	**0.842**** *(0.053)*	**0.790***** *(0.043)*	**0.790***** *(0.049)*	**0.804***** *(0.048)*	**0.790*** *(0.075)*	**0.790***** *(0.043)*
General skills $_{i, j, t-1}$	**1.037**** *(0.014)*	1.037 *(0.039)*	1.013 *(0.030)*	1.013 *(0.034)*	1.016 *(0.034)*	1.013 *(0.054)*	1.013 *(0.029)*
CEO proactivity $_{i, j}$	**1.083***** *(0.009)*	**1.083***** *(0.026)*	**1.096***** *(0.028)*	**1.096***** *(0.028)*	**1.093***** *(0.027)*	**1.096*** *(0.040)*	**1.096***** *(0.030)*
Log likelihood	-10,620.4	-10,620.4	-7,603.2	-7,603.2	-7,713.6	-7,603.2	-7,603.2
Pseudo R^2	0.293	0.293	0.100	0.100			0.100
ln(Alpha)			**0.577*****	**0.577*****		**0.577*****	**0.577*****
Number of observations	5,481	5,481	5,481	5,481	5,481	5,481	5,481

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. Dependent variables are measured at time t. Explanatory variables are measured at time t-1. The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Robust standard errors are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. P_DFLT is the Poisson model with default maximum likelihood standard errors. P_RBST is the Poisson model with robust sandwich standard errors. NB_DFLT is the negative binomial model with default maximum likelihood standard errors. NB_RBST is the negative binomial model with robust sandwich standard errors. NB_PRSN is the generalised linear model (GLM) with the negative binomial distribution and the standard errors corrected using a quasi-GLM model. NB_CLTR is the negative binomial model with the standard errors clustered at the company level. NB_OPG is the negative binomial model with the standard errors based on the outer product of the gradient (the basis model). Sources and variable definitions are given in Table 3.8.

Table 3.A.7. The effect of the CEO tenure length

	Negative binomial models			
	Basis model	CEO tenure ≥ 3 years	CEO tenure ≥ 4 years	CEO tenure ≥ 5 years
DV = Patent applications $_{i, t}$				(based on the specification for Model 1.2)
Legal orientation $_{i, j, t-1}$	**1.545***** *(0.158)*	**1.449**** *(0.192)*	**1.386*** *(0.203)*	**1.309†** *(0.215)*
Scientific orientation $_{i, j, t-1}$	**1.208*** *(0.092)*	**1.219*** *(0.121)*	**1.212†** *(0.134)*	1.083 *(0.145)*
Business orientation $_{i, j, t-1}$	**1.202**** *(0.081)*	**1.181†** *(0.103)*	1.154 *(0.113)*	1.090 *(0.121)*
General skills $_{i, j, t-1}$	**1.138***** *(0.041)*	**1.198***** *(0.053)*	**1.206***** *(0.059)*	**1.246***** *(0.070)*
CEO proactivity $_{i, j}$	**1.286***** *(0.040)*	**1.319***** *(0.048)*	**1.325***** *(0.053)*	**1.354***** *(0.058)*
Log likelihood	-15,143.1	-11,149.8	-9,659.9	-8,255.9
Pseudo R^2	0.162	0.162	0.164	0.166
ln(Alpha)	**0.787*****	**0.829*****	**0.848*****	**0.862*****
Number of observations	5,481	4,120	3,621	3,162
DV = Innovation-based trademark applications $_{i, t}$				(based on the specification for Model 2.2)
Legal orientation $_{i, j, t-1}$	0.925 *(0.063)*	0.919 *(0.077)*	0.896 *(0.082)*	0.856 *(0.085)*
Scientific orientation $_{i, j, t-1}$	**0.899†** *(0.051)*	0.934 *(0.064)*	0.905 *(0.067)*	0.891 *(0.073)*
Business orientation $_{i, j, t-1}$	1.004 *(0.044)*	0.959 *(0.050)*	**0.903†** *(0.050)*	**0.878*** *(0.054)*
General skills $_{i, j, t-1}$	1.006 *(0.024)*	1.002 *(0.028)*	0.994 *(0.030)*	1.018 *(0.034)*
CEO proactivity $_{i, j}$	**1.123***** *(0.027)*	**1.105***** *(0.030)*	**1.080**** *(0.032)*	**1.071*** *(0.033)*
Log likelihood	-12,727.6	-9,412.2	-8,176.4	-7,083.2
Pseudo R^2	0.112	0.113	0.114	0.115
ln(Alpha)	**0.354*****	**0.361*****	**0.360*****	**0.359*****
Number of observations	5,481	4,120	3,621	3,162
DV = Reputation-based trademark applications $_{i, t}$				(based on the specification for Model 3.2)
Legal orientation $_{i, j, t-1}$	**0.643***** *(0.057)*	**0.700***** *(0.076)*	**0.749*** *(0.089)*	**0.690**** *(0.095)*
Scientific orientation $_{i, j, t-1}$	**0.898†** *(0.059)*	**0.873†** *(0.071)*	**0.848†** *(0.078)*	**0.775*** *(0.078)*
Business orientation $_{i, j, t-1}$	**0.790***** *(0.043)*	**0.741***** *(0.050)*	**0.745***** *(0.055)*	**0.731***** *(0.059)*
General skills $_{i, j, t-1}$	1.013 *(0.029)*	1.007 *(0.037)*	1.006 *(0.041)*	1.052 *(0.049)*
CEO proactivity $_{i, j}$	**1.096***** *(0.030)*	**1.086**** *(0.033)*	**1.080*** *(0.034)*	**1.081*** *(0.035)*
Log likelihood	-7,603.2	-5,647.4	-4,927.9	-4,245.8
Pseudo R^2	0.100	0.103	0.106	0.114
ln(Alpha)	**0.577*****	**0.587*****	**0.593*****	**0.572*****
Number of observations	5,481	4,120	3,621	3,162

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. Dependent variables are measured at time t. Explanatory variables are measured at time t-1. The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. Sources and variable definitions are given in Table 3.8.

Table 3.A.8. The effect of economic recession

	Negative binomial models		
	Full sample	Recession CEOs	Non-recession CEOs
DV = Patent applications $_{i, t}$			(based on the specification for Model 1.2)
Legal orientation $_{i, j, t-1}$	**1.545***** *(0.158)*	1.592 *(0.480)*	**1.490***** *(0.175)*
Scientific orientation $_{i, j, t-1}$	**1.208*** *(0.092)*	**2.436***** *(0.634)*	1.142 *(0.094)*
Business orientation $_{i, j, t-1}$	**1.202**** *(0.081)*	**1.522*** *(0.305)*	**1.232**** *(0.088)*
General skills $_{i, j, t-1}$	**1.138***** *(0.041)*	**1.204**† *(0.134)*	**1.233***** *(0.046)*
CEO proactivity $_{i, j}$	**1.286***** *(0.040)*	**3.255***** *(0.493)*	**1.128***** *(0.042)*
Log likelihood	-15,143.1	-2,309.8	-12,541.4
Pseudo R^2	0.162	0.215	0.170
ln(Alpha)	**0.787*****	**0.270*****	**0.690*****
Number of observations	5,481	955	4,526
DV = Innovation-based trademark applications $_{i, t}$			(based on the specification for Model 2.2)
Legal orientation $_{i, j, t-1}$	0.925 *(0.063)*	1.071 *(0.191)*	0.948 *(0.077)*
Scientific orientation $_{i, j, t-1}$	**0.899**† *(0.051)*	0.958 *(0.159)*	**0.878*** *(0.056)*
Business orientation $_{i, j, t-1}$	1.004 *(0.044)*	**2.176***** *(0.367)*	0.940 *(0.044)*
General skills $_{i, j, t-1}$	1.006 *(0.024)*	1.051 *(0.070)*	**1.066*** *(0.029)*
CEO proactivity $_{i, j}$	**1.123***** *(0.027)*	**1.591***** *(0.157)*	**1.046**† *(0.027)*
Log likelihood	-12,727.6	-2,017.9	-10,508.8
Pseudo R^2	0.112	0.174	0.115
ln(Alpha)	**0.354*****	**-0.055*****	**0.289*****
Number of observations	5,481	955	4,526
DV = Reputation-based trademark applications $_{i, t}$			(based on the specification for Model 3.2)
Legal orientation $_{i, j, t-1}$	**0.643***** *(0.057)*	0.767 (0.207)	**0.701***** (0.070)
Scientific orientation $_{i, j, t-1}$	**0.898**† *(0.059)*	0.654 (0.171)	0.952 (0.073)
Business orientation $_{i, j, t-1}$	**0.790***** *(0.043)*	1.401 (0.326)	**0.791***** (0.049)
General skills $_{i, j, t-1}$	1.013 *(0.029)*	**0.830**† (0.092)	**1.061**† (0.033)
CEO proactivity $_{i, j}$	**1.096***** *(0.030)*	**1.482**** (0.188)	**1.055**† (0.031)
Log likelihood	-7,603.2	-1,068.9	-6,408.0
Pseudo R^2	0.100	0.177	0.102
ln(Alpha)	**0.577*****	**-0.037*****	**0.563*****
Number of observations	5,481	955	4,526

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. Dependent variables are measured at time t. Explanatory variables are measured at time t-1. The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. Sources and variable definitions are given in Table 3.8.

Table 3.A.9. Testing for the inclusion of additional firm-level controls

	Negative binomial models					
	Basis model	FLC_DV_LG	FLC_TOB_Q	FLC_CP_IN	FLC_CS_HL	FLC_ALL_IN
DV = Patent applications $_{i, t}$	(based on the specification for Model 1.2)					
Legal orientation $_{i, j, t-1}$	**1.545***** *(0.158)*	**1.343**** *(0.129)*	**1.574***** *(0.157)*	**1.548***** *(0.158)*	**1.575***** *(0.155)*	**1.595***** *(0.155)*
Scientific orientation $_{i, j, t-1}$	**1.208*** *(0.092)*	**1.176†** *(0.102)*	**1.238**** *(0.092)*	**1.201*** *(0.092)*	**1.237**** *(0.088)*	**1.250**** *(0.089)*
Business orientation $_{i, j, t-1}$	**1.202**** *(0.081)*	**1.122†** *(0.069)*	**1.192**** *(0.080)*	**1.229**** *(0.083)*	**1.202**** *(0.079)*	**1.210**** *(0.080)*
General skills $_{i, j, t-1}$	**1.138***** *(0.041)*	**1.300***** *(0.052)*	**1.135***** *(0.041)*	**1.156***** *(0.042)*	**1.123***** *(0.040)*	**1.137***** *(0.040)*
CEO proactivity $_{i, j}$	**1.286***** *(0.040)*	**1.111**** *(0.040)*	**1.168***** *(0.040)*	**1.297***** *(0.040)*	**1.144***** *(0.037)*	**1.087*** *(0.039)*
Patent applications $_{i, t-1}$		**1.003***** *(0.0002)*				
Tobin's q $_{i, t-1}$			**1.360***** *(0.041)*			**1.231***** *(0.039)*
Capital intensity $_{i, t-1}$				**0.716**** *(0.082)*		**0.768*** *(0.091)*
Cash holdings $_{i, t-1}$					**51.017***** *(13.253)*	**28.139***** *(7.535)*
Log likelihood	-15,143.1	-15,564.6	-15,083.7	-15,131.5	-15,030.2	-14,994.5
Pseudo R^2	0.162	0.138	0.165	0.162	0.168	0.170
ln(Alpha)	**0.787*****	**0.997*****	**0.754*****	**0.782*****	**0.723*****	**0.704*****
Number of observations	5,481	5,481	5,481	5,481	5,481	5,481
DV = Innovation-based trademark applications $_{i, t}$	(based on the specification for Model 2.2)					
Legal orientation $_{i, j, t-1}$	0.925 *(0.063)*	0.970 *(0.060)*	0.931 *(0.063)*	0.921 *(0.063)*	0.919 *(0.063)*	0.921 *(0.063)*
Scientific orientation $_{i, j, t-1}$	**0.899†** *(0.051)*	0.959 *(0.048)*	**0.905†** *(0.051)*	**0.896†** *(0.051)*	**0.906†** *(0.051)*	**0.906†** *(0.051)*
Business orientation $_{i, j, t-1}$	1.004 *(0.044)*	1.004 *(0.039)*	1.001 *(0.044)*	1.010 *(0.044)*	0.997 *(0.043)*	1.001 *(0.044)*
General skills $_{i, j, t-1}$	1.006 *(0.024)*	1.025 *(0.021)*	1.007 *(0.024)*	1.016 *(0.025)*	1.008 *(0.024)*	1.018 *(0.025)*
CEO proactivity $_{i, j}$	**1.123***** *(0.027)*	**1.042†** *(0.023)*	**1.101***** *(0.028)*	**1.126***** *(0.027)*	**1.100***** *(0.028)*	**1.089***** *(0.028)*
Innovation-based trademark applications $_{i, t-1}$		**1.051***** *(0.002)*				
Tobin's q $_{i, t-1}$			**1.074**** *(0.025)*			**1.057*** *(0.025)*
Capital intensity $_{i, t-1}$				**0.880***** *(0.032)*		**0.887***** *(0.032)*
Cash holdings $_{i, t-1}$					**2.405***** *(0.521)*	**2.111***** *(0.467)*
Log likelihood	-12,727.6	-12,358.3	-12,721.7	-12,724.5	-12,717.9	-12,711.8
Pseudo R^2	0.112	0.138	0.112	0.112	0.113	0.113
ln(Alpha)	**0.354*****	**0.095*****	**0.350*****	**0.352*****	**0.347*****	**0.343*****
Number of observations	5,481	5,481	5,481	5,481	5,481	5,481

DV = Reputation-based trademark applications $_{i, t}$	(based on the specification for Model 3.2)					
Legal orientation $_{i, j, t-1}$	**0.643***** *(0.057)*	**0.701***** *(0.059)*	**0.646***** *(0.057)*	**0.643***** *(0.057)*	**0.644***** *(0.057)*	**0.646***** *(0.057)*
Scientific orientation $_{i, j, t-1}$	**0.898†** *(0.059)*	0.936 *(0.059)*	0.898 *(0.059)*	0.898 *(0.059)*	**0.896†** *(0.059)*	0.897 *(0.059)*
Business orientation $_{i, j, t-1}$	**0.790***** *(0.043)*	**0.829***** *(0.044)*	**0.789***** *(0.043)*	**0.789***** *(0.043)*	**0.788***** *(0.043)*	**0.788***** *(0.043)*
General skills $_{i, j, t-1}$	1.013 *(0.029)*	0.990 *(0.028)*	1.013 *(0.029)*	1.013 *(0.031)*	1.014 *(0.029)*	1.013 *(0.031)*
CEO proactivity $_{i, j}$	**1.096***** *(0.030)*	**1.067**** *(0.026)*	**1.092***** *(0.029)*	**1.096***** *(0.030)*	**1.090**** *(0.031)*	**1.087**** *(0.030)*
Reputation-based trademark applications $_{i, t-1}$		**1.110***** *(0.008)*				
Tobin's q $_{i, t-1}$			1.033 *(0.030)*			1.029 *(0.031)*
Capital intensity $_{i, t-1}$				1.001 *(0.049)*		1.004 *(0.049)*
Cash holdings $_{i, t-1}$					1.310 *(0.323)*	1.254 *(0.314)*
Log likelihood	-7,603.2	-7,480.6	7,602.4	-7,603.2	-7,602.6	-7,602.0
Pseudo R^2	0.100	0.115	0.100	0.100	0.100	0.100
ln(Alpha)	**0.577*****	**0.446*****	**0.576*****	**0.577*****	**0.576*****	**0.575*****
Number of observations	5,481	5,481	5,481	5,481	5,481	5,481

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. Dependent variables are measured at time t. Explanatory variables are measured at time t-1. The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. FLC_DV_LG is the model with a lagged value of the dependent variable. FLC_TOB_Q is the model with Tobin's q added to the list of firm-level controls; it was calculated as the sum of total assets plus the difference between the market and the book value of equity divided by total assets. FLC_CP_IN is the model with capital intensity added to the list of firm-level controls; it was calculated as the ratio of property, plants, and equipment to the number of employees. FLC_CS_HL is the model with cash holdings added to the list of firm-level controls; it was calculated as the ratio of cash and all securities readily transferable to cash to total assets. FLC_ALL_IN is the model with Tobin's q, capital intensity, and cash holdings added to the list of firm-level controls. To achieve convergence in Model FLC_DV_LG for patent applications, we used the Fama and French 12 industry classification when introducing industry fixed effects. Sources and variable definitions are given in Table 3.8.

Table 3.A.10. Testing for the inclusion of additional CEO-level controls

	Negative binomial models			
	Basis model	ILC_COM_TEN	ILC_CEO_AGE	ILC_ALL_IN
DV = Patent applications $_{i, t}$ (based on the specification for Model 1.2)				
Legal orientation $_{i, j, t-1}$	**1.545***** *(0.158)*	**1.534***** *(0.154)*	**1.557***** *(0.155)*	**1.540***** *(0.153)*
Scientific orientation $_{i, j, t-1}$	**1.208*** *(0.092)*	**1.278**** *(0.099)*	**1.280***** *(0.098)*	**1.289***** *(0.100)*
Business orientation $_{i, j, t-1}$	**1.202**** *(0.081)*	**1.188**** *(0.079)*	**1.147*** *(0.077)*	**1.149*** *(0.077)*
General skills $_{i, j, t-1}$	**1.138***** *(0.041)*	**1.131***** *(0.042)*	**1.178***** *(0.042)*	**1.189***** *(0.046)*
CEO proactivity $_{i, j}$	**1.286***** *(0.040)*	**1.307***** *(0.040)*	**1.270***** *(0.040)*	**1.267***** *(0.040)*
Company tenure $_{i, j, t-1}$		**1.022*** *(0.011)*		1.012 *(0.011)*
Company tenure^2 $_{i, j, t-1}$		**0.9994**** *(0.0002)*		0.9997 *(0.0002)*
CEO age $_{i, j, t-1}$			0.973 *(0.042)*	0.969 *(0.042)*
CEO age^2 $_{i, j, t-1}$			0.9999 *(0.0004)*	1.0000 *(0.0004)*
Founder CEO $_{i, j, t-1}$		**0.651***** *(0.084)*	**0.703**** *(0.091)*	**0.697**** *(0.090)*
Log likelihood	-15,143.1	-15,139.8	-15,121.9	-15,121.1
Pseudo R^2	0.162	0.162	0.163	0.163
ln(Alpha)	**0.787*****	**0.783*****	**0.775*****	**0.775*****
Number of observations	5,481	5,481	5,481	5,481
DV = Innovation-based trademark applications $_{i, t}$ (based on the specification for Model 2.2)				
Legal orientation $_{i, j, t-1}$	0.925 *(0.063)*	**0.891†** *(0.060)*	0.930 *(0.063)*	**0.894†** *(0.060)*
Scientific orientation $_{i, j, t-1}$	**0.899†** *(0.051)*	0.930 *(0.052)*	**0.898†** *(0.051)*	0.924 *(0.052)*
Business orientation $_{i, j, t-1}$	1.004 *(0.044)*	1.012 *(0.043)*	1.005 *(0.044)*	1.004 *(0.044)*
General skills $_{i, j, t-1}$	1.006 *(0.024)*	1.026 *(0.025)*	1.016 *(0.024)*	1.025 *(0.025)*
CEO proactivity $_{i, j}$	**1.123***** *(0.027)*	**1.100***** *(0.027)*	**1.106***** *(0.028)*	**1.104***** *(0.028)*
Company tenure $_{i, j, t-1}$		**1.039***** *(0.007)*		**1.038***** *(0.007)*
Company tenure^2 $_{i, j, t-1}$		**0.9990***** *(0.0002)*		**0.9991***** *(0.0002)*
CEO age $_{i, j, t-1}$			**1.104**** *(0.041)*	**1.081*** *(0.041)*
CEO age^2 $_{i, j, t-1}$			**0.9991**** *(0.0003)*	**0.9993*** *(0.0003)*
Founder CEO $_{i, j, t-1}$		1.139 *(0.106)*	**1.191†** *(0.112)*	1.153 *(0.108)*
Log likelihood	-12,727.6	-12,707.2	-12,723.2	-12,705.2
Pseudo R^2	0.112	0.113	0.112	0.113
ln(Alpha)	**0.354*****	**0.338*****	**0.351*****	**0.337*****
Number of observations	5,481	5,481	5,481	5,481

DV = Reputation-based trademark applications $_{i,t}$	(based on the specification for Model 3.2)			
Legal orientation $_{i,j,t-1}$	**0.643***** *(0.057)*	**0.634***** *(0.056)*	**0.656***** *(0.058)*	**0.633***** *(0.056)*
Scientific orientation $_{i,j,t-1}$	**0.898†** *(0.059)*	**0.895†** *(0.059)*	**0.892†** *(0.059)*	**0.892†** *(0.059)*
Business orientation $_{i,j,t-1}$	**0.790***** *(0.043)*	**0.800***** *(0.044)*	**0.792***** *(0.044)*	**0.794***** *(0.044)*
General skills $_{i,j,t-1}$	1.013 *(0.029)*	1.039 *(0.030)*	1.003 *(0.028)*	1.039 *(0.030)*
CEO proactivity $_{i,j}$	**1.096***** *(0.030)*	**1.080**** *(0.028)*	**1.092***** *(0.029)*	**1.082**** *(0.028)*
Company tenure $_{i,j,t-1}$		**1.043***** *(0.009)*		**1.041***** *(0.009)*
Company tenure^2 $_{i,j,t-1}$		**0.9992***** *(0.0002)*		**0.9992***** *(0.0002)*
CEO age $_{i,j,t-1}$			**1.109*** *(0.055)*	1.083 *(0.055)*
CEO age^2 $_{i,j,t-1}$			**0.9991*** *(0.0004)*	0.9993 *(0.0005)*
Founder CEO $_{i,j,t-1}$		**1.303*** *(0.151)*	**1.383**** *(0.166)*	**1.320*** *(0.159)*
Log likelihood	-7,603.2	-7,590.5	-7,600.5	-7,589.1
Pseudo R^2	0.100	0.102	0.100	0.102
ln(Alpha)	**0.577*****	**0.561*****	**0.577*****	**0.560*****
Number of observations	5,481	5,481	5,481	5,481

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. Dependent variables are measured at time t. Explanatory variables are measured at time t-1. The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. ILC_COM_TEN is the model with company tenure (and its squared term to account for potential nonlinearities) added to the list of CEO-level controls; it was calculated as the difference between the year of the observation and the year in which the individual joined the company. ILC_CEO_AGE is the model with CEO age (and its squared term to account for potential nonlinearities) added to the list of CEO-level controls; it was calculated as the difference between the year of the observation and the birth year of the individual. ILC_ALL_IN is the model with the company tenure, CEO age, and founder CEO variables added to the list of CEO-level controls. Sources and variable definitions are given in Table 3.8.

Table 3.A.11. The direct effect of various components of the proactivity index

	Negative binomial models						
	Basis model	PR_LDR	PR_POW	PR_VIS	PR_POS	PR_PRO	PR_OTH
DV = Patent applications $_{i, t}$				(based on the specification for Model 1.2)			
Legal orientation $_{i, j, t-1}$	**1.545***** *(0.158)*	**1.494***** *(0.156)*	**1.663***** *(0.166)*	**1.604***** *(0.165)*	**1.661***** *(0.173)*	**1.676***** *(0.173)*	**1.582***** *(0.162)*
Scientific orientation $_{i, j, t-1}$	**1.208*** *(0.092)*	**1.238**** *(0.094)*	**1.248**** *(0.092)*	**1.156†** *(0.092)*	**1.254**** *(0.098)*	**1.232**** *(0.097)*	**1.251**** *(0.098)*
Business orientation $_{i, j, t-1}$	**1.202**** *(0.081)*	**1.192**** *(0.078)*	**1.224**** *(0.082)*	**1.161*** *(0.079)*	**1.163*** *(0.078)*	**1.165*** *(0.078)*	**1.160*** *(0.079)*
General skills $_{i, j, t-1}$	**1.138***** *(0.041)*	**1.141***** *(0.042)*	**1.159***** *(0.041)*	**1.117**** *(0.042)*	**1.130***** *(0.042)*	**1.131***** *(0.042)*	**1.132***** *(0.042)*
CEO proactivity $_{i, j}$	**1.286***** *(0.040)*						
Leadership $_{i, j}$		**1.211***** *(0.038)*					
Power and influence $_{i, j}$			**1.140***** *(0.028)*				
Vision and inventiveness $_{i, j}$				**1.624***** *(0.223)*			
Position-related awards $_{i, j}$					1.033 *(0.027)*		
Professionalism and entrepreneurial talent $_{i, j}$						1.031 *(0.043)*	
Other honours and prizes $_{i, j}$							**1.060***** *(0.014)*
Log likelihood	-15,143.1	-15,155.5	-15,128.2	-15,162.8	-15,176.0	-15,177.0	-15,157.4
Pseudo R^2	0.162	0.161	0.163	0.161	0.160	0.160	0.161
ln(Alpha)	**0.787*****	**0.796*****	**0.777*****	**0.796*****	**0.804*****	**0.804*****	**0.794*****
Number of obs.	5,481	5,481	5,481	5,481	5,481	5,481	5,481
DV = Innovation-based trademark applications $_{i, t}$				(based on the specification for Model 2.2)			
Legal orientation $_{i, j, t-1}$	0.925 *(0.063)*	0.915 *(0.063)*	0.960 *(0.065)*	0.968 *(0.066)*	0.952 *(0.065)*	0.927 *(0.062)*	0.953 *(0.065)*
Scientific orientation $_{i, j, t-1}$	**0.899†** *(0.051)*	**0.906†** *(0.051)*	**0.906†** *(0.051)*	**0.896†** *(0.052)*	0.914 *(0.052)*	**0.898†** *(0.051)*	**0.904†** *(0.052)*
Business orientation $_{i, j, t-1}$	1.004 *(0.044)*	1.003 *(0.044)*	1.011 *(0.044)*	0.998 *(0.044)*	0.998 *(0.044)*	1.001 *(0.044)*	0.999 *(0.044)*
General skills $_{i, j, t-1}$	1.006 *(0.024)*	1.009 *(0.024)*	1.011 *(0.024)*	1.011 *(0.024)*	1.008 *(0.024)*	1.010 *(0.024)*	1.007 *(0.024)*
CEO proactivity $_{i, j}$	**1.123***** *(0.027)*						
Leadership $_{i, j}$		**1.107***** *(0.027)*					
Power and influence $_{i, j}$			**1.059*** *(0.026)*				
Vision and inventiveness $_{i, j}$				1.068 *(0.076)*			
Position-related awards $_{i, j}$					**1.035*** *(0.016)*		
Professionalism and entrepreneurial talent $_{i, j}$						**1.112***** *(0.022)*	
Other honours and prizes $_{i, j}$							**1.019*** *(0.010)*

Log likelihood	-12,727.6	-12,730.2	-12,724.5	-12,741.4	-12,738.2	-12,725.3	-12,738.9
Pseudo R^2	0.112	0.112	0.112	0.111	0.111	0.112	0.111
ln(Alpha)	**0.354*** **	**0.355*** **	**0.350*** **	**0.363*** **	**0.361*** **	**0.355*** **	**0.361*** **
Number of obs.	5,481	5,481	5,481	5,481	5,481	5,481	5,481
DV = Reputation-based trademark applications $_{i, t}$	(based on the specification for Model 3.2)						
Legal orientation $_{i, j, t-1}$	**0.643*** ** *(0.057)*	**0.636*** ** *(0.055)*	**0.683*** ** *(0.058)*	**0.683*** ** *(0.060)*	**0.656*** ** *(0.058)*	**0.619*** ** *(0.053)*	**0.684*** ** *(0.061)*
Scientific orientation $_{i, j, t-1}$	**0.898†** *(0.059)*	0.899 *(0.059)*	**0.894†** *(0.059)*	**0.894†** *(0.060)*	0.918 *(0.060)*	0.901 *(0.059)*	0.901 *(0.059)*
Business orientation $_{i, j, t-1}$	**0.790*** ** *(0.043)*	**0.789*** ** *(0.043)*	**0.801*** ** *(0.044)*	**0.796*** ** *(0.044)*	**0.789*** ** *(0.043)*	**0.789*** ** *(0.043)*	**0.796*** ** *(0.044)*
General skills $_{i, j, t-1}$	1.013 *(0.029)*	1.015 *(0.029)*	1.016 *(0.029)*	1.015 *(0.029)*	1.015 *(0.029)*	1.016 *(0.029)*	1.013 *(0.029)*
CEO proactivity $_{i, j}$	**1.096*** ** *(0.030)*						
Leadership $_{i, j}$		**1.123*** ** *(0.034)*					
Power and influence $_{i, j}$			**1.034†** *(0.019)*				
Vision and inventiveness $_{i, j}$				1.059 *(0.081)*			
Position-related awards $_{i, j}$					**1.043** ** *(0.017)*		
Professionalism and entrepreneurial talent $_{i, j}$						**1.129*** ** *(0.026)*	
Other honours and prizes $_{i, j}$							1.005 *(0.009)*
Log likelihood	-7,603.2	-7,599.4	-7,607.3	-7,610.0	-7,606.1	-7,593.2	-7,610.1
Pseudo R^2	0.100	0.101	0.100	0.099	0.100	0.101	0.099
ln(Alpha)	**0.577*** **	**0.571*** **	**0.580*** **	**0.584*** **	**0.581*** **	**0.570*** **	**0.584*** **
Number of obs.	5,481	5,481	5,481	5,481	5,481	5,481	5,481

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. Dependent variables are measured at time t. Explanatory variables are measured at time t-1. The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. PR_LDR is the model where the proactivity index is replaced with its component – the number of awards that emphasise leadership. PR_POW is the model where the proactivity index is replaced with its component – the number of power and influence-related awards. PR_VIS is the model where the proactivity index is replaced with its component – the number of awards that highlight vision and inventiveness. PR_POS is the model where the proactivity index is replaced with its component – the number of position-related awards. PR_PRO is the model where the proactivity index is replaced with its component – the number of professional awards and the awards that emphasise entrepreneurial talent. PR_OTH is the model where the proactivity index is replaced with its component – the number of other honours and prizes. Sources and variable definitions are given in Table 3.8.

Table 3.A.12. The interaction of CEO characteristics with various components of the proactivity index

	Negative binomial models							
	Legal orientation		Scientific orientation		Business orientation		General skills	
	Main effect	*Interaction*	*Main effect*	*Interaction*	*Main effect*	*Interaction*	*Main effect*	*Interaction*
DV = Patent applications $_{i, t}$								(based on the specification for Model 1.2)
Leadership $_{i, j}$	**1.516*****	0.975	**1.269****	0.927	**1.368*****	**0.708*****	**1.147*****	0.987
	(0.171)	*(0.063)*	*(0.104)*	*(0.091)*	*(0.095)*	*(0.056)*	*(0.044)*	*(0.031)*
Power and influence $_{i, j}$	**1.654*****	1.011	**1.201***	1.081	**1.179***	1.072	**1.159*****	0.999
	(0.180)	*(0.097)*	*(0.094)*	*(0.074)*	*(0.085)*	*(0.053)*	*(0.043)*	*(0.028)*
Vision and inventiveness $_{i, j}$	**1.691*****	0.608	1.072	**1.917***	**1.219****	**0.576†**	**1.102****	1.256
	(0.176)	*(0.239)*	*(0.087)*	*(0.522)*	*(0.087)*	*(0.181)*	*(0.041)*	*(0.214)*
Position-related awards $_{i, j}$	**1.656*****	1.003	**1.220***	1.082	**1.281*****	**0.858****	**1.097***	**1.066***
	(0.191)	*(0.054)*	*(0.099)*	*(0.096)*	*(0.091)*	*(0.046)*	*(0.041)*	*(0.031)*
Professionalism and entrepreneurial talent $_{i, j}$	**1.804*****	0.880	**1.148†**	**1.174†**	**1.188***	0.953	**1.145*****	0.966
	(0.193)	*(0.069)*	*(0.095)*	*(0.105)*	*(0.086)*	*(0.073)*	*(0.045)*	*(0.052)*
Other honours and prizes $_{i, j}$	**1.664*****	0.976	**1.227***	1.014	**1.446*****	**0.871*****	**1.155*****	0.987
	(0.216)	*(0.034)*	*(0.108)*	*(0.034)*	*(0.110)*	*(0.020)*	*(0.049)*	*(0.014)*
Number of obs.	5,481		5,481		5,481		5,481	
DV = Innovation-based trademark applications $_{i, t}$								(based on the specification for Model 2.2)
Leadership $_{i, j}$	0.952	**0.927†**	**0.905†**	1.002	1.070	**0.830*****	1.006	1.007
	(0.069)	*(0.042)*	*(0.054)*	*(0.067)*	*(0.049)*	*(0.041)*	*(0.026)*	*(0.025)*
Power and influence $_{i, j}$	0.965	0.990	**0.863***	**1.125***	1.032	0.948	1.016	0.987
	(0.068)	*(0.053)*	*(0.051)*	*(0.060)*	*(0.047)*	*(0.040)*	*(0.025)*	*(0.014)*
Vision and inventiveness $_{i, j}$	0.985	0.836	**0.887***	1.092	1.013	**0.739†**	1.015	0.924
	(0.068)	*(0.121)*	*(0.053)*	*(0.156)*	*(0.045)*	*(0.122)*	*(0.025)*	*(0.075)*
Position-related awards $_{i, j}$	0.944	1.008	**0.881***	**1.114****	**1.093†**	**0.833*****	0.993	1.029
	(0.068)	*(0.030)*	*(0.051)*	*(0.046)*	*(0.050)*	*(0.025)*	*(0.024)*	*(0.020)*
Professionalism and entrepreneurial talent $_{i, j}$	0.989	**0.876*****	**0.872***	1.074	1.061	**0.845*****	1.003	1.016
	(0.069)	*(0.035)*	*(0.052)*	*(0.053)*	*(0.048)*	*(0.032)*	*(0.027)*	*(0.024)*
Other honours and prizes $_{i, j}$	0.985	0.984	**0.853***	**1.043†**	**1.096†**	**0.936*****	1.001	1.003
	(0.077)	*(0.019)*	*(0.054)*	*(0.023)*	*(0.053)*	*(0.016)*	*(0.028)*	*(0.009)*
Number of obs.	5,481		5,481		5,481		5,481	
DV = Reputation-based trademark applications $_{i, t}$								(based on the specification for Model 3.2)
Leadership $_{i, j}$	**0.676*****	**0.909†**	**0.819****	**1.248****	**0.811*****	0.936	1.010	1.010
	(0.061)	*(0.048)*	*(0.057)*	*(0.103)*	*(0.046)*	*(0.053)*	*(0.030)*	*(0.026)*
Power and influence $_{i, j}$	**0.663*****	1.047	**0.820****	**1.153***	**0.806*****	0.988	1.018	0.992
	(0.059)	*(0.044)*	*(0.060)*	*(0.066)*	*(0.046)*	*(0.033)*	*(0.029)*	*(0.029)*
Vision and inventiveness $_{i, j}$	**0.669*****	1.173	**0.881†**	1.114	**0.806*****	0.824	1.019	0.913
	(0.059)	*(0.178)*	*(0.061)*	*(0.171)*	*(0.045)*	*(0.134)*	*(0.029)*	*(0.114)*
Position-related awards $_{i, j}$	**0.610*****	**1.069†**	0.921	0.993	**0.859****	**0.860*****	1.021	0.990
	(0.057)	*(0.037)*	*(0.064)*	*(0.059)*	*(0.049)*	*(0.031)*	*(0.031)*	*(0.022)*
Professionalism and entrepreneurial talent $_{i, j}$	**0.639*****	0.951	**0.859***	**1.114***	**0.834*****	**0.875*****	1.018	0.998
	(0.057)	*(0.043)*	*(0.060)*	*(0.058)*	*(0.047)*	*(0.035)*	*(0.031)*	*(0.021)*

Other honours and prizes $_{i, j}$	**0.642*** **	1.026	**0.861***	1.033	**0.814*** **	0.985	0.996	1.009
	(0.063)	*(0.019)*	*(0.063)*	*(0.021)*	*(0.049)*	*(0.017)*	*(0.031)*	*(0.008)*
Number of obs.	5,481		5,481		5,481		5,481	

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. Dependent variables are measured at time t. Explanatory variables are measured at time t-1. The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. Sources and variable definitions are given in Table 3.8.

Table 3.A.13. A comparison of lagged and contemporaneous model specifications

	Negative binomial models	
	Basis model (T = t-1)	Contemporaneous model (T = t)
DV = Patent applications $_{i, t}$		(based on the specification for Model 1.2)
Legal orientation $_{i, j, T}$	**1.545***** *(0.158)*	**1.513***** *(0.150)*
Scientific orientation $_{i, j, T}$	**1.208*** *(0.092)*	**1.189*** *(0.088)*
Business orientation $_{i, j, T}$	**1.202**** *(0.081)*	**1.185**** *(0.078)*
General skills $_{i, j, T}$	**1.138***** *(0.041)*	**1.136***** *(0.040)*
CEO proactivity $_{i, j}$	**1.286***** *(0.040)*	**1.266***** *(0.039)*
Log likelihood	-15,143.1	-15,747.3
Pseudo R^2	0.162	0.163
ln(Alpha)	**0.787*****	**0.782*****
Number of observations	5,481	5,742
DV = Innovation-based trademark applications $_{i, t}$		(based on the specification for Model 2.2)
Legal orientation $_{i, j, T}$	0.925 *(0.063)*	0.965 *(0.065)*
Scientific orientation $_{i, j, T}$	**0.899†** *(0.051)*	**0.906†** *(0.051)*
Business orientation $_{i, j, T}$	1.004 *(0.044)*	0.991 *(0.042)*
General skills $_{i, j, T}$	1.006 *(0.024)*	1.004 *(0.024)*
CEO proactivity $_{i, j}$	**1.123***** *(0.027)*	**1.103***** *(0.026)*
Log likelihood	-12,727.6	-13,241.4
Pseudo R^2	0.112	0.111
ln(Alpha)	**0.354*****	**0.371*****
Number of observations	5,481	5,742
DV = Reputation-based trademark applications $_{i, t}$		(based on the specification for Model 3.2)
Legal orientation $_{i, j, T}$	**0.643***** *(0.057)*	**0.657***** *(0.056)*
Scientific orientation $_{i, j, T}$	**0.898†** *(0.059)*	0.914 *(0.059)*
Business orientation $_{i, j, T}$	**0.790***** *(0.043)*	**0.816***** *(0.043)*
General skills $_{i, j, T}$	1.013 *(0.029)*	1.015 *(0.027)*
CEO proactivity $_{i, j}$	**1.096***** *(0.030)*	**1.080**** *(0.027)*
Log likelihood	-7,603.2	-7,941.9
Pseudo R^2	0.100	0.099
ln(Alpha)	**0.577*****	**0.589*****
Number of observations	5,481	5,742

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. Dependent variables are measured at time t. Explanatory variables are measured at time t-1 (basic models) or at time t (contemporaneous models). The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. Sources and variable definitions are given in Table 3.8.

APPENDIX 3.B. THE CONSTRUCTION OF THE GENERAL ABILITY INDEX

To evaluate the generality of knowledge and skills acquired by the CEO over their professional life, we decided to follow the approach set out by Custódio *et al.* (2013) and constructed the general ability index. In doing so, we first examined the career progression statistics from the BoardEx database and other sources to extract the information on the number of (1) industries, (2) companies, and (3) positions in which the chief executive worked; as well as on (4) the chief executive's previous experience in the CEO function.[a] Due to data availability, we did not include the fifth element of the original index, which is the chief executive's conglomerate experience. However, we believe that our measure still captures a great deal of general skills, given that the missing element was actually assigned the lowest weight. This belief is also corroborated by the results of the correlation analysis: despite the methodological difference, the two indices show a high degree of similarity with each other (Pearson's correlation coefficient is 0.72).[b]

Turning back to the data analysis, the *number of industries* was derived by counting unique SIC codes aggregated at the 2-digit level. As the BoardEx database contains no industry affiliation, we first extracted the historical list of companies across all executives and then hand-collected industry codes by looking up each company name in the Compustat database; the company's official web-site; SEC filings; and business profiles compiled by Nasdaq, Inc., Morningstar, Inc., siccode.com, and manta.com. It needs to be stressed here that maximum effort was given to avoiding mismatches: for example, when searching for the industry data, we also controlled for a variety of factors, including location, legal form, and name similarity. Whenever there was a doubt in the validity of the obtained result, the matching was not established. Overall, we were able to identify industry affiliation for 75.2% of all the companies in the historical list. Next, we counted the *number of companies* in which the chief executive worked. Before proceeding with this step, we harmonised company names to exclude various artificial parts that can inflate the resulting variable (e.g., a former name, a trading name, or the date when the company was de-listed). We used post names to count the *number of previous positions* held by the chief executive. This variable was constructed without any further adjustment, though having "Various positions" as a post

[a] Since we were unable to find 51 CEOs from our sample in the BoardEx database, the missing information was then manually collected by searching the LexisNexis news database; Marquis Who's Who biographical data; SEC filings; obituaries; and other suchlike data sources. The same applies to Appendix 3.C.

[b] Custódio *et al.* (2013) made their index freely available at http://jfe.rochester.edu/data.htm. However, we were unable to utilise it because of the differences in the period of coverage.

name might lead to underestimating the overall effect (in total, 530 CEOs have at least one position denoted in this way). Finally, we examined company names, post names, and role descriptions to create a dummy variable for *previous CEO experience*. To reveal this experience, we searched for such patterns as "CEO", "principal executive", and "chief executive". The dummy takes the value of one if the chief executive previously had CEO experience, and zero otherwise.

We used the principal component analysis to pool these measures into a one-dimension index (Jolliffe, 2002). This approach allowed us to capture the multiplicity of sources through which general skills could be obtained, while avoiding the multicollinearity problem due to high correlation among the components. We first extracted principal components, which are mutually orthogonal, and then arranged them according to the proportion of the total variance each can explain (see Table 3.B.1).

Table 3.B.1. Eigenvalues of the correlation matrix

Component	Eigenvalue	Difference	Proportion	Cumulative
Component 1	2.399	1.399	0.600	0.600
Component 2	1.000	0.570	0.250	0.850
Component 3	0.430	0.259	0.108	0.957
Component 4	0.171	.	0.043	1.000

Table 3.B.2. Principal components (eigenvectors)

Variable	Comp. 1	Comp. 2	Comp. 3	Comp. 4
Number of industries	0.561	-0.077	0.689	0.453
Number of companies	0.610	-0.039	0.020	-0.792
Number of positions	0.558	0.032	-0.721	0.410
Previous CEO experience	0.049	0.996	0.077	-0.010

Our decision regarding the factors to keep for further examination is based on the results of Horn's (1965) parallel analysis. It starts with extracting principal components from a randomly generated dataset, which contains the same number of variables and observations as the original sample, and then continues with the calculation of corresponding eigenvalues. The same procedure is repeated N times (we set N = 100 iterations), after which it returns the average eigenvalue for each of the components. The rule for choosing the factors to retain from the principal component analysis is that their eigenvalues must be greater than the average eigenvalues obtained from the parallel analysis. As Table 3.B.3 indicates, only the first factor satisfies the described rule and, hence, will be used to finalise the index construction.

Table 3.B.3. Parallel analysis

Component	Principal component analysis	Parallel analysis	Difference
Component 1	2.399	1.028	1.371
Component 2	1.000	1.008	-0.008
Component 3	0.430	0.993	-0.562
Component 4	0.171	0.971	-0.800

As expected, the first factor has positive loadings on all four variables, ranging from 0.049 for the previous CEO experience to 0.610 for the number of companies in which the chief executive has worked to date (see Table 3.B.2). It also captures 60.0% of the total variation in the characteristics. Therefore, we interpret it as being a measure of the generality of the chief executive's human capital, with its higher values relating to the prevalence of general knowledge and skills.[c] We completed the analysis by calculating the general ability index (*GAI*) for each CEO in our sample. The regression scoring method was used to calculate the weights that were assigned to each demographic factor according to the following formula (all variables were mean-centred beforehand):

$$GAI_{i,t} = 0.214 * Y_{1,i,t} + 0.594 * Y_{2,i,t} + 0.202 * Y_{3,i,t} + 0.010 * Y_{4,i,t},$$

where $Y_{1,i,t}$ is the number of industries CEO_i had worked in until year t; $Y_{2,i,t}$ is the number of companies CEO_i had worked for until year t; $Y_{3,i,t}$ is the number of positions CEO_i had worked in until year t; and $Y_{4,i,t}$ is a dummy variable that takes the value of one for the chief executive with previous professional experience in the CEO functions at another company, and zero otherwise. To improve the index's interpretability, it was subsequently normalised to have zero mean and a standard deviation of unity.

[c] We also assessed the internal consistency of the items in the general ability index by calculating Cronbach's alpha (Cronbach, 1951). The analysis suggests that our set of career-based indicators is internally consistent because the alpha coefficient is 0.699, while a reliability coefficient of 0.70 or higher appears to be sufficient (see Nunnally and Bernstein, 1994).

APPENDIX 3.C. THE CONSTRUCTION OF THE PROACTIVITY INDEX

Since individual proactivity shows a close positive association with the need for achievement (Bateman and Crant, 1993; Miller and Toulouse, 1986a), we decided to employ the BoardEx statistics on awards, honours, and prizes to measure it. We started with coding awards received by sampled CEOs into nine categories: (1) publications; (2) compensation-related awards; (3) awards that highlight leadership; (4) awards that highlight power and influence; (5) awards that highlight vision and inventiveness; (6) position-related awards; (7) awards that highlight professional and entrepreneurial achievements; (8) honorary degrees and alumni awards; and (9) other honours and prizes. Table 3.C.1 assigns the key words we identified by examining award names to corresponding award categories (our dataset contains the information on 2,698 prizes, honours, and achievements for 535 chief executives). Because of some awards accentuating different aspects of the laureate's achievement, these categories are not mutually exclusive (except for compensation-related awards). For example, "Agribusiness Leader of the Year" is classified as an award that highlights both leadership and professional achievements.

Table 3.C.1. The mapping of the key words identified in award names to award categories

No.	Award category	Key words	Number of associated awards
1	Publications	author; co-author	49
2	Compensation-related awards	CEO compensation/pay performance; executive pay; for compensation; Forbes list; highest paid; list of billionaires; richest Americans/man/people/person; top paid; wealthiest Americans	228
3	Awards that highlight leadership	business leader/person; leader; leader award; leadership; leadership award; leading woman; man/woman/person of the year/decade; outstanding person/professional; top women/people	239
4	Awards that highlight power and influence	elite; great living; hero; impact list; influence; influential; hall of achievement/distinction/fame/ honor/excellence; legend; most admired/ important/ influential/inspiring/powerful/respected; newsmaker; power ranking/list; role model; super; thinker; to watch	352
5	Awards that highlight vision and inventiveness	above and beyond; future; innovation; innovator; inventor; pioneer; revolutionary; tomorrows Chief Executive Officers; vision; visionary/visionaries	35
6	Position-related awards	best boss/CEO/CFO/chairman/chief/manager; CEO award/diversity/leader; CEO/CFO/director/executive/ manager/officer of the week/year/decade/century; director award/list; executive award; good CEO; highest rated CEO; most valuable CEO; outstanding CEO/chief/director/executive/manager; top board member/CEO/CFO/chief executive/manager	345

7	Awards that highlight professional and entrepreneurial achievements	advertiser of the year; advocate of the year; agribusiness leader; banker of the year; best builder; builder of the year; captains of industry; engineer of the year; entrepreneur award; entrepreneur of the year; entrepreneurship award; farmer of the year; greatest entrepreneur; hotelier of the year; in technology; industrialist of the year; industry; industry award; industry leadership; industry man of the year; manufacturer of the year; marketer of the year; marketing man of the year; operator of the year; outstanding engineer; outstanding industrialist; railroader of the year; restaurateur of the year; retailer of the year; steelmaker of the year	238
8	Honorary degrees and alumni awards	alumni; alumni achievement; alumni fellow; alumni/alumnus award; alumni/student hall; alumnus of the year; distinguished alumna/alumni/alumnus/ graduate; doctor of; honorary alumni/alumnus; honorary degree; honorary doctor/doctorate; noted alumni; outstanding alumni/alumnus/graduate	437
9	Other honours and prizes	(e.g.) admitted to the bar; Columbus Award; fellow; Golden Chain Award; Horatio Alger Award; inducted; Legion of Honour; Luminary Award; Maimonides Award; Spirit of Achievement Award; Watauga Medal	937

Before proceeding to the index construction, we made a few adjustments to the set of awards under consideration. First, we excluded compensation-related awards due to the possibility that their inclusion would artificially inflate the overall measure. The basic reason here is that once top managers have reached a certain level of compensation, they are likely to keep reappearing in pay-based rankings, regardless of the actual achievements. Furthermore, the size of a remuneration package (and, hence, the corresponding award) also depends on the factors that tend to fluctuate with market conditions rather than actual leadership qualities and characteristics. Next, publications were dropped because they are predominantly a CEO-side factor, thus having very little to do with the external appraisal and recognition of the top manager's talent. Finally, we excluded honorary degrees and alumni awards due to their biasness as well as the scarcity of personality traits we can derive from this category.

Similarly to the general ability index (see Appendix 3.B), we utilised the principal component analysis to combine the six factors into a one-dimensional index of the chief executive's proactivity.[a] The results of the application of this method are presented in Tables 3.C.2 and 3.C.3. In order to determine the number of components to retain for further processing, the parallel analysis was employed (see Table 3.C.4). Its outcomes suggest that the first component contributing 58.1% towards the total variation in characteristics should be kept.

[a] Cronbach's alpha for this set of award-based indicators is equal to 0.852, suggesting the internal consistency of the index.

Table 3.C.2. Eigenvalues of the correlation matrix

Component	Eigenvalue	Difference	Proportion	Cumulative
Component 1	3.488	2.702	0.581	0.581
Component 2	0.786	0.192	0.131	0.712
Component 3	0.594	0.098	0.099	0.811
Component 4	0.497	0.113	0.083	0.894
Component 5	0.384	0.134	0.064	0.958
Component 6	0.250	.	0.042	1.000

Table 3.C.3. Principal components (eigenvectors)

Variable	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Comp. 5	Comp. 6
Leadership	0.430	0.046	-0.375	-0.329	-0.742	0.113
Power and influence	0.297	0.886	0.349	0.054	0.029	0.016
Vision and inventiveness	0.405	-0.029	-0.398	0.815	0.058	-0.098
Position-related awards	0.445	-0.293	0.418	-0.113	-0.032	-0.727
Professionalism and entrepreneurial talent	0.431	-0.354	0.484	0.087	0.047	0.668
Other honours and prizes	0.424	0.026	-0.414	-0.453	0.664	0.052

Table 3.C.4. Parallel analysis

Component	Principal component analysis	Parallel analysis	Difference
Component 1	3.488	1.044	2.444
Component 2	0.786	1.024	-0.238
Component 3	0.594	1.006	-0.412
Component 4	0.497	0.992	-0.495
Component 5	0.384	0.977	-0.592
Component 6	0.250	0.957	-0.707

As Table 3.C.3 suggests, the first principal component has positive loadings on all the dimensions of CEO achievement, ranging from a loading of 0.297 on Power and influence to a loading of 0.445 on Position-related awards. In line with our theoretical reasoning, we thus interpret this component as a proactivity measure. To complete the analysis, we derived the proactivity score (PRO) for each chief executive in our sample by using the following formula (the scoring coefficients were obtained based on the regression method):

$$PRO_i = 0.218 * X_{1,i} + 0.082 * X_{2,i} + 0.163 * X_{3,i} + 0.280 * X_{4,i} + 0.236 * X_{5,i} + 0.200 * X_{6,i},$$

where $X_{1,i}$ is the number of awards received by CEO_i that highlight leadership; $X_{2,i}$ is the number of awards received by CEO_i that highlight power and influence; $X_{3,i}$ is the number of awards received by CEO_i that highlight vision and inventiveness; $X_{4,i}$ is the number of position-related awards received by CEO_i; $X_{5,i}$ is the number of awards received by CEO_i that highlight professional and entrepreneurial achievements; and $X_{6,i}$ is the number of other honours and prizes received by CEO_i. It should also be noted that the initial estimates were centred by subtracting the sample mean. The final index was normalised to have zero mean and a standard deviation of one.

CHAPTER 4. MANAGERIAL ASPECTS OF PRODUCT DIFFERENTIATION: EVIDENCE FROM THE ANALYSIS OF U.S. TRADEMARK STATISTICS

4.1. INTRODUCTION

The literature on industrial organisation usually defines product differentiation as a company's natural response to variation in consumer preferences (see Chamberlin, 1933). By differentiating its product offering from that of competitors, the company can essentially exploit this variation to gain competitive advantages (Tirole, 1990). More specifically, it can create a monopoly over its output and, hence, enjoy benefits that are normally associated with a monopolistic position, including less intense price competition, higher market power, the existence of price premiums, and an opportunity to deter new firm entry. When studying the company's decision to differentiate its products, scholars tend to focus on organisational and industrial factors.[1] Without dismissing the importance of these accounts, our study suggests that a behavioural component stemming from idiosyncrasies of decision-makers may be not less decisive and, in fact, often have a significant impact on how organisations approach competitive strategy.[2]

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[1] The prepotency of environmental forces for organisational adaptation at the level of an individual firm is usually associated with the system-structural view. According to this view, top managers are assigned with a reactive role consisting in "fine-tuning the organization according to the exigencies that confront it" (Astley and Van de Ven, 1983:248).

[2] This argument is widely recognised by strategic choice theorists (see Child, 1972).

In addressing this issue, our research integrates upper echelons theory (see Hambrick and Mason, 1984) with the hierarchical view of strategy (see Vancil and Lorange, 1975) to examine the extent to which CEO background characteristics can affect differentiation strategy in organisations. Specifically, we argue that along with direct involvement, chief executives may eventually facilitate or restrain product differentiation by choosing businesses to be in and then allocating scarce resources among them (Varadarajan and Clark, 1994). The conceptual model we propose here includes such managerial characteristics as executive tenure; higher education; previous experience and its diversity; and company-specific knowledge. To capture the extent of product differentiation at the company level, we use a flow of newly introduced trademarks. The choice of this measure is dictated by a number of reasons, among which the tightest association with CEOs, in the sense that "[i]mportant trademark decisions other than strictly legal interpretations usually rest with top management" (Cohen, 1986:61), is the most compelling.

Our research differs from the existing studies on competitive strategies and their alignment with managerial demography (see Beal and Yasai-Ardekani, 2000; Govindarajan, 1989; Gupta and Govindarajan, 1984) in a number of critical respects. First, unlike previous works that mainly focus on small manufacturing companies or strategic business units, we examine large corporations in 39 different industries. As the nexus between the CEO and competitive strategies in such organisations is more ambiguous, we invoke the hierarchical view of strategy to explicate the major sources of concern. We then identify some conditions that lead to the CEO's immediate involvement in devising differentiation strategy, as well as suggest how decisions made as part of corporate strategy can affect differentiation strategy. Second, by expanding the list of CEO characteristics to concentrate on, we take into account recent empirical findings that enable us to better trace the sources of managerial perceptions and values, and their effect on strategy outcomes. In particular, we rely on prior works that examine R&D, patent, innovation, new product development, and marketing strategies to reveal the effect of the curvilinearity of executive tenure, educational and professional backgrounds, and the founder status, to name a few. And third, our analysis employs longitudinal data obtained from widely-used databases, such as Compustat and ExecuComp. Such a research design makes it possible to draw causal inferences and to avoid subjectivism in compiling key variables, which pertains to survey-based studies (see Bettis *et al.*, 2014).

Alongside the contributions highlighted above, this research adds to the literature on the managerial involvement in the new product development process (e.g., Barker and Mueller, 2002; Kor, 2006; Wu *et al.*, 2005) by showing that CEO characteristics are important also at its final, market introduction stage. On the empirical side, our study is among the first to use U.S. trademark statistics to capture product differentiation, thereby contributing to the corresponding literature on intellectual property rights (e.g., Crass and Schwiebacher, 2017; Mangàni, 2007; Semadeni, 2006). Finally, and on a more general level, this work also adds to the long-standing choice determinism debate (Astley and Van de Ven, 1983; Bourgeois, 1984) by confirming that strategic outcomes of an organisation are likely to be guided by the cognitive bases, values, and perceptions of its chief executive.

The rest of this essay is organised as follows. In Section 4.2, we identify several conditions that lead to the involvement of a CEO in the planning and implementation of differentiation strategy, as well as draw on previous studies to derive research hypotheses on the role of managerial characteristics in guiding this strategy. Section 4.3 describes the data and develops an econometric framework which is used to generate estimates. Section 4.4 presents empirical findings, while Section 4.5 concludes with a discussion of study implications and limitations, and also outlines avenues for future research.

4.2. THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

When rationalising the power and influence wielded by managers in determining strategy content and process, the starting point generally recognised by organisation theorists is to settle on what prevails in the decision-making context – external forces or individual actions. To put it succinctly, proponents of environmental determinism insist on the pre-eminence of outer factors and constraints in shaping organisational behaviour and, hence, assign to managers a largely technical function to react to the evolving environment; yet, scholars working in the voluntarist tradition are more inclined to consider organisational change as predominantly triggered by individuals – especially those in power – and their idiosyncratic actions and political motives (Astley and Van de Ven, 1983; Bourgeois, 1984; Papadakis *et al.*, 1998). Despite the well-voiced criticism of such a dichotomisation, especially for its over-simplicity that precludes researchers from adequately explicating the mechanisms underpinning organisational adaptation (see Hrebiniak and Joyce, 1985; Whittington, 1988), the way in which our analysis should proceed still very much depends on the emphasis placed on either of these two perspectives.

While adhering to the voluntaristic orientation, we follow upper echelons theory (Carpenter *et al.*, 2004; Hambrick, 2007; Hambrick and Mason, 1984) and focus on the cognitive bases and values of chief executives for studying the human side of differentiation strategy. One may argue that bringing corporate leaders and their characteristics to the centre of attention appears somewhat restrictive. However, this approach proves advantageous if we intend to bypass, at least to some degree, uncertainties and disparities observed in different streams of the organisational literature. In particular, earlier works on the strategic choice perspective seemed far less definitive about the specific group of decision-makers to target (e.g., Child, 1972; Weick, 1979), while the proposed focus on top executives enables us to identify "a fixed locus of strategic choice in a cross-section of organizations" (Finkelstein *et al.*, 2009:8). By sharing the premise that individuals are bounded cognitively and, as such, act according to personal interpretations of the strategic situation they face (Cyert and March, 1963; March and Simon, 1958), the upper echelons perspective also reconciles theoretical ideas with the existing empirical evidence on human aspects of decision making in organisations (e.g., House and Singh, 1987; March, 1982). Overall, its key contribution consists in recognising that variance in organisational outcomes can be partially explained by differences in managerial perceptions and values (Hambrick and Mason, 1984). It should also be noted that methodology-wise, the theory suggests employing observable managerial characteristics, such as functional background and education, to approximate certain psychological dimension because "the cognitive bases, values, and perceptions of top level managers are not convenient to measure or even amenable to direct measurement" (Hambrick and Mason, 1984:196).

Since its inception, upper echelons theory has undergone a number of principal refinements (see Hambrick, 2007). One of them is an attempt to achieve greater consistency with the deterministic approach, which resulted in devising the notion of managerial discretion (Finkelstein and Hambrick, 1990; Hambrick and Finkelstein, 1987; Wangrow *et al.*, 2015). Drawing on the idea that environmental determinism and strategic choice are interdependent forces rather than mutually exclusive alternatives (Bourgeois, 1984; Hrebiniak and Joyce, 1985), managerial discretion is therefore defined as the latitude of action available to top executives in a specific situation (Hambrick and Finkelstein, 1987). Given that the level of discretion varies (depending on the composition of environmental, organisational, and personal factors), so does the ability of top managers to exert control over firm-level outcomes – it tends to be fairly negligible in those organisations where internal and external pressures exceedingly prevail (Wangrow *et al.*, 2015). Although this and other critical enhancements of the theory have qualitatively improved the results obtained with its aid, there are still many challenges and opportunities for further advances. For example, by regarding various strategic choices as an ultimate prerogative of top managers, upper echelons theory may, whether intentionally or not, underscore other potentially insightful methods and approaches. We specifically refer to the hierarchical view of strategy, which, among other things, implies that key decisions associated with a certain strategy are expected to be made by the managers at the level to which this strategy belongs (Vancil and Lorange, 1975). Owing to our particular interest in product differentiation – a generic competitive strategy which is traditionally associated with the business unit level (Porter, 1979; 1980; 1985), we provide an extensive discussion about why it may also be relevant to corporate level decision-makers. Furthermore, the theory fails to articulate, at least in an explicit and systematic manner, what constitutes strategy content at the corporate level and what are the mediators through which the decisions made by chief executives may influence organisational outcomes (see Priem *et al.*, 1999). In what follows, we first examine the strategic management and marketing literatures to address these criticisms and then proceed to formulating a set of testable hypotheses.

4.2.1. Linking the CEO function to differentiation strategy

According to Chamberlin (1933:56), product differentiation refers to "distinguishing the goods (or services) of one seller from those of another [... on such a basis that] is of any importance whatever to buyers, and leads to a preference for one variety of the product over another". The overriding objective of this strategy consists in diminishing sensitivity to price competition to the extent that the company can earn above-average returns in the industry (Comanor, 1967; Tirole, 1990). By differentiating its offerings from those of competitors, the company seeks to insulate submarkets and, through a better preference match, induce brand loyalty. Both loyalty to brands and distinctive product characteristics provide grounds for using product differentiation as one of the most important barriers to entry, discouraging potential rivals attracted by the presence of higher profit margins from attempts to compete for market share (Bain, 1956). In the light of its considerable importance for the company's competitive position, product differentiation has long been associated with corporate leaders and their decisions. Indeed, previous studies have demonstrated that organisations with high individual choice are likely follow differentiation strategy (see Hrebiniak and Joyce, 1985), partly because it often provides managers with a wider discretionary set (Hambrick and Finkelstein, 1987). The managerial aspect also proves significant in determining firm-level R&D expenditure, patenting, and innovation (e.g., Balsmeier and Buchwald, 2014; Barker and Mueller, 2002; Kor, 2006; Wu *et al.*, 2005) – all this will eventually nurture product differentiability (Comanor, 1967; Ettlie, 1998).

Despite these arguments, the conditions under which one would expect top managers to become actively and directly involved in devising differentiation strategy have been rather loosely articulated,[3] thus casting doubts about the extent or even the very existence of such a relationship. To identify where the major concerns stem from, we have to invoke the hierarchical view of strategy (Hofer, 1975; Hofer and Schendel, 1980; Vancil and Lorange, 1975) because of its proven capacity to make "the conceptual, methodological, and practical complexities of strategic decision making tractable" (Varadarajan and Clark, 1994:93). This view largely draws on earlier studies of organisational structures (e.g., Chandler, 1962) and proposes to disintegrate strategy planning and formulation to match the company's internal

[3] For example, one may find it appealing to follow Child's (1972) approach and treat strategic choice in a broad sense so as to include domain and competitive decisions. Coupled with the dominant coalition concept (Cyert and March, 1963) and qualified further by the argument about top managers' ultimate power and influence over the firm's strategic choices (Barker and Mueller, 2002; Bourgeois and Eisenhardt, 1988; Hambrick and Mason, 1984), this approach then enables us to establish an association between competitive strategies on the one hand and senior leadership on the other. This way of reasoning can also be enhanced by assuming the inherent complexity and organisational significance of such strategies – both characteristics usually require a great deal of administrative authority. Other approaches may rely on the resource-based theory or concentrate on SMEs (especially owner-managed firms), where the organisational hierarchy tends to be flatter and power is more centralised, to justify the role top executives play in devising certain strategies (e.g., Beal and Yasai-Ardekani, 2000; Kor, 2006; Lefebvre *et al.*, 1997). We believe, however, that the approach we are proposing in this work complements existing research by focusing on specific conditions, other than managerial discretion, which may lead to chief executives' greater involvement in the formulation and implementation of competitive strategies in large corporations with a complex and diverse organisational structure.

hierarchy. The disintegration process usually culminates in the identification of corporate (head office), business (business unit), and functional (department) level strategies; then the locus of decision making can be established by mapping each strategy to that level's managers. At the same time, such a fine-grained delineation of strategic domains should not disregard the fact that "these levels of strategy impinge on each other to some extent" (Vancil and Lorange, 1975:82). Moreover, the divergence between the locus of strategy and the locus of decision making may also occur (Varadarajan and Clark, 1994).

From this perspective, assigning product differentiation to the class of competitive strategies, as Porter (1980) famously suggested,[4] leads one to conclude that it is divisional managers who are actually responsible for its design, thereby objecting to its presumed link with chief executives' decision making. However, matters become even more controversial if we refer, for example, to the marketing literature regarding what constitutes the essential content of business strategy. Some studies have repeatedly insisted on viewing it through the lens of its coalescence with functional level strategies and, above all, marketing strategy as fundamentally concerned with gaining a competitive edge – something that scholars outside of the marketing field usually ignore (Day, 1992; Slater and Olson, 2001; Webster, 1988). To support this opinion, Wind and Robertson (1983:12) point to marketing's "boundary role function between the firm and its customers, competitors and other stakeholders [..., making it] uniquely able to assess consumer needs and the firm's potential for competitive advantage". Once accepted, this line of reasoning entails that differentiation strategy, albeit being potentially inclusive of a variety of activities at the functional level, can nevertheless be largely construed as integrating certain marketing strategy layers and other tightly related functional strategies (Bermingham, 1996; Varadarajan, 2010), with the decisions made by marketing and other line managers also directing its development pathway.

Does this analysis effectively suggest that there is little or even no room for chief executives to engage in differentiation strategy? After a closer examination of the marketing and strategic management literatures, we can offer at least four arguments that would cause us to seriously doubt such a peremptory conclusion. First of all, the scope of top managers' personal involvement in and time devoted to dealing with product differentiation depends on the level of diversification in an organisation (Varadarajan, 1992; Vancil and Lorange, 1975). In practical terms, this implies that "the more diversified the firm [...], the more time is spent on corporate-level planning" (Leontiades and Tezel, 1981:417), hence depriving chief executives of closer contacts with business and functional units. On the contrary,

[4] To avoid any possible confusion, it is worth mentioning that so-called business strategy, competitive strategy, market strategy, product-market strategy, and business unit strategy are normally used as synonyms in the strategic management literature (Varadarajan and Clark, 1994).

deconglomeration and other similar activities that aim to optimise the size of the company's business portfolio would lead to a reduction in bureaucratic control and procedures and, therefore, to top managers' greater attention to the remaining businesses, including more vigorous participation in designing competitive strategies (Varadarajan *et al.*, 2001). Next, the degree to which certain elements of differentiation strategy seem to be crucial to the core business will indeed be reflected in how decision-making responsibilities are distributed across the organisational hierarchy (Day, 1992; Webster, 1992). It is evident that the locus of decision making diverges from the locus of strategy in those situations when the importance of marketing and related strategies attached to business functioning is high; the risks to future cash flows and market share associated with pursuing these strategies are non-negligible; or the resources directed to strategy implementation, including brand equity expenditures, are significant (Barker and Mueller, 2002; Varadarajan and Clark, 1994). In all these scenarios, the decisional context dictates that differentiation strategy cannot be left to the exclusive discretion of middle or lower managers, and a more intimate involvement of corporate executives in its formulation and planned changes would be desirable to maintain competitive advantages (Varadarajan, 1992). In addition, Varadarajan and Clark (1994) point to several intraorganisational factors, such as the level of decision-making autonomy, the complexity and formalisation of procedures existing in a company, and the attitude of dominant coalitions towards marketing and related functions, – each of these factors is likely to guide the focus of decision making regarding product differentiation. Finally, the quality of human resources and their career choices may impel chief executives to reconsider the degree to which they are engaged in differentiation strategy issues in order to avoid mismanagement problems (Johnson, 1987). As Webster (1981:11-15) demonstrate, CEOs are particularly "critical of their marketing managers for a failure to think creatively and innovatively and to understand the financial implications of their decisions [..., as well as for a strong desire] to move into general management quickly", often leaving upper managers with no choice but to accept greater personal responsibility for differentiation activities.

So far, we have almost exclusively centred on the problem of whether or not senior managers exert direct influence over product differentiation. To finalise our discussion, it is necessary to acknowledge that differentiation strategy can also be subject to indirect effects which conceivably arise from the decisions chief executives make in a wider, corporate context. More specifically, active support from corporate leaders is critical for a successful development of new goods or services (Brown and Eisenhardt, 1995). Among other things, this includes managerial sponsorship of project teams when it comes to securing staffing and capital resources required to foster the development effort, as well as carrying out control activities so as to pull various functional groups together (Zirger and Maidique, 1990). By imposing their vision of which innovative idea is worth pursuing, top managers can shape the trajectory of new product development (Tripsas and Gavetti, 2000), thereby affecting the very basis for differentiation strategy. From the corporate strategy perspective, the existence of indirect effects reflects the above argument that cross-level strategic interdependencies exist – as a result, corporate level decisions will surely be echoed at business and functional levels. By adopting this outlook, a more precise transmission mechanism can be sketched:[5] to achieve business objectives, corporate strategy solves a coordination problem regarding the product markets or industries to be in, and the allocation of scarce resources among them on a rational basis (Bourgeois, 1980; Vancil and Lorange, 1975; Tilles, 1966). Subsequently, the solution is passed onto business and functional managers who, relying on corporate strategy's outcomes, have to choose "competitive weapons [...] to give organization its «distinctive competence»", and then to combine these weapons with the allocated resources to gain the competitive edge in the market of interest (Bourgeois, 1980:26; Hambrick, 1980; Varadarajan and Clark, 1994). Overall, our conceptual framework entails that along with direct involvement, chief executives' participation in the development and implementation of differentiation strategy can be influenced by such decisions as with what product, in what market, and at what cost the firm is planning to distinguish itself, if at all (see Figure 4.1).

4.2.2. Managerial characteristics and their impact on differentiation strategy

It has been noted that much of the modern literature linking top managers' personality to organisational outcomes falls into two broad categories. The first category is populated by scholars who attempt to directly assess psychological mechanisms invoked by corporate leaders when making strategic decisions (e.g., Eggers and Kaplan, 2009; Lefebvre *et al.*, 1997; Miller *et al.*, 1982). Authors contributing to the second category advocate concentrating on demographic profiles first and then assigning them to relevant cognitive bases and values (e.g., Barker and Mueller, 2002; Daellenbach *et al.*, 1999; Hambrick and Mason, 1984). There does not appear to be any basic agreement as to which approach is superior and yields more accurate results because both inevitably suffer from certain limitations; therefore, the choice is largely dictated by data availability (Hambrick and Mason, 1984). As the statistics used in this research presuppose the adoption of the second

[5] As described, this approach corresponds to the so-called one-cycle planning process. Fairly often, however, organisations perform multiple iterations before they settle on the final budget and, hence, corporate strategy takes its shape. A likely reason consists in top management being "increasingly uneasy over its ability to resolve all the strategic issues implicit in the budget" (Vancil and Lorange, 1975:84). So, they may call for a meaningful contribution from divisional or functional managers at a corresponding stage of the planning process to reduce the probability of the conflict of interests and objectives during strategy implementation. Similarly to this view, Mintzberg (1987) describes the umbrella strategy that combines top managers' setting out broad guidelines and lower managers' responding with specifics.

approach, the influence of CEOs on differentiation strategy is gauged by utilising observable managerial characteristics. In doing so, we draw on previous studies that examine R&D, patenting, innovation, new product development, and marketing strategies, as well as firms' competitive behaviour and organisational change at large. While the original intention of such an eclectic mix of literature is to reflect the fact that, in its essence, differentiation strategy consists of a number of interrelated strategy layers, this approach also sits well with portraying product differentiation as an outcome of multiple processes that determine a firm's competitiveness and survival. To exemplify, Comanor (1967:646) maintains that "[w]hile research expenditures may serve many functions, an important one is to foster and promote a rapid rate of new product introduction, which then serves to facilitate the achievement of differentiation". Miller *et al.* (1982:241) develop this idea further by suggesting that "[i]nnovation adds complexity and diversification to the environment [..., so] the organization becomes highly differentiated to reduce the uncertainty created by environmental dynamism and heterogeneity". Finally, Barker and Mueller (2002:782) conclude more generally that "firm investments in developing new products, processes, or technologies often are the driver of future competitive advantage and productivity". Following these arguments, one may then expect that the idiosyncrasies of decision makers manifest themselves in an approximately similar fashion, no matter whether product differentiation or its constituting elements are dealt with.[6]

Executive tenure. We start our analysis of the human side of differentiation strategy with considering executive tenure – a demographic characteristic that has constituted one of the most popular topics in strategic leadership studies over the past few decades. The basic premise here is that an organisation's ability to confront challenges posed by external forces depends, *inter alia*, on the length of time an individual has served as its CEO (Miller, 1991). In practical terms, this implies that "long-tenured executives tend not to make major changes in their organizations" (Finkelstein *et al.*, 2009:85), thereby creating a mismatch between the existing organisational strategies and structures, and the actual requirements imposed by the environment (Miller, 1991). At the same time, "[CEOs] of moderate tenure might be more prompt in adapting, fostering frequent piecemeal and incremental change" (Miller, 1991:49). This effectively generalises earlier anecdotal evidence showing that the relationship between a chief executive's time in office and organisational outcomes has an inverted U-shaped pattern (e.g., Eitzen and Yetman, 1972).[7]

[6] This is, of course, not to say that there are no behavioural specificities associated with differentiation strategy *per se*. We will elaborate on this further by referring to the still relatively scarce literature on the formulation and implementation of competitive strategies at business and corporate levels.

[7] The CEO's tenure in the position is just one aspect of executive tenure, which also spans tenures in the organisation and in the industry (see Finkelstein *et al.*, 2009). Given that the three elements are

To uncover the roots of the outlined temporal effect, Hambrick and Fukutomi (1991) proposed a model that disintegrates the CEO's tenure in the position into a set of discernable phases – or seasons, as the authors denote them, – and then identifies specific patterns of attention and behaviour pertaining to each phase. The model particularly suggests that earlier in their tenures, executives choose to stick to the paradigms[8] they had practised before being appointed to the CEO position. The basic intuition here lies in the fact that despite having task knowledge and power at relatively low levels, newly hired managers are still under great pressure to demonstrate immediate efficacy in response to the mandate of the board or the predecessor CEO. So, the most likely scenario for this stage is when the very competencies that earned the manager the job are invoked to achieve the required outcome. Yet, the initial paradigm is not necessarily immutable and will be revised as learning occurs. Under certain conditions, learning can also encourage such traits as open-mindedness and experimentation, which, if successful, result in CEOs further adjusting their schemas and repertoires in favour of alternative, more efficient and comfortable approaches. The culmination point of the model refers to the top manager's adoption of a specific stance on the organisation's structure and the ways it should be governed – the so-called enduring theme. While task knowledge reaches its relative maximum at this stage, CEOs become more meticulous about the information sources they rely on, trying to select the ones that largely reinforce their paradigms while ignoring the others. As their tenure progresses, it becomes harder for executives to retain the same level of enthusiasm, mainly because such attitudes as boredom, fatigue, and habituation start mounting. It causes task interest to gradually fade away, so the period of major changes gives way to the period of incremental alterations. The model enters its terminal phase when CEOs start experiencing psychological disengagement reflected in a greater inclination towards ceremonial duties rather than substantial actions. During this period, executives normally adhere to the long-enduring theme and use extremely filtered sources of information to support their decisions. Coupled with the power that CEOs with long tenure tend to accumulate, this may eventually endanger the organisation's ability to adapt to external shocks.[9] Hence, whenever possible, executive turnover is used as a counter-measure that helps break up inertia and enables a radical change to occur; otherwise, the

conceptually nested, one may assume that they demonstrate similar dynamics, yet on a different scale. A few studies, however, have attempted to challenge this argument by showing, for example, that the retention of top managers with longer organisational tenure results in more successful acquisition outcomes (see Bergh, 2001).

[8] Hambrick and Fukutomi (1991:721) define the CEO's paradigm as a combination of (i) "the pre-existing knowledge system that a manager brings to an administrative situation" (schema), and (ii) "a supply of skills, devices, or expedients possessed by a person" (repertoire).

[9] Miller (1991:49) describes this as "[CEOs] grow stale in the saddle, eventually failing to match strategy and structure with environment, and as a result, compromising the organization's performance".

dysfunction stage can linger for an extended period of time, seriously damaging corporate performance.

Empirical studies on differentiation strategy and its elements have mostly supported these assertions. For example, Thomas *et al.* (1991) examined 224 U.S. publicly-traded companies in the electronic computing equipment industry over the period 1985-1988 and found that shorter tenures in the company and the position correspond to pursuing risky and innovative strategies, whereas longer-tenured top managers direct major efforts towards the improvement of operational efficiency. Similarly, Hambrick *et al.* (1993) suggested that a CEO's commitment to status quo – that is, facilitating inertial forces, not innovation and new product development, – is positively related to tenures in the industry and the company, with the former having a more pronounced effect. Further elaborating on learning across the life cycle, Miller and Shamsie (2001) surveyed film studio heads in Hollywood and came to a conclusion that product line experimentation exhibits a tendency to decline with executive tenure. As for specific proxies of the innovation process, Barker and Mueller (2002:782) studied 172 firms over the period 1989-1990 and confirmed that "CEO effects on relative R&D spending increase with longer CEO tenure implying that CEOs, over time, may mold R&D spending to suit their own preferences". Comparable results were obtained by Chen *et al.* (2013) based on the analysis of 330 electronics firms listed on the Taiwan Stock Exchange between 2007 and 2010. At the same time, Daellenbach *et al.* (1999) failed to find any support for the hypothesis that industry or company tenure can be a reliable predictor of variations in R&D investment. In turn, Wu *et al.* (2005) analysed 84 U.S. publicly traded biotechnology companies and showed that the relationship between CEO tenure and the organisation's inventive activities, measured as the total number of patents a company successfully filed, represents an inverted U-shaped curve. Finally, Kor (2006) examined 77 U.S. technology-based entrepreneurial firms that went public during 1990-1995 and found that the level of R&D expenditure is negatively and nonlinearly related to top management teams' tenure in the company. In her interpretation of the observed effect, she stressed that "managers who are relatively new to the firm and thus want to be affiliated with new product successes push for an intense R&D strategy to increase the likelihood and speedy development of innovative products" (Kor, 2006:1093).

Despite the clear-cut empirical evidence that the volatility in product differentiation inputs can partly be attributable to executive tenure, previous studies of differentiation strategy itself draw a rather ambiguous picture. On the one hand, Miller's (1991) analysis of a sample of 95 firms from the province of Quebec revealed that both innovation and market differentiations are positively related to short-tenured CEOs, while the effect for long-tenured executives is statistically insignificant. These results partially correspond to the fact that product differentiation at the industry level, proxied by the degree of advertising intensity, appears to be negatively associated with the executive's tenure in the organisation (Datta and Rajagopalan, 1998; Rajagopalan and Datta, 1996). On the other hand, earlier studies that looked specifically at generic competitive strategies have failed to identify any sizable performance benefits stemming from the interaction between managers' tenure and the strategies they choose to pursue in order to gain competitive advantages over industry rivals (Beal and Yasai-Ardekani, 2000; Govindarajan, 1989; Gupta and Govindarajan, 1984).

Hence, the arguments presented above lead us to the first hypothesis:

Hypothesis 1: *There is a curvilinear, inverted U-shaped relationship between executive tenure (in the position and in the organisation) and the extent of differentiation strategy.*

Executive age. Another temporal dimension tightly linked to tenure (Finkelstein *et al.*, 2009) is executive age. The existing literature identifies several mechanisms through which it impacts the process of strategic decision making (see Hambrick and Mason, 1984). To begin with, the physiological approach maintains that aging contributes to a decline in human cognitive abilities and, as such, makes top managers less susceptible, amenable, and malleable to new ideas and behaviours (Bantel and Jackson, 1989; Tihanyi *et al.*, 2000).[10] Having "less physical and mental stamina", older managers lack the capability to integrate relevant information to fully support the process of strategy formulation and implementation, with a corresponding adverse effect on their confidence in and time required for making decisions (Hambrick and Mason, 1984:198). In turn, the psychological approach emphasises older managers' inclination to accept a more conservative view of organisational adaptation, which may particularly be a source of corporate rigidity and resistance to change (Wiersema and Bantel, 1992). Such CEOs are more likely to preserve the status quo due to their utter confidence that the strategies and problem-solving recipes they had practiced during their careers are the most suitable and efficient (McClelland *et al.*, 2010; Tihanyi *et al.*, 2000). Finally, the age of chief executives can also be associated with the propensity to take risk (Hambrick and Mason, 1984; Herrmann and Datta, 2005; MacCrimmon and Wehrung, 1986). That is, older managers tend to be reluctant to step out of the comfort zone and pursue innovative strategies that can endanger their financial and career security, whereas younger executives have a longer career horizon and, as a result, more opportunities to mitigate possibly negative consequences of risky decisions.

[10] In fact, this decline can be significantly eased by relying on experience, expertise, or external counselling and support, hence allowing individuals to maintain high levels of competence even when age-related changes in cognition become more pronounced (see Blazer *et al.*, 2015).

So far, the outcomes of studying the effect of executive age on differentiation and its underlying strategies have been quite inconclusive. Thomas *et al.* (1991:513), for example, empirically confirmed that "younger managers are associated with innovativeness and risk-taking [...,] while older managers are more risk averse and tend to make more conservative decision". This result has been further corroborated by showing that CEO age negatively impacts R&D expenditure (Barker and Mueller, 2002; Chen *et al*, 2013) and patent filings (Wu *et al.*, 2005; Xu and Yan, 2014). After examining 290 U.S. publicly-traded companies over the period 1980-1994, Galasso and Simcoe (2011) also observed that older managers appear to have a lower innovative output. At the same time, Datta and Rajagopalan (1998) failed to find support for the aging hypothesis when studied the association between advertising intensity and the characteristics of CEO successors. And so did Miller (1991) – his analysis showed that there is no statistically significant effect of executive age on product differentiation. Beal and Yasai-Ardekani (2000) came to a somewhat similar conclusion after surveying CEOs of 101 U.S. small manufacturing firms: they were unable to identify any impact of executive age on organisational performance, no matter which competitive strategy this demographic characteristic was aligned with.

Despite the so far mixed empirical evidence, we formulate the following hypothesis:

Hypothesis 2: *There is a curvilinear, inverted U-shaped relationship between executive age and the extent of differentiation strategy.*

Educational background. In studying human capital, a widely accepted approach is to view higher education and other forms of occupational training as potent enhancers for the ability of an individual to acquire and employ professional knowledge and skills (Becker, 1962; Katz, 1955; Schultz, 1961).[11] Formal education achieves this goal by offering the depth and breadth of articulable knowledge in an area of specialism which can then be turned into an important cognitive resource for learning at the workplace (Hitt *et al.*, 2001; Wally and Baum, 1994). However, the knowledge built up during the schooling period permits the assimilation and effective use of new information only if there is a certain degree of commonality between the two; in other instances, the individual's diverse background should be considered as a robust basis for learning because of its capability to mitigate the existing disparities between the educational background and professional needs (see Cohen and Levinthal, 1990). The outlined approach corresponds to a major principle in educational psychology stating that success in such cognitive arenas as comprehension, problem solving,

[11] Let alone the fact that having a degree has become *per se* a prerequisite for entering the professional world. As Collins (1971:1004) notes, there has been a long-standing trend towards tightening educational requirements for employment, which results in careers being "increasingly shaped within the educational system".

and decision making largely depends on the individual's prior knowledge, its activation and application (Anderson *et al.*, 1977; Ausubel, 1968; Spiro *et al.*, 1987).

In the organisational context, the effect of formal education on top managers' values and perceptions is usually described by using three wider perspectives (see Hambrick and Mason, 1984). First of all, it has been observed that the amount of education individuals possess stimulates open-mindedness, or in other words, the mental ability to recognise merits in counter-arguments and willingness to accept them if needed (Hare, 1979). One particular implication of this finding is that more educated managers show a greater receptivity to new ideas, they are apt to encourage experimentation and creativity, and, hence, have a positive effect on the adoption of innovation in their organisations (Kimberly and Evanisko, 1981). The next perspective is related to assessing the effect of educational attainment on corporate performance. Formal education, for example, enables greater productivity of human capital and, as such, represents a potential source of competitive advantages for the company, provided that similarly qualified human resources are not equally available to its competitors (Hatch and Dyer, 2004). Another line of reasoning puts forward social networks individuals establish while studying towards a university degree and their role in facilitating cross-organisational connections, supplying clients and workforce, or providing the company with access to valuable external resources (Collins, 1971; Hitt *et al.*, 2001). The final perspective concentrates on some particular fields of study and suggests that individuals who were trained as professional managers are associated with greater administrative complexity and sophistication of their organisations, exhibit a higher degree of risk aversion, as well as adopt a more conservative approach towards investment strategies (Hambrick and Mason, 1984). Perhaps one the most notable examples of the latter phenomenon is MBA graduates who "by their nature probably are not as innovative or risk-prone as more «self-made» executives"; however, the programme itself contributes little towards tackling this perceptual skewness (Barker and Mueller, 2002; Hambrick and Mason, 1984:201).

It is also worth mentioning that different academic institutions provide knowledge and training which range significantly across the quality spectrum. Therefore, graduates from top programmes are assumed "to have more and better knowledge and to have high intellectual potential to learn and accumulate tacit knowledge" (Hitt *et al.*, 2001:14). If this argument is correct, association with an elite university should be indicative of more credible knowledge and skills with respect to a particular profession (D'Aveni, 1989). We can assess the validity of this statement, at least to a degree, by looking at the patterns of competition among top business schools. To ensure that quality standards are met, such schools seek to recruit both the highest-calibre faculty and staff, and the most talented students; obviously, imposing considerable selectivity in student admissions also leads to satisfying the condition for elite socialisation and prestige (D'Aveni, 1996). Overall, one can predict that executives from top-ranked institutions should be more prepared to achieve better organisational performance than their colleagues who attended less prominent universities (e.g., Palmer and Barber, 2001; Palmer *et al.*, 1993; Useem and Karabel, 1986).

Turning to differentiation strategy, an extensive body of research has generally supported linking its inputs and outputs to the educational attainment of CEOs. In particular, Kimberly and Evanisko (1981) examined the innovation process in American hospitals and revealed that the amount of education of its administrators positively affects the adoption of both technological and administrative innovations in these institutions. In a similar fashion, the results presented by Thomas *et al.* (1991) suggest that top managers with higher levels of education follow risky and innovative strategies, and also create an inner environment that facilitates entering new product markets. Bantel and Jackson (1989:120) extended these findings by comparing education levels of CEOs and some members of top management teams; drawing on the information about innovation activities in 199 U.S. chartered and national banks, they concluded that "[b]oth CEO and team education level were significantly correlated with total innovation, but team education level was more strongly related to innovation than was CEO education level". Likewise, Datta and Guthrie (1994) analysed 195 CEO successions in the Business Week 1000 companies during 1980-1989 and reported that firms with higher levels of R&D intensity seek to hire more educated CEOs. Finally, Rajagopalan and Datta (1996) assessed 410 U.S. manufacturing firms over the period 1973-1987 and found a positive relationship between the amount of education chief executives attain and industry advertising intensity, no matter whether high or low performing firms were considered. These results were then reinforced by Datta and Rajagopalan's (1998) work that focused on the education level of CEO successors. However, in such an empirical setup, firm advertising intensity has no association with education levels of newly recruited CEOs, and neither does industry advertising intensity in the low-performing subgroup.

Although the lion's share of subsequent studies have reported similar findings (e.g., Chen *et al.*, 2013; Lin *et al.*, 2011), there are a few notable exceptions that did not support the relationship of interest. One of them is the work of Daellenbach *et al.* (1999), who examined 31 firms in the primary metals industry and 26 firms in the semiconductor industry in the U.S. over the period 1988-1993, and reported that the effect of executive education on R&D expenditure is not statistically significant. Barker and Mueller (2002:782) qualified this finding by arguing that "the amount of a CEO's formal education had no significant association with R&D spending once a CEO has attained a college degree". Damanpour and Schneider (2006) also failed to find any clear sign of education bias when modelled the innovation process in its dynamics: drawing on the results of a survey of 1,276 U.S. city managers and chief administrators, they found no significant impact of executive education on different phases of innovation adoption in organisations. On top of that, Beal and Yasai-Ardekani (2000) reported that the education level of top managers does not affect firm performance when it is aligned with differentiation or cost leadership strategies.

Unlike the amount of education of CEOs, the type of educational curriculum has received much less attention – this is despite the fact that emerging works provide tentative support for its valid use in researching upper echelons. As Tyler and Steensma (1998:943) pointed out, top executives with a degree in engineering or physical science are better at recognising the transformative potential of technological alliances, their capacity to "provide firms with a relatively novel and innovative strategy for growth in an effort to seize perceived opportunities". In turn, Barker and Mueller (2002) proved empirically that those CEOs who obtained science-related degrees are more inclined to facilitate R&D expenditure at the firm level. However, this comes in sharp contrast to chief executives majoring in other disciplines: for example, they reported that CEOs who possess a degree in legal studies have a negative association with innovation activities, yet there is no observable effect for professional managers. These findings confirm their initial hypothesis that legal education either attracts or creates "people with attitudes that favor spending less on R&D" (Barker and Mueller, 2002:798), and also support Kimberly and Evanisko's (1981) earlier scepticism about the actual influence of formal management training on the adoption of innovation. As for a firm's competitive behaviour, some insight can be gained by examining the effect of industry deregulation. For instance, Goldfarb and Xiao (2011:3131) looked at entry decisions made by local exchange carriers in 234 midsize markets following significant deregulation of the U.S. telecommunications industry in 1996; their analysis revealed that "experienced CEOs, CEOs with an economics or business education, and CEOs who attended the most selective undergraduate institutions tended to enter markets with fewer competitors". Contrary to the argument of risk aversion among MBA students, Grimm and Smith's (1991) study of 855 managers in the U.S. railroad industry before and after its deregulation showed that regardless of the number of years of formal education, top managers with a degree in business administration are associated with strategic change. Relatedly, Bertrand and Schoar (2003:1204) arrived at a general conclusion that "CEOs with MBAs appear to be on average more aggressive, choosing to engage in a higher level of capital expenditures, hold more debt, and pay less dividends". Their explanation also emphasises the path dependence and inertia of MBA holders reflected in operating under "textbook guidelines" when it comes to making investment decisions; as such, these executives are far more focused on growth opportunities but less concerned with the availability of internal financial sources.

On the basis of the above discussion, the following hypotheses can be stated:

Hypothesis 3(a): *The amount of education chief executives possess positively affects the extent of differentiation strategy.*

Hypothesis 3(b): *CEOs with a degree in engineering, technology, or natural sciences positively affect the extent of differentiation strategy.*

Hypothesis 3(c): *CEOs with a degree in business or legal studies negatively affect the extent of differentiation strategy.*

Hypothesis 3(d): *CEOs with a degree from an elite academic institution positively affect the extent of differentiation strategy.*

Functional experience and its diversity. As previously noted, whenever there is a gap in, or even absence of, formal education that impedes CEOs' meaningful involvement in administering certain strategies, the skills and knowledge they had acquired through work experience and on-the-job training may serve as an efficient cognitive enhancer. To explain the underlying mechanics of this effect, Finkelstein *et al.* (2009) sketched a framework that integrates psychological attributes of individuals with their functional-track orientation and approach towards decision making. It particularly shows that upon entering the professional world, prospective workers face a limited range of careers that seem not only most appealing to them, but also provide a close fit to their personality and life objectives. More importantly, the initial job choice is likely to set the direction for further development of an individual's perceptual models and values. As time goes on, workers accumulate more knowledge and experience necessary to succeed in the chosen functional area; this often goes hand in hand with gradually accepting the way of thinking and behaving practiced by other members of their professional circle. So, the chances are that the toolset available to these individuals for problem solving and decision making will eventually be confined to the most preferred and familiar methods, even though some of these methods might be used in a different functional context and, as such, require modification.[12] Having admitted that functional background restricts cognitive processing, this framework effectively draws on the broader concept of bounded rationality and its treatment of how human beings perceive reality and actuate according to it (see Cyert and March, 1963; March and Simon, 1958). However, Finkelstein *et al.* (2009) plead for a cautious interpretation of the outlined relationships as the strength of functional area bias usually depends on the breadth of cultural milieu, the amount of formal management education, the nature of strategic stimuli, and other factors.

[12] Interestingly enough, one may see that the temporal view of functional experience partly resembles that of executive tenure, especially its potential nonlinearity. This observation is not totally new: for example, Miller and Toulouse (1986a) pointed out that a chief executive's overspecialisation in a professional area or industry can have a negative effect on organisational performance. Similarly, Govindarajan (1989) pointed to a possibly non-monotonic impact of expertise in certain functional areas on the effectiveness of strategic business units. To our knowledge, however, the hypothesis regarding the curvilinear effect of professional experience has yet to be formally tested.

Along with the emphasis on a single specialisation, a number of studies have been devoted to examining various combinations of work experience in relation to an individual's capabilities and knowledge.[13] One of the most popular classifications relies on the typology of organisational behaviour proposed by Miles and Snow (1978). On the one hand, there are Prospectors – their core business problem consists in gaining a competitive edge via product innovation and market development. To solve it, these organisations actively promote and recruit executives with externally oriented backgrounds who can scan the outer environment, identify new domain opportunities, and exploit them by initiating a change in the industry. Clearly, top managers specialising in such output functions as marketing, sales, and R&D best fit the named requirements and, therefore, usually enjoy the most power and influence in a Prospector's dominant coalition. On the other hand, there are Defenders, or those who emphasise the stability of the environment and organisational structure, and use different means and methods that help them achieve and maintain this stability. While doing so, they favour limited product development – often closely associated with the existing assortment – as well as strive to insulate their sub-markets from potential rivals by pursuing competitive pricing and delivering better customer service, to name a few. Organisations adhering to this strategic type seek executives who have an inward orientation, can successfully resolve the cost-efficiency dilemma, and ensure cautious and incremental growth. As practice suggests, the experience of top managers with such throughput functions as production, engineering, and accounting proves indispensable for dealing with the outlined objectives. Additionally, Hambrick and Mason (1984:199) point to the third, so-called peripheral function, which includes financial and legal tracks: being less integrated in an organisation's core activities, executives whose prime specialisation is in these functional areas "pursue strategies that fit with their relative deficiencies in «hands-on» experience". Yet, the literature has primarily focused on the former two, often relating that expertise to the internal orientation.

At an even more general level, scholars also attempt to distinguish managers with deeper expertise in a smaller number of functions from those who have relatively shallow expertise in a large number of functions (see Buyl *et al.*, 2011; Ferreira and Sah, 2012; Rajagopalan and Datta, 1996). The need to make this distinction becomes apparent when one looks at generalist CEOs and their communication patterns with other actors in the company. The diversity of functional background is instrumental in overcoming the silo mentality that keeps different parts of the organisational structure from efficiently interacting with each other (Fisher and Oberholzer-Gee, 2013). Being able to speak the same language to various

[13] It is worth noting that taking such a diversity-based stance on professional background can address, to an extent, of course, the likely criticism that by the moment of appointment, many chief executives have already been involved in multiple functions – as a result, it becomes extremely difficult to isolate the effect of a single function (see Kor, 2006).

stakeholders, generalist executives may thus be better equipped for integrating and fostering cross-functional communication and information exchange. Meanwhile, some studies insist on avoiding the excessive centralisation of information flows at the corporate level because it is likely to result in a significant lack of awareness, appreciation, and trust among interacting functions – these qualities are especially critical for achieving success in innovation projects (see Moenaert *et al.*, 1994). Executives who have various types of expertise also tend to be "less susceptible to functionally grounded biases and stereotypes", and faster at retrieving, processing, and evaluating necessary information, largely owing to knowledge overlaps with other members of the management team (Buyl *et al.*, 2011:155). Unlike specialist managers, such CEOs are less concerned about the functional proximity with other top managers when it comes to the engagement in decision making, thereby reducing the possibility of functional inbreeding and its adverse impact on organisational outcomes (Bunderson, 2003). Finally, "the breadth of the expertise of the top manager is larger [...] if there is a greater unpredictability or complexity in the organization's business, or if exogenous changes reduce the difficulties in communication" (Ferreira and Sah, 2012:578).

From the empirical point of view, there has been an emerging consensus that CEOs' functional background should be taken into account when evaluating the role of managerial traits in product differentiation and related strategies. Bearing that in mind, we can first refer to the study by Daellenbach *et al.* (1999), whose analysis revealed a positive impact of CEOs with technical orientation (such as production, operations, engineering, and research and development) on the level of R&D investment compared to executives specialising in other functions. These results largely corroborate Datta and Guthrie's (1994) earlier findings that in order to ensure that core operations and technologies are handled efficiently, R&D intensive companies prefer to hire CEOs with strong technical background. At the same time, Barker and Mueller (2002) drew a slightly different picture. They still predicted that the decisions on R&D expenditure are positively associated with the executive's engineering, research and development, and also marketing experience; however, the association turns negative when production, operations, or legal functions are considered. Interestingly enough, the sub-group analysis they conducted based on the CEO's tenure in office suggested that the described effects hold only for long-tenured chief executives. The authors interpreted such tenure bias by an increase in executive power and influence over time that leads to CEO-related effects becoming deeper imprinted in organisational functioning. Considering the adaptation process at the strategic business unit level, Gupta (1984) came up with a hypothesis that general managers with functional background in research and development would make a greater contribution to the effectiveness of product differentiation. In turn, the study by Gupta and Govindarajan (1984) extends this hypothesis further by showing that the implementation of "build" strategies (or the strategies that emphasise aggressive market share expansion) is more efficient in the business units where managers have experience in marketing or sales. Govindarajan (1989) examined the data on general managers of 121 strategic business units to tease out more inclusive, yet still consistent with the above findings conclusions. He particularly reported that individuals whose specialisation is in research and development or general management make a positive contribution to the effectiveness of the business units pursuing differentiation strategy, while general managers with manufacturing, finance, or accounting experiences appear to hamper it. Finally, Beal and Yasai-Ardekani (2000) adopted a multidimensional view of differentiation strategy to demonstrate that although having a specialisation in research and development allows top managers to successfully execute innovation-based differentiation strategy, quality- and service-based differentiation strategies yield much better outcomes when CEOs' background is in engineering.

Empirical studies that adopt the Miles and Snow (1978) strategic classification also provide valuable insight into the matter. For example, Chaganti and Sambharya (1987) tested several hypotheses about the proportion of managers with certain functional backgrounds in the upper echelons of the three major tobacco companies: Philip Morris, R. J. Reynolds, and American Brands. Their findings indicate that Prospectors tend to have more top managers with production, research and development, and marketing orientations, and fewer – with financial orientation. Similarly, Thomas *et al.* (1991:517-519) and subsequently Thomas and Ramaswamy (1996) found "significant differences in the pattern of executive characteristics associated with Prospector and Defender […, where] Prospector firms were more likely to be led by CEOs with backgrounds in output related function". As for product differentiation measures, Rajagopalan and Datta (1996) noted a negative association between the degree of advertising intensity in the industry and the CEO's throughput orientation, with the effect being mainly due to highly performing companies. At the same time, they found no support for the hypothesis that industry advertising intensity is positively associated with functional heterogeneity of executives. Datta and Rajagopalan (1998) reinforced the validity of these results by concentrating on CEO turnover. The authors reported that in a subgroup of high-performing companies, the likelihood of a throughput background in the CEO successor is negatively associated with advertising intensity at the industry level.

Accordingly, the following hypotheses are proposed:

Hypothesis 4 (a): *CEOs with previous experience in engineering or research and development positively affect the extent of differentiation strategy.*

Hypothesis 4 (b): *CEOs with previous experience marketing or sales positively affect the extent of differentiation strategy.*

Hypothesis 4 (c): *CEOs with previous experience in accounting, finance, or audit negatively affect the extent of differentiation strategy.*

Hypothesis 4 (d): *CEOs with previous experience in administration, operations, or manufacturing negatively affect the extent of differentiation strategy.*

Hypothesis 4 (e): *CEOs with previous experience in law or compliance negatively affect the extent of differentiation strategy.*

Hypothesis 4 (f): *CEOs with diverse functional background positively affect the extent of differentiation strategy.*

Institutional experience and its diversity. Turning to another dimension of CEOs' career pathway, we should also touch upon institutional experience due to its substantial impact on managerial perceptions and, as such, on strategy formulation and implementation (Gupta, 1984; Smith and White, 1987; White *et al.*, 1994). Simply put, this branch of upper echelons analysis seeks to determine the extent to which internally promoted executives and their personality characteristics formed on the basis of close familiarity with organisational functioning have a different effect on strategic outcomes compared to those CEOs who were recruited from the external labour market.[14] Previous studies have identified several possible reasons for an organisation to leap into a search for an external candidate (see Finkelstein *et al.*, 2009; Kesner and Sebora, 1994). First of all, bringing in new expertise and vision seems to be the most appealing reason for a suchlike decision as "[e]xecutives who have spent their entire careers in one organization can be assumed to have relatively limited perspectives" (Hambrick and Mason, 1984:200). Hence, hiring an outsider CEO can reflect, for instance, the board's desire to break up the status quo, which is usually associated with the incumbent, often long-tenured, executive and tends to be particularly harmful for the innovation process (Hambrick and Mason, 1984; Miller, 1993; Stopford and Baden-Fuller, 1990). Another closely related reason emphasises the need for a change in the course of the existing strategy to achieve a certain level of performance, especially when previous attempts with internal candidates failed to do so (Datta and Guthrie, 1994; Miller, 1993; Tushman and Rosenkopf, 1996).[15] The choice to recruit a CEO from outside the organisation has its reverse side, too. Evidently, it is firm-specific knowledge that enables internally promoted chief executives to be better at building trust and facilitating coordination among business units (Gupta, 1984),

[14] To better capture the environmental aspect of knowledge accumulation, this "insider-outsider" setting can be extended to the industry level (see Gupta, 1984; Smith and White, 1987; Zhang and Rajagopalan, 2003).

[15] Meanwhile, earlier research of executive succession maintained that "inside successors tend to be less disruptive than outside successors", therefore not harming firm performance as much, if at all (e.g., Allen *et al.*, 1979; Grusky, 1964:74). However, the modern literature – after accounting for a larger set of organisational and environmental factors – takes a generally positive stance on the performance implications of hiring an outsider CEO.

as well as to make more accurate decisions about which strategic opportunities that emerge in the environment can be matched with the organisation's existing resources and capabilities (Kor and Mahoney, 2005). Since this expertise is non-transferable and mainly accumulated through learning by doing, on-site training, rotation among departments, and other similar channels of knowledge diffusion, it will be lacking under the external succession regime, so the resulting effect of hiring an outsider manager on organisational outcomes may, in fact, fall far below expectations (Becker, 1962; Hatch and Dyer, 2004). It should also be noted that the outer environment, which is a contingency in the relationship between succession antecedents and consequences, favours insiders and their "in-depth industry familiarity and tested working relationships" during periods of stability; otherwise, outsiders seem to be better positioned to deal with radical changes in market, competition, regulation, technology, and other external pressures (Hambrick and Mason, 1984:200).

Studying chief executives' institutional specialisation leads us to the realisation that its diversity may also explain some notable patterns in managerial perception and behaviour. To be more precise, a combination of industrial and organisational experiences CEOs have gained during their professional careers is likely to reflect the trade-off between general and firm-specific skills. The intuition here is that, by being subject to multiple working settings, senior managers accumulate transferable skills, which, alongside in-house knowledge, are also critical for the administration of organisational strategies, especially when it involves dealing with industry deregulation, foreign competition, or innovation development, among other things (Custódio *et al.*, 2013; 2015). According to Murphy and Zabojnik's (2004) argument about the acquisition of human capital, recent changes in storing, processing, and communicating information have eased the access to certain types of knowledge pertaining to a specific company. Coupled with the growing complexity and uncertainty of the business environment (Ferreira and Sah, 2012), this has led firms to put greater emphasis on general managerial skills, thus contributing towards the recently observed trend for external hires. What might other advantages for a company of recruiting a generalist chief executive be? Along with a chance to borrow more efficient managerial practices from other institutional domains (Benmelech and Frydman, 2015; Bertrand *et al.*, 2007; Corolleur *et al.*, 2004), it has been documented that generalist CEOs are more likely to exhibit risk-taking behaviour because their diverse expertise acts as an insurance policy, providing them with still enough career opportunities even after failing in one professional area (Custódio *et al.*, 2015). At the same time, some scholars have expressed their concerns that a lack of industry familiarity may result in top managers with a diverse institutional background to be less efficient on the competitive dimension (see Gupta, 1984).

Relatively few studies have actually addressed the link between a chief executive's institutional experience and the strategies related to product differentiation.[16] So far as the regime of executive succession is concerned, empirical evidence has been somewhat mixed. On the one hand, Chaganti and Sambharya (1987:395) maintained that Prospector companies prioritise "qualities that cannot be easily cultivated from within", so their top management often includes a significant share of outsiders. This result was also confirmed by Thomas and Ramaswamy (1996), who looked at firms in electronics, chemicals, and petroleum refining industries and found that Prospectors have more outsiders among their senior executives than Defenders. Similarly, Kaplan (2008) examined firms' response to the fiber-optic revolution and came to a conclusion that outside experience enhances a CEO's receptivity to new ideas. On the other hand, Balsmeier and Buchwald's (2014:1013) study of the patenting behaviour of 70 large German corporations over the period 2000-2008 suggested that "firm-specific knowledge of inside top managers is relatively more important to facilitate innovative firm activities than experiences from outside the firm". Meanwhile, Datta and Guthrie (1994) did not identify any statistically significant relationship between CEOs' internal promotion and the level of R&D expenditure. Yet, when it comes to the scope of the previous professional experience, Custódio *et al.* (2015) demonstrated that executives with prevailing general skills are associated with more patent registrations. Their line of reasoning suggests that, due to inherent riskiness, inventive activities may be restrained by generally risk-averse managers. However, this effect can be substantially lowered, or even reversed, for generalist CEOs because they "have more outside options, which act as a labor market mechanism of tolerance for failure rather than internal mechanisms, such as executive compensation plans" (Custódio *et al.*, 2015:35).

Thus, the following hypotheses can be stated:

Hypothesis 5: *CEOs hired from outside the organisation positively affect the extent of differentiation strategy.*

Hypothesis 6: *CEOs with diverse institutional background positively affect the extent of differentiation strategy.*

Founder CEOs. Prior studies of corporate governance arrangements have identified marked differences between founder CEOs and those executives who joined the organisation at a later stage of its development (see Gedajlovic *et al.*, 2004; Lee *et al.*, 2016; Souder *et al.*, 2012). These studies have particularly suggested that founding managers tend to consolidate control and ownership in a single pair of hands and, hence, enjoy "the largely unchallenged

[16] A possible reason is that organisation tenure and outside experience are highly correlated; hence, scholars choose to focus on the former due to its perceived importance, while skipping the latter (e.g., Kaplan, 2008).

discretion to share (or not share) authority with family members and trusted associates" (Gedajlovic *et al.*, 2004:902; Wasserman, 2003). Perceiving the organisation as their lifetime achievement, founders may also take a firmer stance on how it should be administered and developed, so their personality becomes deeply ingrained in corporate culture and practices, producing a long-lasting inertia in the overall adaptation process (Baron *et al.*, 1999; Nelson, 2003).[17] The outlined cognitive and behavioural patterns, taken separately or in combination, may lead one to suppose that founding executives should demonstrate a different perception of risk and uncertainty than professional managers, thereby affecting their strategic choices and decisions. More specifically, greater latitude of action coupled with entrepreneurial spirit and long-term objectives makes founder CEOs more predisposed to pursuing innovative and risky projects (Begley, 1995; Eisenmann, 2002; Fahlenbrach, 2009; Kor, 2003). By contrast, facing the permanent threat of dismissal for erroneous actions, professional executives would require additional, often equity-based incentives to reduce risk aversion and, more generally, to mitigate the agency problem and dissuade myopic behaviour (Souder *et al.*, 2012). Yet, some scholars insist that the net effect of having a founder at the CEO position still remains ambiguous and fairly inconclusive. For founders, so the argument goes, having most of their wealth invested in the organisation may become a major obstacle in accepting potential losses, both material and reputational, stemming from new ventures (Gedajlovic *et al.*, 2004; Jayaraman *et al.*, 2000). Moreover, founding executives are highly prone to the self-control problem, which, along with an intrinsic motivation to align their personal interests with those of the organisation, can damage organisational learning. That is, experiencing the founder's opportunism, other key stakeholders would "avoid making relationship-specific investments in resources and processes and [...] withhold required capital, effort and valued information" (Gedajlovic *et al.*, 2004:904; He, 2008). Finally, founder CEOs possess an abundance of firm-specific skills and knowledge. At the same time, their expertise may be insufficient in highly dynamic and complex environments where general managerial skills are required to achieve superior performance (Gedajlovic *et al.*, 2004; George, 2005).

A number of empirical works have attempted to evaluate the role of founding executives in shaping the competitive position of an organisation. In the famous case study by Tripsas and Gavetti (2000:1157), the authors carefully investigated how Edwin Land – the founder CEO of Polaroid Corporation – and his beliefs and perceptions of the major technological trends at that time contributed towards undermining the company's strategic capabilities, so it eventually "failed to adapt to the radical changes that had occurred in the

[17] One may think of it as a self-fulfilling process: that is, more the identity of the organisation resembles that of its founders, stronger their organisational commitment and psychological attachment will be (see O'Reilly and Chatman, 1986; Wasserman, 2003).

imaging competitive landscape". Interestingly, Wasserman (2003) identified a similar effect, but at a more general level: he surveyed 202 Internet start-ups and came to a conclusion that once the original product is developed, the chief executive requires a much broader set of skills and competences in order to bring this product to the marketplace. Given the technical emphasis of founder CEOs in high-tech firms, the mismatch between the actual managerial ability and the new needs of the company is likely to emerge and even persist over time; therefore, hiring a professional executive can be a useful alternative to resolve this problem. In elaborating further on this theme, Xu and Yan (2014) empirically confirmed that founder CEOs who are about to retire exhibit an adverse effect on innovative performance in their organisations. According to the authors, due to a shorter planning horizon and conservatism, such chief executives place a greater emphasis on incremental innovations: although not as technologically advanced as radical ones, this type of innovation is usually less risky and yields quicker returns. Another potential problem linked to the founder status was articulated by Souder *et al.* (2012). They examined 173 U.S. cable operators during the period of 1972-1996 and discovered that the relationship between the founder CEO's tenure and market expansion is strictly negative, while the same relationship for professional managers shows a curvilinear pattern. Despite the presented criticism of founder control in organisations, there is still some degree of optimism regarding its effect on the innovation process. A good example is Fahlenbrach's (2009) study of 3,633 CEOs in 2,327 U.S. public companies over the period 1992-2002. It supported their initial hypothesis that founding executives facilitate capital and R&D expenditures and, thus, enhance the firm's value. Some interesting insights into the effect of founders on organisational outcomes can also be obtained by focusing on an individual's self-awareness and beliefs. In particular, Lee *et al.* (2016) looked at the behaviour of CEOs on social networks, in media, and with key stakeholders in 1,238 S&P 1500 companies and concluded that in large corporations, founder CEOs seem to be more overconfident compared to their professional colleagues. To substantiate this result and align it with competitive strategy, one may refer to previous studies underscoring the association between CEO overconfidence and a greater propensity to innovate (see Galasso and Simcoe, 2011; Hirshleifer *et al.*, 2012).

The above empirical analysis effectively suggests that the founder effect varies with the size of an organisation.[18] Given our specific interest in large corporations, we formulated the hypothesis so that it would be consistent with the studies taking the same perspective:

Hypothesis 7: *Founder CEOs positively affect the extent of differentiation strategy.*

[18] Strictly speaking, it depends on a stage of the organisational lifecycle at which the founder CEO operates (see Wasserman, 2003).

4.3. DATA AND METHODS

4.3.1. Sample and data collection procedure

The hypotheses were tested by examining more than two decades of statistics on the trademarking behaviour of U.S. large publicly-traded companies. The longitudinal panel was constructed in multiple stages. First of all, we matched the Standard & Poor's ExecuComp dataset to the Standard & Poor's Compustat North America dataset. In the merged sample, we selected only the companies with the coverage for the entire period of interest and for which we were able to identify CEOs at any year.[19] In addition, all financial variables were adjusted to constant 2009 U.S. dollars using the GDP deflator obtained from the U.S. Bureau of Economic Analysis. CEO demographics were then manually added by drawing on such sources as Marquis Who's Who directories; the Bloomberg database; the BoardEx database; the LexisNexis biographies database; companies' SEC filings, annual reports, press releases, and official web-sites; and CEOs' LinkedIn profiles, interviews, university yearbooks, and obituaries. Finally, trademark data were mapped from the USPTO Trademark Case Files dataset. Since there was no unique identifier by means of which the trademark statistics could be linked to the rest of our data, we used a combination of approximate search heuristics, the edit distance method, and the token algorithm to match related companies (Raffo and Lhuillery, 2009). While mapping trademarks, we controlled for company location (including country, state, city, and address) to minimise the probability of false positives.[20] To ensure methodological consistency, we also had to exclude entries with non-U.S. owners (based on both the owner's address and nationality) and where the class type was missing. As a result, our final sample contains 5,698 firm-year observations of 821 CEOs in 259 U.S. companies from 39 industries captured over the period 1992-2013. For these companies we were able to identify 40,993 trademarks, which is about 2% of all trademarks introduced during the same period of time.[21]

[19] Extensive revisions to the U.S. Securities and Exchange Commission's executive compensation disclosure requirements became effective in 1992 – the first year for which detailed compensation statistics are available in the ExecuComp database. In turn, the upper bound was imposed by the availability of trademark data: we used the 2015 release of the USPTO Trademark Case Files dataset, which also contains some trademarks registered in 2016. Given that the average time to issuance does not normally exceed two years (see Graham *et al.*, 2013), we chose to limit the observation period by 2013 to minimise selection bias.

[20] It should be noted that firms may create an intellectual property holding company in states such as Delaware in order to minimise or even avoid tax royalty payments on the income received from intangible assets (see Nguyen, 2005). We took this into account when controlled for firm location.

[21] To better trace the CEO-trademark link, we concentrated on the first use in commerce year. Also, we account only for the marks that were registered at some point. In our opinion, it is a less noisy measure compared to trademark applications because during the prosecution process, some marks

4.3.2. Dependent variables

A cursory review of the relevant literature revealed that product differentiation is usually operationalised by using either factor analysis of survey data (e.g., Beal and Yasai-Ardekani, 2000; Dess and Davis, 1984; Miller, 1988), or R&D and advertising intensities (e.g., Finkelstein and Boyd, 1998; Hambrick and Abrahamson, 1995; Rajagopalan and Prescott, 1990).[22] In this research, however, we propose an alternative empirical approach, which employs information about a company's trademark activities. This approach not only accounts for a trademark's legally stipulated function to distinguish goods or services of one party from those of another (Blackett, 1998), but also corresponds to the observation that important trademark decisions are usually subordinated to senior executives (Cohen, 1986). Conceptually, the main advantage of utilising trademark statistics, as we see it, resides in its ability to illuminate decision making at the corporate level by looking at the composition of product markets which the company selects to operate in. Still, the question can be asked: how efficient is this indicator at capturing the multifaceted nature of product differentiation? Due to the data availability problem existed before (Graham *et al.*, 2013), only a handful of empirical studies, mainly in international economics, have invoked trademark analysis to assess some aspects of product differentiability (see Baroncelli *et al.*, 2007; Fink *et al.*, 2005; Mangàni, 2007). Nevertheless, their results lend support for the use of trademarks to capture horizontal and vertical product differentiation. Trademark statistics also seem to fit well with a multidimensional view of differentiation strategy, prevailing in the strategic management literature and integrating innovation, marketing, quality, and service differentiation methods (see Beal and Yasai-Ardekani, 2000). The latter argument can particularly be supported by referring to the diversity of mark types and meanings they attempt to convey to customers, their physical characteristics and vehicles that can be used for the purpose of trademarking.

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can be abandoned; an opposition proceeding can be instituted, eventually precluding the mark from being registered; the registration can be refused because the examining attorney's assessment suggests that the mark is likely to cause confusion in the marketplace, and it cannot be mitigated in any way; and so on (see Graham *et al.*, 2013). Hence, we view the fact that the mark has actually been registered as an official endorsement that it is capable of serving the purpose of product differentiation. To avoid possible confusion and for the sake of simplicity, we shall further refer to them as trademark introductions. Finally, this study uses the Fama-French industrial classification (see Fama and French, 1997).

[22] See Geroski (1991) on a critical appraisal of using advertising intensity to measure product differentiation. Also, Bain (1956:143) argues that "advertising per se is not necessarily the main or most important key to the product-differentiation problem as it affects intra-industry competition and the condition of entry". Schmalensee (1978:498), in turn, shows that "advertising levels do not necessarily provide correct information about quality", thus resulting in a wrong inference about the vertical dimension of product differentiation. Finally, the study by Fosfuri and Giarratana (2009:185) suggests that being "a crucial step in new advertising campaigns [..., trademark registrations represent] a valuable indicator of new advertising output".

Based on the conceptual framework devised in the previous section (see Figure 4.1), three dependent variables were produced. First, we identified the *trademark flow in existing markets* by calculating the number of trademarks introduced by the company in one of the same product classes[23] as in the previous three-year period.[24,25] If the trademark is associated with more than one product class, each of these classes must satisfy the above "existingness" condition in order for the trademark to be accounted for. We assume a weaker dependence of such trademarks on corporate strategy considerations and, thus, use this measure to capture chief executives' direct involvement in differentiation issues. To simplify the interpretation, we denote this behavioural type as "market exploitation". By contrast, the *trademark flow in new markets* was gauged by counting the number of trademarks introduced by the company in a product class which had never been used in the prior three-year period. For trademarks filed in multiple product classes at least one of them has to satisfy the described "newness" condition to be included in the final count. Such trademarks are thought to have a closer link with decisions made at the corporate level (in other words, with market selection and, correspondingly, resource allocation); therefore, we use them to trace the indirect influence of chief executives on product differentiation. This behavioural type is, in turn, referred to as "market exploration". Finally, we also created the *trademarking in a new market* dummy that takes the value of one if at least one trademark is assigned to the trademark flow in new markets, and zero otherwise. This dummy variable aims to proxy the corporate level decision to access (as manifested by trademark activities) new product markets.

Overall, the outlined method for constructing the dependent variables (see Figure 4.2 for a scheme depicting the relationships among them) corresponds to the idea expressed by

[23] A product class can be defined as a category of goods or services in which the trademark is used for the purpose of differentiation. When applying for a trademark registration, the trademark owner has to specify the product class or classes with which the trademark will be associated. Therefore, "[t]he same trademark can be by different owners used in different classes because there is less likelihood for confusion" (Shipman, 1998:256). At the same time, "to expand protection of the mark for use on other products, the owner must apply for a new registration of the same mark identifying the additional goods and services" (Graham *et al.*, 2013:13). The USPTO currently follows the International Classification of Goods and Services under the NICE Agreement, which was adopted in 1973 (see Appendix 4.A, Table 4.A.11 for a complete list of product classes).

[24] We used a three-year window to avoid treating as a change in corporate strategy those situations when companies introduce trademarks in the same product classes, but infrequently. For multiple class trademarks we also experimented with how many new product classes the trademark should be used in so as to be associated with the flow of new marks – all, more than a half, or at least one. The results are generally robust to either of these specifications of the dependent variables (see Appendix 4.A, Table 4.A.1).

[25] According to Graham *et al.* (2013:14), "[e]xpanded coverage across classes may also reflect changes to the classes themselves". We believe, however, that this does not pose any significant problem for our analysis because in the final sample, the total share of trademarks introduced in the supposedly affected classes (e.g., classes 14, 42, 43, 44, and 45) is below 3%.

Graham *et al.* (2013:14) that introducing trademarks in new product classes or expanding their use into complementary classes signals "strategic behavior by owners for such purposes as creating licensing opportunities, intensifying consumer associations and confidence in a brand, or easing entry into new product marks by leveraging consumer brand associations". At the same time, this method has certain limitations: for example, one of its assumptions is that market diversification (and corporate-level decisions that underlie it) occurs when the company introduces its trademark in a new product market. Meanwhile, the company might have already entered that market some time ago; hence, trademarking in this case should not necessarily be associated with corporate strategy considerations. Although the trademark will not be protected at the federal level beyond the product classes listed in the registration at the USPTO, nothing precludes the company from still using it in commerce. Since we do not have the data on the specific range of markets in which companies operate, we are unable to confirm whether trademarking happens shortly after a new market entry or there is a large time gap between these two events.

4.3.3. Explanatory variables

Executive tenure and age. To measure *company tenure*, we calculated the difference between the observation year and the year in which the individual joined the company. There are several cases in our sample when individuals leave and rejoin their companies – for these we added together the terms. Similarly, *CEO tenure* was derived by counting the number of years the chief executive had been in office. Although managers may hold the CEO position in the same company more than once, we still treat each term separately. As for *CEO age*, we computed it by subtracting the executive's birth year from the observation year. It should further be noted that we squared each of the above variables and included the products into all model specifications to account for the possibility of non-linear effects.

Educational background. First, we identified the amount of higher education by calculating the *total number of university degrees* the chief executive earned. To substantiate the insights gained from this measure, we also captured the *depth* and *breadth of educational background* by counting the number of degrees in the same discipline and the number of different disciplines in which the CEO was awarded their degrees, respectively. Since simple counts could be criticised for failing to fully reflect the hierarchy of academic degrees, we introduced an alternative measure of educational level, which is based on a four-point scale (see Barker and Mueller, 2002; Daellenbach *et al.*, 1999). That is, we created the *highest level of education* attained variable and coded it into one of the following categories: 0 – no college degree; 1 – a bachelor's degree; 2 – a master's degree or JD; and 3 – a PhD degree.

Next, we designed a set of dummy variables each of which represents an *academic discipline* in which the CEO earned their degree. We opted for separate dummies because some of our executives hold more than one degree in different fields, thereby violating the mutual exclusivity condition necessary for employing, for example, simple or effect coding systems (von Eye and Schuster, 1998).[26] Before creating the dummies, we classified degrees by the following academic fields: (i) arts and humanities; (ii) engineering and technology; (iii) life sciences and medicine; (iv) natural sciences; and (v) social sciences (see Appendix 4.B for more details). We then separated business and legal degrees from the rest of social sciences so as to be consistent with the way our hypotheses are formulated. For parsimony, we excluded from our analysis the degrees in life sciences, medicine, and the social sciences other than business and law. Additionally, we added *MBA* and *JD* dummies to account for potential idiosyncrasies of these academic programmes.

Finally, we captured the effect of elitism and selectivity in higher education by adopting the widely-used *Ivy League* classification. That is, we included a dummy variable, which was set to one for the degrees awarded by Brown University; Columbia University; Cornell University; Dartmouth College; Harvard University; University of Pennsylvania; Princeton University; or Yale University, and zero otherwise. Given that such a restricted list of universities may not fully address the argument concerning the quality of knowledge, we created two alternative proxies, each with certain advantages and disadvantages. First of all, universities were classified according to their status – public or private. As Aghion *et al.* (2010:8) put it, "public universities [in the U.S.] differ considerably in their autonomy and the degree to which they face local competition from private universities"; hence, this may adversely impact their performance and financial standing. Following this line of arguments, we speculate that greater administrative and financial flexibility associated with the private status provides such institutions with more opportunities to offer attractive compensation packages and create conducive working conditions compared to their public rivals. As such, private universities are in a better position to recruit faculty members who are professionally more visible and committed to conducting extensive research, with a corresponding effect on the quality of disseminated knowledge. In the rest of this study, we will concentrate on *private universities* merely for exposition purposes. However, it is worth remembering that the correlation between the two variables is negative.[27] Since the premise about governance

[26] Even though this approach prohibits cross-discipline comparisons, its main advantage consists in avoiding the need for arbitrary assigning each individual with a single subject area (see Barker and Mueller, 2002).

[27] Our sample contains a minor share of executives who obtained their degrees from foreign universities: in those cases, we set both private and public university dummies to zero in order not to mix up institutional peculiarities of different countries. That is why we pointed to the negative correlation

and financial arrangements influencing knowledge quality may not be entirely convincing, we also utilised an external appraisal to derive another measure. In particular, we identified higher education institutions participating in the Association of American Universities – an organisation that represents higher education institutions with a strong emphasis on scientific research. Based on this coding, we then created the *research intensity* dummy, which was set to one for the association's members, and zero otherwise.

Professional experience and its diversity. Unlike some previous studies (e.g., Daellenbach *et al.*, 1999; Michel and Hambrick, 1992), we did not attempt to identify each executive's major *functional specialisation*. Instead, we created a set of variables indicating the number of years the CEO had spent in various professional areas. More specifically, all positions were classified with respect to the following categories: (i) general management; (ii) engineering and R&D; (iii) marketing and sales; (iv) accounting, finance, and audit; (v) administration, operations, and manufacturing; (vi) law and compliance; (vii) personnel; (viii) advisory services, planning, and strategy; and (ix) other unclassified positions (see Appendix 4.C for a description of the coding procedure). In the subsequent analysis, we will focus only on categories (ii) through (vi), largely owing to their specific relevance for testing our hypotheses. In addition, we captured the *diversity of functional experience* by counting the number of functional tracks in which the CEO had specialised (apart from general management, advisory services, and other unclassified functions).

To distinguish between CEOs who were hired from the outside labour market and their internally promoted colleagues, we used the *external hire* dummy. This dummy takes the value of one if the individual was appointed to the CEO position one year or less since joining the company, and zero otherwise (Brick *et al.*, 2006; Gillan *et al.*, 2009). It has to be noted, however, that there is no uniformity of opinion in the literature on what should be regarded as an external hire, and the decision does not necessarily depend on how precise the data at hands are (see Agrawal and Knoeber, 1998; Datta and Guthrie, 1994). For example, the heir apparent may be appointed to an intermediate position while waiting for the moment when the incumbent CEO is ready to leave the company – this succession regime is often used to ensure a smooth leadership transition (see Miles and Watkins, 2007). In this scenario, it is clear that the gap between joining the company and assuming CEO responsibilities should not be classified as internal promotion. Therefore, allowing for some deviation from the exact dates enables us to accommodate the nuances and subtleties pertaining to the process of executive succession.

between the two groups of universities, whereas the magnitude of the estimated effect can be slightly different.

In turn, the *diversity of institutional experience* was assessed by looking at the chief executive's previous professional record. We were particularly interested in such aspects as (i) the number of industries in which the CEO worked; (ii) the number of companies where the CEO worked; (iii) the CEO's military experience; (iv) the CEO's civil service experience; and (v) the CEO's academic experience. The former two variables were included because of their ability to capture a variety of operating environments encountered by senior managers during their professional career, whereas the latter three (dummies) addressed the growing evidence that the prior involvement of individuals in certain socio-economic activities leave an imprint on their perceptions and strategic behaviours. For example, it has been shown that military experience is associated with conservative corporate policies and ethical behaviour (Benmelech and Frydman, 2015); civil service experience may induce politically-motivated actions, with a potentially negative effect on organisational outcomes (Bertrand *et al.*, 2007); and academic experience, in certain cases, leads to path dependencies in the application of human capital and the productivity of inventive activities (Corolleur *et al.*, 2004; Dietz and Bozeman, 2005). In order to combine these variables into a one-dimensional index, principal component analysis was employed (see Appendix 4.D for more details on how the index was constructed): that is, for each chief executive in our sample we calculated a score by using the following formula:[28]

$$IDI_{i,t} = 0.611 * Y_{1,i,t} + 0.604 * Y_{2,i,t} + 0.169 * Y_{3,i,t} + 0.392 * Y_{4,i,t} + 0.283 * Y_{5,i,t}, \quad (1)$$

where $Y_{1,i,t}$ is the number of industries in which CEO_i had worked until year t; $Y_{2,i,t}$ is the number of companies where CEO_i had worked until year t; $Y_{3,i,t}$ is the military experience dummy for CEO_i in year t; $Y_{4,i,t}$ is the civil service experience dummy for CEO_i in year t; and $Y_{5,i,t}$ is the academic experience dummy for CEO_i in year t. We adopted the approach of Custódio *et al.* (2013), who deemed chief executives with the index above the yearly median to be generalists, while those with the index equal or below the yearly median – specialists.

Finally, we created the *founder CEO* dummy that equals one if the chief executive is also the firm's founder, and zero otherwise. Founding managers were revealed by looking at the historical profile of each company in our sample. On the chief executive's side, we searched for such patterns as "founder", "co-founder", and "founding" in post names and post descriptions to make sure that the founder status was assigned correctly. Additionally, we checked the year in which the CEO joined the company to confirm that for founders it coincides with the company's establishment year.

[28] To calculate these weights, we applied the regression scoring method. All the components were mean-centred before being used in the analysis. The index was also normalised to have zero mean and a standard deviation of one.

4.3.4. Control variables

Individual-level characteristics. Following previous studies, we controlled for *CEO stock option pay* because of its presumed incentive effect on managerial decisions and behaviours (e.g., Lerner and Wulf, 2007; Wu and Tu, 2007). This variable was derived by taking the natural logarithm of the fair value of option grants to the CEO in the observation year. Stock options were valued by using the modified Black-Scholes and fair value methods. All negative values and missing observations were set to zero. We expect that this form of executive compensation has a positive impact on the extent of product differentiation by discouraging myopic resource allocation and inducing risk-taking preferences in senior executives (Currim *et al.*, 2012; Sanders, 2001).

Given that some decisions, especially radical ones, require a significant degree of authority in order to be implemented, we controlled for the chief executive's discretion and ability to exercise power. In doing so, we focused on the *CEO duality structure* and created a dummy variable that takes the value of one if the titles of CEO and Chairman are vested in the same person, and zero otherwise (Boyd, 1995; Galasso and Simcoe, 2011). In addition, we controlled for *CEO ownership* by calculating the percentage of common stock held by the chief executive (Kim and Lu, 2011; Wu *et al.*, 2005). All missing observations were set to zero, and the resulting values were winsorized at +1 to control for outliers. The rationale behind its inclusion in our analysis is based on the fact that "even though CEOs are in control, their ability to make decisions harmful to shareholders, the level of entrenchment, may depend on the percentage of voting rights they currently own" (Kim and Lu, 2011:275).

Finally, we controlled for the role of gender in strategic decision making by including the *CEO gender* dummy that takes the value of one if the chief executive is male, and zero otherwise. Despite some authors questioning the existence of gender-specific risk preferences (e.g., Kruse and Thompson, 2003; Schubert *et al.*, 1999), findings from field studies largely favour the idea of systematic differences between men and women in their response to uncertainty, with women generally being more risk averse than men (Eckel and Grossman, 2008). At this point, however, it is difficult to predict the resulting effect of CEO gender on product differentiation. The reason is that companies led by female executives tend to demonstrate greater market orientation, which is often associated with the active use of differentiation strategy to communicate with consumers, especially in highly competitive industries with many alternative offerings (Davis *et al.*, 2010; Kohli and Jaworski, 1990).

Firm-level characteristics. We calculated *firm size* by taking the natural logarithm of the total number of employees. This variable was added to account for the so-called Schumpeterian hypothesis on the advantages enjoyed by large organisations in innovation development (Cohen and Klepper, 1996). From the managerial perspective, this implies that chief executives are able to allocate a greater amount of resources to R&D activities, thereby also facilitating the achievement of differentiation (Comanor, 1967). However, as Barker and Mueller (2002) correctly noted, CEOs in large corporations may still have deep reservations about expanding R&D investment: for example, they can be discouraged by the uncertainty associated with its outcomes as well as the disturbing effect it may have on the status quo. So, they may instead find it more appealing to leverage the company's market power, which is usually derived from its size. As for trademarking behaviour, recent studies have identified clear differences between small and large firms, with the former being more active when it comes to filing for a new trademark (e.g., Block *et al.*, 2015).

To account for the company's lifecycle and accumulated experience in differentiating its output, we used *firm age*. It was computed by subtracting the year to which the company traces its origins from the observation year. The inclusion of this variable can be justified by pointing to the empirically supported relationship between organisational aging and innovation processes (Sørensen and Stuart, 2000). Since older companies are likely to have the motives to engage in trademarking that are different from those of younger companies, controlling for firm age also allows us to accommodate variations in trademarking behaviour at different stages of organisational development. More specifically, older companies tend to operate in mature markets where differentiation based on the physical characteristics of a product may have a smaller impact on the consumer's purchasing decisions compared to brand awareness, reputation, and loyalty – those are normally leveraged via trademarks; however, younger firms may use the registration of a new trademark as a signal to potential investors about the degree of their market and growth orientation (Block *et al.*, 2014a; Block *et al.*, 2015).

In addition, we included a set of financial controls. Some studies have found that a company's decision to invest in R&D often depends on prior profitability (Daellenbach *et al.*, 1999). We accounted for this finding by calculating *return on assets* (ROA) as the ratio of income before extraordinary items to total assets. The resulting values were subsequently winsorized at -1 and +1 to limit outliers. We then introduced the *book leverage* variable to control for the influence that debt levels have on R&D spending (Barker and Mueller, 2002). It was measured as the ratio of long-term debt plus current liabilities to total assets. Initially, we also intended to capture resource allocation between the two major inputs of product differentiation – advertising and R&D expenditures. Given that the relevant statistics contained in the Compustat database were sparsely populated, we eventually decided to employ a more inclusive measure, which is *commercial expenditure* scaled by total assets (Knoeber, 1986).

4.3.5. Model formulation and estimation

As we have already pointed out, studies adopting the upper echelons perspective interpret strategic decisions made by top managers as a uniform process which is cascaded down through all corporate levels. This research, however, advocates a slightly different approach which, in our opinion, tends to be more consistent with the hierarchical view of strategy. Our conceptual framework (see Figure 4.1) particularly suggests the dichotomisation of managerial participation in differentiation strategy. On the one hand, chief executives can be directly involved in its formulation and execution at the business unit or functional level. Such involvement reflects the fact that, under certain conditions, the locus of decision making diverges from the locus of strategy. On the other hand, product differentiation can also be affected, especially at early stages, by corporate strategy considerations. In this case, the CEO's participation spans two consequent phases: first, to make an active decision[29] on whether to differentiate in a new product market or not, which, if positive, entails solving market selection and resource allocation problems; and second, to determine the extent of product differentiation by choosing the number of trademarks to introduce in the new market. Therefore, the strategy's outcomes are expected to be driven by the same managerial factors, but their interpretations should depend on the type and the phase of the decision process.

Turning to the modelling approach used in this work, we have to start with clarifying the underlying distribution characteristics of our dependent variables. Since both trademark flow measures take on a limited range of nonnegative integer values, it is natural to assume that they follow a discrete probability distribution and then apply corresponding statistical techniques in order to fit the model to the data (Allison, 2009; Cameron and Trivedi, 1986). By definition, the Poisson distribution should be adopted only when the dependent variable satisfies the equidispersion property: in other words, the conditional mean must be equal to the conditional variance. Failing that, the statistical inference will likely yield overly optimistic or even erroneous estimates (Cox, 1983; Dean and Lawless, 1989; Paul and Plackett, 1978). To detect overdispersion, Cameron and Trivedi (2005) proposed a two-step procedure, namely: first, to regress $[(y - \hat{\mu})^2 - y] \,/\, \hat{\mu}$ on $\hat{\mu}$, while omitting the constant; and second, to perform the t-test to see if the coefficient before $\hat{\mu}$ is significantly different from zero. Since the test's results provide strong evidence for overdispersion in the trademark data, we chose to employ the negative binomial model, which is specifically designed to tackle the problem of excessive variability in observed outcomes. Its density function can be specified as follows (adapted from Allison, 2009):

[29] Here, we intentionally classify this choice as active in order to juxtapose it with the passive choice to stay in the same market. In the absence of an active corporate decision, resource allocation and other activities related to product differentiation are attributed to the CEO's direct involvement.

$$f(y_{i,t}) = P(Y_{i,t} = y_{i,t}) = \frac{\Gamma(\theta + y_{i,t})}{\Gamma(\theta)\Gamma(1 + y_{i,t})} \left(\frac{\lambda_{i,t}}{\theta + \lambda_{i,t}}\right)^{y_{i,t}} \left(\frac{\theta}{\theta + \lambda_{i,t}}\right)^{\theta}, \tag{2}$$

where $y_{i,t}$ is the number of trademarks introduced by firm *i* in period *t*; $\lambda_{i,t}$ is the expected value of $y_{i,t}$; θ is the overdispersion parameter; and $\Gamma(\cdot)$ is the gamma function. The expected value of $y_{i,t}$ is described by a log-linear function:

$$log\,(\lambda_{i,t}) = \mu_t + X^i_{j,t-1}\beta_1 + M_{i,t-1}\beta_2 + \zeta_i + \eta_h + \tau_t, \tag{3}$$

where $\lambda_{i.t}$ is the expected number of trademarks introduced by firm *i* in period *t*; μ_t is the intercept that can be different for each period; $\mathrm{X}^{\mathrm{i}}_{\mathrm{j,t-1}}$ is the vector of CEO-related variables for CEO *j* in firm *i* in period *t-1*; $\mathrm{M}_{\mathrm{i,t-1}}$ is the vector of firm controls for firm *i* in period *t-1*; ζ_i denotes unobservable time-invariant firm-specific effects for firm *i*; η_h denotes unobservable time-invariant industry-specific effects for industry *h*; and τ_t denotes year-specific effects to control for the general economic trend. We lagged all independent variables by one period to avoid simultaneity bias. This model will utilise the trademark flow in existing markets to assess the chief executive's direct involvement in product differentiation.

To capture the managerial involvement through corporate strategy considerations, we transformed the above negative binomial model so that to frame it into a hurdle specification (see Deb and Trivedi, 1997; Mullahy, 1986; Pohlmeier and Ulrich, 1995). The main advantage of using the hurdle model in our analysis consists in its hierarchical structure which matches the phasing of decision making and, thus, simplifies the interpretation of the obtained results.[30] In particularly, it presupposes that at the first stage, there is a binary choice process between $y_{i,t} = 0$ and $y_{i,t} > 0$; and at the second stage, the decision to participate is followed by a zero-truncated process that determines the extent of participation by concentrating on $y_{i,t} > 0$. Therefore, the probability density function can be expressed in the following form (adapted from Deb and Trivedi, 1997):

$$f(y_{i,t}) = P(Y_{i,t} = y_{i,t}) = \begin{cases} \pi_{i,t}, & y_{i,t} = 0 \\ (1 - \pi_{i,t}) \frac{\Gamma(\theta + y_{i,t})}{\Gamma(\theta)\Gamma(1 + y_{i,t})} \left(\frac{\lambda_{i,t}}{\theta + \lambda_{i,t}}\right)^{y_{i,t}} \left(\frac{\theta}{\theta + \lambda_{i,t}}\right)^{\theta}, & y_{i,t} > 0 \end{cases} \tag{4}$$

where $\pi_{i,t}$ and $\lambda_{i,t}$ correspond to the binary choice and the zero-truncated processes, respectively. In turn, $\pi_{i,t}$ is described by a logistic model, while $\lambda_{i,t}$ – by a log-linear model:

$$logit\,(\pi_{i,t}) = \mu_{h,t} + X^i_{j,t-1}\beta_{p,1} + M_{i,t-1}\beta_{p,2} + \zeta_i + \eta_h + \tau_t, \tag{5}$$

$$log\,(\lambda_{i,t}) = \mu_{e,t} + X^i_{j,t-1}\beta_{e,1} + M_{i,t-1}\beta_{e,2} + \zeta_i + \eta_h + \tau_t, \tag{6}$$

[30] Another advantage of using a hurdle model for our data consists in its ability to handle the excess zeros problem (see Cameron and Trivedi, 2010).

where $\pi_{i,t}$ corresponds to the decision of firm *i* to enter a new market; $\lambda_{i.t}$ is the expected number of trademarks introduced by firm *i* in the new market in period *t*; $\mu_{h,t}$ and $\mu_{e,t}$ are intercepts that can be different for each period; $\mathrm{X}^{\mathrm{i}}_{\mathrm{j,t-1}}$ is the vector of CEO-related variables for CEO *j* in firm *i* in period *t-1*; $\mathrm{M}_{\mathrm{i,t-1}}$ is the vector of firm controls for firm *i* in period *t-1*; ζ_i denotes unobservable time-invariant firm-specific effects for firm *i*; η_h denotes unobservable time-invariant industry-specific effects for industry *h*; and τ_t denotes year-specific effects to control for the general economic trend. So, equation (5) models the CEO's decision on whether to introduce a trademark in a new product market or not; and equation (6) estimates the extent of product differentiation, should the outcome of the participation decision be positive.

Finally, it is essential to include several comments on the functional form and the estimation strategy adopted in this study. Due to the panel nature of our data, we had to determine whether a fixed or random effects specification suits it best. Although the random effects model allows for more degrees of freedom, it may suffer from inconsistency caused by the assumption that individual effects are uncorrelated with other regressors. By contrast, the fixed effects model exploits the within-group variation over time to estimate the regression coefficients, thus avoiding omitted variable bias (Greene, 2003). To make an informed decision as to what model type to select, we could perform the specification test designed by Hausman (1978). This would entail the necessity to work with the fixed effects negative binomial model developed by Hausman *et al.* (1984) and based on the conditional maximum likelihood method. However, several authors have expressed concerns about its validity (see Allison and Waterman, 2002; Guimarães, 2008), particularly arguing that very specific assumptions have to be satisfied in order for this method to control for all stable covariates. As a robust alternative, Allison and Waterman (2002:264) suggested using "conventional negative binomial regression with direct estimation of the fixed effects rather than conditioning them out of the likelihood". While generally following this approach, we slightly amended it by incorporating the mean scaling estimator proposed by Blundell *et al.* (1999) to account for firm-specific effects. That is, for each firm we calculated the 5-year pre-sample mean of newly introduced trademarks[31] and included it directly into the model to account for the entry level of product differentiation (ζ_i). Similar to Galasso and Simcoe (2011), who used this method for studying the effect of CEO overconfidence on a firm's patenting behaviour, we argue that it enables us to avoid imposing the strict exogeneity assumption on the explanatory variables and, hence, to accommodate possible unobserved shocks in marketing strategy or brand value that change the firm's current and future trademark activities.

[31] We also experimented with longer pre-sample periods (for up to 9 years). Despite these alterations, our results have remained broadly consistent with the basis model (see Appendix 4.A, Table 4.A.2).

4.4. RESULTS

The descriptive statistics and correlation matrix for the study variables are presented in Tables 4.1 and 4.2, respectively. The average firm in our dataset introduces 6 trademarks per year in existing markets and 1 trademark per year in new markets. In 38% of all observations, a part of the trademark flow can be attributed to changes in the composition of the product markets in which the company operates. Turning to CEO characteristics, the average sampled chief executive is a 56-year-old male who has been in office for 8 years and worked for the company for as long as 22 years. The recruitment pattern is such that 16 individuals out of 100 were hired from outside the company, while the rest – promoted internally. Only 7% founded the company they manage; the average share of stockholdings for those who own the company is about 2%. Along with performing executive duties, seven in ten managers are assigned with an extra responsibility to chair the board of directors. Among all functions, their working experience tends to be lengthier in accounting and finance compared to, for example, personnel management, where it is the shortest. The average CEO specialises in at least one professional area not directly related to general management or other non-classified functions. Almost all sampled chief executives obtained a bachelor's degree, with a significant number of them also having a master's degree completed. The most popular major is business studies, mainly because of an MBA degree awarded to 37% of all individuals. Roughly one-half of executives attended a private college, of which 12% were enrolled at an Ivy League university. Finally, correlation coefficients suggest that some of the variables we have included in our analysis are significantly correlated, thus giving rise to multicollinearity concerns. To address this issue, we calculated the variance inflation factor, and its values indicated no serious problem (see Appendix 4.A, Table 4.A.3).

Market exploitation. Table 4.3 presents the results of the regression analysis that links CEO characteristics to the trademark flow associated with existing markets. Overall, they confirm one of the central premises of this study that managerial perceptions and values can partially predict the extent of differentiation strategy. In the given context, we interpret this outcome as a signal that along with business unit managers, chief executives also have an impact on product differentiation, or, as it was defined before, that there is the divergence of the locus of decision making from the locus of strategy. Our findings particularly suggest that both executive age and tenure in the company have an inverted U-shaped relationship with the number of trademarks introduced in existing markets because their quadratic terms are negative and statistically significant (Hypothesis 1 is partially confirmed; Hypothesis 2 is confirmed). At the same time, the length of tenure in the CEO position has no visible effect, no matter whether the quadratic term is included or not.

Next, the number of university degrees awarded to CEOs is positively related to the market exploitation behaviour (Hypothesis 3a is confirmed). In an additional analysis (see Appendix 4.A, Table 4.A.4), we used alternative proxies for the amount of higher education to verify and substantiate this finding. Its results indicate that the depth of education, not its breadth, underpins the efficiency of this measure because both the number of the same degrees and the degree-based index are statistically significant and positively related to the extent of trademark activities in existing markets. However, more insights can be gained when we concentrate on the subject in which chief executives major, even though these results are somewhat mixed. More specifically, CEOs with a degree in natural sciences facilitate the extent of product differentiation in existing markets, unlike those whose degree is in engineering and technology – for them this relationship turns negative (Hypothesis 3b is partially confirmed). Our findings also show (see Appendix 4.A, Table 4.A.4) that individuals with a degree in business or legal studies are likely to reduce the company's trademark activities in existing markets (Hypothesis 3c is confirmed), including executives who hold an MBA degree. As for university heterogeneity, Ivy League graduates have a stronger propensity to engage in differentiation activities, as expected (Hypothesis 3d is confirmed). Following this outcome, we decided to clarify whether the effect is due to knowledge quality or the selectivity issue, and ranged universities according to their research intensity and the governance status. This analysis reveals (see Appendix 4.A, Table 4.A.4) that chief executives who ever attended a private university are more apt to demonstrate the market exploitation behaviour, whereas having an affiliation with a research intensive university adds little to explaining variations in differentiation strategy.

Interesting patterns can be observed when the functional background of CEOs is considered. In contrast to the theoretical arguments and empirical evidence presented in earlier studies, we were unable to identify any statistically significant relationship between the tenure in engineering, R&D, administration, operations, manufacturing, compliance, or legal functions, and the extent of product differentiation in existing markets (Hypothesis 4a, 4d, and 4e are not confirmed). Meanwhile, executives with a lengthier functional tenure in accounting, finance, or audit seem to restrain the company's differentiation activities (Hypothesis 4c is confirmed). CEOs' experience in marketing or sales is also negatively related to the number of trademarks introduced in existing markets, and this result is strikingly different to what was predicted (Hypothesis 4b is not confirmed). Despite the reasoning that the exposure to a variety of environments would enhance managerial cognition, develop multiple skills, and stimulate pursuing risky strategies, our analysis leads to a different conclusion. In particular, the effect of functional diversity on the market exploitation behaviour is found to be negative and statistically significant (Hypothesis 4f is not confirmed), while there is not enough evidence to support the idea about the positive impact of institutional diversity on differentiation strategy.

Finally, our analysis reveals that founder CEOs have a positive effect on trademark activities in existing product markets (Hypothesis 7 is confirmed). The relationship between chief executives who were recruited from outside the company and product differentiation, however, is statistically insignificant, thus suggesting no influence of internal knowledge and expertise on this type of strategy (Hypothesis 5 is not confirmed). The focus on individual-level controls can also provide us with some useful information regarding product differentiation. For example, both CEO duality and option incentives positively affect the market exploitation behaviour; yet, the effect of stock ownership is strictly negative. In addition, we have found that gender bias tends to have significant explanatory power for predicting variations in the company's differentiation strategy.

New market selection and exploration. The conceptual framework we have proposed in this study suggests that chief executives can also indirectly affect product differentiation by making decisions on corporate strategy issues, such as market selection and corresponding resource allocation. Our empirical analysis supports this idea, but we have to acknowledge that CEOs seem to utilise their perceptions and values selectively, depending on the stage of the decision process (see Tables 4.4 and 4.5). To exemplify, we can refer to an individual's age: it demonstrates an inverted U-shaped relationship with the company's decision to trademark in a new market and has no statistically significant effect on the extent of differentiation strategy. By contrast, tenure in the CEO position has an inverted U-shaped relationship with the extent of product differentiation in new product markets, whereas its effect on the market selection process is statistically insignificant. At the same time, an inverted U-shaped pattern describes the relationship between organisational tenure and both the decision to access a new market and subsequently differentiate in it (Hypothesis 1 is fully confirmed).

Unlike the case of market exploitation, the impact of higher education on the chief executive's exploration behaviour is fairly limited. For example, individuals with a degree in engineering and technology still have a negative effect on the extent of differentiation strategy; however, this effect is significant only for corporate strategy considerations. Similarly, the results suggest that individuals with a major in legal studies tend to avoid trademarking in new markets, and this outcome is mainly driven by those who hold the professional doctorate in law: that is, when we include the JD degree dummy in the model specification, the effect becomes even more pronounced (see Appendix 4.A, Tables 4.A.5 and 4.A.6). We can also confirm that the CEO's affiliation with an Ivy League university has a positive impact on their decision to facilitate product differentiation in new markets, while other university classifications were unable to reach an acceptable level of statistical significance.

Finally, we have failed to find any evidence that the diversity of functional experiences as well as the functional specialisation of executives guide their involvement in differentiation strategy at the corporate level. Having said that, we have found that generalist managers tend to differentiate less in new product markets, albeit the effect is only marginally significant (Hypothesis 6 is not confirmed). Our analysis has also identified a positive role of founder CEOs in intensifying product differentiability upon entering a new market. However, it appears that owner executives demonstrate a significant reluctance to trademark in new product markets. Furthermore, chief executives who chair the board favour new market entries; and extra financial incentives – such as option grants – would be beneficial to induce the expansion of differentiation strategy in those markets. In contrast to what was observed before, there is not enough evidence to confirm gender bias.

4.4.1. Robustness checks

When CEO professional specialisation was reviewed, we explicitly pointed out a potentially non-random selection of managers by companies in order to ensure the fit with their strategic profiles. Michel and Hambrick (1992), in turn, argue that the relationship between organisational strategy and functional background of top managers is likely to be mutually reinforcing. Furthermore, there can also be an element of self-selection in how individuals choose companies to work for. To partially address these concerns, we followed the method proposed by Hirshleifer *et al.* (2012) and focused on longer-tenured executives. In such a setting, the effect of matching can be significantly diminished because, if present, it would be especially pronounced during the first few years after the CEO appointment. However, having that period passed, internal and external pressures may cause organisational characteristics to diverge from CEO personality traits because the latter are relatively stable over time. In Table 4.A.7 in Appendix 4.A, we provide a summary of this analysis. It can be clearly seen that our results do not primarily come from the endogenous matching of chief executives with certain characteristics to firms that pursue active differentiation strategy, thereby reinforcing the validity of the conclusions we have drawn from the data.

Next, to confirm that our findings are not driven by the econometric specification adopted in this research, a comparative analysis of different models was performed. As Table 4.A.8 in Appendix 4.A shows, the results are still generally consistent, no matter what assumption about the underlying distribution of the dependent variable or the method to adjust standard errors is used. In order to address the reverse causality problem, we estimated all models with one-period lagged explanatory variables. Such an approach also accounts, to a degree at least, for a time lag that naturally occurs between the moments when the CEO decides to intervene in strategy making and when the actual outcome of this intervention can be observed. Furthermore, we decided to assess the model specification that had a lagged value of the depended variable among its regressors. This was done to capture the inertia in strategy adjustment and examine how past realisations of differentiation strategy can affect its current levels. Although the lagged dependent variable absorbed much of the variation in our data, thereby reducing significance levels of other potentially important regressors, we were still able to largely reproduce our basis results (see Appendix 4.A, Table 4.A.9).

Finally, among other checks we have done to ensure the robustness of our conclusions, the following ones should be specifically highlighted: (i) changing the "newness" condition for all our dependent variables to ensure that the results are not driven by the way these variables are constructed; (ii) including additional firm-level controls, such as cash holdings and capital intensity to capture the sensitivity of differentiation strategy to cash flow shortfalls and to the cost of new product development (see Custódio *et al*., 2015; Datta and Rajagopalan, 1998); and (iii) using Tobin's q to control for a potential influence of brand strategy on the extent of product differentiation (see Rao *et al*., 2004). Despite these alterations, our findings of the chief executive's direct and indirect impact on product differentiation broadly holds (see Appendix 4.A, Tables 4.A.1 and 4.A.9).

4.5. DISCUSSION AND CONCLUSIONS

In this research, we have developed and tested a theory of the CEO's involvement in product differentiation. We have particularly argued that there are two key channels through which the chief executive's individual characteristics influence the outcomes of this strategy. On the one hand, the divergence of the locus of decision making from the locus of strategy is likely to cause the elevation of functional and business-unit strategies to the corporate level, thus resulting in chief executives' immediate attention to their planning and implementation. On the other hand, decisions made within the corporate strategy domain, including market selection and resource allocation, can also affect the trajectory and the extent to which the company differentiates its output. The empirical analysis based on examining U.S. trademark statistics provides support to our broad hypothesis that managerial perceptions and values are important in determining the company's differentiation strategy, even after controlling for industry, firm, and year fixed effects (see Table 4.6 for a summary of the results).

To be more specific, we have presented additional evidence for the nonlinearity of executive tenure (see Hambrick and Fukutomi, 1991; Miller, 1991) by revealing the inverted U-shaped relationship between an individual's tenure in both the organisation and the CEO position, and the extent of product differentiation. This result is largely consistent with the idea that "long-tenured executives tend not to make major changes in their organizations" (Finkelstein *et al*., 2009:85), no matter whether these changes stem from an increase in R&D expenditure and inventive activities (Barker and Mueller, 2002; Kor, 2006; Wu *et al*., 2005), or from new product development and differentiability, as it is in our case. Furthermore, our research also suggests that tenure in the organisation has a more fundamental effect on the outcomes of product differentiation than tenure in the CEO position – this is despite the view that various types of executive tenure are conceptually nested (see Finkelstein *et al*., 2009). We can hence extrapolate Finkelstein and Hambrick's (1990:488) argument regarding top-management-team organisational tenure to the CEO level and conclude that "[e]xecutives with short [company] tenures have fresh, diverse information and are willing to take risks, often departing widely from industry conventions. As tenure increases, perceptions become very restricted and risk taking is avoided. The lowest-risk thing to do is to follow the general tendency of mainstream competitors." Tenure in the CEO position is, in turn, significant only for differentiating in new product markets: facing a new competitive environment, managers at the time they take office may still be inclined to experiment and, therefore, encourage differentiation activities. However, a lower degree of task interest coupled with job security is among the likely reasons for why those who are approaching the retirement stage may choose to lower the intensity of product differentiation. Executive age also seems to mimic the pattern observed for organisational tenure – except for market exploration – and, as such, signals psychological and behavioural disparities existing between different cohorts of senior executives.

As expected, formal educational has demonstrated its significance for the decision-making process concerning differentiation strategy, too. In line with the previously expressed point of view that the amount of education enhances an individual's receptivity to innovation (see Thomas *et al.*, 1991), we have shown that the same principle applies to the outcomes of the innovation process. For example, our results indicate that the number of degrees earned by a chief executive have a positive relationship with the extent of product differentiation in existing markets. Furthermore, the focus on a specific field of study, which we termed as the depth of education, is the main driver behind the significance of this factor. The argument against business education as breeding risk-averse managers (see Barker and Mueller, 2002) has found some support, largely owing to CEOs with an MBA degree, who differentiate less in existing markets. Similarly, executives with a degree in legal studies also negatively affect differentiation strategy; yet, the effect is confined to market exploitation and to the situation when the decision to trademark in a new product market needs to be made. We speculate that this relationship can be attributed to the lack of emphasis on innovation in such programmes. Given that trademarks also serve the function of protecting intellectual property, we suppose that CEOs educated in law are better at envisaging that the unwary use of trademarks leads to a credible threat of litigation (related, for example, to trademark infringement or dilution); hence, they may prefer to rely on already established brands than introduce new trademarks. Finally, higher education institutions usually differ with respect to the quality of knowledge and network opportunities they provide. So, it was natural to expect that the affiliation with certain university types could point to more capable chief executives. Our empirical analysis reinforces this intuition by identifying a positive impact of greater selectivity and networking (Ivy League universities), and the quality of knowledge and facilities (private universities) on differentiation strategy.

Unlike previous research, we have found only limited support for the ability of prior functional experience to act as an inhibitor for managerial perceptions. Despite the prediction that chief executives with a background in marketing and sales are more aware of strategic advantages conferred by product differentiation and, thus, use this strategy more extensively, our results suggest the opposite. That is, CEOs with longer tenure in these functions restrain the company's differentiation activities, which fact is consistent with the idea that they are better at recognising risks stemming from the creation and promotion in the marketplace of a new brand. Likewise, executives with a deeper knowledge of accounting and finance may be guided by cost-related considerations when making decisions on product differentiation, thereby also restraining its extent because of substantial investments this strategy is likely to require. As far as the diversity of functional experience is concerned, it clearly pushes CEOs towards diminishing the scope of differentiation activities in existing markets. We have also found a negative effect of generalist executives on the company's exploration behaviour, which is in striking contrast to the already observed pattern for patents, demonstrating that "CEOs who gain more human capital through their lifetime work experience promote more innovation in the organizations that they run" (Custódio *et al*., 2015:34). At the same time, firm-specific knowledge has little value for pursuing intensive differentiation strategy: this conclusion is based on the observation that organisations managed by outsider CEOs do not show any systematic difference in the propensity to trademark compared to those companies where chief executives were promoted internally.

Finally, there is general agreement that the higher the level of discretion available to managers, the greater their influence on organisational outcomes (see Wangrow *et al*., 2015). We have corroborated this statement further by showing that CEO duality is significant for differentiation strategy and, more importantly, has a positive impact on it, thereby suggesting a closer involvement of chief executives in its planning and implementation. Moreover, we have also confirmed that the founder status does, in fact, designate entrepreneurial managers (see Begley, 1995; Kor, 2003), who tend to differentiate more not only in current, but also in new product markets. In line with prior research pointing to CEO ownership as exacerbating the agency problem associated with discretionary investment (see Chin *et al*., 2009; Ghosh *et al*., 2007), we have demonstrated that chief executives with a larger shareholding restrain the extent of differentiation activities. However, adding options to the compensation package incentivises CEOs to pursue risky activities, with a corresponding positive effect on product differentiation.

4.5.1. Managerial implications

This study offers at least three key implications for managers and, more generally, stakeholders. First of all, it confirms that the divergence between the locus of strategy and the locus of decision making exists. In practical terms, it should cause a greater involvement of company leaders in the planning and execution of business-unit and functional strategies and, as such, can be observed not only in small and medium enterprises, but also in large, multidivisional corporations. To some extent, this result is hardly surprising in view of the importance of differentiation strategy to the firm's competitive position, including its ability to secure higher profit margins by exploiting brand loyalty. Hence, along with a considerable amount of resources often required for pursuing this type of strategy, chief executives should also be motivated to dedicate their time and extra effort to dealing with it directly in order to ensure that its implementation is synchronised with and contributes towards supporting the goals determined at the corporate level.

Second, it needs to be emphasised that decisions made as part of corporate strategy affect the extent of a company's differentiation strategy, too. By first selecting which product markets to serve and then allocating scarce resources necessary for operating in them, CEOs thereby predetermine the scope and, most likely, the intensity of differentiation activities. Moreover, the number of the new product markets to trademark in seems as important as industry characteristics, which are also significant for making a decision on the intensity of new trademark introductions. One particularly interesting example here is companies with operations concentrated in regulated sectors: arguably, they may find it more appealing to access another, possibly non-regulated market in order to relieve the administrative pressure. Once the market is accessed, these companies may differentiate their output to signal a new entry and, subsequently, gain wider market recognition.

And third, despite the prevailing opinion that CEOs should possess a great deal of general skills, the empirical evidence presented above clearly indicates that the specialised knowledge they have acquired over their lifetime as well as the cognitive schemas associated with it also influence the trajectory of differentiation strategy. By confirming the importance of managerial perceptions and values, this study once again draws attention to the need for matching managers to strategies – an idea that has been widely discussed in the management literature (see Beal, and Yasai-Ardekani, 2000; Thomas *et al.*, 1991). However, another part of the story is that characteristics sought after in chief executives have to be aligned with the direction (or planning stage) of strategy. In more specific terms, companies that prioritise the exploitation of the existing product markets should recruit CEOs who have the set of skills and abilities which are different from those required in companies placing greater emphasis on the exploration of new market opportunities. And this is regardless of the fact that in both cases, the preference is still given to product differentiation as a means for competing.

4.5.2. Study limitations and avenues for future research

The findings of this study have to be interpreted in the light of its limitations. First, the use of trademark analysis has its own merits and demerits. On the one hand, the USPTO trademark statistics represent a valuable source of accurate and very detailed information, extending over several decades, about various aspects of the trademark registration process at the federal level. On the other hand, in countries sharing a common law system, including the U.S., trademark rights are generally acquired based on being the first to use in commerce (so-called technical trademarks; see Cohen, 1986). Therefore, federal registration, although being beneficial in many respects, is not mandatory for enjoying some basic legal protection.

Given that, the proposed measure of product differentiation may suffer from selection bias because not every mark is captured by the USPTO statistics, thus underestimating the actual effect. At the same time, we expect the above argument to be mainly applicable to small and medium-sized enterprises, whereas large companies with diverse product portfolios may find it strategically challenging to exclusively rely on common law and, as such, should be more inclined to file for federal protection.[32]

Another potential limitation of trademark analysis is related to using it for examining product-market diversification. More specifically, the main difficulty arises from the fact that new trademarks can be added to a firm's existing trademark portfolio not only as a result of branding activities, but also following mergers and acquisitions. For example, one can model a situation in which the acquiring firm takes control over the target firm with trademarks that are used in commerce, yet not registered.[33] By registering these trademarks under its name, the acquiring firm hence includes the target firm's trademarks and, relatedly, product markets in which this firm operates in its portfolio of trademarks and markets. Since we are unable to observe target firms' trademarks and markets in which they operate prior to takeover, this may eventually lead to the confusion between the diversification due to the firm's corporate-level decision to enter a new product market and the diversification caused by the acquisition of another firm. To address this issue, at least partially, we have compared whether owners at application tend to be the same as owners at registration. This comparison shows that among all trademarks filed between 1983 and 2013, only 3.9% have their owner at application being different from the owner at registration, thereby suggesting a negligible effect. Nevertheless, future research should assess the actual extent of this problem.

A firm's brand strategy may also have a significant impact on product differentiation and, thus, disturb our results (see Agostini *et al.*, 2015; Krasnikov *et al.*, 2009). According to Rao *et al.* (2004), all firms can be classified into three broad categories, depending on the adopted brand strategy: *corporate branders*, or firms with one dominating corporate brand (e.g., Hewlett-Packard, McDonald's, and FedEx); *the house of brands*, or firms that design an individual brand for each good or service (e.g., Unilever, Procter & Gamble); and *mixed branders*, or firms that combine the previous two strategies (e.g., Pepsi). Clearly, corporate branders should generate the flow of new trademarks which is weaker compared to those companies that pursue the house of brands or mixed brand strategies. Interestingly enough, the authors also identified a tight association between brand strategy and Tobin's q, such that

[32] In economic terms, for a large company the opportunity cost of obtaining a trademark registration is likely to be much lower than the expected value of this registration (see Mendonça *et al.*, 2004).

[33] At the same time, acquiring a firm with already registered trademarks should not pose a problem to our analysis because in this case, the acquiring firm's name would be recorded as a reassignment, not as an owner at registration (the latter is used here to assign trademarks to companies).

its higher values correspond to corporate branding, while lower values – to mixed branding. We have used this observation to verify our results and found no major difference (see Appendix 4.A, Table 4.A.9), no matter if Tobin's q was included in the model specification or not. However, we expect this issue to be fully addressed in subsequent studies.

This work places great emphasis on CEOs, particularly regarding them as the most powerful actors in the organisation whose background characteristics significantly affect its functioning (Hambrick and Mason, 1984). At the same time, such an assumption can be criticised for limiting the analysis because it does not account for organisations where power is less polarised and distributed across a wide range of senior managers, not just concentrated in the hands of the chief executive (Finkelstein, 1992). As Kor (2006:1082) correctly argues, "strategic decisions are often made and implemented through dynamic processes where managers interact, consult, and debate with each other"; moreover, major strategic decisions usually require input from the board of directors. Although we have attempted to capture corporate governance arrangements by including in our analysis such controls as CEO stock options, CEO equity, and CEO duality, an important avenue for future research is to evaluate the extent to which the CEO-board power differential as well as the composition of the top management team shape the outlined relationships. Furthermore, a fruitful line of research would be to first investigate why diversification occurs: is it in the interests of the firm and its shareholders? Or does the CEO, in pursuit of their own benefits, over-diversify the firm? Then each diversification strategy could be tested with respect to specific managerial traits.

And finally, our research does not control for the influence of organisational form (see Williamson, 1985). To partly address this issue, we have experimented with including the "diversification" variable into all specifications; this variable was calculated by counting the number of unique product classes in which the firm has introduced its trademarks. While this addition did not change the results significantly (see Appendix 4.A, Table 4.A.10), it was found to be highly correlated with company size (r = 0.455) and, therefore, dropped from subsequent analysis. Given that previous studies have viewed organisational form as a key determinant of R&D investment and the company's entrepreneurial orientation (see Hoskisson and Hitt, 1988; Miller, 1983), future research should examine if it affects the relationship between CEO characteristics and product differentiation, preferably using a better proxy for corporate structure.

Figure 4.1. A conceptual framework linking CEO observable characteristics to differentiation strategy

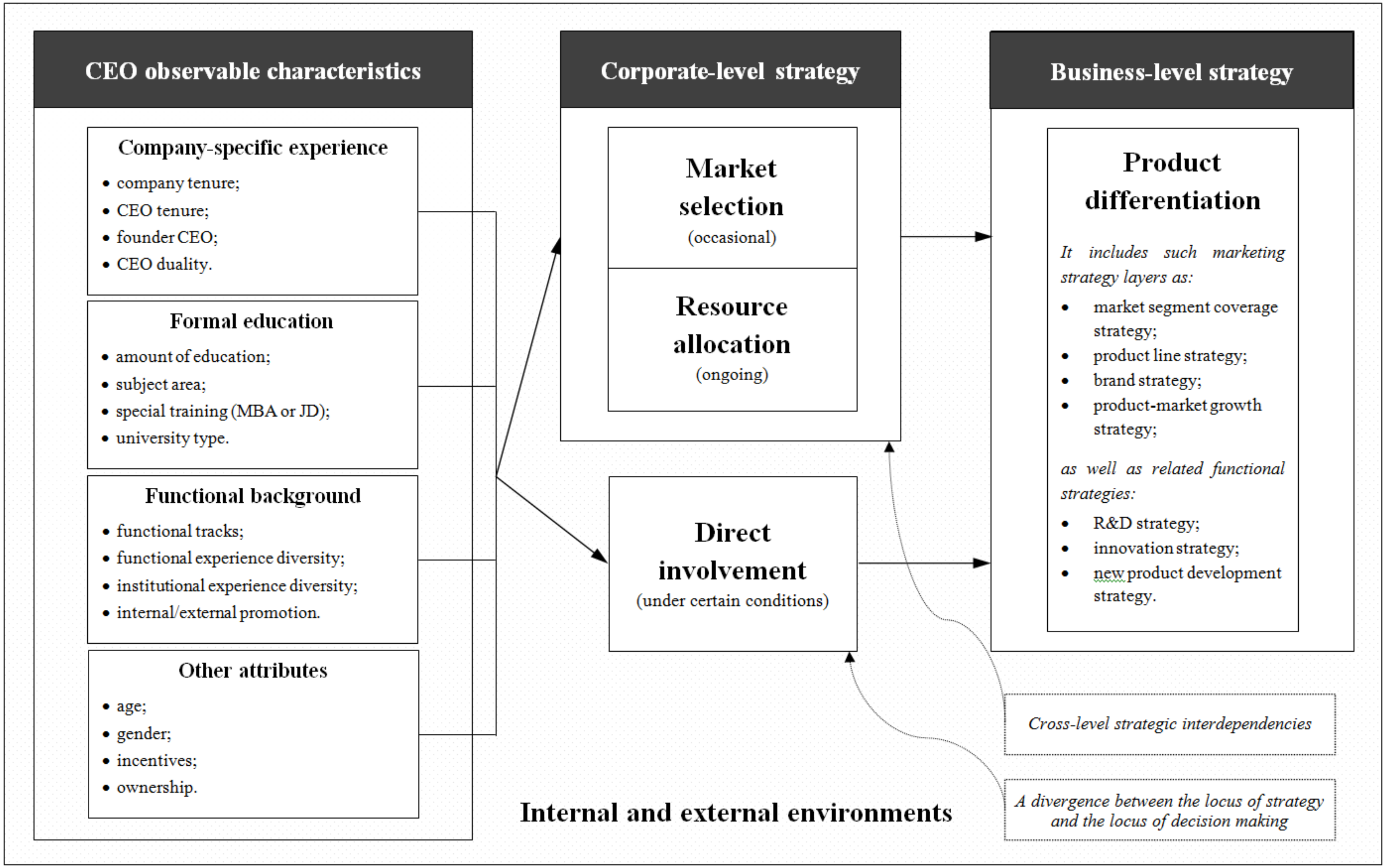
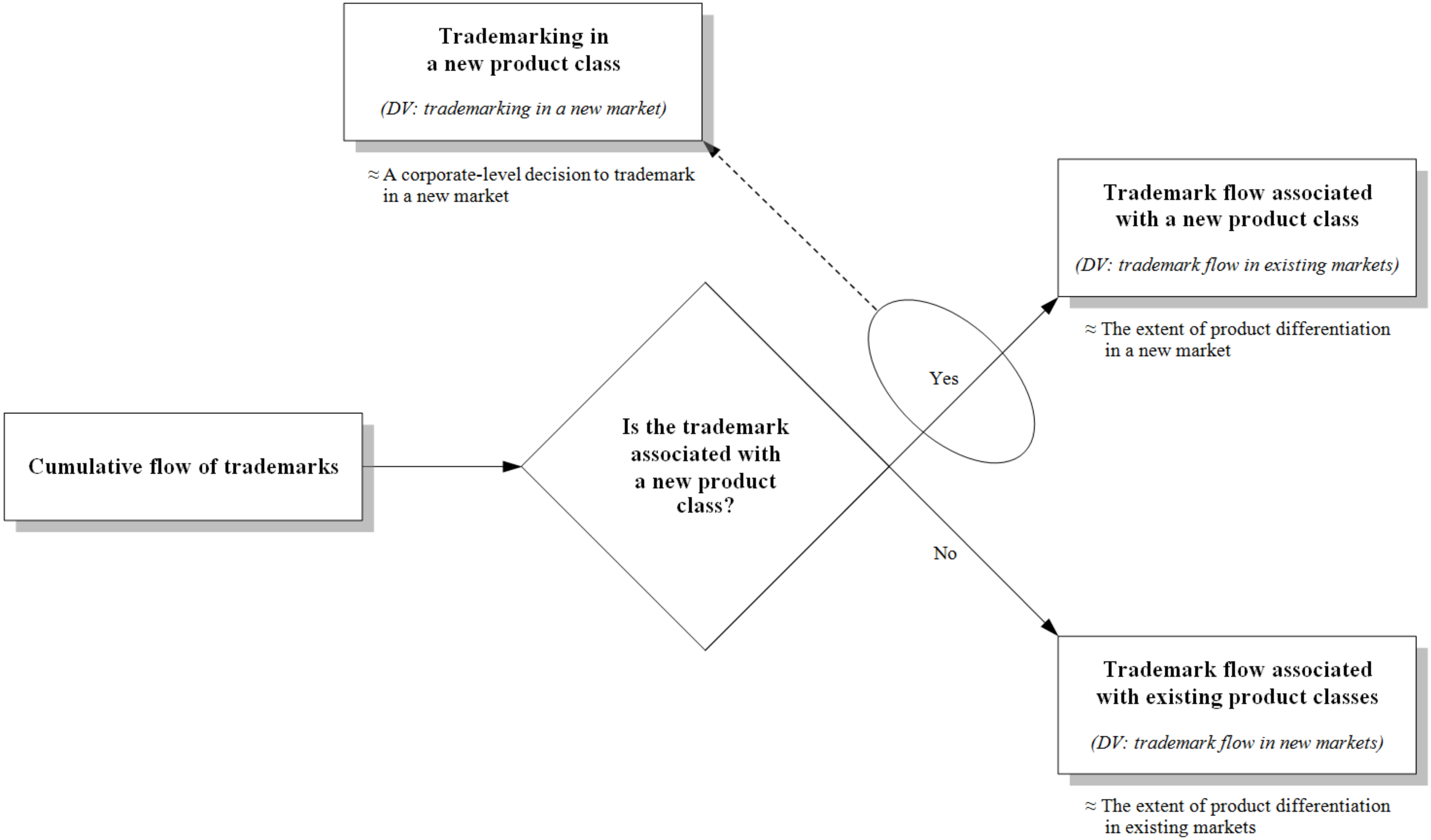


Figure 4.2. A scheme describing the construction of the dependent variables



Note: the product class is treated as *existing* if it has at least once been used by the company in the previous three-year period; otherwise, the product class is treated as *new*. If the mark is associated with several product classes, at least one of these classes should be regarded as new in order for the mark to be included in the trademark flow in new markets.

Table 4.1. Descriptive statistics

No.	Variable	Obs.	Mean	SD	Quantiles				
					min	.25	mdn	.75	max
1	Trademark flow in existing markets	5,698	6.329	15.012	0.00	0.00	1.00	6.00	288.00
2	Trademark flow in new markets	5,698	0.865	1.753	0.00	0.00	0.00	1.00	25.00
3	Trademarking in a new market	5,698	0.376	0.485	0.00	0.00	0.00	1.00	1.00
4	Number of degrees	5,661	1.661	0.715	0.00	1.00	2.00	2.00	4.00
5	Degree in arts and humanities	5,661	0.121	0.326	0.00	0.00	0.00	0.00	1.00
6	Degree in engineering and technology	5,661	0.275	0.447	0.00	0.00	0.00	1.00	1.00
7	Degree in natural sciences	5,661	0.081	0.272	0.00	0.00	0.00	0.00	1.00
8	Degree in business studies	5,661	0.615	0.487	0.00	0.00	1.00	1.00	1.00
9	Degree in legal studies	5,661	0.109	0.312	0.00	0.00	0.00	0.00	1.00
10	Ivy League university	5,657	0.228	0.420	0.00	0.00	0.00	0.00	1.00
11	Years in engineering and R&D	5,698	1.572	4.362	0.00	0.00	0.00	0.00	32.00
12	Years in marketing and sales	5,698	2.506	5.261	0.00	0.00	0.00	2.00	29.00
13	Years in accounting and finance	5,698	2.508	5.726	0.00	0.00	0.00	1.00	40.00
14	Years in operations and manufacturing	5,698	4.964	6.529	0.00	0.00	3.00	7.00	39.00
15	Years in law and compliance	5,698	0.516	2.349	0.00	0.00	0.00	0.00	29.00
16	Functional diversity index	5,698	1.653	1.100	0.00	1.00	2.00	2.00	6.00
17	Institutional diversity index	5,698	0.000	1.000	-1.30	-0.70	-0.19	0.53	5.59
18	Company tenure	5,698	21.758	11.824	0.08	11.53	22.02	31.53	58.04
19	CEO tenure	5,698	8.248	7.668	0.08	3.00	5.99	10.76	49.03
20	CEO age	5,698	56.411	6.455	34.00	52.00	57.00	61.00	83.00
21	Externally hired CEO	5,698	0.162	0.369	0.00	0.00	0.00	0.00	1.00
22	Founder CEO	5,698	0.066	0.249	0.00	0.00	0.00	0.00	1.00
23	CEO gender (male)	5,698	0.985	0.123	0.00	1.00	1.00	1.00	1.00
24	CEO duality	5,698	0.659	0.474	0.00	0.00	1.00	1.00	1.00
25	CEO option pay*	5,698	0.890	9.755	-13.82	-13.82	6.65	7.76	13.51
26	CEO ownership	5,698	0.017	0.052	0.00	0.00	0.00	0.01	0.52
27	Firm size*	5,698	9.325	1.489	1.61	8.36	9.31	10.33	13.09
28	Firm age	5,698	83.860	42.140	7.00	49.00	86.00	111.00	229.00
29	ROA	5,698	0.053	0.069	-0.85	0.02	0.05	0.09	0.95
30	Book leverage	5,698	0.235	0.168	0.00	0.12	0.22	0.33	1.46
31	Intensity of commercial expenditures	5,698	0.184	0.180	0.00	0.02	0.15	0.27	1.17

The asterisk denotes the natural logarithm of a variable. Sources and variable definitions are given in Table 4.7.

Table 4.2. Correlations

No.	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	TM flow in existing markets	1.00																														
2	TM flow in new markets	0.27	1.00																													
3	TM in a new market	0.22	0.64	1.00																												
4	Number of degrees	-0.04	-0.01	-0.01	1.00																											
5	Degree in arts/humanities	0.07	0.01	-0.01	0.03	1.00																										
6	Degree in engin./technol.	-0.07	-0.04	-0.03	0.21	-0.20	1.00																									
7	Degree in natural sciences	0.08	0.03	0.02	0.15	-0.07	-0.05	1.00																								
8	Degree in business studies	0.02	0.04	0.04	0.31	-0.20	-0.18	-0.13	1.00																							
9	Degree in legal studies	-0.08	-0.07	-0.07	0.32	0.14	-0.16	-0.04	-0.17	1.00																						
10	Ivy League university	0.05	0.02	0.02	0.28	0.15	-0.04	0.02	0.10	0.18	1.00																					
11	Years in engineering/R&D	0.03	0.03	0.02	0.08	-0.06	0.33	0.06	-0.16	-0.09	-0.05	1.00																				
12	Years in marketing/sales	0.14	0.06	0.06	-0.13	0.04	-0.05	0.08	0.01	-0.13	-0.11	0.07	1.00																			
13	Years in account./finance	-0.06	-0.03	-0.02	0.10	-0.02	-0.11	-0.02	0.16	0.02	-0.02	-0.08	-0.14	1.00																		
14	Years in operat./manufact.	-0.01	0.01	0.02	-0.01	0.01	0.10	0.04	-0.06	-0.03	-0.11	0.29	0.03	-0.07	1.00																	
15	Years in law/compliance	-0.05	-0.02	-0.01	0.17	0.05	-0.10	-0.02	-0.11	0.54	0.04	-0.06	-0.08	0.06	-0.01	1.00																
16	Functional diversity index	0.09	0.05	0.04	0.19	0.01	0.12	0.11	0.07	0.03	-0.04	0.37	0.28	0.19	0.36	0.17	1.00															
17	Institutional diversity index	0.05	0.02	0.03	0.24	0.02	0.02	0.05	0.10	0.15	0.25	0.01	-0.07	0.03	-0.01	0.13	0.12	1.00														
18	Company tenure	0.07	0.03	0.04	-0.14	0.06	-0.03	-0.06	-0.09	0.01	0.03	0.06	0.03	0.01	0.02	-0.02	-0.06	-0.14	1.00													
19	CEO tenure	-0.07	-0.05	-0.05	-0.05	0.07	-0.04	-0.06	-0.06	0.07	0.19	-0.11	-0.13	-0.06	-0.19	-0.06	-0.31	0.04	0.39	1.00												
20	CEO age	-0.02	0.01	0.02	-0.01	0.02	0.06	0.01	-0.13	0.08	0.06	0.08	-0.06	0.03	0.07	0.04	-0.08	0.22	0.36	0.41	1.00											
21	Externally hired CEO	-0.02	-0.03	-0.03	0.06	-0.07	0.05	0.01	0.05	-0.05	-0.02	-0.04	-0.04	-0.09	-0.06	-0.04	-0.11	0.14	-0.51	-0.02	-0.03	1.00										
22	Founder CEO	-0.04	0.02	-0.01	-0.11	-0.06	0.09	0.01	-0.16	-0.03	0.05	-0.06	-0.07	-0.01	-0.11	-0.06	-0.23	-0.09	0.09	0.46	0.04	-0.12	1.00									
23	CEO gender (male)	-0.05	0.01	0.02	-0.02	-0.08	0.03	0.01	0.01	0.03	0.04	-0.02	-0.10	-0.02	-0.03	-0.02	-0.15	-0.10	0.08	0.08	0.03	-0.02	0.04	1.00								
24	CEO duality	0.05	0.06	0.09	0.06	-0.01	0.03	0.01	0.02	0.05	0.03	-0.07	-0.04	0.02	-0.09	0.02	-0.05	0.16	0.15	0.25	0.24	0.03	0.10	0.01	1.00							
25	CEO option pay*	0.09	0.09	0.11	0.03	0.03	-0.01	-0.04	0.02	-0.04	-0.04	-0.01	0.08	0.01	-0.02	-0.01	0.08	0.01	-0.01	-0.17	-0.08	-0.04	-0.10	0.01	0.08	1.00						
26	CEO ownership	-0.06	-0.06	-0.07	-0.11	0.01	-0.09	-0.06	-0.02	-0.01	0.10	-0.09	-0.09	-0.03	-0.09	-0.06	-0.19	-0.03	0.19	0.41	0.15	-0.02	0.25	0.04	0.08	-0.19	1.00					
27	Firm size*	0.33	0.22	0.24	0.02	-0.05	-0.01	0.04	0.11	-0.10	0.02	0.06	0.09	0.03	0.11	0.02	0.21	0.18	0.16	-0.13	0.13	-0.08	-0.15	-0.07	0.13	0.21	-0.12	1.00				
28	Firm age	0.09	0.04	0.06	0.10	0.06	-0.05	0.02	0.07	0.03	-0.01	0.02	0.03	0.20	0.02	0.13	0.26	0.18	0.08	-0.27	0.13	-0.06	-0.38	-0.05	0.10	0.17	-0.22	0.25	1.00			
29	ROA	0.12	0.06	0.09	-0.07	-0.05	0.02	0.03	-0.02	-0.06	-0.03	-0.02	0.07	-0.08	0.03	-0.05	-0.06	-0.10	0.08	0.04	0.01	-0.04	0.08	0.03	0.04	0.06	0.08	0.07	-0.14	1.00		
30	Book leverage	-0.05	-0.02	-0.03	0.14	0.12	0.01	0.01	0.03	0.12	0.03	0.02	-0.03	0.05	0.05	0.12	0.13	0.13	-0.10	-0.14	-0.03	-0.01	-0.16	-0.08	0.05	0.03	-0.17	0.05	0.14	-0.23	1.00	
31	Intensity of com. expend.	0.12	0.12	0.14	-0.16	-0.01	-0.07	0.03	-0.01	-0.19	-0.02	-0.11	0.17	-0.13	-0.05	-0.15	-0.12	-0.16	-0.02	0.08	-0.03	-0.01	0.17	-0.01	0.01	0.02	0.13	0.05	-0.27	0.25	-0.28	1.00

The table presents Pearson's pairwise correlations. The asterisk denotes the natural logarithm of a variable. Correlation coefficients above 0.3 are highlighted in red. Sources and variable definitions are given in Table 4.7.

Table 4.3. CEO characteristics and product differentiation in existing markets: Exploitation behaviour

Dependent variable: Trademark flow in existing markets $_{i,t}$	Negative binomial models							
	Model 1.1	Model 1.2	Model 1.3	Model 1.4	Model 1.5	Model 1.6	Model 1.7	Model 1.8
Number of degrees $_{i,j,t-1}$					**1.130**** *(0.045)*	**1.122**** *(0.044)*	**1.138***** *(0.045)*	**1.138**** *(0.046)*
Degree in engineering and technology $_{i,j,t-1}$					**0.848**** *(0.053)*	**0.835**** *(0.054)*	**0.855*** *(0.054)*	**0.827**** *(0.053)*
Degree in natural sciences $_{i,j,t-1}$					**1.198*** *(0.105)*	**1.250*** *(0.111)*	**1.207*** *(0.106)*	**1.251*** *(0.111)*
Degree in business studies $_{i,j,t-1}$					**0.910†** *(0.050)*	0.930 *(0.052)*	**0.911†** *(0.050)*	0.948 *(0.053)*
Degree in legal studies $_{i,j,t-1}$					**0.817*** *(0.073)*	**0.820†** *(0.084)*	**0.830*** *(0.074)*	**0.825†** *(0.085)*
Ivy League university $_{i,j,t-1}$					**1.100†** *(0.061)*	1.084 *(0.060)*	**1.098†** *(0.062)*	1.087 *(0.061)*
Years in engineering and R&D $_{i,j,t-1}$						0.997 *(0.006)*		0.998 *(0.006)*
Years in marketing and sales $_{i,j,t-1}$						**0.984***** *(0.004)*		**0.986**** *(0.005)*
Years in accounting and finance $_{i,j,t-1}$						**0.990*** *(0.004)*		**0.990*** *(0.005)*
Years in operations and manufacturing $_{i,j,t-1}$						1.003 *(0.003)*		1.005 *(0.003)*
Years in law and compliance $_{i,j,t-1}$						0.996 *(0.014)*		0.997 *(0.014)*
Functional diversity $_{i,j,t-1}$							**0.954*** *(0.020)*	0.980 *(0.026)*
Generalist CEO $_{i,j,t-1}$							0.993 *(0.046)*	0.993 *(0.046)*
Company tenure $_{i,j,t-1}$		**1.030***** *(0.007)*			**1.029***** *(0.007)*	**1.029***** *(0.007)*	**1.030***** *(0.007)*	**1.028***** *(0.007)*
Company tenure^2 $_{i,j,t-1}$		**0.9993***** *(0.0002)*			**0.9993***** *(0.0002)*	**0.9993***** *(0.0002)*	**0.9993***** *(0.0002)*	**0.9994***** *(0.0002)*
CEO tenure $_{i,j,t-1}$			0.998 *(0.009)*					
CEO tenure^2 $_{i,j,t-1}$			1.0000 *(0.0003)*					
CEO age $_{i,j,t-1}$				**1.102**** *(0.039)*				
CEO age^2 $_{i,j,t-1}$				**0.9991**** *(0.0003)*				
Externally hired CEO $_{i,j,t-1}$			1.039 *(0.062)*					
Founder CEO $_{i,j,t-1}$								**1.310**** *(0.124)*
CEO gender (male) $_{i,j,t-1}$		**1.349†** *(0.212)*	**1.338†** *(0.209)*	**1.369*** *(0.215)*	**1.402*** *(0.216)*	**1.352†** *(0.210)*	**1.373*** *(0.216)*	**1.361†** *(0.215)*
CEO duality $_{i,j,t-1}$		**1.267***** *(0.057)*	**1.265***** *(0.064)*	**1.289***** *(0.061)*	**1.267***** *(0.058)*	**1.256***** *(0.058)*	**1.253***** *(0.058)*	**1.231***** (0.058)
CEO option pay $_{i,j,t-1}$		1.003 *(0.002)*	1.003 *(0.002)*	1.002 *(0.002)*	**1.004†** *(0.002)*	**1.004†** *(0.002)*	**1.004†** *(0.002)*	**1.004†** *(0.002)*
CEO ownership $_{i,j,t-1}$		**0.254**** *(0.111)*	**0.260**** *(0.121)*	**0.291**** *(0.127)*	**0.296**** *(0.128)*	**0.268**** *(0.117)*	**0.262**** *(0.114)*	**0.192***** *(0.088)*
Firm size $_{i,t-1}$	**1.442***** *(0.028)*	**1.429***** *(0.029)*	**1.435***** *(0.028)*	**1.434***** *(0.028)*	**1.430***** *(0.030)*	**1.433***** *(0.030)*	**1.437***** *(0.030)*	**1.442***** *(0.030)*

Firm age $_{i, t-1}$	**0.9964*** *(0.0007)*	**0.9960*** *(0.0007)*	**0.9957*** *(0.0007)*	**0.9957*** *(0.0007)*	**0.9958*** *(0.0007)*	**0.9960*** *(0.0007)*	**0.9959*** *(0.0007)*	**0.9964*** *(0.0008)*
ROA $_{i, t-1}$	**3.418*** *(1.085)*	**3.156*** *(0.966)*	**3.390*** *(1.044)*	**3.240*** *(1.005)*	**3.333*** *(0.999)*	**3.307*** *(0.996)*	**3.317*** *(0.996)*	**3.281*** *(0.995)*
Book leverage $_{i, t-1}$	**0.453*** *(0.065)*	**0.405*** *(0.059)*	**0.409*** *(0.060)*	**0.403*** *(0.059)*	**0.399*** *(0.059)*	**0.411*** *(0.060)*	**0.412*** *(0.061)*	**0.424*** *(0.062)*
Commercial expenditure $_{i, t-1}$	**3.861*** *(0.647)*	**3.906*** *(0.668)*	**3.983*** *(0.681)*	**3.980*** *(0.672)*	**3.619*** *(0.624)*	**3.696*** *(0.645)*	**3.648*** *(0.630)*	**3.864*** *(0.688)*
Firm fixed effects	BGV	BGV	BGV	BGV	BGV	BGV	BGV	BGV
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log likelihood	-12,317.0	-12,285.6	-12,296.6	-12,292.5	-12,190.4	-12,179.5	-12,187.7	-12,174.9
Pseudo R^2	0.122	0.124	0.123	0.123	0.125	0.126	0.126	0.127
ln(Alpha)	**0.367***	**0.338***	**0.351***	**0.347***	**0.323***	**0.318***	**0.321***	**0.316***
Number of obs.	5,439	5,439	5,439	5,439	5,399	5,399	5,399	5,399

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. The dependent variable is measured at time t. Explanatory variables are measured at time t-1. The constant term is omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. Sources and variable definitions are given in Table 4.7.

Table 4.4. CEO characteristics and product differentiation in new markets: Market selection

Dependent variable: Trademarking in a new market $_{i,\,t}$	**Logit models**							
	Model 2.1	Model 2.2	Model 2.3	Model 2.4	Model 2.5	Model 2.6	Model 2.7	Model 2.8
Number of degrees $_{i,\,j,\,t-1}$					0.092 *(0.059)*	0.081 *(0.060)*	0.088 *(0.059)*	0.086 *(0.060)*
Degree in engineering and technology $_{i,\,j,\,t-1}$					**-0.177*** *(0.085)*	**-0.180*** *(0.087)*	**-0.180*** *(0.085)*	**-0.192*** *(0.088)*
Degree in natural sciences $_{i,\,j,\,t-1}$					0.041 *(0.122)*	0.052 *(0.122)*	0.036 *(0.122)*	0.049 *(0.122)*
Degree in business studies $_{i,\,j,\,t-1}$					-0.045 *(0.078)*	-0.034 *(0.079)*	-0.046 *(0.078)*	-0.027 *(0.079)*
Degree in legal studies $_{i,\,j,\,t-1}$					**-0.295*** *(0.127)*	**-0.385**** *(0.147)*	**-0.298*** *(0.127)*	**-0.384**** *(0.146)*
Ivy League university $_{i,\,j,\,t-1}$					0.008 *(0.080)*	0.018 *(0.081)*	0.009 *(0.082)*	0.013 *(0.082)*
Years in engineering and R&D $_{i,\,j,\,t-1}$						0.007 *(0.008)*		0.007 *(0.009)*
Years in marketing and sales $_{i,\,j,\,t-1}$						-0.003 *(0.006)*		-0.003 *(0.007)*
Years in accounting and finance $_{i,\,j,\,t-1}$						0.005 *(0.006)*		0.004 *(0.006)*
Years in operations and manufacturing $_{i,\,j,\,t-1}$						0.002 *(0.005)*		0.002 *(0.006)*
Years in law and compliance $_{i,\,j,\,t-1}$						0.024 *(0.017)*		0.023 *(0.017)*
Functional diversity $_{i,\,j,\,t-1}$						0.019 *(0.033)*	0.019 *(0.033)*	0.004 *(0.040)*
Generalist CEO $_{i,\,j,\,t-1}$						0.009 *(0.068)*	0.009 *(0.068)*	0.007 *(0.068)*
Company tenure $_{i,\,j,\,t-1}$		**0.031**** *(0.011)*			**0.033**** *(0.011)*	**0.032**** *(0.011)*	**0.032**** *(0.011)*	**0.031**** *(0.011)*
Company tenure^2 $_{i,\,j,\,t-1}$		**-0.0007**** *(0.0002)*			**-0.0007**** *(0.0002)*	**-0.0007**** *(0.0002)*	**-0.0007**** *(0.0002)*	**-0.0007**** *(0.0002)*
CEO tenure $_{i,\,j,\,t-1}$			0.011 *(0.012)*					
CEO tenure^2 $_{i,\,j,\,t-1}$			-0.0006 *(0.0004)*					
CEO age $_{i,\,j,\,t-1}$				**0.105†** *(0.056)*				
CEO age^2 $_{i,\,j,\,t-1}$				**-0.0010*** *(0.0005)*				
Externally hired CEO $_{i,\,j,\,t-1}$			-0.116 *(0.089)*					
Founder CEO $_{i,\,j,\,t-1}$								0.184 *(0.155)*
CEO gender (male) $_{i,\,j,\,t-1}$		0.472 *(0.321)*	0.484 *(0.321)*	0.517 *(0.320)*	0.518 *(0.322)*	0.504 *(0.325)*	**0.537†** *(0.325)*	0.515 *(0.327)*
CEO duality $_{i,\,j,\,t-1}$		**0.153*** *(0.071)*	**0.161*** *(0.075)*	**0.167*** *(0.072)*	**0.157*** *(0.071)*	**0.165*** *(0.072)*	**0.159*** *(0.072)*	**0.153*** *(0.073)*
CEO option pay $_{i,\,j,\,t-1}$		0.006 *(0.003)*	0.005 *(0.003)*	0.005 *(0.004)*	0.005 *(0.004)*	0.005 *(0.004)*	0.005 *(0.004)*	0.006 *(0.004)*
CEO ownership $_{i,\,j,\,t-1}$		**-2.445***** *(0.696)*	**-2.036**** *(0.713)*	**-2.246***** *(0.688)*	**-2.521***** *(0.708)*	**-2.525***** *(0.710)*	**-2.505***** *(0.709)*	**-2.682***** *(0.728)*
Firm size $_{i,\,t-1}$	**0.255***** *(0.029)*	**0.245***** *(0.030)*	**0.243***** *(0.030)*	**0.248***** *(0.030)*	**0.244***** *(0.030)*	**0.238***** *(0.030)*	**0.241***** *(0.030)*	**0.241***** *(0.030)*

Firm age $_{i, t-1}$	0.0003 *(0.0010)*	-0.0002 *(0.0010)*	-0.0007 *(0.0011)*	-0.0006 *(0.0010)*	-0.0004 *(0.0011)*	-0.0006 *(0.0011)*	-0.0005 *(0.0011)*	-0.0003 *(0.0011)*
ROA $_{i, t-1}$	**1.598**** *(0.568)*	**1.462**** *(0.566)*	**1.499**** *(0.567)*	**1.496**** *(0.567)*	**1.451*** *(0.574)*	**1.460*** *(0.573)*	**1.455*** *(0.575)*	**1.460*** *(0.573)*
Book leverage $_{i, t-1}$	0.005 *(0.228)*	-0.108 *(0.232)*	-0.119 *(0.231)*	-0.136 *(0.231)*	-0.128 *(0.235)*	-0.118 *(0.234)*	-0.134 *(0.236)*	-0.101 *(0.235)*
Commercial expenditure $_{i, t-1}$	0.367 *(0.247)*	0.409 *(0.253)*	0.394 *(0.252)*	0.391 *(0.251)*	0.337 *(0.255)*	0.365 *(0.257)*	0.341 *(0.255)*	0.379 *(0.257)*
Firm fixed effects	BGV	BGV	BGV	BGV	BGV	BGV	BGV	BGV
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log pseudolikelihood	-3,227.1	-3,210.3	-3,212.2	-3,212.1	-3,184.0	-3,182.0	-3,183.8	-3,181.3
Pseudo R^2	0.104	0.109	0.108	0.108	0.110	0.111	0.110	0.111
Number of obs.	5,439	5,439	5,439	5,439	5,399	5,399	5,399	5,399

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

The dependent variable is measured at time t. Explanatory variables are measured at time t-1. The constant term is omitted. Heteroskedasticity robust standard errors are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. Sources and variable definitions are given in Table 4.7.

Table 4.5. CEO characteristics and product differentiation in new markets: Exploration behaviour

Dependent variable: Trademark flow in new markets $_{i,t}$	**Truncated negative binomial models**							
	Model 3.1	Model 3.2	Model 3.3	Model 3.4	Model 3.5	Model 3.6	Model 3.7	Model 3.8
Number of degrees $_{i,j,t-1}$					0.990 *(0.062)*	0.987 *(0.064)*	0.997 *(0.062)*	1.029 *(0.067)*
Degree in engineering and technology $_{i,j,t-1}$					0.867 *(0.087)*	0.867 *(0.089)*	0.879 *(0.089)*	0.860 *(0.088)*
Degree in natural sciences $_{i,j,t-1}$					1.227 *(0.167)*	1.227 *(0.169)*	1.227 *(0.167)*	1.213 *(0.165)*
Degree in business studies $_{i,j,t-1}$					0.989 *(0.091)*	0.992 *(0.094)*	0.996 *(0.091)*	1.013 *(0.095)*
Degree in legal studies $_{i,j,t-1}$					0.827 *(0.134)*	0.774 *(0.154)*	0.833 *(0.135)*	0.756 *(0.149)*
Ivy League university $_{i,j,t-1}$					**1.232*** *(0.116)*	**1.231*** *(0.117)*	**1.275*** *(0.122)*	**1.259*** *(0.121)*
Years in engineering and R&D $_{i,j,t-1}$						1.005 *(0.010)*		1.004 *(0.010)*
Years in marketing and sales $_{i,j,t-1}$						0.999 *(0.007)*		1.001 *(0.007)*
Years in accounting and finance $_{i,j,t-1}$						1.002 *(0.007)*		1.001 *(0.007)*
Years in operations and manufacturing $_{i,j,t-1}$						0.991 *(0.006)*		0.992 *(0.007)*
Years in law and compliance $_{i,j,t-1}$						1.015 *(0.021)*		1.017 *(0.021)*
Functional diversity $_{i,j,t-1}$							0.990 *(0.037)*	1.011 *(0.044)*
Generalist CEO $_{i,j,t-1}$							**0.868†** *(0.069)*	**0.870†** *(0.068)*
Company tenure $_{i,j,t-1}$		**1.024†** *(0.013)*			**1.022†** *(0.013)*	**1.022†** *(0.013)*	1.019 *(0.013)*	1.014 *(0.013)*
Company tenure^2 $_{i,j,t-1}$		**0.9994*** *(0.0003)*			**0.9995†** *(0.0003)*	**0.9995†** *(0.0003)*	0.9996 *(0.0003)*	0.9997 *(0.0003)*
CEO tenure $_{i,j,t-1}$			**1.030†** *(0.016)*					
CEO tenure^2 $_{i,j,t-1}$			**0.9989†** *(0.0005)*					
CEO age $_{i,j,t-1}$				0.964 *(0.079)*				
CEO age^2 $_{i,j,t-1}$				1.0003 *(0.0007)*				
Externally hired CEO $_{i,j,t-1}$			0.919 *(0.098)*					
Founder CEO $_{i,j,t-1}$								**1.804***** *(0.326)*
CEO gender (male) $_{i,j,t-1}$		1.155 *(0.390)*	1.118 *(0.377)*	1.216 *(0.410)*	1.185 *(0.400)*	1.179 *(0.399)*	1.130 *(0.381)*	1.161 *(0.390)*
CEO duality $_{i,j,t-1}$		1.024 *(0.089)*	0.995 *(0.091)*	1.041 *(0.091)*	1.033 *(0.090)*	1.027 *(0.090)*	1.055 *(0.093)*	1.028 *(0.090)*
CEO option pay $_{i,j,t-1}$		**1.008†** *(0.004)*	**1.008†** *(0.004)*	**1.008†** *(0.004)*	**1.010*** *(0.004)*	**1.009*** *(0.004)*	**1.010*** *(0.004)*	**1.009*** *(0.004)*
CEO ownership $_{i,j,t-1}$		0.287 *(0.297)*	0.444 *(0.496)*	0.301 *(0.312)*	0.282 *(0.293)*	0.242 *(0.253)*	0.270 *(0.280)*	**0.096*** *(0.105)*
Firm size $_{i,t-1}$	**1.179***** *(0.042)*	**1.162***** *(0.043)*	**1.158***** *(0.042)*	**1.167***** *(0.043)*	**1.161***** *(0.044)*	**1.160**** *(0.044)*	**1.164***** *(0.044)*	**1.173***** *(0.044)*

Firm age $_{i, t-1}$	0.9983 *(0.0012)*	**0.9979†** *(0.0012)*	**0.9977†** *(0.0012)*	**0.9978†** *(0.0012)*	**0.9975*** *(0.0012)*	**0.9974*** *(0.0012)*	**0.9976†** *(0.0012)*	0.9985 *(0.0013)*
ROA $_{i, t-1}$	1.109 *(0.781)*	1.085 *(0.763)*	1.072 *(0.754)*	1.055 *(0.744)*	1.051 *(0.741)*	1.181 *(0.838)*	1.092 *(0.767)*	1.359 *(0.955)*
Book leverage $_{i, t-1}$	0.976 *(0.280)*	0.888 *(0.258)*	0.919 *(0.265)*	0.853 *(0.247)*	0.852 *(0.248)*	0.859 *(0.250)*	0.839 *(0.243)*	0.820 *(0.237)*
Commercial expenditure $_{i, t-1}$	0.753 *(0.236)*	0.706 *(0.224)*	0.745 *(0.235)*	0.711 *(0.226)*	0.622 *(0.199)*	0.617 *(0.200)*	0.623 *(0.199)*	0.710 *(0.230)*
Firm fixed effects	BGV	BGV	BGV	BGV	BGV	BGV	BGV	BGV
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log likelihood	-3,091.7	-3,086.9	-3,086.5	-3,088.1	-3,068.1	-3,066.8	-3,066.4	-3,059.7
Pseudo R^2	0.030	0.031	0.031	0.031	0.033	0.033	0.034	0.036
ln(Alpha)	**0.611*** **	**0.573*** **	**0.562** **	**0.579** **	**0.550** **	**0.546** **	**0.533** **	**0.484** **
Number of obs.	2,045	2,045	2,045	2,045	2,036	2,036	2,036	2,036

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. The dependent variable is measured at time t. Explanatory variables are measured at time t-1. The constant term is omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. Sources and variable definitions are given in Table 4.7.

Table 4.6. A summary of hypothesis testing

Hypothesis number	Hypothesis formulation	Prediction	Findings		
			Exploitation	Market selection	Exploration
Hypothesis 1:	There is a curvilinear, inverted U-shaped relationship between executive tenure (in the position and in the organisation) and the extent of differentiation strategy.	U-shaped relationship	only for company tenure	only for company tenure	confirmed
Hypothesis 2:	There is a curvilinear, inverted U-shaped relationship between executive age and the extent of differentiation strategy.	U-shaped relationship	confirmed	confirmed	N.S.
Hypothesis 3(a):	The amount of education chief executives possess positively affects the extent of differentiation strategy.	(+)	(+)	N.S.	N.S.
Hypothesis 3(b):	CEOs with a degree in engineering, technology, or natural sciences positively affect the extent of differentiation strategy.	(+)	mixed	mixed	N.S.
Hypothesis 3(c):	CEOs with a degree in business or legal studies negatively affect the extent of differentiation strategy.	(-)	(-)	(-)	N.S.
Hypothesis 3(d):	CEOs with a degree from an elite academic institution positively affect the extent of differentiation strategy.	(+)	(+)	N.S.	(+)
Hypothesis 4(a):	CEOs with previous experience in engineering or research and development positively affect the extent of differentiation strategy.	(+)	N.S.	N.S.	N.S.
Hypothesis 4(b):	CEOs with previous experience marketing or sales positively affect the extent of differentiation strategy.	(+)	(-)	N.S.	N.S.
Hypothesis 4(c):	CEOs with previous experience in accounting, finance, or audit negatively affect the extent of differentiation strategy.	(-)	(-)	N.S.	N.S.
Hypothesis 4(d):	CEOs with previous experience in administration, operations, or manufacturing negatively affect the extent of differentiation strategy.	(-)	N.S.	N.S.	N.S.
Hypothesis 4(e):	CEOs with previous experience in law or compliance negatively affect the extent of differentiation strategy.	(-)	N.S.	N.S.	N.S.
Hypothesis 4(f):	CEOs with diverse functional background positively affect the extent of differentiation strategy.	(+)	(-)	N.S.	N.S.
Hypothesis 5:	CEOs hired from outside the organisation positively affect the extent of differentiation strategy.	(+)	N.S.	N.S.	N.S.
Hypothesis 6:	CEOs with diverse institutional background positively affect the extent of differentiation strategy.	(+)	N.S.	N.S.	(-)
Hypothesis 7:	Founder CEOs positively affect the extent of differentiation strategy.	(+)	(+)	N.S.	(+)

Note: N.S. stands for "not significant".

Table 4.7. The description of study variables

Variable name	Description
TRADEMARKS	
Trademark flow in existing markets	The number of marks introduced by the company in one of the same product classes as in the previous three-year period. For multiple-class trademarks all product classes should satisfy the outlined "existingness" condition.
Trademark flow associated with new markets	The number of marks introduced by the company in a product class which had not been used in the previous three-year period. For multiple-class trademarks at least one product class should satisfy the outlined "newness" condition.
Trademarking in a new market	A dummy variable that takes the value of one if there is at least one mark in the trademark flow associated with new markets, and zero otherwise.
CEO CHARACTERISTICS	
Executive tenure and age	
Company tenure	The difference between the year of the observation and the year in which the individual joined the company.
CEO tenure	The difference between the year of the observation and the year in which the individual was appointed to the CEO position.
CEO age	The difference between the year of the observation and the birth year of the individual.
Formal education (see Appendix 4.B for more details)	
Number of degrees	The number of college and other higher education degrees the individual was awarded.
Depth of educational background	The number of university degrees the individual was awarded which are in the same academic discipline (if the individual specialises in multiple disciplines, the depth of the most frequent is calculated).
Breadth of educational background	The number of different academic disciplines in which the individual was awarded university degrees.
Highest level of education	A four-point scale that reflects the highest level of education attained by the individual: 0 – no college degree; 1 – a Bachelor's degree; 2 – a Master's degree or JD; and 3 – a PhD degree.
Degree in arts and humanities	A dummy variable that takes the value of one for the individual with a degree in arts and humanities (e.g., history, literature, or philosophy), and zero otherwise.
Degree in engineering and technology	A dummy variable that takes the value of one for the individual with a degree in engineering and technology (e.g., computer science, engineering, or technology), and zero otherwise.
Degree in natural sciences	A dummy variable that takes the value of one for the individual with a degree in natural sciences (e.g., mathematics, biology, chemistry, or physics), and zero otherwise.

Degree in business studies	A dummy variable that takes the value of one for the individual with a degree in business studies (e.g., accounting, finance, economics, management, or business administration), and zero otherwise.
Degree in legal studies	A dummy variable that takes the value of one for the individual with a degree in legal studies (e.g., law or taxation), and zero otherwise.
MBA degree	A dummy variable that takes the value of one for the individual with an MBA degree, and zero otherwise.
JD degree	A dummy variable that takes the value of one for the individual with a JD degree, and zero otherwise.
Ivy League university	A dummy variable that takes the value of one for the individual with a degree awarded by Brown University; Columbia University; Cornell University; Dartmouth College; Harvard University; the University of Pennsylvania; Princeton University; or Yale University, and zero otherwise.
Private university	A dummy variable that takes the value of one for the individual with a degree from a university which is not operated by the government, and zero otherwise.
Research intensive university	A dummy variable that takes the value of one for the individual with a degree from a university which belongs to the Association of American Universities, and zero otherwise.

Experience and its diversity
(see Appendices 4.C and 4.D for more details)

Years in engineering and R&D function	The number of years the individual has spent in such functions as engineering or R&D.
Years in marketing and sales function	The number of years the individual has spent in such functions as marketing or sales.
Years in accounting, finance, and audit function	The number of years the individual has spent in such functions as accounting, finance, or audit.
Years in administration, operations, and manufacturing function	The number of years the individual has spent in such functions as administration, operations, or manufacturing.
Years in law and compliance function	The number of years the individual has spent in such functions as law or compliance.
Functional diversity index	An index that includes (1) the engineering and R&D experience dummy; (2) the marketing and sales experience dummy; (3) the accounting, finance, and audit experience dummy; (4) the administration, operations, and manufacturing experience dummy; (4) the law and compliance experience dummy; and (6) the personnel experience dummy.
Externally hired CEO	A dummy variable that takes the value of one for the individual who was appointed to the CEO position a year or less since joining the company, and zero otherwise.
Institutional diversity index	An index that includes (1) the number of industries the individual had worked in; (2) the number of companies the individual had worked for; (3) the military experience dummy; (4) the civil service experience dummy; and (5) the academic experience dummy.
Founder CEO	A dummy variable that takes the value of one for the CEO who is also the company's founder, and zero otherwise.

CONTROL VARIABLES	
Individual-level characteristics	
CEO option pay	The natural logarithm of the monetary value of option grants to the CEO in the observation year: • ln(0.000001 + OPTION_AWARDS_BLK_VALUE) for pre-2006 data, and • ln(0.000001 + OPTION_AWARDS_FV) otherwise.
CEO duality	A dummy variable that takes the value of one if the CEO also serves as the chairman of the board of directors, and zero otherwise.
CEO ownership	The percentage stock ownership held by the CEO: • SHROWN_TOT_PCT or • SHROWN_TOT * 100/(CSHO * 1000), depending on data availability.
CEO gender	A dummy variable that takes the value of one if the individual is male, and zero otherwise.
Firm-level characteristics	
Firm size	The natural logarithm of the total number of employees: ln(EMP).
Firm age	The difference between the year of the observation and the year to which the company traces its origins.
ROA	The ratio of income before extraordinary items to total assets: IBCOM/AT.
Book leverage	The ratio of long-term debt plus current liabilities to total assets: (DLTT + DLC)/AT.
Intensity of commercial expenditures	The ratio of selling, general, and administrative expenditures to total assets: XSGA/AT.

Note: we used (i) the USPTO Case Files dataset (2015 edition) for trademark statistics; (ii) Marquis Who's Who directories; the Bloomberg database; the BoardEx database; companies' SEC filings, press releases, and official web-sites; and CEOs' LinkedIn profiles, university yearbooks, and obituaries, for CEO demographic characteristics; (iii) the Standard & Poor's ExecuComp dataset for executive ownership and compensation; and (iv) the Standard & Poor's Compustat North America dataset for company characteristics.

APPENDIX 4.A. AUXILIARY TABLES

Table 4.A.1. CEO characteristics and product differentiation: Alternative specifications of the dependent variable

	Negative binomial, logit, and truncated negative binomial models				
	DV_1Y	DV_2Y	DV_3Y	DV_CL50	DV_CL100
DV = Trademark flow in existing markets $_{i, t}$	(based on the specification for Model 1.8)				
Number of degrees $_{i, j, t-1}$	**1.165*****	**1.147****	**1.138****	**1.137*****	**1.131****
	(0.054)	*(0.049)*	*(0.046)*	*(0.046)*	*(0.044)*
Degree in engineering and technology $_{i, j, t-1}$	**0.806****	**0.810****	**0.827****	**0.823****	**0.836****
	(0.061)	*(0.055)*	*(0.053)*	*(0.053)*	*(0.052)*
Degree in natural sciences $_{i, j, t-1}$	**1.245***	**1.282****	**1.251***	**1.262****	**1.277****
	(0.131)	*(0.119)*	*(0.111)*	*(0.109)*	*(0.107)*
Degree in business studies $_{i, j, t-1}$	0.938	0.945	0.948	0.948	0.952
	(0.062)	*(0.056)*	*(0.053)*	*(0.053)*	*(0.052)*
Degree in legal studies $_{i, j, t-1}$	0.844	0.840	**0.825†**	**0.825†**	**0.806***
	(0.101)	*(0.090)*	*(0.085)*	*(0.084)*	*(0.080)*
Ivy League university $_{i, j, t-1}$	1.082	1.071	1.087	**1.105†**	**1.121***
	(0.071)	*(0.063)*	*(0.061)*	*(0.061)*	*(0.060)*
Years in engineering and R&D $_{i, j, t-1}$	1.001	1.000	0.998	0.999	0.998
	(0.007)	*(0.006)*	*(0.006)*	*(0.006)*	*(0.006)*
Years in marketing and sales $_{i, j, t-1}$	**0.987***	**0.986****	**0.986****	**0.987****	**0.988****
	(0.005)	*(0.005)*	*(0.005)*	*(0.005)*	*(0.004)*
Years in accounting and finance $_{i, j, t-1}$	**0.988***	**0.989***	**0.990***	**0.990***	**0.991***
	(0.005)	*(0.005)*	*(0.005)*	*(0.005)*	*(0.004)*
Years in operations and manufacturing $_{i, j, t-1}$	1.003	1.003	1.005	**1.006†**	**1.005†**
	(0.004)	*(0.004)*	*(0.003)*	*(0.003)*	*(0.003)*
Years in law and compliance $_{i, j, t-1}$	1.000	0.995	0.997	1.002	1.003
	(0.016)	*(0.015)*	*(0.014)*	*(0.014)*	*(0.014)*
Functional diversity $_{i, j, t-1}$	0.980	0.984	0.980	0.976	0.977
	(0.029)	*(0.027)*	*(0.026)*	*(0.026)*	*(0.025)*
Generalist CEO $_{i, j, t-1}$	1.005	1.008	0.993	0.999	0.998
	(0.055)	*(0.049)*	*(0.046)*	*(0.046)*	*(0.045)*
Company tenure $_{i, j, t-1}$	**1.028****	**1.028*****	**1.028*****	**1.029*****	**1.029*****
	(0.009)	*(0.008)*	*(0.007)*	*(0.007)*	*(0.007)*
Company tenure^2 $_{i, j, t-1}$	**0.9994*****	**0.9994*****	**0.9994*****	**0.9993*****	**0.9993*****
	(0.0002)	*(0.0002)*	*(0.0002)*	*(0.0002)*	*(0.0002)*
Founder CEO $_{i, j, t-1}$	**1.411****	**1.344****	**1.310****	**1.305****	**1.300****
	(0.159)	*(0.133)*	*(0.124)*	*(0.123)*	*(0.120)*
Log likelihood	-11,085.4	-11,845.5	-12,174.9	-12,271.5	-12,500.1
Pseudo R^2	0.126	0.127	0.127	0.126	0.124
ln(Alpha)	**0.565*****	**0.383*****	**0.316*****	**0.307*****	**0.273*****
Number of obs.	5,399	5,399	5,399	5,399	5,399
DV = Trademarking in a new market $_{i, t}$	(based on the specification for Model 2.8)				
Number of degrees $_{i, j, t-1}$	**0.177****	**0.146***	0.086	0.092	0.069
	(0.060)	*(0.059)*	*(0.060)*	*(0.060)*	*(0.062)*
Degree in engineering and technology $_{i, j, t-1}$	**-0.145†**	**-0.151†**	**-0.192***	**-0.176***	**-0.187***
	(0.088)	*(0.087)*	*(0.088)*	*(0.087)*	*(0.090)*
Degree in natural sciences $_{i, j, t-1}$	0.052	0.028	0.049	-0.047	-0.045
	(0.126)	*(0.121)*	*(0.122)*	*(0.124)*	*(0.128)*
Degree in business studies $_{i, j, t-1}$	-0.026	-0.062	-0.027	-0.001	-0.050
	(0.080)	*(0.079)*	*(0.079)*	*(0.079)*	*(0.082)*

Degree in legal studies $_{i, j, t-1}$	**-0.503***** *(0.141)*	**-0.481***** *(0.142)*	**-0.384**** *(0.146)*	**-0.402**** *(0.149)*	**-0.382*** *(0.157)*
Ivy League university $_{i, j, t-1}$	0.133 *(0.084)*	0.077 *(0.082)*	0.013 *(0.082)*	-0.064 *(0.083)*	-0.017 *(0.086)*
Years in engineering and R&D $_{i, j, t-1}$	**0.018*** *(0.009)*	0.007 *(0.009)*	0.007 *(0.009)*	0.007 *(0.009)*	0.013 *(0.009)*
Years in marketing and sales $_{i, j, t-1}$	-0.006 *(0.007)*	-0.006 *(0.007)*	-0.003 *(0.007)*	-0.007 *(0.007)*	-0.008 *(0.007)*
Years in accounting and finance $_{i, j, t-1}$	0.005 *(0.006)*	0.003 *(0.006)*	0.004 *(0.006)*	0.004 *(0.006)*	0.005 *(0.006)*
Years in operations and manufacturing $_{i, j, t-1}$	0.005 *(0.006)*	0.004 *(0.006)*	0.002 *(0.006)*	-0.003 *(0.006)*	-0.002 *(0.006)*
Years in law and compliance $_{i, j, t-1}$	**0.033†** *(0.017)*	**0.031†** *(0.017)*	0.023 *(0.017)*	0.010 *(0.018)*	0.012 *(0.018)*
Functional diversity $_{i, j, t-1}$	-0.047 *(0.041)*	-0.023 *(0.040)*	0.004 *(0.040)*	0.031 *(0.040)*	0.022 *(0.042)*
Generalist CEO $_{i, j, t-1}$	0.027 *(0.068)*	0.001 *(0.068)*	0.007 *(0.068)*	-0.041 *(0.069)*	-0.057 *(0.072)*
Company tenure $_{i, j, t-1}$	**0.034**** *(0.011)*	**0.027*** *(0.011)*	**0.031**** *(0.011)*	**0.027*** *(0.011)*	**0.020†** *(0.012)*
Company tenure^2 $_{i, j, t-1}$	**-0.0008**** *(0.0002)*	**-0.0006*** *(0.0002)*	**-0.0007**** *(0.0002)*	**-0.0006**** *(0.0002)*	**-0.0005*** *(0.0003)*
Founder CEO $_{i, j, t-1}$	0.074 *(0.153)*	0.167 *(0.154)*	0.184 *(0.155)*	0.144 *(0.155)*	0.222 *(0.159)*
Log pseudolikelihood	-3,171.7	-3,209.9	-3,181.3	-3,154.8	-2,985.3
Pseudo R^2	0.152	0.129	0.111	0.100	0.093
Number of obs.	5,399	5,399	5,399	5,399	5,399
DV = Trademark flow in new markets $_{i, t}$	(based on the specification for Model 3.8)				
Number of degrees $_{i, j, t-1}$	1.020 *(0.048)*	1.004 *(0.056)*	1.029 *(0.067)*	1.028 *(0.074)*	1.046 *(0.082)*
Degree in engineering and technology $_{i, j, t-1}$	**0.884†** *(0.066)*	0.916 *(0.080)*	0.860 *(0.088)*	0.885 *(0.098)*	0.881 *(0.108)*
Degree in natural sciences $_{i, j, t-1}$	**1.240*** *(0.122)*	1.159 *(0.135)*	1.213 *(0.165)*	1.238 *(0.189)*	1.010 *(0.172)*
Degree in business studies $_{i, j, t-1}$	1.030 *(0.070)*	1.060 *(0.085)*	1.013 *(0.095)*	0.989 *(0.102)*	1.008 *(0.114)*
Degree in legal studies $_{i, j, t-1}$	0.818 *(0.121)*	0.766 *(0.131)*	0.756 *(0.149)*	**0.684†** *(0.151)*	0.716 *(0.175)*
Ivy League university $_{i, j, t-1}$	**1.123†** *(0.078)*	**1.243**** *(0.101)*	**1.259*** *(0.121)*	**1.230†** *(0.131)*	1.193 *(0.141)*
Years in engineering and R&D $_{i, j, t-1}$	0.996 *(0.007)*	1.000 *(0.009)*	1.004 *(0.010)*	1.005 *(0.011)*	1.011 *(0.012)*
Years in marketing and sales $_{i, j, t-1}$	0.995 *(0.005)*	0.999 *(0.006)*	1.001 *(0.007)*	1.003 *(0.008)*	1.002 *(0.009)*
Years in accounting and finance $_{i, j, t-1}$	1.001 *(0.006)*	1.000 *(0.006)*	1.001 *(0.007)*	1.002 *(0.008)*	1.003 *(0.009)*
Years in operations and manufacturing $_{i, j, t-1}$	1.003 *(0.005)*	1.000 *(0.006)*	0.992 *(0.007)*	0.991 *(0.007)*	**0.986†** *(0.008)*
Years in law and compliance $_{i, j, t-1}$	0.993 *(0.016)*	1.011 *(0.019)*	1.017 *(0.021)*	1.028 *(0.025)*	1.032 *(0.027)*
Functional diversity $_{i, j, t-1}$	1.010 *(0.032)*	1.016 *(0.038)*	1.011 *(0.044)*	1.011 *(0.049)*	0.992 *(0.052)*
Generalist CEO $_{i, j, t-1}$	0.948 *(0.054)*	**0.842**** *(0.056)*	**0.870†** *(0.068)*	**0.851†** *(0.074)*	**0.815*** *(0.077)*
Company tenure $_{i, j, t-1}$	1.007 *(0.010)*	1.008 *(0.011)*	1.014 *(0.013)*	1.005 *(0.014)*	1.021 *(0.016)*

Company tenure$^2_{i, j, t-1}$	0.9998 *(0.0002)*	0.9998 *(0.0002)*	0.9997 *(0.0003)*	0.9999 *(0.0003)*	0.9999 *(0.0003)*
Founder CEO $_{i, j, t-1}$	**1.477**** *(0.198)*	**1.526**** *(0.236)*	**1.804**** *(0.326)*	**2.020***** *(0.404)*	**2.293***** *(0.492)*
Log likelihood	-4,022.6	-3,425.6	-3,059.7	-2,760.1	-2,227.8
Pseudo R^2	0.054	0.041	0.036	0.036	0.040
ln(Alpha)	**-0.343****	-0.023	**0.484****	**0.711****	**0.633****
Number of obs.	2,036	2,036	2,036	1,906	1,614

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect (only for the specifications based on the negative binomial distribution). Dependent variables are measured at time t. Explanatory variables are measured at time t-1. The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Standard errors, corrected for heteroskedasticity by using the White-Huber method (the logit model) or adjusted overdispersion by using the outer product of the gradient (the negative binomial/truncated negative binomial model), are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. DV_1Y is the model with the one-year "newness" condition; for multiple-class trademarks at least one product class should satisfy the one-year "newness" condition for a trademark to be associated with new markets. DV_2Y is the model with the two-year "newness" condition; for multiple-class trademarks at least one product class should satisfy the two-year "newness" condition for a trademark to be associated with new markets. DV_3Y is the model with the three-year "newness" condition; for multiple-class trademarks at least one product class should satisfy the three-year "newness" condition for a trademark to be associated with new markets (the basis model). DV_CL50 is the model with the three-year "newness" condition; for multiple-class trademarks at least 50% of product classes should satisfy the three-year "newness" condition for a trademark to be associated with new markets. DV_CL100 is the model with the three-year "newness" condition; for multiple-class trademarks all product classes should satisfy the three-year "newness" condition for a trademark to be associated with new markets. Sources and variable definitions are given in Table 4.7.

Table 4.A.2. The effect of an alternative specification of the mean scaling estimator

	Negative binomial, logit, and truncated negative binomial models	
	MSE_BASIS	MSE_ALT_SPEC
DV = Trademark flow in existing markets $_{i, t}$		(based on the specification for Model 1.8)
Number of degrees $_{i, j, t-1}$	**1.138**** *(0.046)*	**1.158***** *(0.047)*
Degree in engineering and technology $_{i, j, t-1}$	**0.827**** *(0.053)*	**0.811***** *(0.053)*
Degree in natural sciences $_{i, j, t-1}$	**1.251*** *(0.111)*	**1.213*** *(0.108)*
Degree in business studies $_{i, j, t-1}$	0.948 *(0.053)*	0.970 *(0.055)*
Degree in legal studies $_{i, j, t-1}$	**0.825†** *(0.085)*	**0.825†** *(0.086)*
Ivy League university $_{i, j, t-1}$	1.087 *(0.061)*	1.087 *(0.061)*
Years in engineering and R&D $_{i, j, t-1}$	0.998 *(0.006)*	1.002 *(0.006)*
Years in marketing and sales $_{i, j, t-1}$	**0.986**** *(0.005)*	**0.987**** *(0.005)*
Years in accounting and finance $_{i, j, t-1}$	**0.990*** *(0.005)*	**0.990*** *(0.005)*
Years in operations and manufacturing $_{i, j, t-1}$	1.005 *(0.003)*	1.005 *(0.003)*
Years in law and compliance $_{i, j, t-1}$	0.997 *(0.014)*	1.000 *(0.014)*
Functional diversity $_{i, j, t-1}$	0.980 *(0.026)*	0.972 *(0.026)*
Generalist CEO $_{i, j, t-1}$	0.993 *(0.046)*	0.982 *(0.045)*
Company tenure $_{i, j, t-1}$	**1.028***** *(0.007)*	**1.026***** *(0.007)*
Company tenure^2 $_{i, j, t-1}$	**0.9994***** *(0.0002)*	**0.9994***** *(0.0002)*
Founder CEO $_{i, j, t-1}$	**1.310**** *(0.124)*	**1.349**** *(0.128)*
Log likelihood	-12,174.9	-12,185.8
Pseudo R^2	0.127	0.126
ln(Alpha)	**0.316*****	**0.322*****
Number of obs.	5,399	5,399
DV = Trademarking in a new market $_{i, t}$		(based on the specification for Model 2.8)
Number of degrees $_{i, j, t-1}$	0.086 *(0.060)*	0.095 *(0.060)*
Degree in engineering and technology $_{i, j, t-1}$	**-0.192*** *(0.088)*	**-0.196*** *(0.087)*
Degree in natural sciences $_{i, j, t-1}$	0.049 *(0.122)*	0.030 *(0.123)*
Degree in business studies $_{i, j, t-1}$	-0.027 *(0.079)*	-0.024 *(0.079)*
Degree in legal studies $_{i, j, t-1}$	**-0.384**** *(0.146)*	**-0.381**** *(0.146)*
Ivy League university $_{i, j, t-1}$	0.013 *(0.082)*	0.002 *(0.083)*

Years in engineering and R&D $_{i, j, t-1}$	0.007 *(0.009)*	0.008 *(0.009)*
Years in marketing and sales $_{i, j, t-1}$	-0.003 *(0.007)*	-0.002 *(0.007)*
Years in accounting and finance $_{i, j, t-1}$	0.004 *(0.006)*	0.004 *(0.006)*
Years in operations and manufacturing $_{i, j, t-1}$	0.002 *(0.006)*	0.002 *(0.006)*
Years in law and compliance $_{i, j, t-1}$	0.023 *(0.017)*	0.025 *(0.017)*
Functional diversity $_{i, j, t-1}$	0.004 *(0.040)*	0.000 *(0.040)*
Generalist CEO $_{i, j, t-1}$	0.007 *(0.068)*	0.000 *(0.068)*
Company tenure $_{i, j, t-1}$	**0.031**** *(0.011)*	**0.030**** (0.011)
Company tenure^2 $_{i, j, t-1}$	**-0.0007**** *(0.0002)*	**-0.0007**** *(0.0002)*
Founder CEO $_{i, j, t-1}$	0.184 *(0.155)*	0.194 *(0.154)*
Log pseudolikelihood	-3,181.3	-3,179.5
Pseudo R^2	0.111	0.111
Number of obs.	5,399	5,399
DV = Trademark flow in new markets $_{i, t}$		(based on the specification for Model 3.8)
Number of degrees $_{i, j, t-1}$	1.029 *(0.067)*	1.030 *(0.067)*
Degree in engineering and technology $_{i, j, t-1}$	0.860 *(0.088)*	0.860 *(0.088)*
Degree in natural sciences $_{i, j, t-1}$	1.213 *(0.165)*	1.207 *(0.164)*
Degree in business studies $_{i, j, t-1}$	1.013 *(0.095)*	1.015 *(0.096)*
Degree in legal studies $_{i, j, t-1}$	0.756 *(0.149)*	0.756 *(0.149)*
Ivy League university $_{i, j, t-1}$	**1.259*** *(0.121)*	**1.261*** *(0.121)*
Years in engineering and R&D $_{i, j, t-1}$	1.004 *(0.010)*	1.004 *(0.010)*
Years in marketing and sales $_{i, j, t-1}$	1.001 *(0.007)*	1.001 *(0.007)*
Years in accounting and finance $_{i, j, t-1}$	1.001 *(0.007)*	1.001 *(0.007)*
Years in operations and manufacturing $_{i, j, t-1}$	0.992 *(0.007)*	0.993 *(0.007)*
Years in law and compliance $_{i, j, t-1}$	1.017 *(0.021)*	1.018 *(0.022)*
Functional diversity $_{i, j, t-1}$	1.011 *(0.044)*	1.008 *(0.044)*
Generalist CEO $_{i, j, t-1}$	**0.870†** *(0.068)*	**0.866†** *(0.068)*
Company tenure $_{i, j, t-1}$	1.014 *(0.013)*	1.014 *(0.013)*
Company tenure^2 $_{i, j, t-1}$	0.9997 *(0.0003)*	0.9997 *(0.0003)*
Founder CEO $_{i, j, t-1}$	**1.804**** *(0.326)*	**1.804***** *(0.326)*

Log likelihood	-3,059.7	-3,059.4
Pseudo R^2	0.036	0.036
ln(Alpha)	**0.484****	**0.483****
Number of obs.	2,036	2,036

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect (only for the specifications based on the negative binomial distribution). Dependent variables are measured at time t. Explanatory variables are measured at time t-1. The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Standard errors, corrected for heteroskedasticity by using the White-Huber method (the logit model) or adjusted overdispersion by using the outer product of the gradient (the negative binomial/truncated negative binomial model), are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. MSE_BASIS is the model where the mean scaling estimator is based on a 5-year pre-sample period (the basis model). MSE_ALT_SPEC is the model where the mean scaling estimator is based on a 9-year pre-sample period. Sources and variable definitions are given in Table 4.7.

Table 4.A.3. Multicollinearity diagnostics

	VIF	1/VIF
Company tenure	16.09	0.062
Company tenure^2	16.21	0.062
Degree in legal studies	1.93	0.517
Number of degrees	1.84	0.544
Functional diversity	1.82	0.549
Degree in business studies	1.56	0.641
Years in law and compliance	1.52	0.657
Firm age	1.47	0.678
Degree in engineering and technology	1.43	0.698
Years in engineering and R&D	1.42	0.705
Founder CEO	1.32	0.760
Intensity of commercial expenditures	1.31	0.761
Years in marketing and sales	1.27	0.789
Years in operations and manufacturing	1.25	0.801
Firm size	1.24	0.806
CEO ownership	1.23	0.815
Years in accounting and finance	1.20	0.833
Ivy League university	1.19	0.839
Generalist CEO	1.19	0.843
Book leverage	1.17	0.853
Degree in natural sciences	1.15	0.868
ROA	1.13	0.883
CEO duality	1.12	0.892
CEO option pay	1.11	0.900
CEO gender (male)	1.05	0.952
Mean VIF	2.53	

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

The log-transformed dependent variable (trademark flow in existing market) is measured at time t. Explanatory variables are measured at time t-1. Parameters are estimated by using the ordinary least squares method. Firm fixed effects, industry fixed effects, and year fixed effects are excluded from the estimation. Sources and variable definitions are given in Table 4.7.

Table 4.A.4. CEO characteristics and product differentiation in existing markets: Exploitation behaviour (alternative measures)

Dependent variable: Trademark flow in existing markets $_{i, t}$	**Negative binomial models**					
	Model 1.A	Model 1.B	Model 1.C	Model 1.D	Model 1.E	Model 1.F
Depth of educational background $_{i, j, t-1}$	**1.104**** *(0.041)*					
Breath of educational background $_{i, j, t-1}$		0.904 *(0.056)*				
Highest level of education $_{i, j, t-1}$			**1.098*** *(0.046)*			
MBA degree $_{i, j, t-1}$				**0.864*** *(0.053)*		
JD degree $_{i, j, t-1}$				**0.804*** (0.073)		
Degree from a private university $_{i, j, t-1}$					**1.104†** *(0.058)*	
Degree from a research intensive university $_{i, j, t-1}$						0.963 *(0.047)*
CEO effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	BGV	BGV	BGV	BGV	BGV	BGV
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Log likelihood	-12,191.8	-12,194.7	-12,193.1	-12,188.7	-12,190.0	-12,191.9
Pseudo R^2	0.125	0.125	0.125	0.126	0.126	0.125
ln(Alpha)	**0.325*****	**0.328*****	**0.325*****	**0.323*****	**0.322*****	**0.324*****
Number of observations	5,399	5,399	5,399	5,399	5,399	5,399

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. The dependent variable is measured at time t. Explanatory variables are measured at time t-1. The constant is omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. All models are based on the specification for Model 1.5. Sources and variable definitions are given in Table 4.7.

Table 4.A.5. CEO characteristics and product differentiation in new markets: Market selection (alternative measures)

Dependent variable: Trademarking in a new market $_{i, t}$	Logit models					
	Model 2.A	Model 2.B	Model 2.C	Model 2.D	Model 2.E	Model 2.F
Depth of educational background $_{i, j, t-1}$	0.075 *(0.055)*					
Breath of educational background $_{i, j, t-1}$		-0.074 *(0.089)*				
Highest level of education $_{i, j, t-1}$			0.063 *(0.061)*			
MBA degree $_{i, j, t-1}$				-0.001 *(0.088)*		
JD degree $_{i, j, t-1}$				**-0.277*** *(0.134)*		
Degree from a private university $_{i, j, t-1}$					-0.060 *(0.072)*	
Degree from a research intensive university $_{i, j, t-1}$						-0.059 *(0.071)*
CEO effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	BGV	BGV	BGV	BGV	BGV	BGV
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Log pseudolikelihood	-3,184.3	-3,184.9	-3,184.7	-3,184.2	-3,183.7	-3,183.7
Pseudo R^2	0.110	0.110	0.110	0.110	0.110	0.110
Number of observations	5,399	5,399	5,399	5,399	5,399	5,399

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

The dependent variable is measured at time t. Explanatory variables are measured at time t-1. The constant is omitted. Heteroskedasticity robust standard errors are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. All models are based on the specification for Model 2.5. Sources and variable definitions are given in Table 4.7.

Table 4.A.6. CEO characteristics and product differentiation in new markets: Exploration behaviour (alternative measures)

Dependent variable: Trademark flow in new markets $_{i, t}$	Truncated negative binomial models					
	Model 3.A	Model 3.B	Model 3.C	Model 3.D	Model 3.E	Model 3.F
Depth of educational background $_{i, j, t-1}$	1.024 *(0.060)*					
Breath of educational background $_{i, j, t-1}$		**0.833†** *(0.082)*				
Highest level of education $_{i, j, t-1}$			0.971 *(0.066)*			
MBA degree $_{i, j, t-1}$				0.926 *(0.090)*		
JD degree $_{i, j, t-1}$				0.791 *(0.135)*		
Degree from a private university $_{i, j, t-1}$					1.073 *(0.094)*	
Degree from a research intensive university $_{i, j, t-1}$						0.893 *(0.075)*
CEO effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	BGV	BGV	BGV	BGV	BGV	BGV
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Log likelihood	-3,068.0	-3,066.4	-3,068.0	-3,067.8	-3,070.3	-3,069.8
Pseudo R^2	0.033	0.034	0.033	0.033	0.032	0.032
ln(Alpha)	**0.547****	**0.547****	**0.550****	**0.547****	**0.560****	**0.553****
Number of observations	2,036	2,036	2,036	2,036	2,036	2,036

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. The dependent variable is measured at time t. Explanatory variables are measured at time t-1. The constant is omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. All models are based on the specification for Model 3.5. Sources and variable definitions are given in Table 4.7.

Table 4.A.7. The effect of the CEO tenure length

	Negative binomial, logit, and truncated negative binomial models								
	CEO tenure ≥ 3 years			CEO tenure ≥ 4 years			CEO tenure ≥ 5 years		
	EXPLT	M_SEL	EXPLR	EXPLT	M_SEL	EXPLR	EXPLT	M_SEL	EXPLR
Number of degrees $_{i, j, t-1}$	**1.163*** **	0.098	0.987	**1.171*** **	**0.121†**	0.999	**1.177*** **	**0.118†**	1.006
	(0.050)	*(0.062)*	*(0.068)*	*(0.051)*	*(0.062)*	*(0.070)*	*(0.052)*	*(0.063)*	*(0.072)*
Degree in engineering and technology $_{i, j, t-1}$	**0.824** **	**-0.179***	0.869	**0.816** **	**-0.198***	0.863	**0.808** **	**-0.212***	0.867
	(0.055)	*(0.091)*	*(0.092)*	*(0.055)*	*(0.092)*	*(0.093)*	*(0.055)*	*(0.093)*	*(0.095)*
Degree in natural sciences $_{i, j, t-1}$	**1.266** **	0.043	**1.268†**	**1.282** **	0.038	**1.298†**	**1.309** **	0.046	**1.296†**
	(0.116)	*(0.127)*	*(0.181)*	*(0.118)*	*(0.130)*	*(0.189)*	*(0.122)*	*(0.133)*	*(0.191)*
Degree in business studies $_{i, j, t-1}$	0.942	-0.032	1.038	0.931	-0.045	1.013	0.926	-0.045	1.034
	(0.055)	*(0.081)*	*(0.101)*	*(0.055)*	*(0.082)*	*(0.100)*	*(0.055)*	*(0.083)*	*(0.103)*
Degree in legal studies $_{i, j, t-1}$	0.848	**-0.419** **	0.800	0.845	**-0.461** **	0.810	0.848	**-0.438** **	0.798
	(0.090)	*(0.152)*	*(0.164)*	*(0.090)*	*(0.154)*	*(0.169)*	*(0.093)*	*(0.156)*	*(0.166)*
Ivy League university $_{i, j, t-1}$	1.066	0.052	**1.255***	1.068	0.046	**1.241***	1.047	0.058	**1.222***
	(0.062)	*(0.085)*	*(0.124)*	*(0.063)*	*(0.086)*	*(0.125)*	*(0.062)*	*(0.088)*	*(0.124)*
Years in engineering and R&D $_{i, j, t-1}$	0.995	0.012	1.006	0.993	0.012	1.004	0.993	0.015	1.004
	(0.006)	*(0.009)*	*(0.011)*	*(0.006)*	*(0.009)*	*(0.011)*	*(0.006)*	*(0.009)*	*(0.011)*
Years in marketing and sales $_{i, j, t-1}$	**0.988***	-0.004	0.999	**0.989***	-0.003	0.999	**0.988***	-0.002	0.999
	(0.005)	*(0.007)*	*(0.008)*	*(0.005)*	*(0.007)*	*(0.008)*	*(0.005)*	*(0.007)*	*(0.008)*
Years in accounting and finance $_{i, j, t-1}$	**0.989***	0.004	1.001	**0.988***	0.004	1.002	**0.987** **	0.004	1.003
	(0.005)	*(0.006)*	*(0.008)*	*(0.005)*	*(0.006)*	*(0.008)*	*(0.005)*	*(0.006)*	*(0.008)*
Years in operations and manufacturing $_{i, j, t-1}$	1.006	0.006	0.992	**1.007***	0.006	0.993	**1.007***	0.006	0.992
	(0.003)	*(0.006)*	*(0.007)*	*(0.004)*	*(0.006)*	*(0.007)*	*(0.004)*	*(0.006)*	*(0.007)*
Years in law and compliance $_{i, j, t-1}$	0.996	0.027	1.016	0.998	**0.030†**	1.017	0.995	0.028	1.011
	(0.014)	*(0.017)*	*(0.022)*	*(0.015)*	*(0.018)*	*(0.022)*	*(0.015)*	*(0.018)*	*(0.022)*
Functional diversity $_{i, j, t-1}$	0.967	-0.033	0.998	0.959	-0.025	1.010	0.961	-0.031	1.004
	(0.027)	*(0.042)*	*(0.045)*	*(0.028)*	*(0.043)*	*(0.047)*	*(0.028)*	*(0.044)*	*(0.047)*
Generalist CEO $_{i, j, t-1}$	0.974	0.001	**0.867†**	0.988	-0.004	**0.851***	0.995	0.006	**0.861†**
	(0.046)	*(0.070)*	*(0.070)*	*(0.048)*	*(0.071)*	*(0.070)*	*(0.049)*	*(0.072)*	*(0.071)*
Company tenure $_{i, j, t-1}$	**1.029*** **	**0.037** **	1.007	**1.030** **	**0.038** **	1.015	**1.034*** **	**0.039** **	1.010
	(0.009)	*(0.013)*	*(0.015)*	*(0.010)*	*(0.014)*	*(0.017)*	*(0.011)*	*(0.015)*	*(0.018)*
Company tenure^2 $_{i, j, t-1}$	**0.9993*** **	**-0.0008** **	0.9998	**0.9993*** **	**-0.0009** **	0.9996	**0.9992*** **	**-0.0009** **	0.9997
	(0.0002)	*(0.0003)*	*(0.0003)*	*(0.0002)*	*(0.0003)*	*(0.0004)*	*(0.0002)*	*(0.0003)*	*(0.0004)*
Founder CEO $_{i, j, t-1}$	**1.297** **	0.170	**1.730** **	**1.301** **	0.158	**1.752** **	**1.293** **	0.135	**1.776** **
	(0.125)	*(0.157)*	*(0.318)*	*(0.125)*	*(0.157)*	*(0.325)*	*(0.125)*	*(0.158)*	*(0.331)*
CEO controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	BGV	BGV	BGV	BGV	BGV	BGV	BGV	BGV	BGV
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log (ps.)likelihood	-11,539.9	-3,008.7	-2,922.9	-11,264.3	-2,938.2	-2,847.6	-10,984.3	-2,870.1	-2,788.3
Pseudo R^2	0.129	0.115	0.036	0.130	0.116	0.037	0.131	0.115	0.037
ln(Alpha)	**0.309*** **		**0.512** **	**0.300*** **		**0.517** **	**0.289*** **		**0.502** **
Number of obs.	5,130	5,130	1938	5,010	5,010	1,894	4,889	4,889	1,851

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect (only for the specifications based on the negative binomial distribution). The dependent variable is measured at time t. Explanatory variables are measured at time t-1. The constant term is omitted. Standard errors, corrected for heteroskedasticity by using the White-Huber method (the logit model) or adjusted overdispersion by using the outer product of the gradient (the negative binomial/truncated negative binomial model), are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. EXPLT is a negative binomial model based on the specification for Model 1.8. M_SEL is a logit model based on the specification for Model 2.8. EXPLR is a truncated negative binomial model based on the specification for Model 3.8. Sources and variable definitions are given in Table 4.7.

Table 4.A.8. A comparison of different model specifications

	Poisson, negative binomial, and generalized linear models						
	P_DFLT	P_RBST	NB_DFLT	NB_RBST	NB_PRSN	NB_CLTR	NB_OPG
DV = Trademark flow in existing markets $_{i, t}$	(based on the specification for Model 1.8)						
Number of degrees $_{i, j, t-1}$	**0.974***	0.974	**1.138*****	**1.138*****	**1.138*****	**1.138†**	**1.138****
	(0.011)	*(0.035)*	*(0.042)*	*(0.040)*	*(0.040)*	*(0.087)*	*(0.046)*
Degree in engineering and technology $_{i, j, t-1}$	**0.797*****	**0.797*****	**0.827*****	**0.827****	**0.825*****	**0.827†**	**0.827****
	(0.013)	*(0.048)*	*(0.047)*	*(0.048)*	*(0.048)*	*(0.090)*	*(0.053)*
Degree in natural sciences $_{i, j, t-1}$	**1.217*****	**1.217***	**1.251****	**1.251****	**1.244****	1.251	**1.251***
	(0.023)	*(0.096)*	*(0.098)*	*(0.093)*	*(0.090)*	*(0.200)*	*(0.111)*
Degree in business studies $_{i, j, t-1}$	**1.030†**	1.030	0.948	0.948	0.940	0.948	0.948
	(0.015)	*(0.058)*	*(0.049)*	*(0.050)*	*(0.049)*	*(0.104)*	*(0.053)*
Degree in legal studies $_{i, j, t-1}$	**1.057†**	1.057	**0.825***	**0.825†**	**0.833†**	0.825	**0.825†**
	(0.031)	*(0.101)*	*(0.081)*	*(0.081)*	*(0.081)*	*(0.185)*	*(0.085)*
Ivy League university $_{i, j, t-1}$	**1.188*****	**1.188****	1.087	1.087	1.087	1.087	1.087
	(0.018)	*(0.064)*	*(0.056)*	*(0.057)*	*(0.056)*	*(0.122)*	*(0.061)*
Years in engineering and R&D $_{i, j, t-1}$	**1.021*****	**1.021****	0.998	0.998	1.000	0.998	0.998
	(0.002)	*(0.008)*	*(0.006)*	*(0.006)*	*(0.006)*	*(0.011)*	*(0.006)*
Years in marketing and sales $_{i, j, t-1}$	**0.990*****	**0.990****	**0.986****	**0.986****	**0.986****	0.986	**0.986****
	(0.001)	*(0.004)*	*(0.004)*	*(0.004)*	*(0.004)*	*(0.009)*	*(0.005)*
Years in accounting and finance $_{i, j, t-1}$	**0.985*****	**0.985*****	**0.990***	**0.990****	**0.989****	0.990	**0.990***
	(0.001)	*(0.004)*	*(0.004)*	*(0.004)*	*(0.004)*	*(0.006)*	*(0.005)*
Years in operations and manufacturing $_{i, j, t-1}$	**0.984*****	**0.984*****	1.005	1.005	1.003	1.005	1.005
	(0.001)	*(0.004)*	*(0.004)*	*(0.005)*	*(0.005)*	*(0.009)*	*(0.003)*
Years in law and compliance $_{i, j, t-1}$	**0.964*****	**0.964*****	0.997	0.997	0.995	0.997	0.997
	(0.004)	*(0.010)*	*(0.012)*	*(0.010)*	*(0.010)*	*(0.020)*	*(0.014)*
Functional diversity $_{i, j, t-1}$	**0.968*****	0.968	0.980	0.980	0.983	0.980	0.980
	(0.006)	*(0.030)*	*(0.024)*	*(0.025)*	*(0.025)*	*(0.053)*	*(0.026)*
Generalist CEO $_{i, j, t-1}$	0.997	0.997	0.993	0.993	0.990	0.993	0.993
	(0.013)	*(0.048)*	*(0.043)*	*(0.043)*	*(0.042)*	*(0.084)*	*(0.046)*
Company tenure $_{i, j, t-1}$	**1.059*****	**1.059*****	**1.028*****	**1.028*****	**1.031*****	**1.028***	**1.028*****
	(0.002)	*(0.008)*	*(0.007)*	*(0.008)*	*(0.008)*	*(0.014)*	*(0.007)*
Company tenure^2 $_{i, j, t-1}$	**0.9988*****	**0.9988*****	**0.9994*****	**0.9994*****	**0.9993*****	**0.9994***	**0.9994*****
	(0.0001)	*(0.0002)*	*(0.0002)*	*(0.0002)*	*(0.0002)*	*(0.0003)*	*(0.0002)*
Founder CEO $_{i, j, t-1}$	**1.234*****	**1.234†**	**1.310****	**1.310***	**1.294***	1.310	**1.310****
	(0.039)	*(0.142)*	*(0.128)*	*(0.152)*	*(0.149)*	*(0.307)*	*(0.124)*
Log likelihood	-22,797.5	-22,797.5	-12,174.9	-12,174.9	-12,234.9	-12,174.9	-12,174.9
Pseudo R^2	0.540	0.540	0.127	0.127			0.127
ln(Alpha)			**0.316*****	**0.316*****		**0.316*****	**0.316*****
Number of obs.	5,399	5,399	5,399	5,399	5,399	5,399	5,399
DV = Trademark flow in new markets $_{i, t}$	(based on the specification for Model 3.8)						
Number of degrees $_{i, j, t-1}$	**1.064†**	1.064	1.029	1.029		1.029	1.029
	(0.037)	*(0.066)*	*(0.067)*	*(0.069)*		*(0.066)*	*(0.067)*
Degree in engineering and technology $_{i, j, t-1}$	**0.849****	**0.849†**	0.860	0.860		**0.860†**	0.860
	(0.047)	*(0.080)*	*(0.088)*	*(0.086)*		*(0.078)*	*(0.088)*
Degree in natural sciences $_{i, j, t-1}$	1.109	1.109	1.213	1.213		1.213	1.213
	(0.078)	*(0.137)*	*(0.165)*	*(0.178)*		*(0.169)*	*(0.165)*
Degree in business studies $_{i, j, t-1}$	1.018	1.018	1.013	1.013		1.013	1.013
	(0.050)	*(0.075)*	*(0.095)*	*(0.089)*		*(0.086)*	*(0.095)*
Degree in legal studies $_{i, j, t-1}$	**0.802†**	0.802	0.756	0.756		0.756	0.756
	(0.091)	*(0.138)*	*(0.149)*	*(0.148)*		*(0.142)*	*(0.149)*
Ivy League university $_{i, j, t-1}$	**1.189*****	**1.189***	**1.259***	**1.259***		**1.259***	**1.259***
	(0.060)	*(0.104)*	*(0.121)*	*(0.123)*		*(0.124)*	*(0.121)*

Years in engineering and R&D $_{i, j, t-1}$	1.008 *(0.005)*	1.008 *(0.008)*	1.004 *(0.010)*	1.004 *(0.009)*		1.004 *(0.010)*	1.004 *(0.010)*
Years in marketing and sales $_{i, j, t-1}$	1.001 *(0.004)*	1.001 *(0.005)*	1.001 *(0.007)*	1.001 *(0.007)*		1.001 *(0.008)*	1.001 *(0.007)*
Years in accounting and finance $_{i, j, t-1}$	1.000 *(0.004)*	1.000 *(0.007)*	1.001 *(0.007)*	1.001 *(0.009)*		1.001 *(0.009)*	1.001 *(0.007)*
Years in operations and manufacturing $_{i, j, t-1}$	**0.994†** *(0.003)*	0.994 *(0.005)*	0.992 *(0.007)*	0.992 *(0.006)*		0.992 *(0.007)*	0.992 *(0.007)*
Years in law and compliance $_{i, j, t-1}$	1.007 *(0.012)*	1.007 *(0.017)*	1.017 *(0.021)*	1.017 *(0.021)*		1.017 *(0.019)*	1.017 *(0.021)*
Functional diversity $_{i, j, t-1}$	1.024 *(0.023)*	1.024 *(0.040)*	1.011 *(0.044)*	1.011 *(0.044)*		1.011 *(0.047)*	1.011 *(0.044)*
Generalist CEO $_{i, j, t-1}$	**0.856***** *(0.036)*	**0.856*** *(0.062)*	**0.870†** *(0.068)*	**0.870†** *(0.068)*		**0.870†** *(0.069)*	**0.870†** *(0.068)*
Company tenure $_{i, j, t-1}$	1.004 *(0.007)*	1.004 *(0.011)*	1.014 *(0.013)*	1.014 *(0.012)*		1.014 *(0.013)*	1.014 *(0.013)*
Company tenure^2 $_{i, j, t-1}$	0.9999 *(0.0002)*	0.9999 *(0.0003)*	0.9997 *(0.0003)*	0.9997 *(0.0003)*		0.9997 *(0.0003)*	0.9997 *(0.0003)*
Founder CEO $_{i, j, t-1}$	**1.656***** *(0.146)*	**1.656**** *(0.266)*	**1.804**** *(0.326)*	**1.804***** *(0.317)*		**1.804***** *(0.292)*	**1.804**** *(0.326)*
Log likelihood	-3,443.4	-3,443.4	-3,059.7	-3,059.7		-3,059.7	-3,059.7
Pseudo R^2	0.085	0.085	0.036	0.036			0.036
ln(Alpha)			**0.484****	**0.484****		**0.484****	**0.484****
Number of obs.	2,036	2,036	2,036	2,036		2,036	2,036

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect. The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Robust standard errors, adjusted for overdispersion by using the outer product of the gradient, are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. P_DFLT is the Poisson model with default maximum likelihood standard errors. P_RBST is the Poisson model with robust sandwich standard errors. NB_DFLT is the negative binomial model with default maximum likelihood standard errors. NB_RBST is the negative binomial model with robust sandwich standard errors. NB_PRSN is the generalised linear model (GLM) with the negative binomial distribution and the standard errors corrected using a quasi-GLM model. NB_CLTR is the negative binomial model with the standard errors clustered at the company level. NB_OPG is the negative binomial model with the standard errors based on the outer product of the gradient (the basis model). A zero-truncated specification is used for the trademark flow in new markets. Sources and variable definitions are given in Table 4.7.

Table 4.A.9. Testing for the inclusion of additional firm-level controls

	Negative binomial, logit, and truncated negative binomial models					
	Basis model	FLC_DV_LG	FLC_TOB_Q	FLC_CAP_IN	FLC_CAS_HL	FLC_ALL_IN
DV = Trademark flow in existing markets $_{i, t}$ (based on the specification for Model 1.8)						
Number of degrees $_{i, j, t-1}$	1.138** (0.046)	1.158*** (0.042)	1.146*** (0.046)	1.138** (0.046)	1.141** (0.046)	1.147*** (0.046)
Degree in engineering and technology $_{i, j, t-1}$	0.827** (0.053)	0.844** (0.046)	0.816** (0.052)	0.827** (0.053)	0.826** (0.053)	0.817** (0.052)
Degree in natural sciences $_{i, j, t-1}$	1.251* (0.111)	1.146† (0.085)	1.254** (0.109)	1.251* (0.111)	1.215* (0.109)	1.223* (0.108)
Degree in business studies $_{i, j, t-1}$	0.948 (0.053)	0.982 (0.049)	0.947 (0.053)	0.948 (0.054)	0.947 (0.053)	0.945 (0.053)
Degree in legal studies $_{i, j, t-1}$	0.825† (0.085)	0.788** (0.071)	0.797* (0.082)	0.824† (0.085)	0.814* (0.084)	0.792* (0.082)
Ivy League university $_{i, j, t-1}$	1.087 (0.061)	0.988 (0.048)	1.097† (0.061)	1.087 (0.061)	1.083 (0.061)	1.093 (0.062)
Years in engineering and R&D $_{i, j, t-1}$	0.998 (0.006)	0.991 (0.005)	0.998 (0.006)	0.998 (0.006)	0.998 (0.006)	0.998 (0.006)
Years in marketing and sales $_{i, j, t-1}$	0.986** (0.005)	0.985*** (0.004)	0.986** (0.005)	0.986** (0.005)	0.985** (0.005)	0.985** (0.005)
Years in accounting and finance $_{i, j, t-1}$	0.990* (0.005)	0.994 (0.004)	0.990* (0.005)	0.990* (0.005)	0.990* (0.005)	0.990* (0.005)
Years in operations and manufacturing $_{i, j, t-1}$	1.005 (0.003)	1.008* (0.003)	1.005 (0.003)	1.005 (0.003)	1.006† (0.003)	1.006† (0.003)
Years in law and compliance $_{i, j, t-1}$	0.997 (0.014)	1.002 (0.013)	1.000 (0.014)	0.997 (0.014)	0.996 (0.014)	0.998 (0.014)
Functional diversity $_{i, j, t-1}$	0.980 (0.026)	1.027 (0.025)	0.980 (0.026)	0.980 (0.026)	0.982 (0.026)	0.981 (0.026)
Generalist CEO $_{i, j, t-1}$	0.993 (0.046)	0.980 (0.040)	0.987 (0.046)	0.993 (0.046)	0.993 (0.046)	0.988 (0.046)
Company tenure $_{i, j, t-1}$	1.028*** (0.007)	1.016* (0.007)	1.028*** (0.007)	1.028*** (0.008)	1.028*** (0.007)	1.028*** (0.007)
Company tenure^2 $_{i, j, t-1}$	0.9994*** (0.0002)	0.9996** (0.0001)	0.9994*** (0.0002)	0.9994*** (0.0002)	0.9994*** (0.0002)	0.9994*** (0.0002)
Founder CEO $_{i, j, t-1}$	1.310** (0.124)	1.264** (0.104)	1.265* (0.119)	1.310** (0.124)	1.232* (0.117)	1.213* (0.114)
Trademark flow in existing markets $_{i, t-1}$		1.052*** (0.002)				
Tobin's q $_{i, t-1}$			1.108*** (0.025)			1.086*** (0.025)
Capital intensity $_{i, t-1}$				0.997 (0.040)		0.998 (0.040)
Cash holdings $_{i, t-1}$					2.707*** (0.612)	2.254*** (0.535)
Log likelihood	-12,174.9	-11,814.9	-12,162.4	-12,174.9	-12,162.4	-12,154.4
Pseudo R^2	0.127	0.152	0.127	0.127	0.127	0.128
ln(Alpha)	0.316***	0.044	0.307***	0.316***	0.306***	0.300***
Number of obs.	5,399	5,399	5,399	5,399	5,399	5,399
DV = Trademarking in a new market $_{i, t}$ (based on the specification for Model 2.8)						
Number of degrees $_{i, j, t-1}$	0.086 (0.060)		0.084 (0.060)	0.086 (0.060)	0.086 (0.060)	0.084 (0.060)
Degree in engineering and technology $_{i, j, t-1}$	-0.192* (0.088)		-0.205* (0.088)	-0.192* (0.088)	-0.193* (0.088)	-0.205* (0.088)

Degree in natural sciences $_{i, j, t-1}$	0.049 *(0.122)*		0.044 *(0.123)*	0.047 *(0.122)*	0.046 *(0.122)*	0.043 *(0.123)*
Degree in business studies $_{i, j, t-1}$	-0.027 *(0.079)*		-0.025 *(0.079)*	-0.027 *(0.079)*	-0.027 *(0.079)*	-0.025 *(0.079)*
Degree in legal studies $_{i, j, t-1}$	**-0.384**** *(0.146)*		**-0.400**** *(0.146)*	**-0.381**** *(0.146)*	**-0.384**** *(0.146)*	**-0.398**** *(0.146)*
Ivy League university $_{i, j, t-1}$	0.013 *(0.082)*		0.014 *(0.082)*	0.008 *(0.082)*	0.011 *(0.083)*	0.010 *(0.083)*
Years in engineering and R&D $_{i, j, t-1}$	0.007 *(0.009)*		0.007 *(0.009)*	0.007 *(0.009)*	0.006 *(0.009)*	0.007 *(0.009)*
Years in marketing and sales $_{i, j, t-1}$	-0.003 *(0.007)*		-0.004 *(0.007)*	-0.003 *(0.007)*	-0.003 *(0.007)*	-0.004 *(0.007)*
Years in accounting and finance $_{i, j, t-1}$	0.004 *(0.006)*		0.005 *(0.006)*	0.004 *(0.006)*	0.004 *(0.006)*	0.004 *(0.006)*
Years in operations and manufacturing $_{i, j, t-1}$	0.002 *(0.006)*		0.002 *(0.006)*	0.002 *(0.006)*	0.002 *(0.006)*	0.002 *(0.006)*
Years in law and compliance $_{i, j, t-1}$	0.023 *(0.017)*		0.025 *(0.017)*	0.023 *(0.017)*	0.023 *(0.017)*	0.025 *(0.017)*
Functional diversity $_{i, j, t-1}$	0.004 *(0.040)*		0.002 *(0.040)*	0.003 *(0.040)*	0.004 *(0.040)*	0.002 *(0.040)*
Generalist CEO $_{i, j, t-1}$	0.007 *(0.068)*		0.004 *(0.068)*	0.005 *(0.068)*	0.007 *(0.068)*	0.002 *(0.068)*
Company tenure $_{i, j, t-1}$	**0.031**** *(0.011)*		**0.031**** *(0.011)*	**0.031**** *(0.011)*	**0.031**** *(0.011)*	**0.031**** *(0.011)*
Company tenure^2 $_{i, j, t-1}$	**-0.0007**** *(0.0002)*		**-0.0007**** *(0.0002)*	**-0.0007**** *(0.0002)*	**-0.0007**** *(0.0002)*	**-0.0007**** *(0.0002)*
Founder CEO $_{i, j, t-1}$	0.184 *(0.155)*		0.140 *(0.157)*	0.183 *(0.155)*	0.174 *(0.156)*	0.142 *(0.158)*
Tobin's q $_{i, t-1}$			**0.099**** *(0.032)*			**0.100**** *(0.033)*
Capital intensity $_{i, t-1}$				0.065 *(0.076)*		0.061 *(0.077)*
Cash holdings $_{i, t-1}$					0.135 *(0.340)*	-0.053 *(0.349)*
Log pseudolikelihood	-3,181.3	-3,176.6	-3,180.9	-3,181.2	-3,176.3	-3,181.3
Pseudo R^2	0.111		0.112	0.111	0.111	0.112
Number of obs.	5,399		5,399	5,399	5,399	5,399
DV = Trademark flow in new markets $_{i, t}$				(based on the specification for Model 3.8)		
Number of degrees $_{i, j, t-1}$	1.029 *(0.067)*	1.028 *(0.067)*	1.028 *(0.067)*	1.034 *(0.067)*	1.030 *(0.067)*	1.033 *(0.067)*
Degree in engineering and technology $_{i, j, t-1}$	0.860 *(0.088)*	0.864 *(0.088)*	0.859 *(0.088)*	0.863 *(0.088)*	0.858 *(0.088)*	0.860 *(0.088)*
Degree in natural sciences $_{i, j, t-1}$	1.213 *(0.165)*	1.208 *(0.164)*	1.213 *(0.165)*	1.226 *(0.167)*	1.212 *(0.165)*	1.225 *(0.166)*
Degree in business studies $_{i, j, t-1}$	1.013 *(0.095)*	1.006 *(0.094)*	1.014 *(0.096)*	0.999 *(0.094)*	1.013 *(0.095)*	0.999 *(0.094)*
Degree in legal studies $_{i, j, t-1}$	0.756 *(0.149)*	0.760 *(0.149)*	0.753 *(0.149)*	0.771 *(0.152)*	0.754 *(0.149)*	0.767 *(0.151)*
Ivy League university $_{i, j, t-1}$	**1.259*** *(0.121)*	**1.251*** *(0.120)*	**1.260*** *(0.121)*	**1.224*** *(0.118)*	**1.260*** *(0.121)*	**1.226*** *(0.118)*
Years in engineering and R&D $_{i, j, t-1}$	1.004 *(0.010)*	1.004 *(0.010)*	1.004 *(0.010)*	1.005 *(0.010)*	1.004 *(0.010)*	1.005 *(0.010)*
Years in marketing and sales $_{i, j, t-1}$	1.001 *(0.007)*	1.000 *(0.007)*	1.001 *(0.007)*	1.001 *(0.007)*	1.001 *(0.007)*	1.000 *(0.007)*
Years in accounting and finance $_{i, j, t-1}$	1.001 *(0.007)*	1.001 *(0.007)*	1.001 *(0.007)*	1.001 *(0.007)*	1.001 *(0.007)*	1.001 *(0.007)*

Years in operations and manufacturing $_{i, j, t-1}$	0.992 *(0.007)*	0.992 *(0.007)*	0.992 *(0.007)*	0.993 *(0.007)*	0.992 *(0.007)*	0.992 *(0.007)*
Years in law and compliance $_{i, j, t-1}$	1.017 *(0.021)*	1.018 *(0.021)*	1.017 *(0.022)*	1.014 *(0.021)*	1.017 *(0.021)*	1.015 *(0.021)*
Functional diversity $_{i, j, t-1}$	1.011 *(0.044)*	1.011 *(0.044)*	1.011 *(0.044)*	1.006 *(0.044)*	1.011 *(0.044)*	1.007 *(0.044)*
Generalist CEO $_{i, j, t-1}$	**0.870†** *(0.068)*	0.880 *(0.069)*	**0.869†** *(0.068)*	**0.857*** *(0.067)*	**0.870†** *(0.068)*	**0.855*** *(0.067)*
Company tenure $_{i, j, t-1}$	1.014 *(0.013)*	1.013 *(0.013)*	1.014 *(0.013)*	1.017 *(0.013)*	1.014 *(0.013)*	1.017 *(0.013)*
Company tenure^2 $_{i, j, t-1}$	0.9997 *(0.0003)*	0.9997 *(0.0003)*	0.9997 *(0.0003)*	0.9996 *(0.0003)*	0.9997 *(0.0003)*	0.9996 *(0.0003)*
Founder CEO $_{i, j, t-1}$	**1.804**** *(0.326)*	**1.733**** *(0.314)*	**1.801**** *(0.326)*	**1.796**** *(0.324)*	**1.822**** *(0.335)*	**1.809**** *(0.332)*
Trademark flow in new markets $_{i, t-1}$		**1.031†** *(0.017)*				
Tobin's q $_{i, t-1}$			1.014 *(0.041)*			1.012 *(0.041)*
Capital intensity $_{i, t-1}$				**1.270*** *(0.133)*		**1.268*** *(0.133)*
Cash holdings $_{i, t-1}$					0.884 *(0.368)*	0.899 *(0.376)*
Log likelihood	-3,059.7	-3,057.9	-3,059.6	-3,056.7	-3,059.6	-3,056.6
Pseudo R^2	0.036	0.036	0.036	0.037	0.036	0.037
ln(Alpha)	**0.484****	**0.465****	**0.483****	**0.471****	**0.484****	**0.471****
Number of obs.	2,036	2,036	2,036	2,036	2,036	2,036

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect (only for the specifications based on the negative binomial distribution). The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Standard errors, corrected for heteroskedasticity by using the White-Huber method (the logit model) or adjusted overdispersion by using the outer product of the gradient (the negative binomial/truncated negative binomial model), are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. FLC_DV_LG is the model with a lagged value of the dependent variable added to the list of firm-level controls. FLC_TOB_Q is the model with Tobin's q added to the list of firm-level controls; it was calculated as the sum of total assets plus the difference between the market and the book value of equity divided by total assets. FLC_CAP_IN is the model with capital intensity added to the list of firm-level controls; it was calculated as the ratio of property, plants, and equipment to the number of employees. FLC_CAS_HL is the model with cash holdings added to the list of firm-level controls; it was calculated as the ratio of cash and all securities readily transferable to cash to total assets. FLC_ALL_IN is the model with Tobin's q, capital intensity, and cash holdings added to the list of firm-level controls. Sources and variable definitions are given in Table 4.7.

Table 4.A.10. The effect of accounting for a company's diversification

	Negative binomial, logit, and truncated negative binomial models	
	DVS_BASIS	DVS_ALT_SPEC
DV = Trademark flow in existing markets $_{i, t}$		(based on the specification for Model 1.8)
Number of degrees $_{i, j, t-1}$	**1.138**** *(0.046)*	**1.124***** *(0.037)*
Degree in engineering and technology $_{i, j, t-1}$	**0.827**** *(0.053)*	**0.895*** *(0.048)*
Degree in natural sciences $_{i, j, t-1}$	**1.251*** *(0.111)*	**1.274***** *(0.094)*
Degree in business studies $_{i, j, t-1}$	0.948 *(0.053)*	1.050 *(0.050)*
Degree in legal studies $_{i, j, t-1}$	**0.825†** *(0.085)*	**0.852†** *(0.074)*
Ivy League university $_{i, j, t-1}$	1.087 *(0.061)*	0.972 *(0.045)*
Years in engineering and R&D $_{i, j, t-1}$	0.998 *(0.006)*	**0.991†** *(0.005)*
Years in marketing and sales $_{i, j, t-1}$	**0.986**** *(0.005)*	**0.989**** *(0.004)*
Years in accounting and finance $_{i, j, t-1}$	**0.990*** *(0.005)*	**0.992*** *(0.004)*
Years in operations and manufacturing $_{i, j, t-1}$	1.005 *(0.003)*	1.004 *(0.003)*
Years in law and compliance $_{i, j, t-1}$	0.997 *(0.014)*	1.004 *(0.012)*
Functional diversity $_{i, j, t-1}$	0.980 *(0.026)*	0.994 *(0.022)*
Generalist CEO $_{i, j, t-1}$	0.993 *(0.046)*	1.007 *(0.039)*
Company tenure $_{i, j, t-1}$	**1.028***** *(0.007)*	**1.016**** *(0.006)*
Company tenure^2 $_{i, j, t-1}$	**0.9994***** *(0.0002)*	**0.9996**** *(0.0001)*
Founder CEO $_{i, j, t-1}$	**1.310**** *(0.124)*	1.213 *(0.098)*
The number of unique product classes $_{i, t-1}$		**1.247***** *(0.009)*
Log likelihood	-12,174.9	-11,672.7
Pseudo R^2	0.127	0.163
ln(Alpha)	**0.316*****	**-0.030*****
Number of obs.	5,399	5,399
DV = Trademarking in a new market $_{i, t}$		(based on the specification for Model 2.8)
Number of degrees $_{i, j, t-1}$	0.086 *(0.060)*	0.078 *(0.060)*
Degree in engineering and technology $_{i, j, t-1}$	**-0.192*** *(0.088)*	**-0.169†** *(0.088)*
Degree in natural sciences $_{i, j, t-1}$	0.049 *(0.122)*	0.047 *(0.123)*
Degree in business studies $_{i, j, t-1}$	-0.027 *(0.079)*	-0.017 *(0.079)*
Degree in legal studies $_{i, j, t-1}$	**-0.384**** *(0.146)*	**-0.368*** *(0.147)*

Ivy League university $_{i, j, t-1}$	0.013 *(0.082)*	-0.002 *(0.082)*
Years in engineering and R&D $_{i, j, t-1}$	0.007 *(0.009)*	0.005 *(0.009)*
Years in marketing and sales $_{i, j, t-1}$	-0.003 *(0.007)*	-0.002 *(0.007)*
Years in accounting and finance $_{i, j, t-1}$	0.004 *(0.006)*	0.005 *(0.006)*
Years in operations and manufacturing $_{i, j, t-1}$	0.002 *(0.006)*	0.002 *(0.006)*
Years in law and compliance $_{i, j, t-1}$	0.023 *(0.017)*	0.024 *(0.017)*
Functional diversity $_{i, j, t-1}$	0.004 *(0.040)*	0.001 *(0.041)*
Generalist CEO $_{i, j, t-1}$	0.007 *(0.068)*	0.011 *(0.068)*
Company tenure $_{i, j, t-1}$	**0.031**** *(0.011)*	**0.026*** *(0.011)*
Company tenure^2 $_{i, j, t-1}$	**-0.0007**** *(0.0002)*	**-0.0006*** *(0.0002)*
Founder CEO $_{i, j, t-1}$	0.184 *(0.155)*	0.173 *(0.154)*
The number of unique product classes $_{i, t-1}$		**0.053***** *(0.012)*
Log pseudolikelihood	-3,181.3	-3,171.7
Pseudo R^2	0.111	0.114
Number of obs.	5,399	5,399
DV = Trademark flow in new markets $_{i, t}$		(based on the specification for Model 3.8)
Number of degrees $_{i, j, t-1}$	1.029 *(0.067)*	1.027 *(0.067)*
Degree in engineering and technology $_{i, j, t-1}$	0.860 *(0.088)*	0.869 *(0.089)*
Degree in natural sciences $_{i, j, t-1}$	1.213 *(0.165)*	1.214 *(0.165)*
Degree in business studies $_{i, j, t-1}$	1.013 *(0.095)*	1.017 *(0.095)*
Degree in legal studies $_{i, j, t-1}$	0.756 *(0.149)*	0.759 *(0.149)*
Ivy League university $_{i, j, t-1}$	**1.259*** *(0.121)*	**1.246*** *(0.119)*
Years in engineering and R&D $_{i, j, t-1}$	1.004 *(0.010)*	1.004 *(0.010)*
Years in marketing and sales $_{i, j, t-1}$	1.001 *(0.007)*	1.001 *(0.007)*
Years in accounting and finance $_{i, j, t-1}$	1.001 *(0.007)*	1.002 *(0.007)*
Years in operations and manufacturing $_{i, j, t-1}$	0.992 *(0.007)*	0.992 *(0.007)*
Years in law and compliance $_{i, j, t-1}$	1.017 *(0.021)*	1.019 *(0.021)*
Functional diversity $_{i, j, t-1}$	1.011 *(0.044)*	1.012 *(0.044)*
Generalist CEO $_{i, j, t-1}$	**0.870†** *(0.068)*	**0.876†** *(0.069)*
Company tenure $_{i, j, t-1}$	1.014 *(0.013)*	1.013 *(0.013)*

Company tenure^2 $_{i, j, t-1}$	0.9997 *(0.0003)*	0.9997 *(0.0003)*
Founder CEO $_{i, j, t-1}$	**1.804**** *(0.326)*	**1.779***** *(0.321)*
The number of unique product classes $_{i, t-1}$		**1.020†** *(0.012)*
Log likelihood	-3,059.7	-3,058.2
Pseudo R^2	0.036	0.036
ln(Alpha)	**0.484****	**0.470****
Number of obs.	2,036	2,036

† 10% significance; * 5% significance; ** 1% significance; *** 0.1% significance.

To improve the interpretability of results, all coefficients are reported as incidence rate ratios (IRRs): an IRR greater than one suggests a positive effect, while an IRR below one corresponds to a negative effect (only for the specifications based on the negative binomial distribution). Dependent variables are measured at time t. Explanatory variables are measured at time t-1. The constant, CEO controls, firm controls, firm fixed effects, and industry fixed effects are omitted. Standard errors, corrected for heteroskedasticity by using the White-Huber method (the logit model) or adjusted overdispersion by using the outer product of the gradient (the negative binomial/truncated negative binomial model), are in italics. Firm fixed effects (BGV) are based on including the firm i's 5-year pre-sample mean of each dependent variable (see Blundell *et al.*, 1999). Industry fixed effects are based on the Fama and French (1997) 48 industry classification. DVS_BASIS is the basis model without accounting for a company's diversification. DVS_ALT_SPEC is based on DVS_BASIS, with the number of unique product classes included to account for a company's diversification. Sources and variable definitions are given in Table 4.7.

Table 4.A.11. International trademark classification

Class ID number	Class description
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 preparations; 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 and wicks for lighting.
5	Pharmaceutical and veterinary preparations; sanitary preparations for medical purposes; dietetic food and substances adapted for medical or veterinary use, food for babies; dietary supplements for humans and animals; 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; non-electric 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 (excl. land vehicles); machine coupling and transmission components (excl. land vehicles); agricultural implements other than hand-operated; incubators for eggs; automatic vending machines.
8	Hand tools and implements (hand-operated); cutlery; side arms; razors.
9	Scientific, nautical, surveying, photographic, cinematographic, optical, weighing, measuring, signalling, 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; compact discs, DVDs and other digital recording media; mechanisms for coin-operated apparatus; cash registers, calculating machines, data processing equipment, computers; computer software; 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 (excl. furniture); instructional and teaching material (excl. apparatus); plastic materials for packaging (not included in other classes); printers' type; printing blocks.

17	Rubber, gutta-percha, gum, asbestos, mica and goods made from these materials 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 and parasols; 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; combs and sponges; brushes (excl. paint brushes); brush-making materials; articles for cleaning purposes; steelwool; unworked or semi-worked glass (excl. 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 (excl. 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; bed covers; 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, frozen, dried and cooked fruits and vegetables; jellies, jams, compotes; eggs; milk and milk products; edible oils and fats.
30	Coffee, tea, cocoa and artificial coffee; rice; tapioca and sago; flour and preparations made from cereals; bread, pastry and confectionery; ices; sugar, honey, treacle; yeast, baking-powder; salt; mustard; vinegar, sauces (condiments); spices; ice.
31	Grains and agricultural, horticultural and forestry products 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 beverages; fruit beverages and fruit juices; syrups and other preparations for making beverages.
33	Alcoholic beverages (excl. beers).
34	Tobacco; smokers' articles; matches.
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.

43	Services for providing food and drink; temporary accommodation.
44	Medical services; veterinary services; hygienic and beauty care for human beings or animals; agriculture, horticulture and forestry services.
45	Legal services; security services for the protection of property and individuals; personal and social services rendered by others to meet the needs of individuals.

Source: https://www.uspto.gov/trademark/trademark-updates-and-announcements/nice-agreement-tenth-edition-general-remarks-class.

APPENDIX 4.B. THE CLASSIFICATION OF UNIVERSITY DEGREES BY SUBJECT AREA

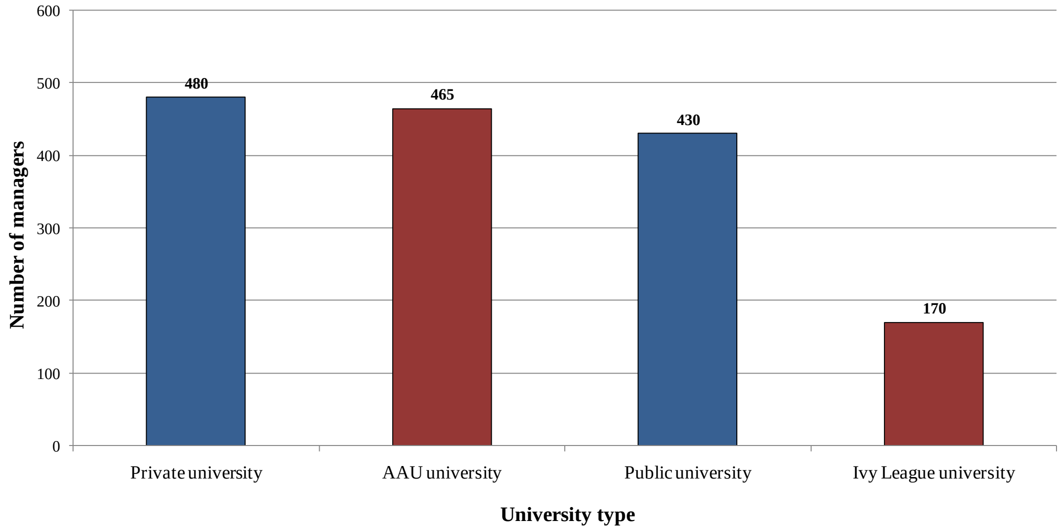
To analyse educational background under the qualitative angle, we coded all higher education degrees into seven categories: (1) arts and humanities; (2) engineering and technology; (3) life sciences and medicine; (4) natural sciences; (5) business studies; (6) legal studies; and (7) other social sciences.[a] For those individuals who hold dual honours degrees (e.g., in engineering and political science), we corrected the final mapping so that to account for both specialisations. Table 4.B.1 assigns the key words identified in degree names to corresponding subject areas (overall, 215 degree names were examined). The results of the final mapping are presented in Figures 4.B.1 and 4.B.2.

Table 4.B.1. The mapping of the key words identified in degree names to subject areas

No.	Subject area	Key words	Number of associated degrees
1	Arts and humanities	American studies; anthropology; communications; European civilization; history; humanities; journalism; language (English, French, of Russian); literature; music; philosophy; radio and television; theater	26
2	Engineering and technology	aeronautics; architectural design; computer science; electronics; engineering; information systems; mechanical drafting; naval science; technology; textiles	43
3	Life sciences and medicine	animal science; behavioral science; health; medicine; pharmacy; poultry science and nutrition; psychology; zoology	12
4	Natural sciences	biology; chemistry; geology; mathematics; mechanics; metallurgy; nuclear science; physics	22
5	Business studies	accounting; administration; banking; business; commerce; economics; executive leadership; finance; industrial and labor relations; management; marketing; MBA; risk and insurance; technology commercialization	63
6	Legal studies	JD; justice; law; taxation	6
7	Other social sciences	education; government; international affairs/relations/studies; political science; public affairs; public policy; real estate; social studies; sociology	18
-	Dual honours degrees	(e.g.) biology and history; education and mathematics; engineering and political science; English and economics; mathematics and economics; psychology and business	25

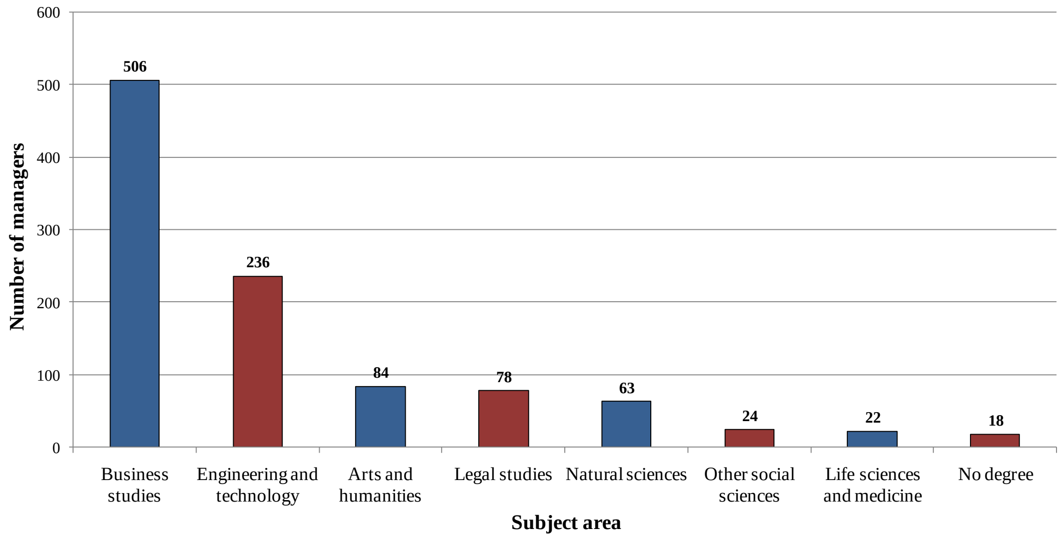
[a] It is worth a mention that the classification used here is largely based on the methodology developed by Quacquarelli Symonds Limited for their university rankings. The only difference is that we had to split the social sciences category into three subcategories – business studies, legal studies, and other social sciences – to be consistent with the way our hypotheses are framed.

Figure 4.B.1. The number of managers by university type



Note: the total counts are based on any university attended. Some individuals studied at different universities, so the results are not mutually exclusive.

Figure 4.B.2. The number of managers by subject area



Note: the total counts are based on any degree attained. Given that individuals could earn degrees in different subject areas, the results are not mutually exclusive.

APPENDIX 4.C. THE CLASSIFICATION OF POST NAMES BY FUNCTIONAL AREA

To obtain information about the functional expertise of CEOs in our sample, we used the career progression statistics covered by the BoardEx database.[a] Since the required data were not readily available, we had to design a two-staged procedure which involved examining 15,315 post-related observations, including 3,774 entries where the role description field was populated. Firstly, we mapped post names to the following functional areas (each area was broadly defined to accommodate potential disparities post names may have in different organisations): (1) general management; (2) engineering and R&D; (3) marketing and sales; (4) accounting, finance, and audit; (5) administration, operations, and manufacturing; (6) law and compliance; (7) personnel; (8) advisory services, planning, and strategy; and (9) other unclassified positions.[b] Table 4.C.1 presents the key words we identified through the analysis of post names and assigns them to corresponding functions (there are 1,002 unique post names in total).

Table 4.C.1. The mapping of the key words identified in post names to functional areas

No.	Functional area	Key words	Number of associated posts
1	General management	(e.g.) CEO (incl. interim); chairman (incl. chairwoman, deputy, senior, and vice); corporate secretary; executive officer; general manager; group executive; group head; president (incl. senior and vice); principal; senior executive	576

[a] One problem we encountered while using the BoardEx database was its time bias due to which 51 CEOs in our sample had not been assigned with any career statistics. To address this issue, we manually collected all the necessary information by analysing the LexisNexis news database; Marquis Who's Who biographical data; SEC filings; obituaries; and other data sources. The same applies to Appendix 4.D.

[b] This classification is largely based on previous works by Barker and Mueller (2002), Beal and Yasai-Ardekani (2000), Govindarajan (1989), Hambrick (1981), and Hoffman and Hegarty (1993). However, we had to rearrange certain areas to account for a high degree of functional proximity. In addition, we also extended the list by adding "Advisory services, planning, and strategy" and "Law and compliance" categories. At first, we identified the 10th area – "Administration"; the reasoning goes that despite their prevailing association with operations, administrative officers may be assigned extra responsibilities related to budgeting, HR, or sales, to name a few. Given that the number of observations coded as "Administration" was marginal (62 out of 15,315, or 0.40%), we then decided to merge it with "Operations and manufacturing", controlling for potential mismatches through the analysis of role description. Finally, it should be stressed that the categories are not mutually exclusive. For instance, the post "President/CFO/COO" was assigned to both "Accounting, finance, and audit" and "Administration, operations, and manufacturing" functions. This approach is consistent with Hambrick's (1981:261) contention that "multiple functions capture hybrid tasks that do not align with a single function".

2	Engineering and R&D	advanced systems; aerospace; communications; design; engineer; information officer; information services; innovation; IT; physicist; product development; programming; project; research; scientist; software architect; technical director; technical officer; technical services; technology	55
3	Marketing and sales	account executive; account manager; advertising; brand; CCO; commercial; customer; marketing; merchandise; merchandising; product development; product management; product manager; product officer; retail; sales; store manager	86
4	Accounting, finance, and audit	accountant; accounting; audit; auditor; cashier; CFO; comptroller; controller; corporate banking; credit; economic; economics; economist; finance; financial; investment; investor; loan; rates; tax; taxation; treasurer; treasury; trust manager	170
5	Administration, operations, and manufacturing	administration; administrative; CAO; communications; COO; corporate services; distribution; energy services; exploration; general manager for gas; geologist; global services; information officer; information services; IT; logistics; manufacturing; materials; operations; operations manager; operations officer; operating manager; operating officer; operating partner; plant manager; production; purchase; purchasing; quality; resource; superintendent; supply; systems; technical director; technical officer; technical services; utility services	170
6	Law and compliance	advocate; attorney; compliance; contracts; counsel; judge; lawyer; legal; legislative	37
7	Personnel	HR; labor relations; personnel; staff	8
8	Advisory services, planning, and strategy	advisor; advisory; commission; commissioner; committee; consultancy; consultant; consulting; council; counsellor; development; mergers & acquisitions; planner; planning; program manager; project; projects; restructuring; strategic; strategy	88
9	Other unclassified positions	(e.g.) correspondent; moderator; limited partner; program director; senior member; trustee	194

Secondly, we rectified the mapping by considering role description whenever that field was populated with data. We effectively had to repeat the approach with the key words employed at the previous stage, also expanding the original vocabulary to reflect a greater variability of plain text used for clarifying job details. When accepting a correction, much effort was given to distinguishing the top manager's functional area description from the information related to the company's business profile. As an illustration, there was no correction made for "Industrial computer and communication group", whereas entries containing "Financial planning and analysis" were assigned to the "Accounting, finance, and audit" function. Overall, we managed to extract additional information for 1,205 observations (see the results of the mapping in Table 4.C.2). For a number of tracks this procedure resulted in significantly improving net counts, namely: "Personnel" (+57.7% of the final number); "Marketing and sales" (+53.9%); and "Engineering and R&D" (+53.2%). For other functions the correction yielded an improvement ranging from 26-28% of the total counts.

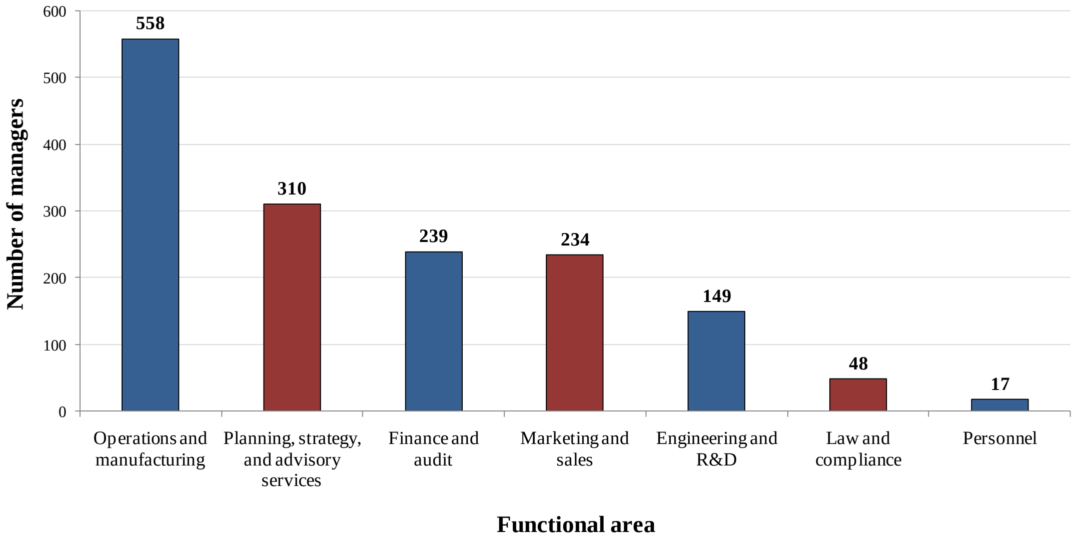
Table 4.C.2. The results of the functional track mapping

No.	Stage name	Number of posts mapped	
		abs.	%
1	Mapping the positions for which role description is not populated	11,541	75.3%
2	Mapping the positions for which there is no extra information in the role description field (no correction)	2,569	16.8%
3	Mapping the positions for which role description includes extra information (with correction)	1,205	7.9%
Total		15,315	100.0%

Recognising the cumulative nature of functional experience, we employed the year in which the top manager was appointed to the position in order to track experience accumulation. It should also be noted, that the start date field contains missing values for 2,225 out of 15,315 observations (or 14.5%). Therefore, such an approach may result in a non-negligible risk of false negatives should we ignore incomplete observations. To address this issue, at least to some extent, we created a set of functional experience dummies based on the assumption that all observations with the missing start year value corresponded to earlier stages of the CEO's career; hence, we related them to the pre-tenure period.[c] A detailed examination of the data for each functional area revealed that regardless of the approach, there were no significant differences in tracking experience across functions. The only notable exception was the "Advisory services, planning, and strategy" category, with 25.7% of its observations having the start year missing. Given the data quality, we decided to exclude this functional track from further analysis. The results of the final mapping are presented in Figure 4.C.1.

[c] In other words, the former method relates these observations to the CEO's *ex post* experience, and it is in contrast to treating them as an *ex ante* experience if the latter method is used. Furthermore, it appears reasonable to assign observations where the start year is missing to CEOs' earlier career stages because the BoardEx database tends to suffer from the recordation problem for older entries.

Figure 4.C.1. The number of managers by functional area



Note: we excluded observations where the start year value was missing; the total number of CEOs in our sample is 821.

APPENDIX 4.D. THE CONSTRUCTION OF THE INSTITUTIONAL DIVERSITY INDEX

Since career experiences other than functional specialisation also tend to influence the approaches top managers adopt to deal with strategic situations (Hambrick and Mason, 1984), our goal here is to separate CEOs who had been exposed to different industrial and organisational environments from those with a more streamlined career path. In doing so, we processed the career progression statistics provided by the BoardEx database and used the results to construct the institutional diversity index for each sampled CEO. The composition of the proposed measure partly corresponds to the index developed by Custódio *et al.* (2013),[a] meaning that we also started with calculating the number of (1) industries and (2) companies chief executives had worked in before. Then we included a set of dummy variables to capture their (3) military, (4) civil service, and (5) academic experiences. The rationale behind using the former two proxies consists in capturing a variety of operating environments top managers had encountered over their prior working lives. As for the industry-specific dummies, they are added due to the growing evidence that the involvement of top managers in certain socio-economic activities is likely to affect their cognition and strategic behaviour. Particularly, it has been shown that military experience is associated with conservative corporate policies and ethical behaviour (Benmelech and Frydman, 2015); civil service experience may induce politically-motivated actions, with a potentially negative impact on corporate outcomes (Bertrand *et al.*, 2007); and academic experience, under certain circumstances, leads to path dependencies in the application of human capital and the productivity of inventive activities (Corolleur *et al.*, 2004; Dietz and Bozeman, 2005).

Each element in our experience diversity measure was calculated by applying a purposely designed procedure. First, we matched publicly traded companies in our sample to those in the Compustat database to extract industry codes.[b] As this method yielded large discrepancies across top managers,[c] we decided to balance it out not only by covering private

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[a] In their study, Custódio *et al.* (2013) refer to it as the general ability index that aims to capture the generality of chief executives' human capital. We believe, however, that "institutional diversity" would be a more precise characteristic of the proposed measure in our case.

[b] For this variable we used the U.S. Standard Industry Classification grouped at the 2-digit level. We also experimented with employing the Fama-French industry classification (Fama and French, 1997) instead; however, the choice of an industry grouping had virtually no influence on the overall experience diversity measure because the estimates produced by using different approaches were highly correlated (Pearson's correlation coefficient was 0.99).

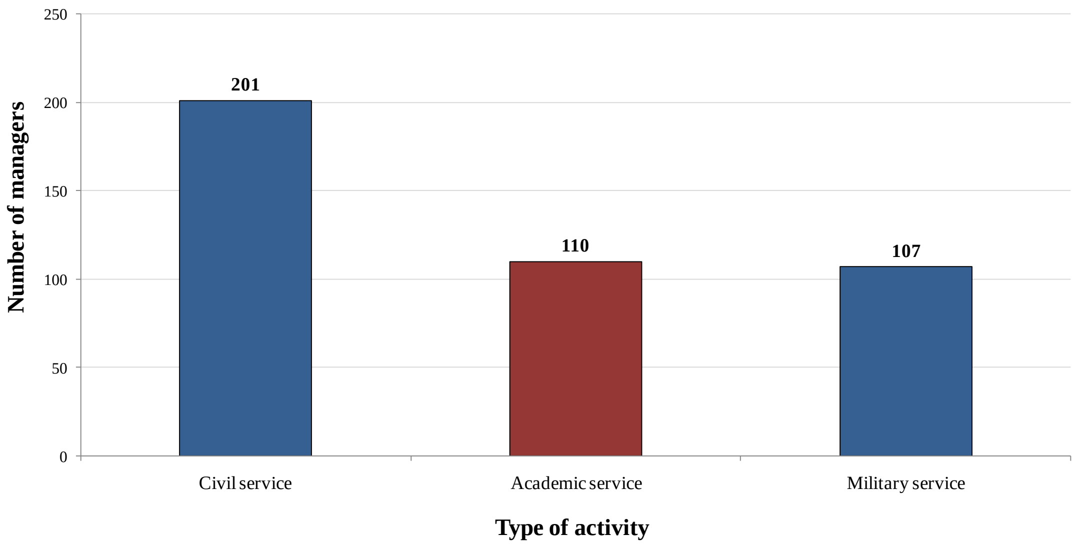
[c] A preliminary analysis revealed that for some CEOs all companies they had worked for were assigned with corresponding industry codes, whereas other executives had up to 90% companies with no industry class identified.

firms, governmental bodies, and educational organisations, to name a few, but also by expanding the range of information sources to rely on. So, we hand-collected the remaining industry codes by referring to companies' official web-sites; SEC filings; business profiles provided by Nasdaq, Inc. and Morningstar, Inc.; and to siccode.com and manta.com databases (the latter two were especially useful for mining the data related to private firms). It should be noted, however, that much effort was given to avoiding potential mismatches: for example, if there were companies with a similar name but different industry codes, locations, legal forms, and so on, no industry affiliation was established. Eventually, we were able to improve the industry linkage by around 40 percentage points – from 35.4% to 75.2%; the average effect was also noticeable and resulted in a decrease in the number of companies with missing industry codes from 21.9% to 10.5% per a CEO. The calculation of this index component was completed by counting the number of unique industries the CEO had experienced (this and other variables are cumulative and determined on a yearly basis).

Next, we derived the number of unique companies a chief executive had worked for. Before proceeding with this task, it is worth a mention that in the BoardEx database, some company names contain extra elements (such as a former name, a trading name, or the date when the company was de-listed) which may lead to name inconsistencies. Without addressing this issue, "GEORGIA PACIFIC GROUP (De-listed 12/2005)" and "GEORGIA PACIFIC GROUP", for example, would be regarded as two different companies. To avoid artificial inflation of the firm diversity estimate, we performed the harmonisation of company names by removing all the unnecessary elements mentioned above. Only after completing that stage was the corresponding variable computed.

Finally, we examined company names, post names, and role descriptions to construct a series of dummy variables for our institutional diversity measure. We identified top managers with military background by checking first post names for the "Military service" pattern and then company names for "United States Marine", "US Air Force", "US Army", "US Coast Guard", and "US Navy" key words. The civil service experience dummy was constructed by looking through company names and selecting the President's office, advisory councils, boards, and committees; national and regulatory commissions; local, state, and federal governments, including their departments and agencies; the U.S. Congress and its constituting chambers – the Senate and the House of Representatives; courts; Federal Reserve Banks; and other state authorities. Academic experience was revealed by focusing on universities and colleges among the companies for which top managers had worked, as well as by searching for such patterns as "professor", "lecturer", "scholar", and "researcher" in post names. Figure 4.D.1 demonstrates some results of the experience matching.

Figure 4.D.1. The number of managers by socio-economic activity



Note: the total number of CEOs in our sample is 821.

The experience diversity measure was then constructed by carrying out the principal component analysis. The main advantage of this method is that it enables us "to reduce the dimensionality of a data set consisting of a large number of interrelated variables, while retaining as much as possible of the variation present in the data set" (Jolliffe, 2002:1). In practical terms, we are able not only to remedy the multicollinearity problem, but also to account for different types of professional experience within one measure. So, we first extracted principal components (mutually orthogonal) and ordered them according to the proportion of the variation in the original dataset they could explain. The weight of each component was determined by the corresponding eigenvector of the correlation matrix (see Tables 4.D.1 and 4.D.2).

Table 4.D.1. Eigenvalues of the correlation matrix

Component	Eigenvalue	Difference	Proportion	Cumulative
Component 1	2.153	1.171	0.431	0.431
Component 2	0.982	0.065	0.197	0.628
Component 3	0.917	0.186	0.183	0.811
Component 4	0.731	0.515	0.146	0.957
Component 5	0.216	-	0.043	1.000

Table 4.D.2. Principal components (eigenvectors)

Variable	Comp.1	Comp.2	Comp.3	Comp.4	Comp.5
Number of industries	0.611	-0.027	-0.094	-0.324	-0.715
Number of companies	0.604	-0.025	-0.056	-0.382	0.697
Military experience	0.169	0.948	-0.111	0.244	0.012
Civil service experience	0.392	-0.315	-0.378	0.776	0.044
Academic experience	0.283	-0.020	0.913	0.294	-0.012

In order to decide on the number of components to retain, we used Horn's (1965) parallel analysis to guide our choice. Specifically, we computed eigenvalues for a randomly generated dataset with the same numbers of observations and variables as in our original dataset. For each component, the average eigenvalue was subsequently calculated by repeating the random generation N times (in our case, we used N = 100 simulations). As the eigenvalues in the principal component analysis should be retained only if they are greater than the average eigenvalues in the parallel analysis, we chose to keep the first component – it accounted for 43.1% of the variation in characteristics (see Table 4.D.3).

Table 4.D.3. Parallel analysis

Component	Principal component analysis	Parallel analysis	Difference
Component 1	2.153	1.037	1.117
Component 2	0.982	1.016	-0.034
Component 3	0.917	1.000	-0.082
Component 4	0.731	0.984	-0.253
Component 5	0.216	0.964	-0.748

As Table 4.D.2 shows, the first component has positive loadings on all the variables. So, we can interpret it as a measure of institutional diversity, with higher levels of institutional diversity being associated with higher levels of the suggested index. To complete the analysis, we derived the institutional diversity index (IDI) for each top manager in our sample by applying the following formula to mean-centred variables (the regression scoring method was used to calculate the weights; the index was subsequently normalised to have zero mean and a standard deviation of unity):

$$IDI_{i,t} = 0.611 * Y_{1,i,t} + 0.604 * Y_{2,i,t} + 0.169 * Y_{3,i,t} + 0.392 * Y_{4,i,t} + 0.283 * Y_{5,i,t},$$

where $Y_{1,i,t}$ is the number of industries CEO_i has worked in until year t; $Y_{2,i,t}$ is the number of companies CEO_i has worked for until year t; $Y_{3,i,t}$ is the military experience dummy for CEO_i in year t; $Y_{4,i,t}$ is the civil service experience dummy for CEO_i in year t; and $Y_{5,i,t}$ is the academic experience dummy for CEO_i in year t.

CHAPTER 5. CONCLUSION

The overall objective of this thesis was to improve our understanding of intellectual property, with a specific focus on the managerial aspects of its protection and exploitation. Unlike previous studies that were primarily concerned with patent matters, this work made extensive use of trademark statistics, a comprehensive analysis of which has still been fairly new to the academic literature.

The thesis opens with *a systematic review of empirical trademark research*. Despite its relative youth, this field of inquiry has already accumulated a critical mass of reliable evidence that might assist scholars with determining, evaluating, and comparing various effects of trademark activities on organisational functioning. So, here we first identified the basic contributions in the field, then carefully reviewed them, and finally suggested a framework that brings together different research streams. Unlike prior reviews that paid most attention to the economic side of trademarking, our work has broadened the analysis further by looking at valuable insights from such disciplines as management and marketing. It has particularly revealed that studies relying on trademark statistics have revolved around five broad areas, namely: (i) the determinants of trademark deposits; (ii) the role of trademarks in differentiating product offerings; (iii) the link between trademark and innovation activities; (iv) the strategic use of trademarks; and (v) the impact of trademarks on organisational performance. We have found that among these areas, considerable interest has been shown in examining the value, profit, and survival gains that companies can obtain from trademarking; another popular topic has been the use of trademark analysis for assessing innovation processes and outcomes. At the same time, little has been known about the managerial dimension of trademark activities – this is in spite of some prior attempts to address this issue. In the next two essays, we sought to fill this gap.

The thesis then turns to *a consideration of the role played by chief executives in intellectual property strategy*. In this part of the study, we first devised a range of personal traits that seemed to be relevant to intellectual property management. More specifically, we argued that by combining the skills, knowledge, and experience possessed by an individual into legal, scientific, and business profiles, one can capture three basic approaches that senior managers might take towards governing intellectual property protection. We also added such characteristics as the generality of previous background and individual proactiveness to obtain a more complete picture of executive personality. As for the latter, we proposed a novel indicator that accounted for awards received by a chief executive and, hence, exploited the already observed link between the need for achievement and individual proactivity. Finally, we used patent and trademark statistics to capture the principal motives behind protecting intellectual property, including the protection of inventions, the protection of new product identity, and the protection of acquired reputation.

The results of this analysis have generally supported the contention that executive characteristics are important for explaining a firm's decision to protect its intangible assets. Unlike previous studies, however, we have shown that senior managers may not necessarily see more protection in a positive light. We have found, among other things, that they tend to favour patent applications, no matter what perspective on intellectual property they take, because the personality profiles in this case only determine the strength of the effect, not its direction. At the same time, the attitude towards trademark applications appears to be more complex: that is, only proactive executives facilitate the protection of new product identity, while the protection of acquired distinctiveness is largely discouraged across all the personality profiles. These findings contribute to our understanding of intellectual property in a number of ways. For example, they prove the hypothesis that the managerial perspective should be considered as yet another determinant of patent and trademark activities, along with firm-level factors and the external environment. Since intellectual property protection consists of multiple stages, it also seems that differences in the attitudes of chief executives towards each of these stages are likely to affect the strategy's overall efficiency.

The thesis concludes with *an analysis of the ways in which chief executives affect product differentiation*. Here, we started with an attempt to address potential concerns about whether senior managers might at all be responsible for the planning and implementation of business, let alone functional, strategies. Based on previous works in strategic marketing and also by referring to the hierarchical view of strategy, we came up with two transmission mechanisms. On the one hand, chief executives can be directly engaged in differentiation issues when certain conditions are met: for example, the company has homogeneous product lines, with the managerial attention not being spread thinly across a number of activities and segments; some elements of differentiation strategy appear to be especially important for the functioning of the business processes and the firm's survival in the marketplace; or the quality of human resources is such that personal involvement helps executives avoid the problem of mismanagement. So, these are likely to result in the divergence between the locus of strategy and the locus of decision making. On the other hand, decisions made by senior mangers as part of corporate strategy can influence lower level strategies as well, provided that strategy levels are interdependent. As for product differentiation per se, to better capture various dimensions of this strategy, we divided the flow of trademarks into the marks introduced in new and existing product markets.

Our results have shown that managerial characteristics do guide the development of differentiation strategy. To be more specific, we have found that executive tenure, age, education, functional experience, monetary incentives, CEO duality, and the founder and owner statuses are statistically significant for explaining variations in product differentiation across various companies, even when firm- and industry-specific effects are controlled for. Furthermore, we have also demonstrated that depending on the transmission mechanism, chief executives may leverage different traits – a fine example is CEO tenure, which is only significant when it comes to differentiating in new markets. Overall, this research, as well as our previous essay, has supported the idea that top managers are not just passive observers – their values and cognitive basis influence the decision-making process and, as such, have a significant impact on strategic choices and performance levels.

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