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THE VALUE OF CORPORATE DIVERSIFICATION: AN ANALYSIS THROUGH THE REAL OPTIONS LENS

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DOCTORAL DISSERTATION:

THE VALUE OF CORPORATE DIVERSIFICATION: AN ANALYSIS THROUGH THE REAL OPTIONS LENS

A dissertation submitted by **María del Pilar Velasco González** to the **University of Valladolid** in partial fulfilment of the requirements for the PhD degree with international doctor mention

Supervised by:
Dr. Pablo de Andrés Alonso
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“¡El mar es todo! Cubre las siete décimas partes del globo terrestre. Su aliento es puro y sano. Es el inmenso desierto en el que el hombre no está nunca solo, pues siente estremecerse la vida en torno suyo”.

(Julio Verne)

“The sea is everything! It covers seven tenths of the terrestrial globe. Its breath is pure and healthy. It is an immense desert, where man is never lonely, for he feels life stirring on all sides”.

(Jules Verne)

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RESUMEN DE LA TESIS

Esta tesis doctoral analiza la relación entre diversificación corporativa y valor de la empresa desde el enfoque de las opciones reales. La relación diversificación-valor ha motivado abundante investigación, con aportaciones destacadas especialmente desde los campos de Dirección Estratégica y Finanzas. Sin embargo, la controversia en torno a ella parece no haberse disipado y la pregunta de si la diversificación corporativa crea o destruye valor permanece abierta. En esta tesis, sostenemos que el impacto de la diversificación depende de las oportunidades de crecimiento de la empresa, las cuales son consideradas por la teoría de opciones como una importante fuente de valor para la firma. Nuestra investigación adopta la perspectiva de opciones reales, desde la cual la diversificación se concibe como una estrategia *path-dependent* basada en la adquisición y ejercicio secuencial de opciones de crecimiento. Esta tesis contribuye a extender la aplicación del enfoque de opciones reales a las estrategias corporativas, y sugiere la relevancia de incorporar una visión multidimensional y un análisis contingente en el debate de la diversificación.

La parte teórica de la tesis se articula en dos capítulos. El Capítulo 1 contiene la revisión de la literatura sobre diversificación empresarial, con especial énfasis en la evidencia empírica disponible sobre la relación diversificación-valor. En el Capítulo 2 se introduce el enfoque de opciones reales y sus principales aplicaciones al análisis de las estrategias corporativas, así como nuestro modelo e hipótesis de estudio a contrastar en los tres capítulos posteriores.

La tesis consta de tres estudios empíricos, todos ellos basados en una muestra de empresas de EEUU desde 1998 a 2010 y en el empleo de técnicas econométricas para

controlar la endogeneidad de la decisión de diversificación. En el Capítulo 3, se investiga si las opciones de crecimiento de la empresa pueden ayudar a explicar la influencia de la diversificación en el valor de la empresa. Encontramos que, en niveles reducidos de diversificación, esta estrategia corporativa principalmente conlleva el ejercicio de oportunidades de inversión previamente adquiridas; mientras que en estados más avanzados se convierte mayoritariamente en fuente de opciones de crecimiento (relación en forma de U). Nuestros resultados también revelan que las oportunidades de crecimiento juegan un papel de mediación parcial en la relación diversificación-valor. Esta estrategia demuestra crear valor por medio del aumento de las opciones de crecimiento de la empresa (efecto indirecto) que surgen de la combinación de múltiples negocios y que, por consiguiente, no pueden ser replicadas por los inversores individuales en los mercados de capital externos.

En el Capítulo 4, contrastamos si el efecto valor de la diversificación depende de cómo se implementa esta estrategia. Distinguimos dos estrategias de diversificación: una basada en inversiones en una única etapa, ejerciendo las opciones disponibles de forma inmediata (diversificación de *assets in place*), y otra estrategia orientada a la construcción de nuevas opciones de crecimiento en otros negocios por medio de inversiones a pequeña escala (diversificación de opciones). Desarrollamos un índice para aproximar estos patones de diversificación y encontramos que a medida que la diversificación se aproxima a un patrón de opciones, tiene un efecto más beneficioso en términos de creación de valor.

El último estudio empírico se recoge en el Capítulo 5. En este caso, examinamos cómo la diversificación corporativa interactúa con la cartera de opciones de crecimiento de la empresa. Nos centramos en dos dimensiones de esta estrategia: el grado de diversificación y la relación entre segmentos de negocio. Primero, encontramos una relación en forma de U invertida entre la relación entre segmentos y el ratio de opciones de crecimiento de la empresa. Los resultados también indican que esta relación es menos pronunciada en empresas más diversificadas que en las menos diversificadas. Adicionalmente, se muestra que el riesgo de anticipación de la competencia modera negativamente la relación de U entre grado de diversificación y ratio de oportunidades de crecimiento mostrada en el Capítulo 3.

En conclusión, esta tesis pone de manifiesto la relevancia de las oportunidades de crecimiento en el efecto valor de la diversificación corporativa. En la medida en que las oportunidades de inversión a las que pueda dar acceso esta estrategia no sean replicables por los inversores individuales, la diversificación empresarial resulta una estrategia eficiente y por tanto, creadora de valor. Para la práctica de dirección de empresas, esta tesis revela cuán importante es para la creación de valor la forma en que se implementan las estrategias.

DISSERTATION ABSTRACT

This PhD dissertation analyses the relationship between corporate diversification and firm value from the real options (RO) approach. The diversification-value linkage has inspired abundant research, with outstanding contributions especially from the fields of strategic management and finance. However, the controversy surrounding the issue does not seem to have dissipated, and the question of whether corporate diversification creates or destroys value for firms remains open. In this dissertation, we argue that the impact of diversification is contingent on the firm's growth opportunities, which are considered by the RO theory as an important source of value for firms. Our research adopts an options-based perspective, from which diversification appears as a path-dependent strategy based on the serial purchase and exercise of call options. This dissertation contributes to extending the applicability of the real options approach to strategy, and suggests the relevance of incorporating a multidimensional view and contingent analysis in the diversification debate.

The theoretical body of this dissertation is structured in two chapters. Chapter 1 contains the review of the literature on corporate diversification, with special emphasis on the empirical evidence concerning the diversification-value relation. In Chapter 2, we introduce the RO approach and its main applications to the analysis of corporate strategies, as well as our model and study hypotheses to test in the three subsequent chapters.

This dissertation consists of three empirical studies, based on a panel sample of U.S. firms from 1998 to 2010 and the use of econometric techniques to control for the endogeneity of the diversification decision. In Chapter 3, we investigate whether firm's

growth options can explain the influence of diversification on firm value. We find that, at lower levels of diversification, this corporate strategy mainly involves exercising previously acquired investment opportunities, whereas in subsequent stages it primarily becomes a source of growth options (U-form relationship). Our results also reveal a partial mediating role of growth opportunities in the diversification-value relationship. This strategy proves value-creating by enhancing the firm's growth options (indirect effect) stemming from the interplay of multiple businesses and thus cannot be replicated by individual investors in external capital markets.

In Chapter 4, we test whether the value effect of diversification depends on "how" this strategy is implemented. We consider two diversification strategies: one based on one-step investments, exercising available options immediately (an assets-in-place diversification), and another aimed at constantly building new growth options in subsequent businesses through low-scale investments (options-based diversification). We develop an index to proxy for these diversification patterns and we find that as diversification approaches a real options pattern, it proves more beneficial in terms of value creation.

The final empirical study is offered in Chapter 5. Here, we examine how corporate diversification interacts with the firm's growth options portfolio. We focus on two dimensions of this strategy: degree of diversification and relatedness between segments. First, we find an inverted U-shaped relation between relatedness and the firm's growth options ratio. Results also indicate that this relationship is less pronounced in high than low diversifiers. Additionally, we show that risk of preemption negatively moderates the U-form relation between degree of diversification and growth opportunities documented in Chapter 3.

In short, this dissertation shows the relevance of growth opportunities in the value effect of corporate diversification. Insofar as the growth opportunities which this strategy can give access to are not replicable by individual investors, corporate diversification becomes an efficient and therefore, value-creating strategy. For management practice, this dissertation reveals how important the way strategies are implemented may prove for value creation.

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INTRODUCTION

Corporate diversification has been a widespread growth strategy in the business environment. Intuitively, this strategy enables firms' managers to *avoid putting all the eggs in one basket* and to expand their enterprises by building large conglomerates. The increasing popularity of business diversification contrasts with the disparity of positions concerning whether such a strategy creates or destroys value for firms. Does corporate diversification make sense if stockholders can diversify their individual portfolios at a lower cost in external capital markets? Should stockholders be able to do so, corporate diversification would become an inefficient strategy and thus, value-destroying. Despite the relevance of this question and the abundant accumulated research on this issue, a controversy-free explanation is yet to be reached.

The impact of corporate diversification on value creation is a long-standing controversy in the literature. The bulk of the research is not optimistic vis-à-vis the implications of this strategy for value creation, whilst diversified firms continue to play such a large part in modern economies. Evidence in prior literature ranges from the diversification discount (the prominent position) to the diversification premium, and also includes the lack of any significant relationship. As it stands today, why firms diversify and the impact which such a strategy has on a firm's value is a puzzle which remains as yet incomplete and indeed which is still missing some pieces.

The so-called *diversification puzzle* remains unsolved in both the academic and the business sphere. The origin of this conflicting evidence also remains unclear. Endogeneity, measurement problems, and database limitations head the list of obstructive factors which may obscure the true relationship between diversification and corporate value, whilst a number of papers point out that the conflicting empirical findings might be an artifact caused by an "aggregation effect" in diversification analyses. Such a dichotomy between the diversification discount and the premium is confined to exploring the value implications of this strategy, since each company has its own intrinsic characteristics and implements diversification in a different manner. In this vein, recent strands of research support a contingent-based perspective from which diversification value outcomes are not homogeneous across firms but are rather viewed as dependent on certain environmental or firm-specific characteristics which may explain the success or failure of diversification expansions. As a result, the question guiding so much research seems to demand review: “Does corporate diversification create value for firms? It depends …” Seeking the conditions under which business diversification is likely to enhance a firm’s value is becoming the core issue.

This dissertation incorporates such a contingent view of the diversification-value relationship from a real options (RO) approach. Recent research emphasizes the potential of RO thinking for analyzing corporate strategies. Such a theoretical framework allows a more direct connection between the analysis of corporate diversification and firm market value in contexts of uncertainty. RO analysis considers that the value of a strategy does not only derive from the expected free cash flow but also from future investment opportunities, “options”, which may emerge along the way, thus opening up to the firm a new range of possibilities to act in the future or even enhancing the value of investments in progress. RO logic conceives the investment process in a more dynamic way, with managers playing an active role. From an RO approach, growth strategies are seen as gradual investments based on the purchase and exercise of a chain of interrelated options. Each minor investment allows *a foot in the door* for better access to future investment opportunities while at the same time firms limit their exposure to risk and remain flexible to readjust the strategy depending on the evolution of uncertainty. The underlying logic in the RO approach seems to guide us towards an additional dimension of corporate diversification to which prior literature has paid insufficient attention, namely how the strategy is implemented. As a result, managers should not only consider the “to diversify or not to diversify” dilemma but also “how” to invest.

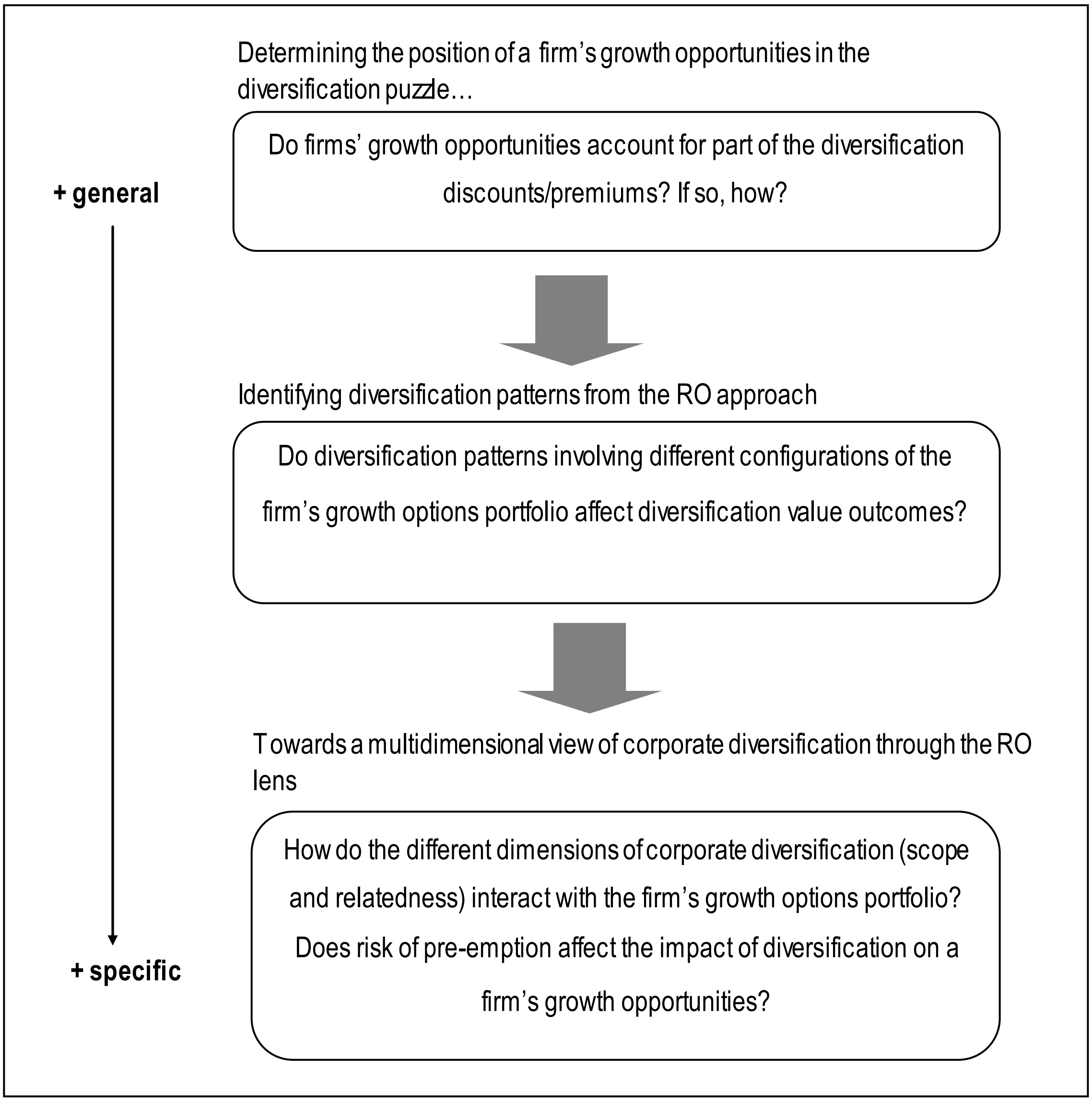
By exploring the diversification-value map adopting the real options (RO) approach as our compass, the diversification puzzle appears as a trinomium comprising a diversification strategy, a firm’s growth opportunities, and a firm’s value. Based on this strand of literature, we formulate our hypotheses which, in general terms, link the various dimensions of corporate diversification to the firm’s portfolio of growth opportunities and the value effect of diversification to the value of such a portfolio. Our hypotheses are tested on a panel sample of U.S. companies from 1998 to 2010.

The research questions raised in this dissertation can be divided into three different levels, from the more general to the more specific. The first level addresses the role which growth opportunities may play in the diversification-value relationship. This level enables us to investigate whether it makes sense to include growth options in the diversification puzzle. This general question is the basis on which our subsequent research is built.

Assuming the relevance of growth options, we delve more deeply into the characterization of corporate diversification as series of growth options. This RO approach leads us to consider how investment strategy is implemented. RO patterns, involving different configurations in the growth options portfolio become of paramount importance. Here, we ask whether such diversification patterns impact firm value.

Next, we proceed to the final level of our research questions. Should diversification patterns contribute to explaining part of the diversification value outcomes, this would provide further support for a multidimensional view of the diversification strategy. Most existing research has focused on the degree of diversification, yet there are additional dimensions which characterize and differentiate the diversification strategy undertaken by each company. As a result, we examine how several dimensions of diversification (degree of diversification and relatedness between divisions) help shape the firm's growth options portfolio. Here, we also consider a potential moderating effect risk of pre-emption which poses a serious threat to the lifespan of the options. **Figure I.1.** illustrates the research questions covered in this dissertation.

Figure I.1
[Research questions]



This doctoral dissertation is structured in five different chapters. Chapter 1, *"The corporate diversification strategy. Implications for corporate value"*, provides a summary of the literature on corporate diversification to offer a map of the state of the art. More specifically, we review the conceptualization and measurement of this corporate strategy, firms' motivations to undertake the strategy (benefits and costs of diversification) as well as the main empirical evidence concerning the impact of diversification on a firm's value.

Chapter 2, *"Rethinking the diversification puzzle from an RO approach: theoretical model and hypotheses"*, introduces the RO approach and extends it to corporate diversification strategy. Drawing on RO theoretical foundations, we characterize diversification as the sequential purchase and exercise of connected growth options. Our research questions described before are reflected in six hypotheses to be tested empirically in chapters three to five. Overall, our hypotheses posit that corporate diversification (defined by different dimensions such as degree of diversification, relatedness between segments, or diversification patterns) interacts with the firm's portfolio of growth options and through it, the value effect of diversification is partly determined. Overall, our study conjectures that the effect of diversification on a firm's value (discount/premium) is contingent on a firm's growth opportunities.

Chapter 3, *"Tackling the corporate diversification-value puzzle using the RO approach"*, provides empirical evidence on how growth opportunities contribute to explaining the effect of corporate diversification on a firm's value. More specifically, we posit that diversification may be a trade-off between exercising and creating growth options and may thus have a direct effect on the firm's growth options portfolio. We then investigate which position growth opportunities take in the diversification puzzle:

in other words, whether they drive part of the diversification discounts/premiums via mediation.

Chapter 4, *"Corporate diversification through the real options lens: measuring a new dimension"*, identifies two contrasting ways to handle corporate diversification (diversification patterns): one-step diversification versus an options-based diversification, each involving a different configuration of the firm's growth options portfolio. Whereas the first pattern focuses on exploiting a firm's growth opportunities through large investment commitments, the latter involves gradual investments which promote not only the exploitation but also the exploration of further growth options along the way. We develop a two-dimensional index to proxy for these diversification patterns and we investigate whether they explain the varying effect of business diversification on a firm's value across diversifiers.

Chapter 5, *"How is corporate diversification coded into real options language? The interaction between growth options, diversification scope, and relatedness"*, focuses on the firm's growth options portfolio and how diversification interacts with it. We adopt a multidimensional view of the diversification strategy based on the dimensions of degree of diversification and relatedness between business segments. We analyze how these dimensions impact the firm's growth opportunities, both individually and jointly. In addition, we shed light on how the risk of pre-emption affects the impact of diversification on growth opportunities, since it accelerates strategic actions by shortening the expiration period of the growth options involved and thereby, their value.

Finally, a summary of the primary conclusions, contributions, and limitations of this dissertation, as well as new avenues for further research brings this dissertation to a close.

Broadly speaking, the theoretical arguments detailed in Part I of this dissertation together with the empirical research conducted in Part II form the two pillars for proposing and testing the thesis presented. This might be summed up thus: *corporate diversification involves both exercising and generating growth options, which in turn contribute to determining the effect of diversification on firms' value, making this strategy more value-creating insofar as it serves as a platform for future growth opportunities for companies.*

PART I

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Chapter 1

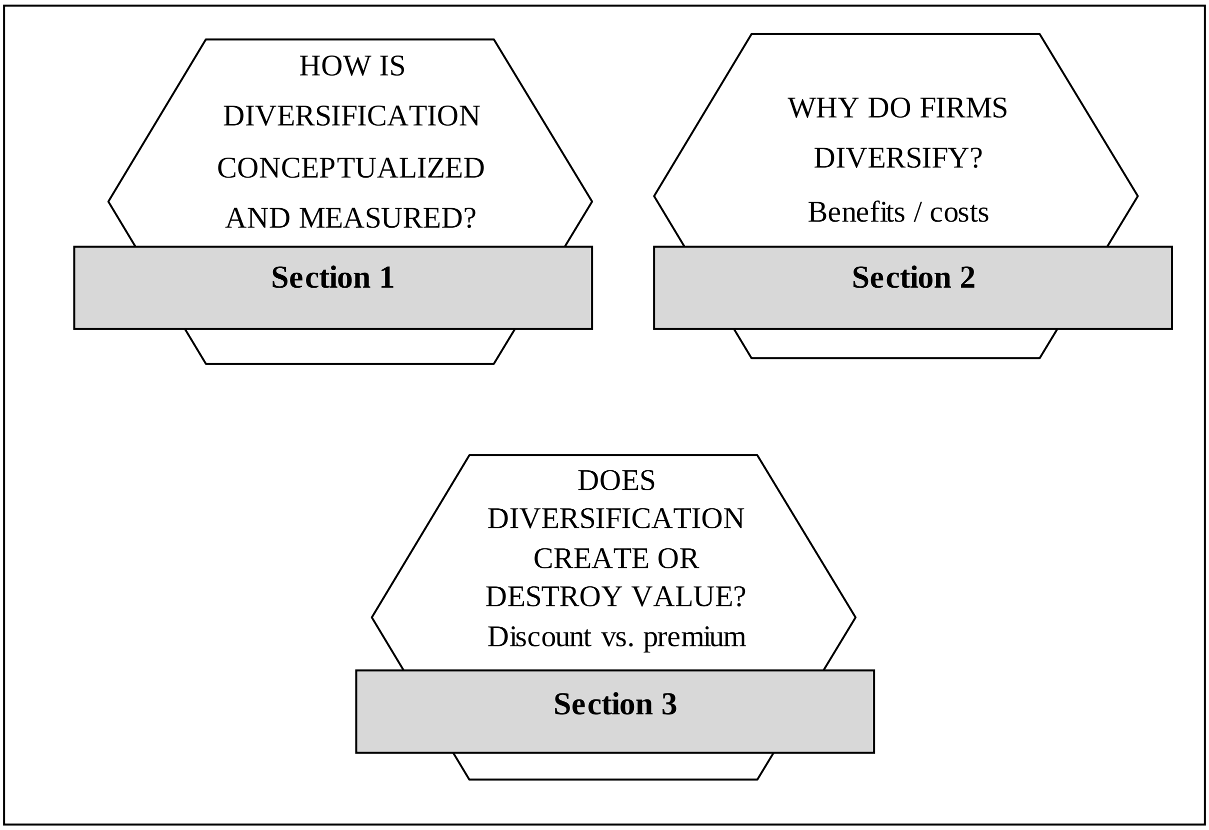
The Corporate Diversification Strategy. Implications for Corporate Value

The growing popularity of business diversification has aroused great interest among academics and practitioners alike concerning firms' motivations to embark on this strategy as well as the failure or success of such a strategy in creating value for firms. The implications of this corporate strategy for value creation have sparked discussion in both finance and strategic management.

The diversification-value linkage constitutes a prolific area for research, since maximizing long-term firm market value has been placed at the top of the objectives which should guide firms' activity (Jensen, 2010: 39) and has even been posed as an enterprise's main *raison d'être* (Becerra, 2009). Yet, far from shedding further light on this issue, several decades of intensive research have yielded mixed findings regarding the relationship between corporate diversification and firm value, with the research question having become widely known as the *diversification puzzle,* a controversy-free explanation having yet to be achieved.

In Chapter 1, we summarize the primary contributions existing in the literature on corporate diversification [see **Figure 1.1**]. Overall, diversification literature revolves around three main blocks, each addressed separately in the different sections of this chapter. The first island of research concerns the conceptualization and measurement of corporate diversification. The second addresses why firms diversify from alternative theoretical approaches, each focusing on certain benefits/costs associated with this strategy. The third island, undoubtedly the most fruitful and at the same time most controversial over the years, aims to answer the yet unresolved question of whether business diversification creates or destroys value for firms.

Figure 1.1
[Main research questions in diversification literature: Chapter structure]



1.1. AN INITIAL APPROACH TO CORPORATE DIVERSIFICATION

1.1.1. Mapping corporate diversification in growth vector alternatives

Since as far back as the fifties and sixties, growth strategies have been gaining increasing relevance in research (through seminal studies such as Penrose (1959) and Ansoff (1965)), coinciding with the 1960s merger wave. Ansoff (1965) recognizes the existence of four main *growth vectors* where firms can expand from their current market and product position. First, if available, they can take advantage of growth opportunities in the existing market with their current products to increase market share (*market penetration*). Two further alternatives might be to renew their product portfolio or to find new functions for their current products (*product development*), or to extend their presence in new markets (*market development*). Finally, a fourth strategy would imply the creation of a new business unit. The latter is called *diversification* and allows enterprises to take part in new markets and offer new products simultaneously.

Ansoff (1965) constructs a graphical matrix to represent corporate growth strategies. The newness degree of the market and product are the two variables placed in the axis. As can be seen in **Figure 1.2**, diversification strategy allows organizations to expand their business activity towards both new markets and new products or services. In other words, diversification incorporates a new business unit through either internal business development or acquisition, and implies changes in firms' administrative structure and management processes (Ramanujam and Varadarajan, 1989: 525).

Figure 1.2
[Growth vector components]

MISSION \ PRODUCT	Present	New
Present	**Market penetration**	**Product development**
New	**Market development**	**DIVERSIFICATION**

Source: Ansoff (1965: 109).

The trajectory described by the growth curve depends on each company. Penrose (1959) draws special attention to the limits on a firm's expansion since she argues that there is a limit to the rate at which firms can grow. She summarizes external/internal inducements to expansion and external/internal obstacles to expansion. Among the factors encouraging firms to expand, emerging opportunities (either as a result of an external shock in the market or company R&D) coupled with the existence of a pool of unused resources within the firm are prominent drivers of expansion. On the other hand, competition in certain markets, patent rights and other entry barriers, as well as the limited amount of certain resources within the firm are likely to slow down the expansion process. One prominent aspect to be considered among those limited resources, is managerial experience, since such knowledge is not available in the market and requires time if it is to develop inside the enterprise. In the particular case of diversification strategy, the need to maintain a competitive position in the core businesses imposes an additional restriction on the degree of diversification.

1.1.2. Corporate diversification: a review of the concept

Ansoff's (1965) early, synthetic, and concise definition based on a growth matrix proves a referential starting point in delimiting the diversification concept. Subsequent strategic management literature (such as Rumelt, 1982; Ramanujam and Varadarajan, 1989 or Becerra, 2009) offers a wide range of definitions for corporate diversification.

Following Ansoff (1965), Rumelt (1982: 363) highlights that diversification implies changes in both product and market dimensions, offering a definition in these terms: "*Diversification takes place when a firm expands to make and sell products or a product line having no market interaction (technically, having zero cross price-elasticity) with each of the firm`s other products*".

Along these lines, Ramanujam and Varadarajan (1989) also emphasize the changes in organizational structure as well as the means to diversify (internal development versus acquisition): "*the entry of a firm or business unit into new lines of activity, either by processes of internal business development or acquisition, which entail changes in its administrative structure, systems, and other management processes*".

Summing up, all the definitions seem to share the idea that diversification incorporates a new business segment into a preexisting enterprise, either by internal or external business development. Becerra (2009: 177) refers to this as *"putting different units under its corporate umbrella"*.

In practice, databases report information about two types of segments: geographic segments (to compute geographic or global diversification) and product segments (to compute product or business diversification). A company is classified as geographically diversified if it has at least two geographic segments; otherwise it is considered a domestic firm. A firm is considered as product diversified if it has at least two product segments; otherwise it is a single-activity firm. This dissertation addresses business diversification. Thus, hereinafter, the remaining literature review as well as all mentions of corporate diversification refer to product diversification[1].

Complementary to the concept of corporate diversification is delimiting segments within a company. Zhao (2008: 6) defines a business segment as "*an enterprise component that provides distinguishable products or service and has a distinguishable production process*". On this issue, Pitts and Hopkins (1982: 621) propose three criteria to be applied to identify each business: resource independence, market discreteness, and product difference. Resource independence focuses on separating resources from those supporting other firm divisions. Market discreteness accounts for certain market characteristics such as customer needs or cross-elasticity. Finally, product difference separates lines of businesses based on the existence of separate products. Indirectly, it combines resource independence and market discreteness criteria. Such a criterion of product difference is broadly used in the corporate diversification empirical literature

[1] Geographic diversification constitutes a distinguishable and separate field of research which lies beyond the scope of this dissertation.
For geographic diversification literature, see studies such as Kim and Lyn (1986); Morck and Yeung (1991); Bodnar and Weintrop (1997); Bodnar, Tang and Weintrop (1999); Click and Harrison (2000); Denis, Denis and Yost (2002); Fauver, Houston and Naranjo (2004); Jory and Ngo (2012); Goetz, Laeven and Levine (2013), among others.

due to the spread of Standard Industrial Classification (SIC) codes, which offer a concrete and replicable classification for research purposes.

1.1.3. Measuring corporate diversification

The bulk of the literature on corporate diversification emphasizes two primary dimensions of this growth strategy: the degree of diversification and relatedness between business segments. The first dimension refers to the scope of diversification, namely the extent to which a firm's business activity is spread across several businesses. Relatedness alludes to the correlation among businesses in terms of the degree of commonality of strategic resources and capabilities[2].

Table 1.1
[Approaches to diversification measurement]

<table>
<tr><td rowspan="4">BUSINESS COUNT APPROACH</td><td>Numerical count</td><td>Number of segments with different SIC code</td><td></td></tr>
<tr><td>Share of the largest business</td><td>Relative importance index</td><td>Rumelt (1974)</td></tr>
<tr><td rowspan="2">Comprehensive indexes</td><td>Herfindahl index</td><td>Hirschman (1964)</td></tr>
<tr><td>Total Entropy</td><td>Jacquemin and Berry (1979)</td></tr>
<tr><td rowspan="4">STRATEGIC APPROACH</td><td rowspan="2">Relatedness</td><td>Related Entropy</td><td>Jacquemin and Berry (1979)</td></tr>
<tr><td>Concentric index</td><td>Montgomery and Hariharan (1991)</td></tr>
<tr><td rowspan="2">Mode of growth</td><td>Internal development</td><td rowspan="2">Simmonds (1990)</td></tr>
<tr><td>Mergers & Acquisitions (M&A)</td></tr>
</table>

Source: Adapted from Pitts and Hopkins (1982)

[2] Related diversification and vertical integration are often confused. Vertical integration internalizes transactions in goods or services that are explicit outputs of one division and explicit inputs for another. The difference between related diversification and vertical integration lies in this latter idea (Raynor, 2002: 374).

As far as measuring diversification strategy is concerned [see **Table 1.1**], Pitts and Hopkins (1982: 626) state that the choice of a diversification measure should be considered together with the research question to be addressed. They distinguish two approaches to assess firm level diversity:

- *Business Count Approach*, more appropriate when comparing diversified and standalone firms. It includes several variants: *numerical count* (the simple account of the number of segments, without considering any differences in size distribution of businesses); *share of the largest business* (relative importance index, explained later); *comprehensive index (*such as the Herfindahl and Entropy indexes), and *composite indexes* of the previous two categories.

- *Strategic Approach*, which comprises *relatedness* between business segments and *growth method* (internal development versus acquisition/mergers)[3]. This criterion proves suitable in the search for differences between diversifiers.

There is an extensive body of literature dealing with diversification measurement. The scope of this strategy proves hard to capture. First, database segment information, mostly based on Standard Industrial Classification (SIC) codes, is limited. Each code represents one industry and its level of aggregation ranges from 2-digit to 4-digit SIC codes. This classification system has the advantage of concreteness and replicability (Rumelt, 1982). Nevertheless, some drawbacks also stem from the variable breadth in SIC classes, which can overrate the level of diversification (Rumelt, 1982; Servaes, 1996). The distance between SIC codes cannot be interpreted as a ratio scale (Montgomery, 1982: 300).

[3] Simmonds (1990) evaluates total sales change from M&A. If they account for at least 10 percent of a firm's total sales change, the firm is considered an externally diversified firm; otherwise, it is classified as an internally diversified firm.

Second, a further measurement problem may arise from possible divergences between external data (i.e. public information about firms, annual reports, press) and internal data (i.e. questionnaire to CEO). Nayyar (1992) confirms such differences and finds that external data classify a larger number of companies as related diversifiers compared to internal data.

Particularly, the dimension of relatedness proves extremely difficult to conceptualize and measure consistently across industries (Lien and Klein, 2009), especially in the presence of intangible resources such as knowledge or organizational culture, which are not directly observable or measurable. One stream of papers points to the multidimensionality of business relatedness (Farjoun, 1998; Pehrsson, 2006), which much research has failed to consider. Farjoun (1998) examines skill bases (such as R&D teams or managerial skills) and physical bases (such as product characteristics) of relatedness, and shows that the two dimensions complement each other and jointly affect firm performance. Another series of papers points to the insufficient information of SIC codes to capture relationships among industries (Davis and Thomas, 1993; Robins and Wiersema, 1995; Stein, 2003)[4]. In this regard, David and Thomas (1993) specify three problems associated with SIC-based relatedness measures:

- Product and output similarities as the only considered source base, overlooking additional similarities such as distribution procedures, human resources, management skills, or target consumers.

- Potential underestimation of relatedness in certain cases where business units not only belong to the same SIC group but are also vertically integrated.

[4] Stein (2003: 148) urges that one should be careful "*not to measure relatedness too mechanically*".

- The assumption that every combination of related businesses (same SIC group) generates the same level of synergies[5].

Yet, despite these drawbacks, certain studies support the validity of SIC-based measures (Montgomery, 1982), which continue to dominate in diversification research due to their higher degree of objectivity and comparability across research studies. Next, we cite the most common measures for the above-mentioned dimensions of diversification.

1.1.3.1. Measuring the degree of corporate diversification

Most measures of the level of diversification compute the number of firm divisions belonging to different SIC codes. Thus, simple measures of diversification are the number of segments or a dummy variable, which equals 1 if the enterprise has at least two segments and zero otherwise.

In an attempt to deal with over-simplicity and capture as much scope of this strategy as possible, more sophisticated indexes have been devised, mainly from the field of strategic management. The most popular indexes are: the Herfindahl index (Hirschman, 1964), the relative importance index (Rumelt, 1974), and the entropy measure (Jacquemin and Berry, 1979). A further explanation of the elements considered by each index as well as some of their advantages and drawbacks are summarized below[6].

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[5] Davis and Thomas (1993) break away from this assumption and propose an approach to estimate synergy coefficients between pairs of industries and compute a modified concentric index taking such coefficients as weighting factors.

[6] Laeven and Levine (2007) and Elsas, Hackethal and Holzhäuser (2010) construct diversification measures for the particular case of financial conglomerates.

a) Herfindahl index

The Herfindahl index measures industry concentration by considering the share of sales (or assets) from each segment: $HERF = 1 - \sum_{s=1}^{n} P_s * W_s$

where "s" is the number of segments of the diversified firm, "P_s" the proportion of firm`s sales (or assets) in business 's' and "W_s" a weight factor. "P_s" is often used as weight. As a result, Herfindahl converts to one minus the sum of the squared proportion of each segment sales (segment assets) to total sales (total assets):

$$HERF = 1 - \sum_{s=1}^{n} P_s^2$$

Unisegment firms show a Herfindahl index equal to zero, and the closer this index is to one, the higher the firm's level of diversification. This index proves easy and intuitive to interpret. However, it changes depending on the level of industry aggregation and fails to capture the contribution of diversification at each aggregation level to the total (Jacquemin and Berry, 1979: 361)[7].

b) Relative importance index

The relative importance index (RFOCUS) (Rumelt, 1974) measures the concentration of a firm's total sales in its primary industry. It is an inverse measure of diversification (ranging from 0 to 1). Therefore, the more diversified, the lower the RFOCUS. This index is calculated as follows:

$$RFOCUS = \frac{\text{sales in the core business}}{\text{firm total sales}}$$

[7] Although Jacquemin and Berry (1979) also point out the lack of decomposability of the Herfindahl measure (into additive elements which show the contribution of diversification at each degree of disaggregation to the total), subsequent papers such as Acar and Sankaran (1999) have in fact demonstrated the decomposability property of the Herfindahl index.

Although easy to calculate, this measure based on the share of the largest business ignores the degree of diversification in the other business activities[8] (Pitt and Hopkins, 1982).

c) Entropy measure

Jacquemin and Berry's (1979) entropy measure captures diversification across different levels of industry aggregation and within them. It is computed as:

$$\text{TENTROPY} = \sum_{s=1}^{n} P_s * \ln\left(\frac{1}{P_s}\right)$$

where 'P_s' is the proportion of a firm's sales in business 's' for a firm with 'n' different 4-digit SIC segments. Despite offering a more comprehensive assessment of the extent of diversification, the entropy measure is not as widely used as the previously described measures, perhaps partly due to the lack of any upper boundary which makes interpretation and comparison between companies more difficult[9].

1.1.3.2. Measuring relatedness

Generally, two business segments are classified as related if they share the same SIC code. According to Markides and Williamson (1994), traditional measures based on dummy variables to distinguish between related and unrelated diversifiers are incomplete. They fail to consider the strategic importance of the assets involved in those activities, providing a static and short-term view.

[8] Troutt and Acar (2005) stress the need to consider both diversification and complementary concentration measures.

[9] See Hoskisson *et al*. (1993) for a study of the validity of the entropy measure.

More elaborate indexes have been built to capture as much relatedness as possible. Researchers into corporate diversification are particularly familiar with the entropy index and the concentric index.

a) Related entropy

The entropy measure (Jacquemin and Berry, 1979) of total diversification (TENTROPY, explained earlier) is split into related (RELATED) and unrelated (UNRELATED) entropy by considering the share of sales in each SIC code (4 digits for TENTROPY, and 2 digits in the case of UNRELATED) and multiplying it by the natural logarithm of its inverse. Similar to TENTROPY, UNRELATED is calculated as:

$$\text{UNRELATED} = \sum_{s=1}^{n} P_s * \ln(\frac{1}{P_s})$$

where 'P_s' is the proportion of a firm's sales in business 's' for a firm with 'n' different 2-digit SIC segments. The related component (RELATED) is computed by subtracting UNRELATED from TENTROPY:

$$\text{RELATED} = \text{TENTROPY} - \text{UNRELATED}$$

where TENTROPY is total entropy and UNRELATED unrelated entropy.

b) Concentric index

An alternative proxy for relatedness is the concentric index (Montgomery and Hariharan, 1991). In contrast to related entropy, the concentric index represents an inverse measure of relatedness. Thus, the lower the concentric index, the higher the relatedness between business segments.

$$\text{CONCENTRIC\_INDEX} = \Sigma_r P_r \Sigma_s P_s d_{rs}$$

where 'P_r' is the proportion of a firm's sales in business '*r*' and 'P_s' is the proportion of a firm's sales in business '*s*'. d_{rs} is a weighting factor such that d_{rs}=0 if *'r'* and *'s'* belong to the same 3-digit SIC industry, d_{rs}=1 if *'r'* and *'s'* belong to the same 2-digit SIC industry but different 3-digit SIC groups, or d_{rs}=2 if *'r'* and *'s'* are in different 2-digit SIC categories.

Despite the fact that related entropy and concentric index have frequently been regarded as alternative approaches, these two measures can give rise to contradictory results since they do not measure the same dimensions of diversification strategy portfolio (Robins and Wiersema, 2003). Whereas the entropy measure seems to show a significant positive sensitivity to the number of segments, the concentric index proves more sensitive to the relative size of the dominant business.

1.2. WHY DO FIRMS DIVERSIFY? BENEFITS AND COSTS OF CORPORATE DIVERSIFICATION

Why firms diversify constitutes another prominent island of research in diversification literature[10]. A large body of literature deals with the primary factors which motivate the diversification decision. Montgomery (1994) explains the firm's decision to diversify from three theoretical perspectives: the market-power view, the resource view, and the agency view. From the first perspective, diversification contributes to building a large conglomerate and serves as a means to gain market

[10] See papers such as Suárez-González (1993) or Montgomery (1994) for a review of the theoretical perspectives on firm's motivation to diversify.

power through different mechanisms such as: cross-subsidization across business segments; mutual forbearance, which implies less aggressive competition with competitors operating in several common markets; and reciprocal buying among large diversifiers, which rules out other smaller sized enterprises. This situation may also result in lower input costs and higher prices for customers (Becerra, 2009).

From the resource view, corporate diversification is seen as a strategy to put underused resources into alternative businesses (Penrose, 1959). Market failures can cause contracting problems when selling certain assets, particularly intangible assets such as knowledge which are embedded in corporate organization. Diversification thus becomes an alternative to put such assets to use within the firm. Moreover, diversification may provide the firm with economies of scale in existing resources as well as synergies derived from potential complementarities across different businesses which can feed back to each other.

Finally, the agency view focuses on potential agency problems stemming from the separation of ownership and control in companies and, more specifically, from the lack of alignment of shareholders' and managers' interests (Jensen and Meckling, 1976). From this perspective, corporate diversification is the result of self-interested behaviour by managers, who seek to secure private benefits from "empire-building" initiatives and reduce their exposure to risk. Amihud and Lev (1981) find that manager-controlled firms are more prone to diversify than owner-controlled firms. Additional studies support the agency problems driving corporate diversification and report that firms with higher ownership concentration (Amihud and Lev, 1999; Zhao, 2010) or stronger shareholder rights (Jiraporn *et al.*, 2006) are less diversified. As far as agency problems are concerned, Aggarwal and Samwick (2003) find that the corporate diversification decision responds to private benefit seeking (such as compensation, prestige, or career prospects) rather than minimizing risk exposure.

Here again, there is no unanimous opinion concerning the reasons which drive firms to diversify their current activities. However, certain studies such as McGahan and Villalonga (2005) show the advantages of such a multi-approach, coming to view the different theoretical approaches as complementary rather than competitive.

Next, we summarize the main benefits and costs attributed to this strategy.

1.2.1. Benefits of corporate diversification: an overview

Both the potential advantages and drawbacks linked to business diversification have also taken up a substantial body of research, since a cost-benefit balance may prove the first step towards determining the value created through this strategy [see **Table 1.2**].

Table 1.2
[Benefits and costs of corporate diversification]

BENEFITS	COSTS
Economies of scope/synergies	**Agency problems**
Economies of scope Synergies Value-enhancing effects of excess resources Transfer of knowledge between divisions	Agency problems managers-shareholders Asymmetric information costs Cross-subsidization Overinvestment
Financial and tax advantages	Coordination costs Organizational complexity and rigidity
Internal capital markets Coinsurance effect Greater debt capacity ("more-money" and "smarter-money") Interest tax shields	
Growth advantages	
Economies of size /economies of growth Growth opportunities Market power	

The main benefits encouraging firms to diversify have been widely documented in the literature. These can be classified into four groups: synergies and economies of scope, financial/tax advantages and growth advantages.

Firstly, diversification allows enterprises to achieve economies of scope and synergies (Penrose, 1959; Ansoff, 1965; Luffman and Reed, 1986; Amit and Livnat, 1988; Markimovic and Phillips, 2002; Gomes and Livdan, 2004; Becerra, 2009). Diversification thus enables firms to take advantage of the complementarities between divisions and to reduce possible redundancies across different businesses. Furthermore, it can enhance the value of excess resources and capabilities in outputs which can be used as inputs in alternative businesses (Penrose, 1959; Zhao, 2008) and whose transfer to the market would imply high transaction costs (especially in the case of intangible resources such as knowledge (Montgomery, 1994)). This corporate strategy may contribute to transferring knowledge between business units and improving firms' absorptive capacity and innovation (Becerra, 2009; Humphery-Jenner, 2010).

Related diversification is deemed to enhance these economies of scope and synergistic effects (Amit and Livnat, 1988; Alonso-Borrego and Forcadell, 2010) to a greater extent. In this vein, Markides and Williamson (1994) stress in particular the potential advantages of this type of diversification, terming it "asset amortization", "asset improvement", "asset creation", and "asset fission". Strategic relatedness between businesses contributes to developing core competences and allows firms to accumulate and renew strategic assets more quickly and cheaply than competitors.

Secondly, another series of works points out that financial and tax advantages associated with corporate diversification can prove value-enhancing for companies. Diversification makes the reallocation of funds between divisions possible, leading to the creation of internal capital markets (Servaes, 1996; Campa and Kedia, 2002; Zhao, 2008; Kuppuswamy and Villalonga, 2010) which may mitigate asymmetric information problems and improve efficiency. Moreover, the combination of businesses with imperfectly correlated earnings allows firms to reduce cash-flow volatility, thus making it easier for them to borrow more: the coinsurance effect (Penrose, 1959; Myers, 1977; Amit and Livnat, 1988; Berger and Ofek, 1995; Servaes, 1996; Becerra, 2009; Kuppuswamy and Villalonga, 2010). Thus, diversified firms benefit from so-called "more-money" (more access to external financing) and "smarter-money" effects (more efficient internal capital allocation). This greater debt capacity also enables firms to take advantage of tax shields[11] (Amit and Livnat, 1988; Berger and Ofek, 1995).

Finally, corporate diversification may also provide firms with growth advantages. As firms exploit and develop their resources and capabilities by entering new businesses, they may access fresh growth opportunities (Penrose, 1959; Lang and Stulz, 1994; Gomes and Livdan, 2004; Zhao, 2008; Becerra, 2009) which can contribute to value creation. Diversification can serve to reach an optimum size (Maksimovic and Phillips, 2002) and achieve economies of growth and size[12] (Penrose, 1959). Furthermore, by taking advantage of these growth opportunities, enterprises may gain market power (Penrose, 1959; Becerra, 2009) owing to their greater size and thus achieve a better competitive position.

[11] In addition, diversified firms may also save on tax payments by offsetting losses from certain segments against gains from others.

[12] Economies of size and growth should not be confused (Penrose, 1959). Economies of size imply improvements in production and distribution efficiency only due to greater size. It only applies to the growth process and thus a later reduction in size does not necessarily imply a rise in costs. Penrose defines economies of growth as "*internal economies available to an individual firm which make expansion profitable in particular directions*". They constitute a competitive advantage and are not necessarily accompanied by economies of size.

1.2.2. Costs of corporate diversification: an overview

On the other side of the coin, certain costs associated with diversification can prevent this strategy from creating value for firms. The benefits arguments described above are called into question when pondering potential agency problems. Managers consider their personal risk when taking decisions which affect firm risk (May, 1995) and may decide to maximize their utility function at the expense of shareholder wealth. Diversification satisfies the managerial utility function in two ways: by reducing firm total risk and by increasing firm size[13]. On the one hand, shareholders can diversify their own portfolios in capital markets efficiently but managers cannot diversify their human capital in the same way. Consequently, they depend on corporate diversification to stabilize cash-flow and reduce firm operating risk in order to preserve their jobs (Amihud and Lev, 1981; Montgomery, 1994). On the other hand, as managers' payment and professional status are related to firm size, 'empire-building' preferences encourage them to expand, especially in low-leveraged firms, since corporate debt contributes to disciplining inefficient managerial behavior.

As a result of these agency problems, corporate diversification is argued to result in asymmetric information costs between divisions (Campa and Kedia, 2002), cross-subsidization from better-performing to poorer segments (Berger and Ofek, 1995; Servaes, 1996), or overinvestment in unprofitable segments[14] (Berger and Ofek, 1995).

Finally, the additional costs of corporate diversification commonly pointed out in the literature stem from a larger size. As the firm progresses in this expansion strategy,

[13] *"[...] unrelated diversification represents a type of merger for which there is a natural presumption of an agency motivation, with managers seeking not only larger, but more stable empires"* (Stein, 2003, page 130).

[14] Managers tend to be reluctant to divest of low-performing divisions because it may be perceived by investors as an admission of a mistake (Stein, 2003).

organizational complexity (Lyandres, 2007; Becerra, 2009; Klein and Saidenberg, 2010; Rawley, 2010) and coordination costs (particularly in related diversification where activities are more interdependent) (Gary, 2005; Rawley, 2010; Zhou, 2011) become more important, thus counteracting the potential benefits of this strategy.

Then, what is the cost-benefit balance of this strategy? This is a complex question to answer since this balance may change over time. Cycles of diversification have been shown to exist throughout economic history. Diversification strategy reached its peak in the sixties and seventies, when a wave of mergers and acquisitions took place (see Servaes (1996) for an analysis of the diversification decision during the conglomerate merger wave). Nevertheless, most of these conglomerates failed to materialize the potential benefits of this strategy. Hence, between 1980 and 1990, many companies disinvested from unprofitable divisions and refocused on their core businesses[15].

1.3. THE CORPORATE DIVERSIFICATION AND FIRM VALUE RELATIONSHIP: SOME EMPIRICAL EVIDENCE

According to Martin and Sayrak (2003), two distinct streams of corporate diversification literature are in evidence: studies which address diversification and value relationship, and those exploring longitudinal studies of diversifying patterns over time. Undoubtedly, the first group of studies has captured most scholarly attention, since long-term value maximization is established as the corporate objective function that firms should aim at (Jensen, 2010).

[15] See Berger and Ofek (1999) for a study of the decision to refocus.

1.3.1. Reviewing the *diversification puzzle*: diversification discount versus premium

Corporate diversification has provided a lively area for research, with the diversification-value linkage located at its core as the great 'enigma' to be solved. Premium or discount for diversifying? Most scholarly investigation has focused on this question[16], with decades of intensive research having thus far failed to culminate in a consensus. The debate surrounding value creation through diversification has also been taken up by managers, who call for a comprehensive explanation regarding this controversial issue. In general, this strategy has also gained a bad reputation among practitioners. As Heuskel, Fechtel and Beckmann (2006: 11) point out in a report published by the Boston Consulting Group, *"diversified companies are rarely held up as paragons of value creation. When they create superior returns, they are usually viewed simply as successful companies"*.

One key contribution to assessing the value outcomes of corporate diversification is Berger and Ofek's (1995) study and their proposal of an "excess value" measure[17], the reference methodology in the vast majority of works. It is based on the comparison of a multi-segment firm with an equivalent portfolio of standalone companies operating in the same industries. If excess value is negative, diversifiers will trade at a discount, relative to undiversified firms. Otherwise, they will show a premium.

[16] See Datta, Rajagopalan and Rasheed (1991), Suárez-González (1993); Martin and Sayrak (2003), Villalonga *et al*. (2003), and Erdorf, Hartmann-Wendels and Heinrichs (2013) for surveys concerning the research on diversification-value (performance) relationship.

[17] The use of Berger and Ofek's (1995) excess value measure has become widespread in diversification literature (see Campa and Kedia, 2002; Villalonga, 2004b; Stowe and Xing, 2006; among others).

Much literature reports evidence that diversified firms trade at a discount[18] relative to non-diversified companies in their industries (Lang and Stulz, 1994; Berger and Ofek, 1995; Servaes, 1996; Bodnar *et al.*, 1999; Denis *et al.*, 2002; Mackey, 2006; Stowe and Xing, 2006; Borghesi, Houston and Naranjo, 2007; Laeven and Levine, 2007; Jiraporn, Kim and Davidson, 2008; Ferris, Sen and Thu, 2010; Grass, 2010; Kuppuswamy and Villalonga, 2010; Ammann, Hoechle and Schmid, 2010; Hoechle *et al.*, 2012), supporting the idea that shareholders could diversify their individual portfolios at a lower cost than the company does[19]. Using cross-sectional regressions, Berger and Ofek (1995) report a 13-15% average discount in multidivisional firms between 1986 and 1991. Servaes (1996) also relies on cross-sectional analysis and studies the impact of diversification on corporate value during the conglomerate merger wave. He documents a discount in the 1960s, which drops and becomes non-significant in the early and mid-1970s. Stowe and Xing (2006) also confirm the discount, even after controlling for the difference in growth opportunities between diversified and single-segment firms. These findings have also been corroborated by using more sophisticated econometric techniques, such as panel regression with firm and year-fixed effects (Hoechle *et al.*, 2012; Grass, 2010) or for the particular case of the financial industry (Laeven and Levine, 2007).

For years, conglomerate discount has held pride of place, considering this strategy to be a value-destroying one. Why then do so many firms continue to diversify if such a strategy seems to perform poorly? At the same time, other papers find a non-statistically significant relationship (Gómez and Menéndez, 2000; Villalonga, 2004b; Çolak, 2010;

[18] See Villalonga *et al*. (2003) for a review of corporate diversification discount literature. In 2003, a discussion session about this topic was organized at Harvard Business School where seventeen leading scholars in this research area were invited.

[19] Myers (1984: 129) states: “Corporate diversification is redundant; the market will not pay extra for it”.

Elsas *et al.*, 2010), a quadratic relationship (Palich, Cardinal and Miller, 2000), or even premiums for diversifying (Campa and Kedia, 2002; Villalonga, 2004a). Some recent papers challenge said diversification discount, attributing part of it to methodological issues. Addressing this concern, Campa and Kedia (2002), and Villalonga (2004a) obtain a diversification premium once the endogenous nature of the diversification decision is accounted for. Nonetheless, this argument is also called into question by subsequent articles such as Hoechle *et al.* (2012), who still find a discount after controlling for endogeneity. Concurring with these results, Lamont and Polk (2002) also find that the diversification discount is not only caused by selection biases or endogenous choices by companies but also because diversification strategy itself destroys value. They document that both exogenous and endogenous changes in diversity have a negative impact on impact firm value.

As far as evidence of a nonlinear relationship is concerned, Palich *et al.* (2000) demonstrate that diversification contributes to enhancing performance when firms move from focused to related diversification but that there is a decline in performance when diversified firms embark on unrelated businesses. In a similar vein, He (2009) reports a negative correlation between the size of the diversification premium and the level of diversification. He assesses the marginal contribution of diversification on value and demonstrates that excessive diversification reinforces the negative effects of this strategy.

Overall, this controversial evidence [see **Table 1.3** for a summary], together with performance differences observed across diversifiers, leaves one question unresolved: “To diversify: a successful decision or a decision doomed to failure?” So much ‘noise’ has revived even greater interest in delving more deeply into the nature of the mixed findings, with inconsistent findings being mostly attributed to measurement difficulties and methodological problems.

Table 1.3
[Summary of the empirical evidence on the diversification-value relationship]

STUDY	SAMPLE	PROXY FOR DIVERSIFICATION	ESTIMATION METHODOLOGY	RESULTS	NOTES
Lang and Stulz (1994)	U.S. firms (1978-1990)	No. of segments, sales-based Herfindahl, assets-based Herfindahl	Cross-sectional regression, "Chop-Shop" approach	DISCOUNT	---
Berger and Ofek (1995)	U.S. firms (1986-1991)	Dummy variable, no. of segments	Cross-sectional regression	DISCOUNT	---
Servaes (1996)	U.S. firms (1961-1976)	Dummy variable	Cross-sectional regression	DISCOUNT	---
Bodnar *et al.* (1999)	U.S. firms (1987-1993)	Dummy variable	Cross-sectional regression	DISCOUNT	Control for geographic diversification
Gómez and Menéndez (2000)	Spanish firms (1990-1994)	No. of segments, relative importance index, sales-based Herfindahl index, Total Entropy	Fixed effects	Non-statistically significant relationship	---
Campa and Kedia (2002)	U.S. firms (1978-1996)	Dummy variable	Cross-sectional regression, fixed-effects, instrumental variables estimation, Heckman two-stage	PREMIUM	---
Denis *et al.* (2002)	U.S. firms (1984-1997)	Dummy variable. sales-based Herfindahl	Cross-sectional regression, fixed effects	DISCOUNT	Control for geographic diversification
Fauver *et al.* (2004)	U.S. firms, U.K. firms and German firms (1991-1995)	Dummy variable	Cross-sectional regression	DISCOUNT in U.S. and U.K.; non-statistically significant relationship in Germany	
Villalonga (2004a)	U.S. firms (1989-1996)	No. of segments, assets-based Herfindahl index, Total Entropy	Cross-sectional regressions	PREMIUM	BITS data

Villalonga (2004b)	U.S. firms (1978-1997)	Dummy variable	Two-stage estimates of the "average treatment effect on the treated"[20]	Non-statistically significant relationship	---
Jandik and Makhija (2005)	U.S. electric utilities (1980-1997)	Dummy variable, no. of segments	Two-way fixed effect least squares	1980-1992: PREMIUM 1993-1997: no significant effect	---
Mackey (2006)	U.S. firms (1985-1997)	Dummy variable	Heckman two-stage, fixed effects	DISCOUNT	Control for the payout decision
Stowe and Xing (2006)	U.S. firms (1981-1997)	Dummy variable	Cross-sectional regression	DISCOUNT	---
Laeven and Levine (2007)	Banks from 43 different countries (1998-2002)	Diversification measures adapted to the specific case of the financial industry	Instrumental variables regressions, Heckman two-stage	DISCOUNT	---
Borghesi *et al.* (2007)	U.S. firms (1981-2003)	Dummy variable	Fixed effects	DISCOUNT	---
Jiraporn *et al.* (2008)	U.S. firms (1998-2002)	Dummy variable	Fixed-effects, Heckman two-stage	DISCOUNT	Control for geographic diversification
Çolak (2010)	U.S. firms (1989-1998)	Dummy variable	OLS, 2SLS	Non-statistically significant relationship	---
Elsas *et al.* (2010)	Banks from 9 countries (1996-2008)	Adjusted Herfindahl index	Instrumental variables regressions (2SLS), Heckman treatment effects model	Non-statistically significant relationship	---
Ferris *et al.* (2010)	International simple (1991-2006)	Dummy variable	Cross-sectional regression	DISCOUNT	Control for geographic diversification
Grass (2010)	U.S. firms	Dummy variable	Fixed effects	DISCOUNT	---

[20] Dehejia & Wahba estimator, Abadie & Imbens estimation, and Heckman estimator.

	(1984-2005)				
Kuppuswamy and Villalonga (2010)	U.S. firms (2007-2009)	Dummy variable	Treatment-effects and switching regressions	DISCOUNT	---
Ammann *et al.* (2012)	U.S. firms (1985-2005)	Dummy variable, no. of segments, sales-based Herfindahl, assets-based Herfindahl	Cross-sectional regression, fixed effects, Heckman two-stage	DISCOUNT	---
Hoechle *et al.* (2012)	U.S. firms (1996-2005)	Dummy variable	Fixed effects, Heckman two-stage	DISCOUNT	---

As regards measurement problems, the informative nature of data, particularly at the segment-level[21], has been subjected to exhaustive analysis by one series of papers as it may be partly responsible for said conflicting evidence. Villalonga (2004a) posits that difficulties in reflecting the full scope of diversification might prevent conclusive evidence from being reached. By disaggregating firms' activity into businesses using *Business Information Tracking Series*, rather than the segments used by Compustat, Villalonga (2004a) reports that the diversification discount converts into a premium.

Additional database limitations stem from changes in segment reporting standards. For instance, in the United States, SFAS no. 131 replaced the old SFAS 14[22] from fiscal year 1998. This new standard increases the number of reportable segments (Street, Nichols and Gray, 2000), thereby providing more disaggregated information on the extent of diversification (Berger and Hann, 2003). He (2009) points out that the reporting standard is likely to affect the nature of the data, and finds a discount in a pre-1997 sample compared to a premium in a post-1998 sample of US firms. Berger and Hann (2003) also offer evidence that the new SFAS 131 standard impacts excess values but in the opposite direction to that reported by He (2009). They find a higher average discount under SFAS 131 compared to SFAS 14, thanks to its greater potential to reveal agency problems due to their higher segmentation and more information about transfers between segments.

[21] Papers such as Fan and Lang (2000) or Villalonga (2004a) point out the problematical definition of segment. "*Prior studies have found that firms make strategic segment reporting decisions*" (Fan and Lang, 2000: 642).

[22] SFAS 131 was issued by the FASB (Financial Accounting Standards' Board) in June 1997, and heralded a change from an "industry approach" to a "management approach", requiring disaggregated information to be reported according to *"how management internally evaluates the operating performance of its business units"* (Berger and Hann, 2003: 164).
For a study of the impact of SFAS 131 on diversification analyses, see Ettredge, Kwon and Smith (2000) and Berger and Hann (2003).

Another prominent strand of research suggests that endogeneity may obscure the true relationship between diversification and corporate value since the diversification status is not assigned at random within the sample, with firms rather self-selecting to undertake this strategy. In this regard, Campa and Kedia (2002), Miller (2004), and Villalonga (2004b), among others, argue that certain factors affecting a firm's decision to diversify may also drive value outcomes. The bulk of the diversification literature indicates that diversified firms are larger (Anderson *et al.* 2000; Hoechle *et al.* 2012), exhibit greater leverage (Anderson *et al.* 2000; Hoechle *et al.* 2012), have more cash (Hyland and Diltz, 2002), and lower R&D expenses (Anderson *et al.* 2000; Hyland and Diltz, 2002; Miller, 2004; Hoechle *et al.* 2012). Insofar as some of these characteristics are strongly correlated with firm value, failing to control for such ex-ante differences in firm resources may explain part of the ex-post diversification discount[23] (Miller, 2004).

Miller (2006) recognizes the existence of at least two sources of potential endogeneity. Firstly, diversification and performance may be simultaneously determined by other factors. Secondly, feedback from performance to diversification might exist. Overlooking such endogeneity may misattribute valuation effects to this strategy rather than to a firm's circumstances prior to the diversification decision. Once this endogeneity is controlled, Campa and Kedia (2002) report a premium for the 1978-1996 period. However, Hoechle *et al.* (2012) test this same argument by correcting for endogeneity on a sample between 1996 and 2005, yet find a discount, evidencing that some pieces of the puzzle are still missing.

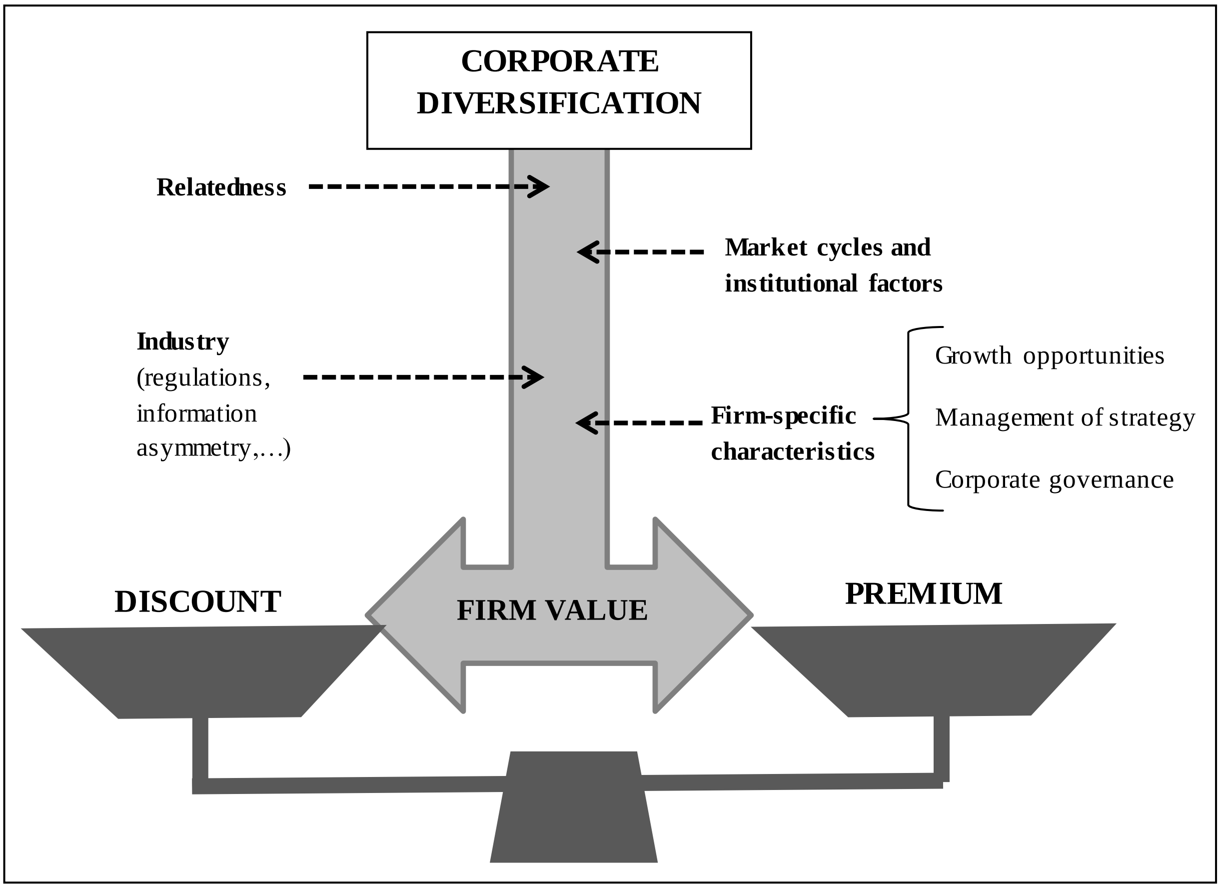
[23] Attributing the whole discount to corporate diversification seems unclear (Lang and Stulz, 1994) since certain firms trade at a discount even before diversifying (Hyland and Dilz, 2002) and would do so in an attempt to seek fresh growth opportunities (Lang and Stulz, 1994) or a better match for their organizational capabilities (Matsusaka, 2001).

1.3.2. From the discount/premium dichotomy towards a contingent-based perspective

Much of the empirical literature addresses the 'average effect' of diversification in terms of discount/premium, yet insufficient attention is paid to the cross-sectional variation of diversification value outcomes (Stein, 2003; Villalonga *et al.*, 2003). Diversification may be neither good nor bad intrinsically (Becerra and Santaló, 2006). Over the last decade, research has sought to overcome such a discount/premium dichotomy. The diversification debate has recently centered on ascertaining the conditions under which diversification proves a value-enhancing strategy for companies (Mackey, 2006; Humphery-Jenner, 2010; Erdorf *et al.*, 2013). Hence, recent research embraces a contingent approach and posits that the impact of diversification on a firm's value may differ across firms.

This contingent approach advocates the search for factors which may impact the sign and size of diversification strategy outcomes, resulting in either a discount or a premium. Such factors affecting the influence of diversification on a firm's value could be classified into four broad categories: (a) relatedness among business segments; (b) market and institutional level factors; (c) industry level factors; and (d), firm level factors [see **Figure 1.3**].

Figure 1.3
[Contingent approach to the diversification-value relationship]



(a) Relatedness refers to the extent a firm's businesses share or draw on common strategic resources and capabilities (Rumelt, 1982). Most empirical evidence attributes better performance to related diversification than to unrelated diversification[24] (Bettis, 1981; Rumelt, 1982; Simmonds, 1990; Markides and Williamson, 1994; Berger and Ofek, 1995; Palich *et al.*, 2000; Villalonga, 2004a) since diversification in connected businesses is likely to promote economies of scope, synergies, and knowledge transfer across divisions, thus

[24] Suárez-González (1994) does not report any statistically significant differences in performance between related and unrelated diversifiers for Spain during the 1987-1990 period. She attributes it to the small size of Spanish companies and the existence of economies of scale yet to be exploited.

increasing diversifier competitiveness over their focused counterparts (Adner and Zemsky, 2006).

(b) Another strand of literature sheds light on the influence of market cycles, causing instability of discounts/premiums over time. For instance, Kuppuswamy and Villalonga (2010) provide evidence that the discount in conglomerates decreased during the 2008-2009 financial crisis as a result of the coinsurance effect and the availability of internal capital markets, which give diversified firms better access to "more money" and "smarter money" than non-diversified firms.

Institutional factors have also been found to drive part of the variation in the excess value of diversified firms over time and within countries (Lins and Servaes, 1999; Fauver *et al.*, 2004; Chakrabarti, Singh and Mohmood, 2007; Kuppuswamy, Serafeim and Villalonga, 2012). In this regard, certain papers report cross-country divergences on the value of corporate diversification. Lins and Servaes (1999) report a discount in Japan (10%) and the UK (15%), while a non-significant discount in Germany. Further supporting evidence comes from Fauver *et al.* (2004), who also confirm the discount in the UK and US, but again report no significant effect for German firms.

Among institutional factors, the degree of development of external capital markets has been the subject of substantial research. Diversification is seen to be more value-enhancing in less developed external capital markets since internal capital markets are expected to mitigate certain market frictions (Hubbard and Palia, 1999; Kuppuswamy *et al.*, 2012).

(c) Certain papers suggest the relevance of the industry where multisegment firms operate (Becerra and Santaló, 2006; Santaló and Becerra, 2008; Aggarwal and Zhao, 2009). Santaló and Becerra's (2008) results yield evidence reflecting that the number of single-segment enterprises, or alternatively the market share of specialized firms' competitors in an industry, moderates the diversification-performance relationship. As a result, it is possible to obtain a premium in certain industries where multisegment companies show competitive advantages over focused firms, and a discount in other industries which are more populated by pure-play firms. Other papers such as Aggarwal and Zhao (2009) provide further supporting evidence that the valuation effects of diversification are contingent on the industry. They find a diversification discount in mature industries where internal capital markets are more likely to carry higher costs due partly to low information asymmetry, whereas they obtain a diversification premium in emerging industries.

Jandik and Makhija (2005) examine the particular case of regulated industries such as U.S. electric utility companies. They provide empirical evidence that diversification gives rise to a premium during the period of strict exogenous regulation (1980-1992) as this strategy enables multisegment companies to spread their investments across multiple businesses, making single regulated-segment firms overinvest to a greater extent than they otherwise would in a context of partial deregulation.

(d) Finally, other papers such as Campa and Kedia (2002) suggest that certain firm-specific characteristics[25] determine the value-creating or value-destroying outcome of diversification.

Among these intrinsic characteristics accounting for differences in value outcomes across diversifiers, the literature has compiled suggestive yet inconclusive evidence concerning firms' growth opportunities. Since Myers' (1977) seminal paper emphasized the present value of future growth opportunities as one of the components of a firm's total value, the *growth generating process of investment opportunities* (Kasanen, 1993) has captured greater attention in making investments create value today and in opening the door to take advantage of further valuable options to invest in the future. Subsequent research such as Xing (2003: 24) also considers them as perhaps *"the most important firm characteristic that needs to be controlled for in assessing firm value"*.

Neither the role of growth opportunities in explaining diversification discounts/premiums nor the sign of said relationship escape controversy. On the one hand, certain papers do not regard them as a driver of the diversification discount (Xing, 2003; Stowe and Xing, 2006). Stowe and Xing (2006) find that the discount remains after controlling for growth opportunities. In contrast, there is more evidence supporting the idea that growth opportunities account for part of the diversification discounts/premiums[26]. Bernardo and Chowdhry

[25] Campa and Kedia (2002) mention characteristics such as unique organizational capabilities or agency costs.

[26] Here it is noteworthy that Graham, Lemmon and Wolf (2002), and Zhao (2008) criticize some points of the Berger and Ofek imputed value method where pure-play firms are considered a suitable benchmark to compare the segments of diversified companies. Stowe and Xing (2006) calculate the industry multiples

(2002) ascribe a significant role of growth opportunities when accounting for the diversification discount: unisegment firms have more options to expand whereas diversified firms may have exhausted part of these. Further supporting evidence, such as Ferris *et al.* (2002), reveals that, for a sample of international joint ventures between 1987 and 1996, diversification is value-destroying in firms with a weak cash flow position and few opportunities for growth. Concurring with this line of argument, Borghesi *et al.* (2007) claim that pure-play firms and their diversified industry-peers display differing growth potential. Once the age of the firm, used as a proxy for growth opportunities, is controlled for, the initially displayed discount decreases. Drawing on arguments of agency problems, Rajan, Servaes and Zingales (2000) also agree as to the relevance of a firm's growth opportunities for diversification value outcomes. They find that greater diversity of growth opportunities across divisions may lead to inefficient investments as a result of transferring funds from segments with good opportunities to poor performance ones.

In addition to growth opportunities, another firm intrinsic characteristic commonly argued in prior research to affect the success/failure of corporate diversification is how the firm manages this growth strategy (Gary, 2005). On the one hand, papers such as Andreou and Louca (2010) focus on the diversification profile. They document a discount in enterprises diversifying from one to multiple segments due to their relative inexperience as diversifiers, whereas they find a premium in firms which undertake this strategy numerous times.

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by taking companies which not only belong to the same industry, but also exhibit comparable growth opportunities.

Other studies analyze corporate governance mechanisms, which are seen to differ between unisegment and multisegment companies[27]. However, whereas studies such as Anderson *et al.* (2000) find no evidence that corporate governance explains the impact of firm value, other papers report results which point in the opposite direction (Jiraporn *et al.*, 2008; Gillan, Kensinger and Martin, 2000; Boumosleh, Cline and Hyder, 2011; Hoechle *et al.*, 2012). Gillan *et al.* (2000) perform a case study on the decision by *Sears, Roebuck & Co.* to expand from retail operations to the financial industry. They attribute the failure of this diversification to agency conflicts, which caused the strategy to be handled poorly. In a similar sprit, Lauenstein (1985) ascribes successful diversifications to the *"system of governance of independent corporations"*. Empirically, Hoechle *et al.* (2012) support the notion that corporate governance affects the diversification-value relationship, observing a decline in the diversification discount once such mechanisms are controlled for.

In sum, all these moderating factors lead to a re-positioning of the research question which has guided so many works: "Does corporate diversification create value for firms?" Based on identifying an average discount/premium, the answer provides too narrow a perspective of this business phenomenon. In recent years, an increasing number of both scholars and practitioners seem to agree on adopting a contingent approach in order to answer such a question. Diversification may not succeed or fail in every situation, since the environment and the firm-specific characteristics may tip the

[27] Anderson *et al.* (2000) report that diversified firms tend to have more outside directors and display higher rates of managerial turnover than focused firms.

scales one way or another. Thus, determining the conditions under which business diversification is likely to enhance a firm's value is becoming the core question.

Chapter 2

Rethinking the Diversification Puzzle from a Real Options Approach: Theoretical Model and Hypotheses

This second chapter constitutes the core of the theoretical foundations of our research. We present our theoretical framework, the real options (RO) approach, and based on it, develop our study model and hypotheses. The RO perspective proves a helpful guide for our research purposes since it is closely linked to a firm's growth opportunities as well as its specific resources and capabilities. As reviewed earlier, firm specific factors such as growth opportunities and management of corporate strategies seem to contribute to shaping the diversification-value relationship.

This dissertation aims to contribute to the diversification puzzle debate by re-examining the diversification-value relationship from a real options (RO) approach, from which corporate strategies are seen as chains of interrelated real options, each affecting the others (Kester, 1984; Luerhman, 1998). More specifically, the analysis focus of our theoretical model lies in the trinomium involving diversification, growth opportunities, and firm value.

This second chapter is organized into five different sections. First, we present the RO approach and its applications as strategic thinking. Second, we present our core study model. In the three remaining sections, our study hypotheses are developed, and are grouped into three submodels (mediating model, diversification patterns model, and growth opportunities model).

2.1. CORPORATE STRATEGIES IN REAL OPTIONS LANGUAGE: RETHINKING BUSINESS DIVERSIFICATION

RO analysis challenges conventional investment criteria based on the net present value in contexts of uncertainty. Under this framework, a firm's value not only stems from the expected cash flows from current allocation of resources (present value of assets-in-place), but also from possible/future resource allocation decisions that ownership of the resources themselves may enable the firm to undertake (present value of future growth opportunities) (Myers, 1977). This latter component mostly captures the essence and distinctive basis of RO as a strategic approach: accounting for the *value of the right to preserve decision rights in the future in their investment choices* (McGrath and Nerkar, 2004: 2). This perspective opens up new horizons for the applicability of RO analysis as 'strategic thinking'[28].

One keystone of the RO approach lies in the active role attributed to managers. This approach assumes that managers are able to revise and readjust strategies[29] during their implementation so as to take advantage of uncertainty by either building preferential access to exploit emerging opportunities or by limiting downside risk to contingencies. As a result, the decision-making process will no longer consist of now-or-never decisions, but rather a more flexible multistage process starting from small-scale

[28] McGrath, Ferrier and Mendelow (2004) review four perspectives from which literature traditionally approaches the concept of real options: as a component of total firm value, as specific investments with option-like properties, as choices, and as a heuristic for strategic investment.

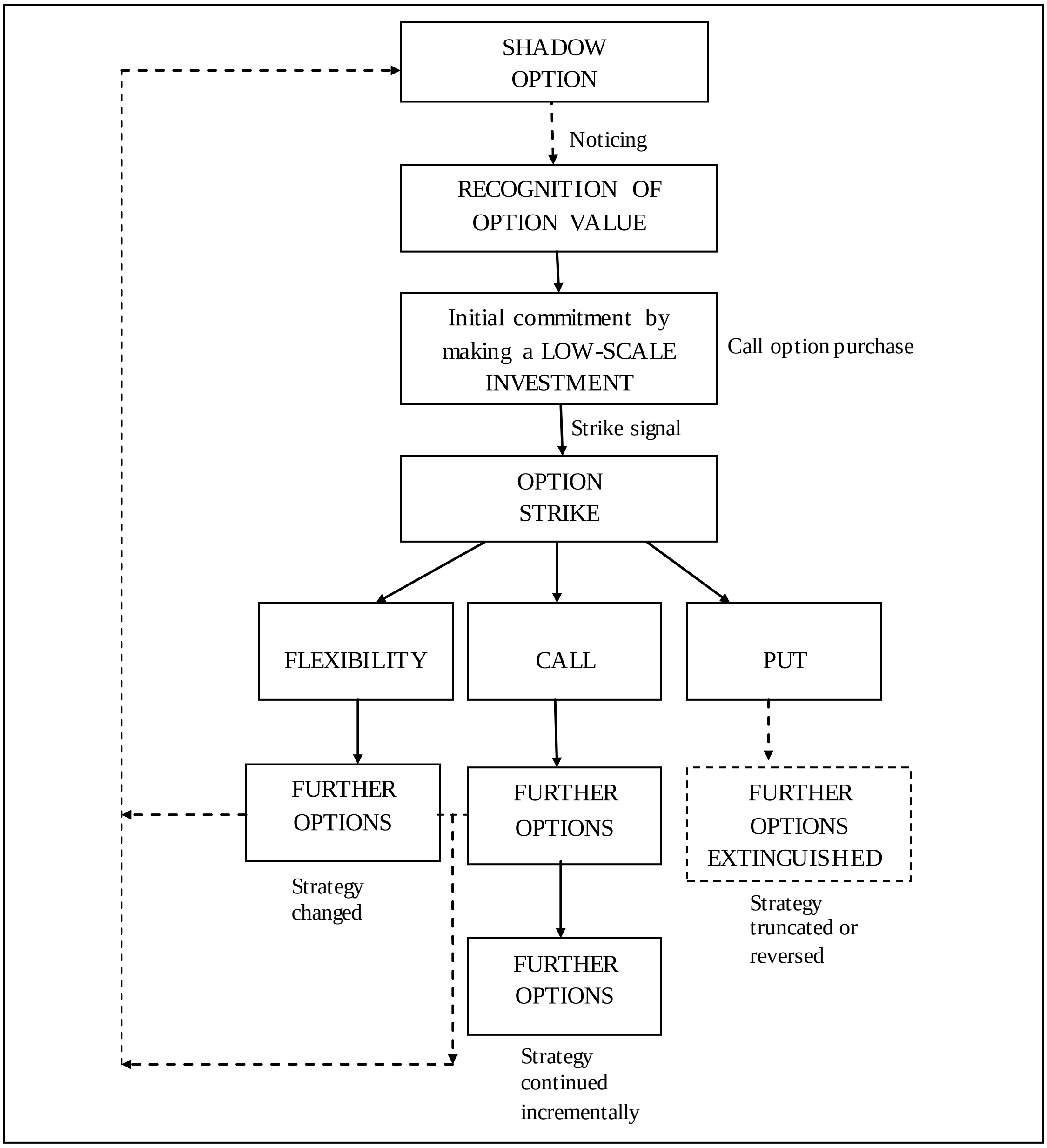
[29] Mun (2002: 10) describes real options as a "learning model", enabling managers to make "better and more informed strategic decisions" as uncertainty unfolds.

commitments of resources which the company may decide to amplify or abandon as uncertainty unfolds[30].

Kester (1984) and Myers (1984) were among the pioneers in the study of resource allocation strategies as options to invest. From the RO lens, expansion strategies are analysed as chains of growth options (Bowman and Hurry, 1993; Luehrman, 1998), exercise of each being linked to the creation of others. Thus, a firm's expansion is conceived as the gradual replacement of growth options by assets-in-place (Bernardo and Chowdhry, 2002), growth thus being achieved sequentially. **Figure 2.1** represents the RO approach to growth strategies.

[30] Endogenous uncertainty, reduction of which is within reach of enterprises, is better resolved by investing sequentially (Folta, 1998).

Figure 2.1
[Stages in growth strategies implemented according to RO logic]



Source: Adapted from Bowman, Hurry and Miller (1992: 97); and Bowman and Hurry (1993: 764).

First, a shadow option needs to be sensed by managers. When doing so, they will consider how valuable this option might be vis-à-vis company expansion. If valuable, the firm will adopt the corresponding growth strategy through a minor start-up investment, equivalent to purchasing an option to invest later[31]. In this way, the firm 'keeps the opportunity open' while at the same time limiting downside risk thanks to the scaled commitment of resources (*'wait and see'* logic). When the company deems the time is right to exercise the option (strike signal), it can increase its commitment. In turn, this option exercise gives rise to further options, such as investing incrementally to exploit further growth opportunities (options to expand), adapting the strategy after receiving feedback and fresh information (flexibility options), or abandoning the growth strategy prematurely if the experience fails (options to abandon).

Growing interest in the application of 'RO logic' to strategic decisions[32] has given rise to a number of papers[33] (**Table 2.1**).

[31] *"Because investment decisions today can create the basis for the investment decisions tomorrow"* (Kester, 1984: 160).

[32] See Reuer and Tong (2007), and Driouchi and Bennet (2012) for surveys on strategy and real options.

[33] In general, many works advocate the need for more empirical studies to advance and drive the real options theory (Reuer and Tong, 2007; Cuervo-Cazurra and Un, 2010).

Table 2.1
[Applications of the real options approach to corporate strategies]

CORPORATE STRATEGY	ILLUSTRATIVE REFERENCES
Entry into new markets	Folta and Miller (2002a); Folta and O'Brien (2004).
Internationalization	Buckley and Tse (1996); Rivoli and Salorio (1996); Li (2007); Li and Rugman (2007); Brouthers, Brouthers and Werner (2008); Jiang, Aulakh and Pan (2009).
Corporate diversification	Bernardo and Chowdhry (2002); Raynor (2002); Andrés and Fuente (2004); Andrés, Azofra and Fuente (2005); Zhao (2008).
R&D investments	Mitchell and Hamilton (1988); Faulkner (1996); McGrath and Nerkar (2004); Oriano and Sobrero (2008); Cuervo-Cazurra and Un (2010).
Strategic alliances	Kogut (1991); Chi and McGuire (1996); Folta (1998); Folta and Miller (2002b); Kumar (2005); Tong, Reuer and Peng (2008); Estrada, Fuente and Martín-Cruz (2010).
Technology investments	McGrath (1997); Miller and Arikan (2004); Andrés, Azofra and Fuente (2006).

Ansoff's (1965) growth vectors (especially market and product development) are reconsidered through the RO lens. As regards market development, Folta and Miller (2002a) recognize the relevance of options value in entry timing, conceiving the initial commitment of resources as the purchase of a call option. In a similar vein, Folta and O'Brien (2004) yield evidence of the entry decision as a trade-off between the option to defer and the option to grow. In low levels of uncertainty, the option to defer dominates, thus deterring entry. Beyond the 93 percentile of uncertainty, the relationship reverses and uncertainty encourages entry, since the value of the growth options outweighs the value of the options to defer.

Moreover, RO analysis offers an insight into product development, particularly in the early stages such as R&D investments, which are seen as call options (Mitchell and Hamilton, 1988; Faulkner, 1996; Miller and Arikan, 2004; Oriani and Sobrero, 2008; Cuervo-Cazurra and Un, 2010). In this vein, Mitchell and Hamilton (1988: 19) claim that *"the major purpose of the R&D option is to influence the future investment favourably"*. Intangible resources generated during the R&D process may prove a springboard to additional options.

Firms may decide to undertake those strategies in partnership with other companies. From an RO perspective, these strategic alliances are seen as an initial stage of a larger investment project, which enables partners to get to know each other while reducing the risk exposure to potential misappropriation of each other's knowledge (Chi and McGuire, 1996). Much research has been conducted into these strategic alliances as options-based strategies[34], with joint ventures having been the focus of particular attention (Kogut, 1991; Chi and McGuire, 1996; Kumar, 2005; Tong *et al.*, 2008; Estrada *et al.*, 2010). Kumar (2005: 323) describes joint ventures as transitional structures in the incremental growth process. Once the necessary capabilities are developed, the company may decide to increase its commitment and acquire a venture. Kogut (1991) also supports the RO nature of these collaborative alliances. He reports an asymmetry in the acquisition and dissolution results of joint ventures, finding that unexpected market growth encourages acquisition while unexpected shortfalls have no statistically significant effect on the likelihood of dissolution.

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[34] They avoid missing out on a potential valuable opportunity while deterring full commitment of resources, thus pooling risks and enjoying greater flexibility.

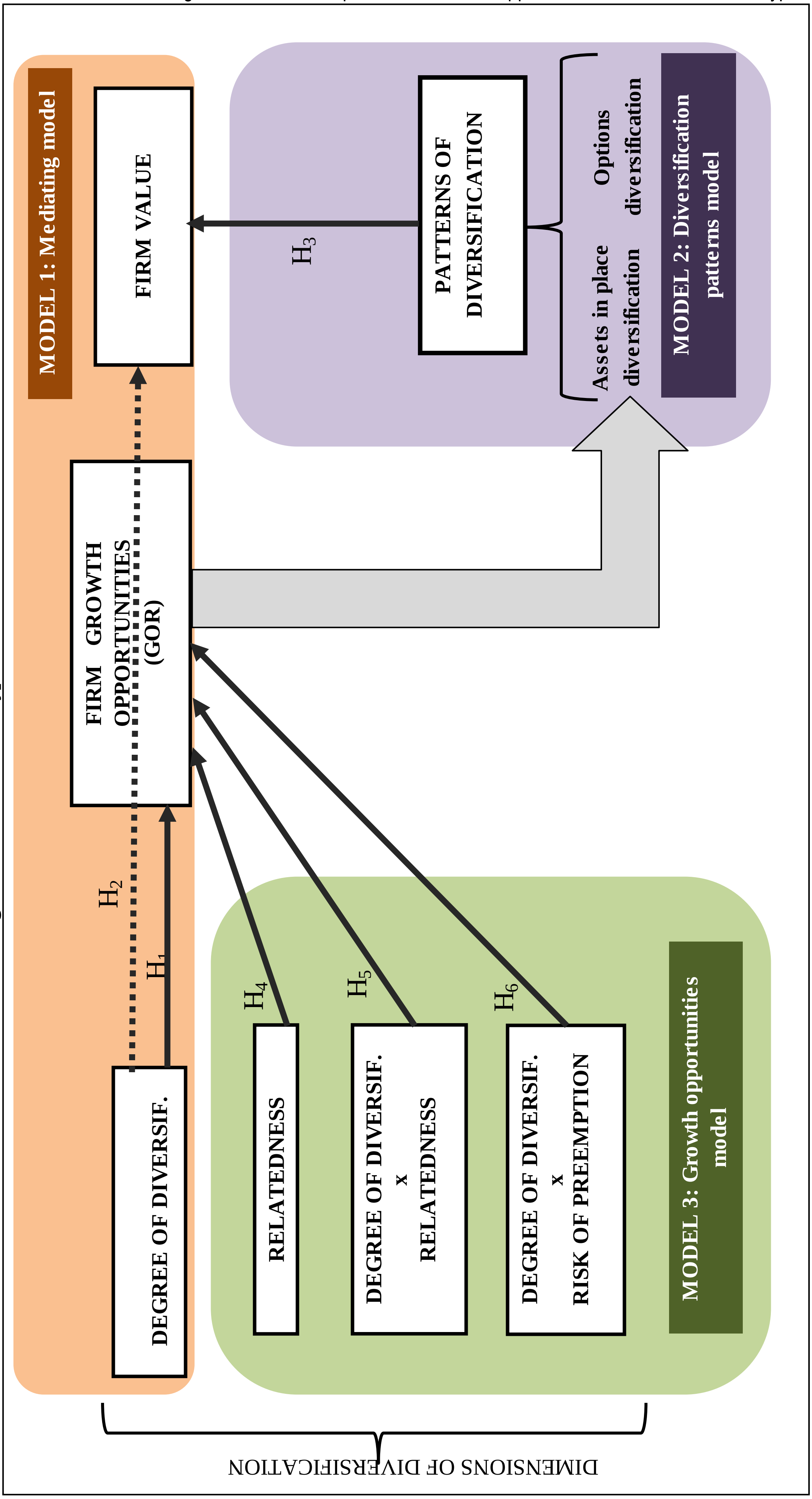
In the diversification research arena, the RO approach is beginning to emerge (Bernardo and Chowdhry, 2002; Raynor, 2002; Andrés and Fuente, 2004; Andrés *et al.*, 2005; Zhao, 2008). Raynor (2002) is among the papers leading the extension of RO logic to diversification. He considers the diversification strategy as *strategic insurance* which reduces firm-specific risk in a way shareholders could not replicate with a portfolio of unisegment companies. Another relevant contribution to the RO insight into diversification has been made by Zhao (2008). She documents a change in the market-to-book ratios around the diversification decision, showing that this strategy affects a firm's growth potential. The sign of the influence diverges between below-industry and above-industry performers, proving only significant in the latter firms which experience an average decrease as a result of exploiting excess capabilities and exercising options.

2.2. THEORETICAL STUDY MODEL: DIVERSIFICATION, GROWTH OPPORTUNITIES, AND FIRM VALUE

In this section, we present the model put forward in the dissertation. **Figure 2.2** illustrates our theoretical model. The RO approach guides us to introduce an additional piece in the diversification puzzle, namely the firm's growth opportunities, which may contribute to shaping the relationship between corporate diversification strategy and firm value. The full model is built on the diversification, firm growth opportunities, and firm value trinomium. First, our research hypotheses posit that corporate diversification has a straightforward relation with the firm's growth opportunities value (more specifically, growth options value to total firm value ratio, GOR). By defining diversification strategy, we distinguish between three dimensions, namely degree of diversification, relatedness between segments and patterns of diversification; as well as two interaction effects (between degree of diversification and relatedness, and between degree and risk of pre-emption). Secondly, our hypotheses suggest that part of the effect of diversification on a firm's value may go through GOR, a firm's growth opportunities thus partly determining the final value outcomes of this strategy.

This full model can be divided into three submodels: *mediating model* (model 1), *diversification patterns model* (model 2) and *growth opportunities model* (model 3).

Figure 2.2.Models and hypotheses



Model 1 (mediating model) constitutes the starting point, which suggests that a firm's growth opportunities drive the effect of corporate diversification on its value. Hypothesis 1 aims to show how corporate diversification strategy, as a growth strategy, relates to the firm's portfolio of growth opportunities (more specifically, the growth options value to total firm value ratio, GOR). Should diversification affect GOR, we argue that growth opportunities may also explain part of the impact of diversification on a firm's value. Given that growth opportunities are one component of firm value (together with assets-in-place (Myers, 1977)), we argue that part of the effect of diversification on performance may not be carried directly but rather be mediated by growth opportunities (hypothesis 2).

In light of the previous arguments, **model 2 (diversification patterns model)** goes one step further. Drawing on the RO approach and its foundations regarding the impact of a firm's strategy on its market value, we identify one dimension of diversification worth examining; namely, how this strategy is implemented. Here, two contrasting patterns emerge. On the one hand, a one-step or 'assets-in-place' strategy in which each diversification decision is addressed as a now-or-never full-scale investment, implying either exercise or abandonment of the option to invest immediately, and, on the other, a multi-step or 'growth option' strategy, involving minor exploratory investments in certain industries with a view to building new strategic options (which the company may sequentially exercise in the future) while limiting downside risk and maintaining flexibility. Since each of these contrasting diversification patterns entails a different configuration of the growth options portfolio, they might lead to diverging values of said portfolio. Each way of diversifying may thus impact a firm's value differently. Model 2 is a single-hypothesis model which aims to examine the impact of these patterns of diversification on a firm's value.

Finally, **model 3 (growth opportunities model)** investigates the impact of corporate diversification on the growth options ratio, GOR. The bulk of existing literature focuses on how growth opportunities influence diversification value outcomes. Yet, whether, and if so, how diversification strategy shapes the firm's set of growth options has received little attention (Zhao, 2008). Given the conflicting findings on the diversification-value relationship, a preliminary step might be to address the effect of diversification on the present value of growth opportunities (one of the components of firm value defined by Myers (1977)). These intangible assets are acquiring major importance in many companies[35]. The diversification strategy profile implemented by the company may alter the configuration of the firm's growth options portfolio, and through it, impact a firm's value.

More specifically, model 3 starts from a multidimensional view of diversification and addresses how different dimensions of business diversification interact with the firm's growth options portfolio. Apart from the degree of diversification, the literature also emphasizes the relatedness dimension, which refers to the interrelationships among the business segments within a company (hypothesis 4). In addition, joint analysis of the scope and relatedness dimensions (hypothesis 5) might offer interesting insights, since their combined effect may either counter or reinforce the impact each carries separately. The final hypothesis (hypothesis 6) incorporates a moderating factor in the analyses: the risk of pre-emption of investment opportunities. Some papers call for greater attention to industry conditions as contingency factors (Datta *et al.*, 1991). We evaluate how the threat of pre-emption influences the relationship between diversification and growth opportunities. The risk of pre-emption is directly linked to the lifespan of the option. A

[35] See Kester (1984: 155) for the percent of market value represented by growth options for a group of selected companies in sectors such as electronics, computers, chemicals, tyres and rubber, and food processing.

more pre-emptive investment opportunity by competitors shortens the time available to experiment and to deter full commitment, thereby reducing option value.

2.3. MEDIATING MODEL (1)

The first two hypotheses put forward in this section shed light on the diversification-growth opportunities-firm value trinomium, which forms the primary frame of our research. Here, we develop an RO logic of corporate diversification to propose how diversification configures the firm's growth options portfolio and subsequently, how the value effect of diversification may be explained by this strategy's contribution to growth opportunities.

2.3.1. Diversification as a trade-off between exercising and creating growth options

According to the RO approach, a firm's value is the sum of the value of its assets-in-place and the value of its growth options (Myers, 1977). Assets-in-place refers to the particular allocations of a firm's resources that are already made. The value of this component stems from the stream of cash-flow expected to be generated over time. However, a firm's value derives not only from ownership of cash-flow as generated by a given resource allocation but also from ownership of resources themselves, and hence from cash-flow from any other alternative allocation. The value of growth options depends on the latter cash flows to emerge from possible/future resource allocation decisions.

Under the RO logic, a firm's expansion is conceived as the gradual replacement of growth options by assets-in-place (Bernardo and Chowdhry, 2002). Such a conception of the investment process requires the previous existence of a growth option and involves materializing this option by assets-in-place. In the case of diversification, the growth option corresponds to the opportunity to invest in a new business and effective participation therein matching the underlying assets-in-place. This replacing process is considered by Stowe and Xing (2006) when they argue that diversified firms hold fewer unexercised growth options than their undiversified counterparts, thus suggesting a negative effect of diversification on GOR.

Conversely, arguments in favour of diversification exerting a positive effect on GOR can also be found. Growth options stem from the everyday management of business operations. Tangible and mainly intangible results emerging from business practice, such as knowledge, corporate image or customer loyalty among others, are the seeds for new investment opportunities. On the RO basis, growth strategies, such as business diversification, are viewed as stage-setting investments consisting of chains of real options (Bowman and Hurry, 1993). Firms engage in a path-dependent course in expansion investments, along which organizational learning is cumulative and incremental, and base capabilities serve as a platform for subsequent and more complex ones. From this perspective, diversification is perceived as a source of new growth options, and widening a firm's range of businesses might have a positive effect on its GOR.

All the above-mentioned arguments together suggest that a diversification strategy may have a two-fold impact on a firm's sources of value. First, diversification means exercising a firm's current growth options, and therefore implies materializing RO into assets-in-place. Second, by exploring and expanding a firm's activity into new businesses, diversification may give rise to new tangible and intangible assets which are the root of subsequent investment opportunities. Considering the two effects jointly, we hypothesize that the net outcome of the degree of diversification on GOR may take a U-form.

At lower levels of diversification, a company's experience is limited to its core business and, as a result, its growth options will be closely connected to it. In this case, the main effect of diversification is to replace growth options with assets-in-place. As a result, a negative effect of diversification on GOR will dominate.

As the firm diversifies more widely, broader business activity together with accumulated learning not only offers the firm preferential access to opportunities but also improves its sense-making and recognition of shadow options (Bowman and Hurry, 1993: 774). Participating in multiple businesses may be the seed of a wider range of investment opportunities by spreading a firm's capabilities across alternative industries (Bowman and Hurry, 1993). Prior accumulated knowledge and experience may place the company in an advantageous position to explore and exploit new opportunities. In this line, Matsusaka (2001) finds that diversification is more valuable among firms that have significant amounts of organizational capital. Moreover, as a company becomes increasingly diversified, resources may potentially be leveraged in multiple businesses. Furthermore, a firm can benefit from synergies between the options it holds and may be able to redeploy existing skills (Vassolo, Anand and Folta, 2004). In sum, as the firm broadens its diversification scope it may at some point reach an inflexion point from which the relationship between GOR and diversification may flip and turn positive (even non-linearly) as a result of diversification becoming a source of additional growth options. At such a stage, a wider range of businesses makes the value of the new growth options generated by diversification higher than the value of the growth option exercised.

Following on from these arguments, we hypothesize a non-linear relationship between diversification and GOR. Thus, our first hypothesis posits that:

H$_1$: The impact of the degree of diversification on GOR displays a U-shaped function.

2.3.2. The mediating role of GOR in the diversification-value relationship

One recent stream of research suggests that the impact of diversification on a firm's value may not be homogeneous across firms but rather contingent on growth opportunities, with mixed results emerging. Vis-à-vis the negative effect of growth opportunities, Rajan *et al.* (2000) find that diversity in investment opportunities between divisions within a conglomerate aggravates agency problems among divisional managers, thus resulting in more inefficient transfers of resources between them. On the positive side, Ferris *et al.* (2002) analyse diversification for a sample of international joint ventures and show that diversification is only value-destroying in enterprises that have a poor set of growth opportunities. Finally, some papers such as Stowe and Xing (2006) fail to find any significant role of growth opportunities. Overall, this conflicting evidence suggests that part of the total effect of diversification on firm value may be channelled via the firm's growth options portfolio (in our case, GOR).

As pointed out earlier, from an RO approach, corporate diversification involves a trade-off between exercising growth options and creating further ones. Those options/capabilities stem from the interplay of the organization's tangible and intangible assets in existing investments (Bowman and Hurry, 1993) and joint management of multiples businesses. This may become the key to determining either the value-enhancing or value-destroying effects of diversification. If diversification has a multiplicative effect on generating new growth options, the value of a growth option portfolio in a diversified firm should be greater than the sum of the values of the growth options embedded in each business considered individually. Consequently, diversification aimed at enhancing GOR may provide the firm with valuable options which individual investors cannot replicate, thus resulting in a diversification premium.

Furthermore, growth options create economic value by generating future decision rights which offer managers the flexibility to redirect company strategy and make midcourse decisions as uncertainty unfolds (Mun, 2002). Growth options enable the firm to keep opportunities open and await fresh information before making a greater or firmer commitment. As a result of this flexibility, corporate diversification may reduce risk and serve as a ‘strategic insurance’ (Raynor, 2002: 380-381). In this regard, Amihud and Lev (1981) argue that the critical question is what kind of risk is reduced by diversification and whether stockholders can diversify it in their individual portfolios. Were investors able to diversify at a lower cost than enterprises, corporate diversification would destroy value. Insofar as diversification mainly involves creating those interrelated flexible growth options, it will likely result in a premium, since investors cannot replicate the optimal exercise policy of a diversified firm’s portfolio of options. Even in the absence of such a multiplicative effect referred to in hypothesis 1, the most an individual investor can hope to achieve is to replicate the growth options portfolio by acquiring those stocks which contain said options. However, the value of this replicated portfolio should be less than the value of the growth options portfolio of the diversified firm, since optimal joint exercise of an options portfolio always proves more efficient than optimal exercise of each individual option[36].

These ideas lead us to hypothesize that, in addition to a direct effect of the level of diversification on a firm's value (which numerous studies have dealt with), such a relationship may also be mediated by GOR. Insofar as the diversification value which cannot be achieved through portfolio diversification in capital markets is the value linked to generating and optimal exercise of growth options, a higher GOR is likely to offer a premium. Following on from this, we enunciate our second hypothesis:

H_2: The relationship between diversification and diversification discounts/premiums is mediated by GOR, such that the more that diversification enhances the GOR, the higher the excess value.

2.4. DIVERSIFICATION PATTERNS MODEL (2)

Corporate diversification may be devised as a strategy whereby a firm seeks to take advantage of its capabilities in current businesses to enter new ones. In this view, each diversification decision depletes part of a firm's growth opportunities as a result of being exercised. This argument is posited by certain papers such as Bernardo and Chowdhry (2002) to explain the diversification discount. However, diversification may also serve as a means of spreading a firm's capabilities across alternative industries, and is thus likely to contribute towards opening up future business opportunities for the firm. Indeed, the interaction of a firm's core business and its current growth options

[36] This is easily illustrated by the fact that the value of an American-type option is always higher than or is equal to the maximum value of a bundle of European-type options maturating sequentially until expiration of the former American option.

where it diversifies may play an important role not only in risk but also in generating further options.

Although corporate diversification and its benefits and costs have been widely studied in the literature, little attention has been paid to how firms implement diversification and reconfigure their growth options portfolio throughout the investment process. Exploring how growth options are created and handled in the resource allocation process constitutes the core of the RO approach. Pioneering studies such as Myers (1977) and Kester (1984) established the analogy between corporate investments and call options, paving the way for an application of the RO framework as a conceptual strategic approach, commonly referred to as ‘RO logic’ or ‘RO reasoning’. Through the RO lens, corporate strategies are analysed as chains of real options related to one another (Bowman and Hurry, 1993). This approach accounts for the value of preserving the right to make future choices under uncertainty, encouraging firms to ‘keep options open’ and to scale resource commitment until uncertainty is resolved and more information becomes available.

Apart from the widely studied dimensions of scope and relatedness of diversification, the RO approach urges a deeper analysis of the nature of diversification, namely *how* the investment is undertaken. In this regard, two contrasting investment paths (Bowman *et al.*, 1992) can be distinguished: a *one-step strategy*, which mainly involves full-scale commitments by making large sunk investments, versus a *growth option (GO) strategy*, entailing minor commitments in strategic areas which serve as platforms for future investments. These two investment patterns translate to opposing ways of diversifying: assets-in-place diversification (AiPD) versus growth-option diversification (OD), respectively.

In AiPD, the firm holds a large participation in the businesses it is involved in. Diversification into a new business is conceived as a one-shot investment strategy, meaning immediate exercise or abandonment of previously acquired growth options. This strategy allows firms faster entry into new markets to exploit potential economies of scope and synergies, at the expense of taking a greater risk in each commitment (since more resources are committed early on in the diversification), losing the flexibility to readjust the strategy along the way, and achieving limited exploratory capacity development. This diversification path prioritizes exploiting available opportunities rather than keeping them open to wait for the best moment to exercise. This AiPD may correspond to a greater extent to the traditional notion of diversification under which each diversification movement "consumes" many of a firm's growth options in return for achieving strategic advantages such as synergies and market power.

In OD, the main objective of diversification is to develop further strategic options in new businesses (Williamson, 2001). A firm expands from its core businesses into new ones in stages, each investment being regarded as *"a foothold in preparation for the next decision"* (Bowman *et al.*, 1992: 98).[37] The firm undertakes small-scale entries into several businesses, which is seen as acquiring an option that can act as a 'platform' for future growth opportunities (Kogut and Kulatilaka, 1994). As investment conditions evolve, firms will maintain, expand, exercise, or abandon these options, while acquiring new options to diversify and keep them open in other areas. Through OD, firms continuously build and maintain a portfolio of strategic options for the future (Williamson, 2001) which encourages experimentation and learning. However, this "wait and see" logic is not exempt from costs such as risk of pre-emption or loss of

[37] According to Bowman *et al.* (1992), an investor following an 'options strategy' will make smaller yet more frequent individual investments.

first-mover advantages due to the undeveloped participation in the new businesses and delaying any major commitment. Overall, OD means simultaneously exploring and exploiting[38] growth options, which is likely to enhance the value of the firm's growth options portfolio.

As these two patterns lead to contrasting ways of handling diversification and the firm's portfolio of growth opportunities, the distinction between AiPD and OD may prove critical when addressing the impact of diversification on firm value. Certain works argue that it is more valuable to have a portfolio of options than an option on an asset portfolio (Bowman and Hurry, 1993). OD offers the firm a bundle of options. Generating strategic options sows the seeds for new opportunities and enables the company to continuously reconfigure its capabilities. This kind of strategy prevents a firm from becoming trapped by its current capabilities, which may only enable it to sense opportunities related to its experience. The slow and complex learning promoted by RO logic enriches the capability development process and through it, the creation of long term value[39].

Some arguments in prior research may support this supposed superiority of the OD pattern for creating value over AiPD. For example, Raynor (2002) argues that the stage-setting commitment of OD can contribute to create superior value by providing firms with "strategy insurance" against firm-specific risk. Similarly, Miller (2006) states that how firms handle diversity and implement the strategy, and not only the degree to which they diversify, also matters. AiPD and OD involve contrasting ways of reaching

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[38] One stream of literature has dealt with the interplay between exploration and exploitation in contexts such as technological innovation (He and Wong, 2004). This synchronous pursuit of both exploration and exploitation is widely known as "ambidexterity" (Gupta, Smith and Shalley, 2006).

[39] A similar idea is stated by Holmqvist (2009) when explaining the benefits of "complicating the organizational learning" to postpone the self-destructive traps of excessive exploration or excessive exploitation.

the same objective, yet offer firms different levels of flexibility to re-evaluate and make midcourse decisions while implementing the strategy. OD implies more active and flexible management of the strategy to react to evolving uncertainty and fresh information, as well as enabling firms to gradually gain experience in a new field and explore further opportunities before fully committing themselves. In this respect, Williamson (2001) stresses the relevance of creating a portfolio of strategic options which enables the firm to continuously develop new capabilities and change its strategic direction rapidly in response to the environment, thus likely outperforming competitors. This flexibility may be a key issue to consider, since it proves an extremely valuable buffer, and allows uncertainty to be taken advantage of to create value.

Among the empirical body of research linking investment profile to firms' performance, Teplensky *et al.* (1993) find that incremental strategies lead to better performance in uncertain and dynamic environments such as emerging markets since they avoid full commitment of resources while past performance acts as a feedback mechanism for future strategic decisions. In a similar vein, Andreou and Louca (2010) report a discount in enterprises moving one-time from a single segment to multiple ones, as opposed to a premium in diversifiers which undertake this strategy multiple times. This latter strategy may fit the more dynamic implementation of OD investments. Chang (1995) also concurs with these findings, arguing that serial investments contribute to minimizing the cost of failure whilst maximizing learning. All of this empirical evidence leads us to hypothesize that the OD pattern may be more value-enhancing than AiPD.

All of these arguments suggest the need to take account of a further dimension in the diversification strategy, namely the RO diversification path followed by the company when implementing this strategy, either by making a single investment decision involving larger commitments in its businesses designed primarily to exploit current opportunities, or by mixing core businesses with low-scale investments in new industries aimed at both exploiting and exploring investment opportunities. Following on from the reasoning set out in this section, our third hypothesis may be summed up thus:

H_3: The closer to an OD pattern, the higher the excess value.

2.5. GROWTH OPPORTUNITIES MODEL (3)

Here, we include an additional dimension of diversification, relatedness between business segments, and we investigate how it may impact GOR. Moreover, we delve into the connection between degree of diversification and GOR stated in hypothesis 1 by including two potential moderating effects from either the relatedness between segments or the risk of pre-emption. On the one hand, relatedness is likely to enhance synergies and economies of scope, which in terms of options may translate into an increase in the value of the underlying asset or a decrease in the option exercise price. On the other hand, risk of pre-emption connects with option lifespan and represents a threat to the option's existence.

2.5.1. Relatedness between segments

Relatedness alludes to the extent a firm's businesses share or draw on common strategic resources and capabilities (Rumelt, 1982). Traditional research underscores the benefits of such similarities to enhance economies of scope and synergies. Most empirical evidence backs up these arguments, concurring in attributing better performance to related diversification (Bettis, 1981; Rumelt, 1982; Simmonds, 1990;

Markides and Williamson, 1994; Berger and Ofek, 1995; Palich *et al.*, 2000; Villalonga, 2004a).

RO literature points out that each individual option value is also influenced by the remaining options that coexist in the same portfolio (McGrath and Nerkar, 2004; Vassolo *et al.*, 2004). As the firm increases its diversification relatedness from a very low level, option interdependence is likely to amplify a joint effect (*portfolio effect*). Although growth options from related diversification are less diverse, the interplay of connected businesses within a firm may carry value-enhancing effects on the options portfolio, either as a result of reducing investment cost ('exercise price') for subsequent projects or by enhancing project returns ('underlying asset value'). Regarding the former, related diversification enables the company to take advantage of complementarities and synergies in costs by deploying and leveraging existing resources and capabilities in multiple segments. As a result, "exercising" subsequent options to expand is less costly in closer industries (Penrose, 1959; Vassolo *et al.*, 2004), thus increasing the growth option value.

Furthermore, relatedness can cause the portfolio of a firm's growth options to be super-additive by enhancing the value of subsequent investment projects. Firstly, relatedness and synergies may exhibit a parallel increase. For instance, as the firm operates in more similar industries, accumulated knowledge and experience is more likely to display commonalities from which both businesses can benefit to increase their investment returns.

Secondly, related diversification can boost the creation of new strategic options. In this line, Markides and Williamson (1994) argue that related diversification contributes to developing core competences as well as the accumulation and renewal of strategic assets faster and at a lower cost than competitors are able to do. Moreover, background related experience enables firms to better sense and seize new emerging opportunities. These related investments are likely to fit in to the firm's current activity and drive further options in neighbouring business domains. Based on another line of argument, one series of papers empirically supports this idea, revealing that related diversification is positively linked to R&D intensity (Baysinger and Hoskisson, 1989; Alonso-Borrego and Forcadell, 2010), implying that related diversifiers are more prone to innovate. As stated earlier, many studies concur in considering those R&D investments as call options (Mitchell and Hamilton, 1988; Faulkner, 1996; Miller and Arikan, 2004; Oriani and Sobrero, 2008; Cuervo-Cazurra and Un, 2010).

Overall, these two complementary option-enhancing effects cause the portfolio of a firm's growth options to be super-additive, its value thus exceeding that of the sum of the call option values taken independently (Vassolo *et al.*, 2004). However, as relatedness exceeds a certain threshold, certain counter value effects on a firm's options portfolio become increasingly dominant. Excessive relatedness is likely to drive duplicities among investment opportunities, thus offering redundant and mutually competitive options. This implies an over-cost in maintaining those options and may even prompt inefficient exercise due to resource constraints (Andrés *et al.*, 2005). In this sense, Vassolo *et al.* (2004) provide empirical evidence that investment in multiple competing projects negatively impacts the options portfolio, making it sub-additive.

In addition, as cumulated learning influences the sense and recognition of shadow options (Bowman and Hurry, 1993), extremely related diversification narrows the diversity of options and constrains a firm's future behaviour to identify and react to opportunities in a broader scope (Hayward, 2002). As a result, the firm may become trapped in its current competences (Williamson, 2001; Holmqvist, 2004), and be unable to build up potential courses of action for the future beyond its limited sphere of expertise. Additionally, as relatedness extends beyond a certain level, capitalization of synergies slows down since handling the interdependencies among businesses becomes more complex and coordination costs gain ground (Rawley, 2010; Zhou, 2011).

These previous arguments suggest a non-linear relationship between relatedness and GOR. We posit that implementing related diversification may, to a certain extent, spark multiplicative effects across the options of a firm's portfolio, but that excessive levels of relatedness may prove detrimental due to competence constraints and options overlaps in the portfolio. To summarize, we state our fourth hypothesis thus:

H_4: The impact of relatedness among businesses of a diversified firm on GOR exhibits an inverted-U shaped function.

2.5.2. Degree of diversification and relatedness between segments

Thus far, we have argued that the degree of connection between the businesses within a firm play a part in the construction of its growth options portfolio. The magnitude of the effect of this relatedness dimension may be contingent on the level of diversification. This latter dimension is likely to widen the range of opportunities within a firm's reach, along which the pervasive effects of relatedness described before are transmitted. Following Bowman and Hurry (1993: 770), holding a portfolio of options (equivalent to a portfolio of businesses) is more valuable than holding an option on an assets portfolio (comparable to the options for a focused firm) since the former gives the firm access to a greater number of investment opportunities.

Further evidence suggests that the effect of relatedness predicted by hypothesis 1 may be moderated by the diversification status. Fan and Lang (2000) report a negative effect of vertical relatedness (input-output (IO) tables) on a firm's value in more widely diversified firms (firms with more than three segments). These findings posit that related diversification has a different impact on low and high diversifiers. In a firm's options portfolio, the dimensions diversification scope and cross-business relatedness are also closely linked and may even carry a joint effect.

Building on these arguments, we expect the level of diversification to shape the inverted U-form association between relatedness and GOR, since it may affect the intensity of both value-enhancing and value-declining effects of relatedness. At higher diversification levels, the company is more likely to have a larger baseline portfolio of options which offer it a wider range of possibilities to achieve synergies and economies of scope. Firstly, it can make the most of participation in one option either to enter new ones at a lower cost due to economies of scope and experience sharing (Vassolo *et al.*, 2004) or to incur lower costs to maintain options through resource sharing. Secondly, increasing relatedness in a larger diversification portfolio increases the likelihood of exploiting similarities and intensifies the spread of core skills across businesses, which may enhance investment returns (for instance, via cross-business complementarities in certain resources such as knowledge). The knowledge required and generated by one division may differ from that of another, yet may prove mutually supportive due to coexistence within a single organization, serving to enhance the returns of both businesses (Tanriverdi and Venkatraman, 2005), thus increasing growth options value at a faster rate.

Overall, all these arguments suggest that a higher degree of diversification accelerates the multiplicative mechanisms of relatedness in the growth options portfolio, making the value of the subsequent options higher as a result of the synergistic/complementary joint effect. Accordingly, we expect the positive relationship between low levels of relatedness and GOR predicted in hypothesis 1 to be more pronounced in higher diversifiers.

On the other side of the coin, greater diversification is likely to magnify the detrimental effects of relatedness. As relatedness increases, greater diversification makes management of interdependencies across businesses more complex (Rawley, 2010; Zhou, 2011), thereby increasing demands on coordination. As a result, we expect to observe a more rapid increase in coordination costs with relatedness, resulting in an increased option exercise price and a more dramatic decline in option value. Moreover, this situation may overstretch shared resources (Gary, 2005), thus preventing the firm from materializing potential synergies. Given that complexities and coordination costs associated with relatedness acquire major importance at higher levels of diversification, we expect the negative relationship between high relatedness and GOR to be more pronounced in more diversified firms.

In light of these arguments, we propose the following hypothesis:

H_5: The degree of diversification moderates the inverted U-form relationship between relatedness across businesses and GOR in such a way that the inverted U-form effect is accentuated in firms with a higher degree of diversification.

2.5.3. Moderating effect of the risk of pre-emption

In certain contexts, there may be a risk of a competitor getting there first to take advantage of an investment opportunity available to the firm. This threat of pre-emption is likely to have a straightforward impact on a firm's growth options value, either through time to option maturity or through its exercise price (Folta and Miller, 2002a).

From the standpoint of time to maturity, the threat of pre-emption shortens options' lifespan and accelerates subsequent actions (Folta, 1998; Folta and Miller, 2002b; Jiang *et al.*, 2009) since there is a risk of a competitor moving ahead earlier to exploit the opportunity, thus reducing or even nullifying a firm's underlying opportunity (Cottrell and Sick, 2001; Folta and Miller, 2002a, 2002b). For instance, in a technological setting, a competitor may launch a substitute technology onto the market, thus making alternative technologies obsolete before they are fully developed (Folta and Miller, 2002b).

Several papers provide empirical evidence that the risk of pre-emption affects investment timing, inducing firms to exercise their growth options earlier (Kulatilaka and Perotti, 1998; Folta and Miller, 2002b; Li *et al.*, 2007). Jiang *et al.* (2009) analyze licensing as European options and find that competitive pre-emption has a negative impact on licensing duration to offer the firm the flexibility to exercise options. In a similar line, Folta (1998) reports evidence that greater rivalry encourages preference for acquisitions over equity collaborations. Supporting these findings, Estrada *et al.* (2010) find that the risk of pre-emption discourages firms from creating a joint venture since the time to maturity is cut, the option thereby losing value. In short, pre-emptive threats reduce option time to expiration, thus causing a decline in option value.

The risk of pre-emption may also have detrimental effects on options value through increases in option exercise price (Folta and Miller, 2002a). Folta and Miller (2002b) illustrate this idea in the particular case of equity partnerships. If each option to buy out the partner is subjected to pre-emption by other companies with a participation in the target firm, each firm's action may push up the bidding, thereby increasing the exercise price of the buyout option.

Based on these arguments, we predict that the threat of pre-emption will shape the U-form relationship between the level of diversification and GOR predicted in hypothesis 1. A firm's growth options being more susceptible to pre-emption sharpens the decline in GOR because of options being exercised at lower levels of diversification, since pre-emptive threats make any subsequent options to emerge from each option strike investment less valuable or may even preclude certain emerging opportunities.

In addition, the positive slope of such a U-shape relationship may also be mitigated by pre-emption. A broader range of diversification may spark multiplicative mechanisms in the options portfolio due to synergies and economies of scope, and as a result of the interplay of options in a single portfolio and their interaction with a firm's diversification investment. The earlier expiration of a firm's options as a result of pre-emptive risks causes their value to drop and slows down the aforementioned multiplicative mechanisms in the options portfolio. In sum, as diversification increases, the option value-enhancing effect may be attenuated by value loss from pre-emption.

All these arguments suggest that the threat of pre-emption moderates the U-form relationship between the degree of diversification and GOR. Hence, we hypothesize:

H_6: The threat of pre-emption moderates the U-form relation between the degree of diversification and GOR, such that at low levels of diversification a greater threat of pre-emption accentuates the declining relationship between the level of diversification and GOR, while at high levels, a greater threat of pre-emption attenuates the positive relationship between level of diversification and GOR.

PART II

EMPIRICAL EVIDENCE

Chapter 3

Tackling the corporate diversification-value puzzle using the real options approach

In his third chapter, we empirically test our mediating model (model 1), which comprises hypotheses 1 and 2. This chapter focuses on analysing the role which growth opportunities play in the diversification-value relationship. Certain firm-specific characteristics, such as unique organizational capability or technological change (Campa and Kedia, 2002), or R&D investments (Morck and Yeung, 2003) are concepts directly related to the value of growth opportunities and flexibility, which previous evidence has shown the diversification-value relationship to be contingent on.

From the real options (RO) approach, our study aims to offer further insights into the trinomium involving diversification, growth opportunities, and firm value. This approach allows for a more direct connection between the analysis of corporate strategies and firm value. Pioneering studies such as Kester (1984) laid the foundation to study resource allocation strategies as chains of options. Since then, an increasing number of scholars have recognized the potential of RO thinking to explain corporate strategies by linking real options to resources and capabilities (Kogut and Kulatilaka, 2001). In the particular case of business diversification, RO reasoning considers this strategy as both a means to exercise previously acquired growth options and a way to obtain new opportunities to invest.

Based on this approach, we argue that the extent of diversification within a firm may exhibit a U-form relationship with its portfolio of growth opportunities (more specifically on the proportion of growth options value over a firm's total value, the growth options ratio, hereinafter GOR). Diversification involves investing in new businesses which thus means replacing growth options with assets-in-place. As a result, a negative effect of diversification on GOR will arise. However, as a firm expands its diversification scope, it accumulates knowledge and develops capabilities which may help it to better sense and seize opportunities in a wider set of industries. As a result, additional options are more likely to be embedded in these firms' investments, this process of generating options also being reinforced by options stemming from the combination of existing ones. The relationship may thus be reversed, with subsequent diversifying movements mostly becoming a source of new growth options for firms. Based on this previous relation, we argue that GOR might mediate part of the diversification effect on a firm's value, making this strategy a more value-enhancing one to the extent that it enriches the growth options portfolio. Insofar as those options (generated through the interplay of multiple businesses within an organization) and their optimal joint exercise policy cannot be replicated by investors, such diversification may turn around and have a positive effect on value.

The remainder of the chapter is organized in three sections. The first section focuses on the research design of this study. The following section explains our empirical findings. The chapter closes with a discussion of our main conclusions and intended contributions.

3.1. RESEARCH DESIGN: SAMPLE SELECTION, MODEL, ECONOMETRIC METHOD, AND VARIABLES

3.1.1. Sample selection

We perform our empirical analyses on an unbalanced panel sample of public U.S. companies between January 1998[40] and December 2010· To minimize survivorship bias,

[40] As of December 15, 1997, the new SFAS 131 reporting standard became effective for fiscal years in the United States, replacing the previous SFAS 14. Our sample starts in 1998 to ensure homogeneity of data.

the sample comprises actives enterprises as well as companies which become inactive or disappear from the sample during the period studied[41]. We use Worldscope as the principal source of data (annual data both at the industry segment and company level). Industry segment data are computed at the 4-digit-SIC code level. Market data are obtained from Datastream. Finally, we draw macroeconomic data from the Bureau of Economic Analysis, part of the U.S. Department of Commerce[42].

To make results comparable to previous literature, we use the Berger and Ofek (1995) sample selection criteria. Firstly, we remove firms' segments with non-positive sales. In addition, we drop firm-year observations with any division in the financial industry (SIC codes 6000-6999). Other Berger and Ofek requirements are sales figures of at least $20 million as well as the availability of data on total capital, total sales, and segment-level sales. As regards sales, the sum of segment sales cannot differ from the firm's reported total sales by more than one percent. Moreover, our estimation methodology, the generalized method of moments (GMM), imposes an additional restriction: the availability of data for at least four consecutive years per firm to test for the lack of second-order residual serial correlation. The final sample for estimation purposes consists of 4,053 firm-year observations corresponding to 635 companies.

3.1.2. Model

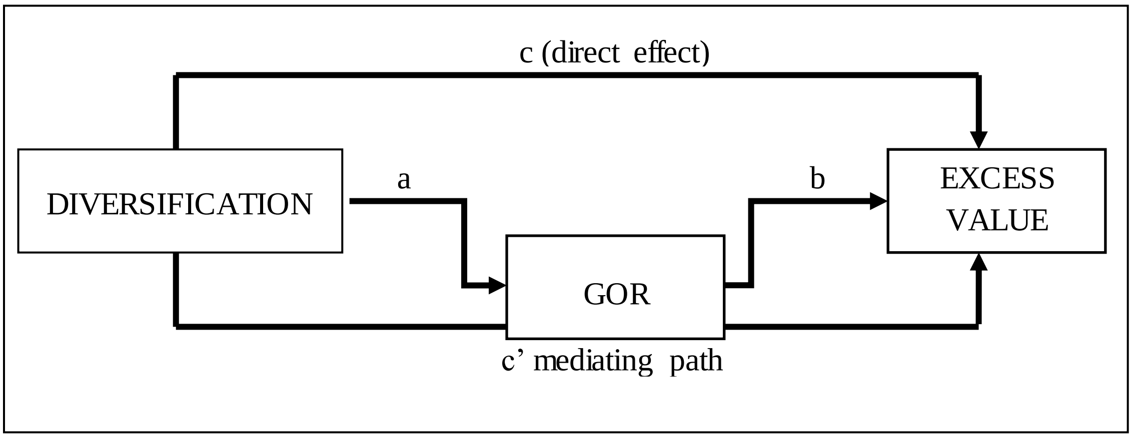
Figure 3.1 illustrates the diagram of our three-variable model:

[41] Firms that cease their activity during our window of analysis due to multiple reasons (bankruptcy, mergers,…).

[42] Official website: http://www.bea.gov/national/index.htm

Figure 3.1
[Causal chain of our proposed mediated model]

This diagram represents the causal chain of the three-variable model we propose. As represented in the figure, the influence of the corporate diversification strategy on the *ExcessValue* may go through two different paths: a direct effect (path <<c>>) and an indirect effect (path <<c'>>) through the *GOR* mediator.



As represented in **Figure 3.1**, the diversification strategy may influence the firm's value outcomes (excess value) through two paths. On the one hand, a direct effect broadly addressed in prior literature (path <<c>>), and on the other, our hypothesized indirect effect (path <<c'>>) through the *GOR* mediator (hypothesis 2). Path <<a>> captures the link between 'Diversification level' and *GOR*, which takes a U-shape as conjectured in our first hypothesis, while path <<b>> illustrates the effect of GOR on 'Excess value'.

According to Baron and Kenny (1986: 1176), *GOR* will act as a mediator if it meets the three following conditions: (i) variations in levels of the independent variable ('diversification level') significantly account for variations in the presumed *GOR* mediator (path <<a>>); (ii) variations in the *GOR* mediator significantly account for variations in the dependent variable (excess value) (path <<b>>); (iii), finally (path <<c'>>), when paths <<a>> and <<b>> are controlled, a previously significant relationship between the independent and dependent variables is no longer significant (full mediation) or becomes weaker (partial mediation).

3.1.3. Equations and variables

Test of hypothesis 1

To test our first hypothesis (path <<a>> in **Figure 3.1**), we estimate equation [1]:

$$GOR_{it} = \alpha + \beta_1 DIVER_{it} + \beta_2 DIVER^2_{it} + \beta_3 LTA_{it} + \beta_4 DTA_{it} + \beta_5 dumINDUSTRY_{it} + \beta_6 dumYEAR_{it} + \eta_i + \nu_{it} \quad [1]$$

where i identifies each firm, t indicates the year of observation (from 1 to 13), α and β_p are the coefficients to be estimated, η_i represents the firm-specific effect, and ν_{it} is the random disturbance for each observation. The dependent variable (*GOR*) is estimated by three alternative proxies[43]: the market to book assets ratio (Adam and Goyal, 2008), Tobin's Q (Cao, Simin and Zhao, 2008), and the ratio of R&D expenses to total sales (Mehran, 1995). The explanatory variable is the degree of diversification (*DIVER*), which we approximate by different measures commonly used in diversification literature in order to test the robustness of our empirical findings: the number of businesses, the Herfindahl index (Hirschman, 1964), and the entropy measure (Jacquemin and Berry, 1979). The former is the simple count of the number of segments at the 4-digit SIC code level (*numsegments*). As usual, the Herfindahl index (*HERF*) is defined by:

$$HERF = 1 - \sum_{s=1}^{n} P_s^2$$

[43] See Adam and Goyal (2008), and Cao *et al.* (2008) for more details about calculation.

where '*n*' is the number of a firm's segments (at the 4-digit SIC code level), and 'P_s' the proportion of the firm's sales from business '*s*'. Unisegment firms will show a Herfindahl index equal to zero, and the closer this index is to one, the higher the level of diversification.

The entropy measure (*TENTROPY*) considers diversification across different levels of industry aggregation and within them. The higher the total entropy, the greater the diversification (this index has no upper boundary). The value of total entropy is obtained as follows:

$$\text{TENTROPY} = \sum_{s=1}^{n} P_s * \ln\left(\frac{1}{P_s}\right)$$

where 'P_s' is the proportion of a firm's sales in business '*s*' for a corporation with '*n*' different 4-digit SIC segments.

To ensure comparability of our results with prior literature, in equation [1] we control for size (Andrés *et al.*, 2005), leverage (Myers, 1977), industry, and year. Size (*LTA*) is estimated by the natural logarithm of the book value of total assets. Leverage (*DTA*) is measured by the total ratio debt over total assets. We include dummy variables to control for the major groups of industries[44] and dummies to control for the year effect. Finally, we control for unobserved individual heterogeneity by including η_i.

Test of hypothesis 2

To test our second hypothesis, which predicts that GOR mediates the relationship between diversification and the firm's excess value, we assess conditions (i) to (iii) proposed by Baron and Kenny (1986) already mentioned, which would correspond to

44 Major groups of industries as defined by the U.S. Department of Labor. The official website provides the matching of these major groups to the 2-digit SIC code classification: http://www.osha.gov/pls/imis/sic_manual.html. See Table A.1. in the Appendix. The industry dummy *j* (*j*=1,…, 8) takes 1 if the firm reports some segment operating in industry *j* and zero otherwise.

estimating equations [2] and [3] for comparing paths <<c>> and <<c'>> (<<a>> + <<b>>).

Path c

$$ExcessValue_{it} = \alpha + \beta_1 DIVER_{it} + \beta_2 EBITsales_{it} + \beta_3 CAPEXsales_{it} + \beta_4 LDTA_{it} + \beta_5 LTA_{it} + \beta_6 LTA2_{it} + \beta_7 dumINDUSTRY_{it} + \beta_8 dumYEAR_{it} + \eta_i + \nu_{it} \qquad [2]$$

Paths b and c'

$$ExcessValue_{it} = \alpha + \beta_1 GOR_{it} + \beta_2 DIVER_{it} + \beta_3 EBITsales_{it} + \beta_4 CAPEXsales_{it} + \beta_5 LDTA_{it} + \beta_6 LTA_{it} + \beta_7 LTA2_{it} + \beta_8 dumINDUSTRY_{it} + \beta_9 dumYEAR_{it} + \eta_i + \nu_{it} \qquad [3]$$

where i identifies each firm, t indicates the year of observation (from 1 to 13), α and β_p are the coefficients to be estimated, η_i is the firm-specific effect, and ν_{it} is the random disturbance for each observation. The dependent variable in equations [2] and [3] is excess value (*ExcessValue*), as developed by Berger and Ofek (1995), and is defined as the natural log of a firm's market value[45] to its imputed value.

A segment's imputed value is computed by multiplying its segment sales (S_s) by the annual median sales multiplier (the median ratio of a firm's value to total sales) of all single-segment firms operating in the same and most restrictive SIC group which comprises at least five unisegment firms (4-digit, 3-digit or 2-digit SIC code levels) *(*ISM_s*)*. The firm's imputed value is calculated as the sum of the imputed values of its divisions:

$$IV = \sum_{s=1}^{n} S_s * ISM_s \qquad [4]$$

's' denoting the number of a firm's divisions (s=1,…,n).

[45] So as to compare with most previous literature, we compute a firm's market value (MV) as the sum of market value of equity (MVE), long-term (LtD), short-tem (StD) debt, and preferred stock (PrefStock) (Campa and Kedia, 2002).

Finally, the excess value is obtained by dividing the firm's value by its imputed value (*MV/IV*), and then taking the natural logarithm of this ratio. If the excess value is negative, a discount will emerge. In contrast, a positive excess value will imply that the diversifier trades at a premium over its single-segment counterparts, a diversification strategy thus contributing towards enhancing a firm's value.

The explanatory variables are *DIVER* in equation [2], and *DIVER* and *GOR* in equation [3]. If GOR were to play a mediating role, the statistical significance of the coefficient of the variable *DIVER* would be reduced (partial mediation) or disappear (full mediation) in equation [3] compared to that in equation [2] in which the mediating variable was not controlled for.

In both equations, we control for factors which are likely to affect *ExcessValue* and are not related to the diversification decision. Following prior research (Berger and Ofek, 1995; Campa and Kedia, 2002; Santaló and Becerra, 2008), we control for profitability, level of current investment, financial leverage, firm size, industry (*dumINDUSTRY*), and year effect (*dumYEAR*). Profitability is computed by the EBIT to sales ratio (*EBITsales*), and the level of investment by capital expenditures to total sales ratio (*CAPEXsales*). Financial leverage is estimated by the ratio of long-term debt to total assets (*LDTA*), and firm size is approximated by the natural logarithm of the book value of total assets (*LTA*). Furthermore, we include the LTA squared (*LTA2*) to control for a possible non-linear effect of firm size on firm value (Campa and Kedia, 2002). As in equation [1], we control for the firm-specific effect (η_i). See **Table 3.1** for a summary of the variables of this study.

Table 3.1
[Description of the variables]

This table contains a summary of the variables used in the analysis. The first column indicates the label of each variable, the second column provides the definition of the variable and the third column offers the source from which that definition is obtained.

VARIABLE	DEFINITION	SOURCE
Excess Value	Natural log of the ratio enterprise value to its imputed value.	Berger and Ofek (1995)
Growth option value to firm total value (GOR)		
MBAR	The market-to-book assets ratio.	Adam and Goyal (2008)
Q	Tobin's Q	Cao *et al.* (2008)
RDsales	R&D expenses to total sales.	Mehran (1995)
Degree of diversification (DIVER)		
numsegments	Number of business segments at the 4-digit SIC code level.	
HERF	Herfindahl index $HERF = 1 - \sum_n P_i * W_i$	Hirschman (1964)
TENTROPY	Total entropy index. $TotalEntropy = 1 - \sum_n P_i * ln(\frac{1}{P_i})$	Jacquemin and Berry (1979)
Control variables		
LDTA	The ratio of long-term debt to total assets.	Campa and Kedia (2002)
DTA	The ratio of total debt with cost to total assets.	Andrés *et al.* (2005)
LTA	Natural log of the book value of assets.	Campa and Kedia (2002); Andrés *et al.* (2005)
EBITsales	The ratio EBIT to firm total sales.	Campa and Kedia (2002)
CAPEXsales	The ratio capital expenditures to total sales.	Campa and Kedia (2002)
dumINDUSTRY	9 major divisions (excluding the financial division) → eight dummy variables.	The United States Department of Labour
dumYEAR	13 years (1998-2010 period) → twelve dummy variables.	

3.1.4. Econometric approach

All equations are estimated by using panel data methodology to address two concerns: the existence of unobservable individual heterogeneity and endogeneity. The former refers to certain time constant firm-specific characteristics (such as the firm's culture or corporate strategy), which determine a firm's behavior and also explain the dependent variable in equations [1] to [3]. Secondly, a key concern in diversification models is endogeneity (Campa and Kedia, 2002; Villalonga, 2004b). The causal relation between diversification and GOR, and between diversification and Excess Value may not only run in the hypothesized direction, but also in both directions. To address this problem, we use the two-step system generalized method of moments (GMM) proposed by Blundell and Bond (1998), which employs the lags of explanatory variables as instruments.

Below all the estimations, we include two model specification tests for GMM estimation validity. The GMM estimator is based on two assumptions: absence of second-order serial correlation and lack of correlation between the instruments and the residuals. First, Arellano and Bond's (1991) m_2 statistic[46] tests the absence of second degree serial correlations in the first-difference residuals. Since the GMM estimator uses lags as instruments under the assumption of white noise errors, it would lose its consistency if the errors were serially correlated (Arellano and Bond, 1991). Secondly, the Hansen J-test of overidentifying restrictions (Hansen, 1982) assesses the instrument exogeneity assumption. The null hypothesis is the joint validity of all the instruments.

[46] We also include the m_1 statistic to test the first-order residual serial correlation, although the existence of this correlation does not invalidate the results.

3.1.5. Robustness analyses

We conduct a number of robustness tests. First, we check whether the U-form relation estimated in equation [1] is robust to the choice of industry classification. We compute the number of firm segments (*numsegments_3d* and *numsegments_2d*) and the Herfindahl index (*HERF_3d* and *HERF_2d*) with 3-digit and 2-digit SIC code business segment data.

Second, to assess further the validity of this U-shaped relationship between *DIVER* and *GOR*, we perform Sasabuchi's (1980) t-test[47]. To test the existence of a U relation, Sasabuchi tests the composite null hypothesis that the relationship increases on the left hand side of the interval and/or decreases on the right hand side. We also estimate the extreme point of the curve and its confidence intervals based on Fieller's (1954) standard error method. The extreme point must be within the limits of the data.

In testing the mediating effect, any previous significant relationship between *DIVER* and *ExcessValue* loses significance when considering *GOR*. If the effect of *DIVER* on *ExcessValue* (equation [2]) does not decrease to insignificant in equation [3] after controlling for *GOR*, full mediation is not supported, although partial mediation may still hold. In this case, Sobel's test (Sobel, 1982) would be conducted to determine the significance of the indirect effect of *DIVER* on *ExcessValue* through the *GOR* mediator by testing the null hypothesis of no difference between the direct effect (path <<c>>) and the indirect effect (path <<c'>>).

[47] This test was computed using the ado-file utest for STATA developed by Lind and Mehlum, available at: http://econpapers.repec.org/software/bocbocode/s456874.htm

Additional robustness analyses re-estimate the models by dropping the 'extreme' excess values from the sample. Berger and Ofek (1995) define these as observations whose excess value is above 1.386 or below -1.386.

Table 3.2 provides the descriptive statistics of the variables for the full sample. Overall, sample firms show a low diversifying profile (1.88 business segments on average), the number of segments ranging between 1 and 5. We notice the presence of an average premium (0.0990).

Table 3.2
[Summary statistics of variables for the full sample (1998-2010)]

This table displays descriptive statistics of the variables involved in our models for the final sample of 4,053 firm-year observations (635 firms). *Excess_value* is the measure developed by Berger and Ofek (1995) to assess the value created by diversifying. *MBAR* (the market to book assets ratio), *Q* (Tobin's Q) and *RDsales* (the ratio of R&D expenses to firm sales) are the three different proxies for growth opportunities. *numsegments* (number of business segments at the 4-digit SIC code level), *numsegments_3d* (number of business segments at the 3-digit SIC code level), *numsegments_2d* (number of business segments at the 2-digit SIC code level), *HERF* (the Herfindahl index at the 4-digit SIC code level), *HERF_3d* (the Herfindahl index at the 3-digit SIC code level), *HERF_2d* (the Herfindahl index at the 2-digit SIC code level) and *TENTROPY* (the Entropy index) are alternative measures for the level of diversification.
Control variables: *LTA* (size), *EBITsales* (profitability), *CAPEXsales* (level of investment in current operations), *DTA* and *LDTA* (financial leverage). Figures are expressed in million US$.

Variable	N	Mean	Median	Standard deviation	Min.	Max.	1st quartile	3rd quartile
Excess_value	4053	0.0990	0.0670	0.8818	-4.2895	4.9299	-0.4132	0.6227
Proxies for growth opportunities								
MBAR	4053	2.2705	1.5422	2.3336	0.1391	34.076	1.0814	2.4981
Q	4053	1.8091	1.1231	2.3045	0.0018	33.285	0.6586	2.0573
RDsales	2032	0.0653	0.0207	0.1588	0	2.8874	0.0029	0. 0692
Diversification								
numsegments	4053	1.8831	2	0.7909	1	5	1	2
numsegments_3d	4053	1.8236	2	0.7436	1	5	1	2
numsegments_2d	4053	1.7496	2	0.6725	1	5	1	2
HERF	4053	0.2417	0.2150	0.2251	0	0.7833	0	0.4615
HERF_3d	4053	0.2292	0.1912	0.2204	0	0.7833	0	0.4448
HERF_2d	4053	0.2123	0.1696	0.2102	0	0.7833	0	0.4224
TENTROPY	4053	0.3854	0.3753	0.3568	0	1.5681	0	0.6662
Control variables								
LTA	4053	6.6710	6.6198	2.0608	1.7710	12.526	5.0447	8.2406
EBIT/sales	4053	0.0610	0.0809	0.2597	-6.6030	0.7455	0.0303	0.1436
CAPEX/sales	4053	0.0706	0.0342	0.1596	0	4.0955	0.0188	0.0668
DTA	4053	0.2312	0.2269	0.1726	0	0.8794	0.0816	0.3434
LDTA	4053	0.1901	0.1736	0.1615	0	0.8362	0.0443	0.2890

3.2. EMPIRICAL RESULTS

3.2.1. The interaction between DIVER and GOR (path <<a>>)

Table 3.3 reports the estimation results of equation [1] in which we test the impact of the degree of diversification on the firm's growth options portfolio. We find strong evidence of a U-form relationship with the growth options proxies. As shown in the first column of **Table 3.3**, the main effect of *numsegments* is negative and statistically significant (β_1=-0.3177, p-value=0.001) and its squared term is positive and significant (β_2=0.0756, p-value=0.000). This U-shape relation remains across the alternative proxies for GOR (*Q*, and *RDsales).* Our results are also robust to the different measures to capture diversification and to the industry classification choice[48]. Overall, the minimum of the curve occurs around two segments[49].

[48] Number of segments and Herfindahl index computed at the 3-digit and 2-digit SIC code level (*numsegments_3d*, *numsegments_2d*, *HERF_3d* and *HERF_2d*, respectively. Most results remain similar. Results available upon request.

[49]Here, we refer to the minimum value taking the *numsegments* proxy as it is easier to interpret.

Table 3.3
[Diversification level and growth opportunities (path <<a>>, eq. [1])]

This table reports the two-step GMM system estimations of equation [1]. Different proxies for the growth options ratio to the firm's total value (GOR) (either *MBAR* (the market to book assets ratio), *Q* (Tobin's Q), or *RDsales* (the ratio of R&D expenses to firm sales)) are regressed on the degree of diversification. This degree of diversification is proxied by *numsegments* (number of business segments at the 4-digit SIC code level), *HERF* (the Herfindahl index at the 4-digit SIC code level), and *TENTROPY* (the Entropy index), alternatively. Firm size (LTA), financial leverage (DTA), industry effect (*dumINDUSTRY*), and time effect (*dumYEAR*) are controlled in all estimations. The Wald test contrasts the null hypothesis of no joint significance of the explanatory variables. m_1 and m_2 are tests for no serial correlation of first-order and second-order, respectively, in the first difference residuals. Hansen J-statistic is the test of over-identifying restrictions. The Hansen test is distributed as $\chi 2$. Standard error is shown in parentheses under coefficients. ****, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively. Below the table, some additional tests of a U-shaped relationship between GOR and diversification are offered.

	Dependent variable: MBAR			Dependent variable: Q			Dependent variable: RDsales		
Constant	3.0801***	3.4105***	3.3881***	2.2225***	2.5954***	2.5883***	0.1048***	0.0725***	0.0456***
	(0.1982)	(0.1899)	(0.1874)	(0.2046)	(0.1920)	(0.1904)	(0.0027)	(0.0158)	(0.0044)
Diversification indexes									
numsegments	-0.3177***			-03211***			-0.0619***		
	(0.0963)			(0.0966)			(0.0009)		
numsegments2	0.0756***			0.0690***			0.0144***		
	(0.0204)			(0.0206)			(0.0002)		
HERF		-2.3981***			-2.1898***			-0.3483***	
		(0.2649)			(0.2736)			(0.0483)	
HERF2		3.0609***			2.6844***			0.5009***	
		(0.4347)			(0.4331)			(0.0738)	
TENTROPY			-1.0690***			-1.0280***			-0.0813***
			(0.1482)			(0.1541)			(0.0052)
TENTROPY2			0.8151***			0.7738 ***			0.0909***
			(0.1258)			(0.1251)			(0.0040)
Control variables									
LTA	0.2545***	0.1818***	0.1793***	0.3103***	0.2232***	0.2165***	0.0027***	0.0007	0.0005
	(0.0206)	(0.0247)	(0.0236)	(0.0217)	(0.0256)	(0.0248)	(0.0003)	(0.0023)	(0.0006)
DTA	-5.6875***	-5.8660***	-5.8352***	-5.3367***	-5.5140***	-5.4192***	0.0041***	0.0007	0.0617***
	(0.1532)	(0.1442)	(0.1378)	(0.1479)	(0.1438)	(0.1450)	(0.0008)	(0.0123)	(0.0038)
dumINDUSTRY	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
dumYEAR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	4053	4053	4053	4053	4053	4053	2032	2032	2032
Wald test	5938.95***	5329.57***	6037.98***	7239.49***	4409.45***	5686.15***	1.97e+06***	170.44***	2869.45***
m_1	-2.96***	-2.97***	-2.97***	-2.95***	-2.96***	-2.96***	-1.05	-1.05	-1.08
m_2	-0.38	-0.40	-0.40	-0.36	-0.39	-0.38	-1.47	-1.54	-1.49

p-value m_2 test	0.704	0.687	0.691	0.716	0.696	0.701	0.142	0.123	0.136
Hansen test	356.45	359.25	348.57	347.71	357.31	347.83	258.22	121.05	207.34
p-value Hansen test	0.143	0.121	0.219	0.229	0.136	0.228	0.315	0.583	0.669
Sasabuchi-test of U-shape in degree of diversification	2.89***	5.23***	5.43***	3.18***	4.49***	5.25***	60.54***	6.22***	15.72***
Estimated extreme point	2.1019	0.3917	0.6558	2.3281	0.4078	0.6643	2.1557	0.3476	0.4474
95% confidence interval (CI)- Fieller method	[1.6435; 2.4149]	[0.3490; 0.4543]	[0.5692; 0.7702]	[1.9377; 2.7779]	[0.3584; 0.4849]	[0.5724; 0.7829]	[2.1384; 2.1728]	[0.3227; 0.3784]	[0.4223; 0.4700]

To verify the validity of this curvilinear relationship, we perform Sasabuchi's test (H_0: Monotone or inverse U shape; H_1: U shape). Consistent with prior estimations, Sasabuchi's test is rejected (at the 1% level) across the alternative estimations, providing further evidence to support the U-effect. In addition, Fieller's confidence interval at 95% for the inflection point of the U-curve is within the limits of our data for each of the diversification variables. For example, as observed in regression in column (1), *numsegments** is in the interval [1.6435, 2.4149], and the values for this variable in the sample range between 1 (minimum) and 5 (maximum) as observed in **Table 3.2**.

As hypothesized, at lower diversification levels investing in a new business has a negative impact on GOR, reflecting the replacement of growth opportunities by assets-in-place. However, the company will reach a minimum from which the firm may have been able to accumulate enough experience and develop superior capabilities, turning diversification into a source of growth options. This critical point from which the relationship turns round and becomes positive appears around *numsegments**=2 (*HERF** around 0.4) for our sample.

Hansen and m_2 tests confirm the validity of our GMM estimations. The Hansen J-statistic fails to reject the null hypothesis of absence of correlation between the instruments and the residuals, thus indicating the instruments are valid. The m_2 statistic does not reject the null hypothesis of no second-order residual serial correlation. The Wald test, significant above the 1% level, confirms the joint significance of the variables in the models.

3.2.2. Analyses of the mediating role of GOR on the diversification-value relationship

In columns (1) to (3) in **Table 3.4**, we replicate the diversification model estimated in prior literature. In line with the main stream of research, our sample shows a diversification discount, statistically significant above the 1% level. This diversification discount persists across the alternative measures of diversification. Apart from this direct effect of diversification of firm's value, our second hypothesis states that this relationship may also be mediated by GOR (indirect effect).

We apply Baron and Kenny's conditions to test whether the GOR affects diversification value outcomes, and whether the effect of the level of diversification on *ExcessValue* becomes weaker or loses its statistical significance once growth opportunities are included in the model to test for the mediating effect. Columns (4) to (12) in **Table 3.4** display estimation results.

Table 3.4

[Diversification, growth opportunities and excess value (paths <<c>>, <<b>> and <<c’>>, eq. [2] to [3])]

This table reports the two-step GMM system estimations of the analysis of the mediating role of GOR in the diversification-value relationship by applying the Baron and Kenny (1986) criteria to establish mediation (equations [2] and [3]). Columns (1) to (3) contain the two-step GMM system estimations of the direct effect of diversification on *ExcessValue* (equation [2]). The *ExcessValue* is regressed on the level of diversification. This degree of diversification is proxied by *numsegments* (number of business segments at the 4-digit SIC code level), *HERF* (the Herfindahl index at the 4-digit SIC code level), and *TENTROPY* (the Entropy index), alternatively. Columns (4) to (12) contain the estimation results of the regression of *ExcessValue* on *GOR* and the degree of diversification (equation [3]) to test the mediating role of *GOR*. Different proxies for *GOR* (either *MBAR* (the market to book assets ratio), *Q* (Tobin’s Q) or *RDsales* (the ratio of R&D expenses to firm sales)) are used. Profitability (*EBITsales*), level of investment in current operations (*CAPEXsales*), financial leverage (*LDTA*), firm size (*LTA*) and its square (*LTA2*), industry effect (*dumINDUSTRY*), and time effect (*dumYEAR*) are controlled in all estimations.The Wald test contrasts the null hypothesis of no joint significance of the explanatory variables. m_1 and m_2 are tests for no serial correlation of first-order and second-order, respectively, in the first difference residuals. The Hansen J-statistic is the test of overidentifying restrictions. The Hansen test is distributed as $\chi2$. Standard error is shown in parentheses under coefficients. ****, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Dependent variable: EXCESS VALUE [Path<<c>> (without mediators)]			Dependent variable: EXCESS VALUE [Path<< c’>> (with mediators)]								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	-2.8711*** (0.0294)	-2.9938*** (0.0272)	-2.9983*** (0.0245)	-2.5749*** (0.2571)	-2.3611*** (0.2567)	-2.9691*** (0.3232)	-3.0242*** (0.3775)	-2.8107*** (0.3803)	-2.3094*** (0.3371)	-3.0108*** (0.3786)	-2.7883*** (0.3813)	-2.2536*** (0.3326)
Growth opportunities proxies												
MBAR				0.1713*** (0.0085)			0.1782*** (0.0135)			0.1792*** (0.0134)		
Q					0.1741*** (0.0084)			0.1769*** (0.0131)			0.1776*** (0.0131)	
RDsales						1.2590*** (0.0980)			1.2190*** (0.0929)			1.2393*** (0.0928)
Diversification indexes												
numsegments	-0.0797*** (0.0019)			-0.0823** (0.0318)	-0.0694** (0.0316)	-0.0302 (0.0373)						
HERF		-0.3111*** (0.0065)					-0.2318 (0.1432)	-0.2288 (0.1428)	-0.2639** (0.1119)			
TENTROPY			-0.2165*** (0.0043)							-0.1526* (0.0895)	-0.1476* (0.0891)	-0.1063 (0.0718)
Control variables												
EBITsales	0.1057*** (0.0018)	0.0870*** (0.0018)	0.0884*** (0.0018)	-0.1035** (0.0481)	-0.1352** (0.0522)	0.7534*** (0.0725)	-0.0629 (0.0601)	-0.0876 (0.0618)	0.6920*** (0.0638)	-0.0690 (0.0598)	-0.0950 (0.0613)	0.6931*** (0.0647)
CAPEXsales	0.8137***	0.7755***	0.7817***	0.6318***	0.6089***	0.3850	0.3836*	03378	0.1416	0.3717	0.3250	0.2173

	(0.0063)	(0.0054)	(0.0054)	(0.0764)	(0.0790)	(0.3245)	(0.2320)	(0.2375)	(0.3307)	(0.2317)	(0.2372)	(0.3281)
LDTA	-1.0700***	-1.1389***	-1.1281***	-0.4265***	-0.5210***	-0.4930***	-0.3758*	-0.5021**	-0.6541***	-0.3833*	-0.5173**	-0.6511***
	(0.0064)	(0.0037)	(0.0045)	(0.1047)	(0.1085)	(0.1076)	(0.2224)	(0.2118)	(0.1088)	(0.2237)	(0.2129)	(0.1095)
LTA	0.9231***	0.9426***	0.9431***	0.6741***	0.6325***	0.9294***	0.7712***	0.7462***	0.7744***	0.7647***	0.7374***	0.7435***
	(0.0070)	(0.0065)	(0.0061)	(0.0810)	(0.0817)	(0.1033)	(0.1192)	(0.1194)	(0.1101)	(0.1191)	(0.1193)	(0.1089)
LTA2	-0.0562***	-0.0573***	-0.0573***	-0.0410***	-0.0384***	-0.0594***	-0.0466***	-0.0453***	-0.0480***	-0.0460***	-0.0445***	-0.0456***
	(0.0005)	(0.0004)	(0.0004)	(0.0058)	(0.0058)	(0.0075)	(0.0083)	(0.0083)	(0.0080)	(0.0083)	(0.0083)	(0.0079)
dumINDUSTRY	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
dumYEAR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	4053	4053	4053	4053	4053	2032	4053	4053	2032	4053	4053	2032
Wald test	3.23e+07***	3.15e+07***	9.01e+07***	1008.01***	1096.47***	866.34***	557.03***	558.27***	756.38***	562.06***	564.04***	782.13***
m_1	-9.80***	-9.80***	-9.79***	-8.59***	-8.51***	-7.14***	-8.29***	-8.36***	-7.31***	-8.26***	-8.33***	-7.28***
m_2	-0.87	-0.8	-0.88	-1.56	-1.58	0.21	-1.58	-1.60	-0.01	-1.59	-1.62	0.05
p-value m_2 test	0.384	0.377	0.378	0.118	0.115	0.833	0.115	0.109	0.995	0.111	0.105	0.963
Hansen test	560.76	558.61	555.14	213.09	217.19	133.67	160.00	158.00	140.07	160.44	158.47	139.91
p-value Hansen test	0.471	0.497	0.538	0.142	0.103	0.721	0.171	0.201	0.577	0.165	0.194	0.581

Firstly, we find a positive and strongly significant statistical relationship (p-value=0.000) between the proxies for GOR (either *MBAR*, *Q* or *RDsales*) and *ExcessValue*, thereby confirming the significance of path <<b>>. Contrary to Stowe and Xing (2006), we find that the value of the firm's set of growth opportunities significantly contributes towards impacting the value of diversification. We report evidence that the larger the fraction represented by growth opportunities over the firm's total value, the higher the *ExcessValue*. This finding is consistent with prior literature such as Ferris *et al.* (2002).

Secondly, our results also reveal strong evidence of partial mediation. When *GOR* proxies are introduced in the regressions, the diversification coefficients show lower statistical significance, or even lose it. The clearest evidence is obtained when *HERF* variables are introduced in the model together with *MBAR* or *Q* (columns (7) and (8)), and *numsegments* or *TENTROPY* with *RDsales* (columns (6) and (12)). In these cases, the diversification variable drops to non-significant and thus, might even support full mediation. All these empirical findings taken together support some form of mediation of *GOR* in the relationship between *ExcessValue* and the degree of diversification. As the statistical significance of the diversification variables does not disappear completely in most cases, these findings support the idea that *GOR* is a partial mediator between diversification and *ExcessValue*, and that additional mediators might be operating in said relationship. Growth opportunities may drive an indirect effect of diversification on *ExcessValue,* making this corporate strategy more value-enhancing insofar as it serves as a platform for further growth options.

Finally, we conduct the Sobel test [see **Table 3.5**] as an additional robustness analysis. This test also supports the indirect effect of diversification on *ExcessValue* through *GOR*. Results are statistically significant above the 1% level, except in cases when *HERF* is used as a proxy for diversification together with *Q*, in which significance is lower. The proportion of total effect mediated by growth options proxies ranges between 0.1465 and 0.3569.

Table 3.5
[Sobel test results of mediation]

This table shows the results of the Sobel test for the statistical significance of the indirect effect of the level of diversification on *ExcessValue* through the mediator *GOR* (path <<c'>> in Figure 3.1). The independent variable (IV) is the level of diversification proxied by either *numsegments* (number of business segments at the 4-digit SIC code level), *HERF* (the Herfindahl index at the 4-digit SIC code level), or *TENTROPY* (the Entropy index). The mediator is *GOR* proxied by either *MBAR* (the market to book assets ratio), *Q* (Tobin's Q), or *RDsales* (the R&D expenses to firm sales ratio). The dependent variable (DV) is the *ExcessValue* measure developed by Berger and Ofek (1995). The square term of diversification is introduced as a covariate variable in all regressions. 'a' represents the unstandardized regression coefficient for the independent variable (IV) on the mediator; SE_a represents the standard error for a; b denotes the unstandardized regression coefficient for the mediator on the dependent variable (DV) when IV is also a predictor; SE_b is the standard error for b. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

				Step 1		*Step 2*			
IV	**Mediator**	**DV**	**Covariate variables**	**a**	**SE_a**	**b**	**SE_b**	**Sobel test (z)**	**Proportion of total effect mediated**
numsegments	MBAR	ExcessValue	numsegments2	-0.1330	0.0413	0.4042	0.0055	-0.0537***	0.3139
HERF	MBAR	ExcessValue	HERF2	-0.3999	0.1533	0.4039	0.0055	-0.1615***	0.3569
TENTROPY	MBAR	ExcessValue	TENTROPY 2	-0.2648	0.0778	0.4133	0.0070	-0.1094***	0.3540
numsegments	Q	ExcessValue	numsegments2	-0.1061	0.0403	0.4486	0.0055	-0.0476***	0.2778
HERF	Q	ExcessValue	HERF2	-0.2808	0.1497	0.4484	0.0055	-0.1259*	0.2782
TENTROPY	Q	ExcessValue	TENTROPY 2	-0.2297	0.0760	0.4593	0.0070	-0.1055***	0.3412
numsegments	RDsales	ExcessValue	numsegments2	-0.0217	0.0051	1.1265	0.0812	-0.0244***	0.1465
HERF	RDsales	ExcessValue	HERF2	-0.0838	0.0181	1.1166	0.0812	-0.0936***	0.2416
TENTROPY	RDsales	ExcessValue	TENTROPY 2	-0.0415	0.0088	1.0707	0.1085	-0.0444***	0.1792

All the findings detailed in this section are robust to the exclusion from the sample of the 'extreme' *Excess Value* (below -1.386 or above 1.386)[50]. In all regressions, both the Hansen and m_2 test support the validity of the GMM estimations. The Wald test confirms the joint significance of the variables.

In sum, diversification is both directly and indirectly related to *ExcessValue*. Part of the influence of diversification on *ExcessValue* is through GOR (partial mediator) although our results leave room for the existence of other mediating variables which may account for the relation between diversification and *ExcessValue*. Thus, as predicted by our second hypothesis, GOR partially mediates the relationship between diversification and value creation through this strategy, making it less value-destroying when it boosts creation of new growth options to a greater extent than exercising acquired ones.

3.3. SUMMARY AND CONCLUSIONS

We join the controversial diversification-value linkage debate. This chapter sheds further light on the role growth options play in said relationship, and contributes to the existing literature in a number of ways. First, we offer updated evidence on a post-1997 sample, after implementation of the new SFAS 131 reporting standard in the U.S. Second, we address the '*diversification puzzle*' from an RO approach. This investment theory establishes a more direct connection between corporate strategy analysis and market value by explaining diversification and its effects on a firm's value in terms of purchase and subsequent exercise of growth options. We report evidence that initial diversification expansions entail exploiting the growth opportunities currently available

[50] Results are available upon request.

to the firm, thus causing a decline in the growth options ratio. After a certain level of diversification, multiplicative effects start up in the growth options portfolio, this strategy primarily becoming a source of new investment opportunities.

By way of a third contribution, we add a further piece to the value-diversification puzzle: a firm's growth opportunities. We demonstrate the partial mediating role in this diversification-value relationship. This evidence ties in with prior research such as Campa and Kedia (2002) or Rajan *et al.* (2000) by demonstrating that firm-specific characteristics account for certain diversification discounts/premiums.

From a practical point of view, our study also has major implications for management. We encourage practitioners and scholars alike to examine diversification through a different lens, RO analysis, which promotes active management to exploit and explore investment opportunities, and stresses the importance of flexibility for capitalising on uncertainty. In order to create corporate value, managers should implement diversification those strategies that are non-replicable by individual investors in capital markets.

Chapter 4

Corporate Diversification through the Real Options Lens: Measuring a New Dimension

This chapter contains the empirical study of our diversification patterns model (model 2). The research question guiding this chapter is whether the diversification patterns identified from an RO perspective (assets-in-place diversification versus options diversification) help to explain the diversification-value relationship. A growth options diversification boosts flexibility to adjust decisions as uncertainty unfolds, and is geared towards not only exploiting but also exploring and generating further opportunities in new industries before fully committing. Such arguments lead us to claim that RO-oriented diversification might be a value-enhancing pattern of diversification (hypothesis 3).

The rest of the chapter is structured as follows. The first section develops our proposed index to capture the various diversification patterns. The following section describes our empirical models, estimation methodology, data set, and variables. The fourth section explains our main empirical findings. To round off the chapter, a discussion of the implications of the findings and contributions is offered.

4.1. A PROXY FOR CAPTURING RO DIVERSIFICATION PATTERNS

Traditional diversification indexes are geared towards capturing the scope of diversification in terms of distributing firms' business activity across their segments. Yet, by themselves they fail to provide information as to how the firm undertakes the investment throughout this expansion strategy. Degree and pattern of diversification constitute two different dimensions of this strategy, each requiring specific measures. To the best of our knowledge, no prior research has attempted to measure this latter dimension. Accordingly, we propose a two-dimensional index to proxy for the diversification pattern identified from an RO perspective, either AiPD or OD.

Our index incorporates two dimensions: an inter-segment dimension ($INTER_{SD}$) and an intra-segment dimension ($INTRA_{SD}$). The former captures the firm's activity distribution profile (in terms of sales) across its divisions. An AiPD is defined by a more uniform distribution of the weight of the various segments over a firm's total activity, whereas an OD is characterized by a wider dispersion in a firm's total sales activity. However, this dimension itself is not enough to discriminate between diversification patterns. To determine whether a uniform distribution displays an AiPD, an $INTRA_{SD}$ must also be captured; in other words, the firm's scale of participation in its businesses.

4.1.1. Inter-segment dimension ($INTER_{SD}$)

The $INTER_{SD}$ measures the adherence of a firm's diversification profile as being either closer to AiPD or to OD, by the degree of inequality in the distribution of the firm's level of diversification across the businesses it is involved in. An AiPD will translate to a more uniform distribution of the firm's total sales across the different segments since it holds a more balanced commitment in the various industries. In contrast, an OD will reflect unequal distribution, mostly concentrating its participation in core businesses coupled with minor exploratory investments in new industries.

The $INTER_{SD}$ we develop is intended to offer such an overview of the investment strategy followed by the firm in its overall business portfolio. We approximate this dimension by a Gini index, computed as follows:

$$\text{GiniI} = \frac{\sum_{s=1}^{n-1}(p_s - q_s)}{\sum_{s=1}^{n-1} p_s} \qquad [1]$$

where '*s*' represents the number of firm segments (s ranges from 1 to n), 'p_s' denotes the cumulative proportion of sales (from segment 1 to segment *s*), 'q_s' denotes the cumulative proportion of total diversification (calculated as the cumulative sum of ($P_s^2/HERF$), from segment 1 to segment *s*), and total diversification is approximated by the Herfindahl index (Hirschman, 1964):

$$HERF = \sum_{s=1}^{n} P_s^2 \qquad [2]$$

The Gini index (*GiniI*) takes values between 0 and 1. A *GiniI* equal to zero reflects perfect equality, and the higher the *GiniI*, the greater the inequality[51]. Thus, the nearer the Gini index is to zero, the closer the firm's diversification pattern is to AiPD; whereas the nearer the Gini index is to one, the closer the firm's diversification pattern is to OD.

4.1.2. Intra-segment dimension ($INTRA_{SD}$)

Both the distribution of the diversification status and the firm's scale of involvement in each business prove relevant to frame the company's diversification profile as being either closer to AiPD or to OD. We evaluate whether a firm's participation in each industry is below or above the average of its industry peers in that sector.

To incorporate this industry comparative framework, we use a multiplier approach to estimate the sales each firm would obtain from each business segment (imputed sales) were it to follow average industry commitment. We follow a similar procedure to Berger and Ofek's (1995) methodology for assessing a firm's imputed value. First, we take all public listed firms (both single-segment and diversified) operating in each industry *j*, and calculate each firm *i*'s ratio of *i*'s sales in industry *j* over firm *i*'s total assets. Sales are scaled by total assets to eliminate the size effect and make the

[51] For single-segment firms, we assume the *GiniI* to equal zero.

commitment of different sized enterprises comparable. Next, we compute the mean ratio for each industry *j* at the 4-digit code level. We then multiply this industry mean multiple by the firm's total assets to calculate imputed sales for each segment *s* of each firm *i*.

$$imputed\_segment\_sales_{is} = TA_i * \overline{multiple}_s(S/TA) \qquad [3]$$

where TA_i represents firm *i*'s total assets, and $\overline{multiple}_s(S/TA)$ denotes the mean multiple of the industry of segment *s*.

To evaluate the firm's scale of participation relative to the average of its industry peers, we compute a *commitment ratio* which compares firm *i's* real sales figures in each segment *s* against its corresponding imputed sales:

$$commitment\_ratio_{is} = \frac{firm's\_segment\_sales_{is}}{firm's\_imputed\_segment\_sales_{is}} \qquad [4]$$

A commitment ratio above or equal to 1 will indicate that firm *i* holds an above-average commitment in the industry and thus pursues an AiP pattern of investment in that sector. Otherwise, it will display a GO pattern based on under-developed participation in certain businesses, seen as the acquisition of an option which may serve as a platform for further opportunities.

Next, we propose the measure for the $INTRA_{SD}$ of our index, which seeks to capture the company's overall degree of commitment in all its business segments. We compute the $INTRA_{SD}$ as the ratio of the number of firm *i*'s segments displaying commitment ratios above or equal to 1 over firm *i*'s total number of segments. This $INTRA_{SD}$ variable is denoted by *num*, and proxies for the proportion of segments the company has a major commitment in. *num* is positively related to the AiP pattern of diversification: the closer the firm is to AiPD, the higher the *num*, the latter's value ranging between 0 and 1. If the company followed an AiP strategy in all its businesses, *num* would by definition be 1.

4.1.3. The two-dimensional index (DIVPAT)

Finally, we combine the $INTER_{SD}$ and the $INTRA_{SD}$ in a two-dimensional index devised on the basis of the Euclidean distance. Following Venkatraman (1989: 433), we take a concept of *fit* as profile deviation to analyse the degree of adherence of a firm's diversification pattern to an externally specified profile. In our analysis, that externally specified profile serving as reference will be the extreme case of AiPD.

The reference profile can be specified either theoretically or empirically (Venkatraman, 1989). From a theoretical standpoint, in an extreme AiPD, the $INTER_{SD}$ (measured by the *GiniI*) would equal 0, representing perfect equality, whereas the $INTRA_{SD}$ (measured by *num*) would equal 1, indicating that every firm's segment holds a commitment above the industry mean.

Next, our diversification profile index (*DIVPAT*) based on the Euclidean distance determines the deviation of the firm's diversification pattern (in both its $INTER_{SD}$ and $INTRA_{SD}$) from the extreme AiPD (*GiniI*=0, *num*=1). Thus, our comprehensive index to capture RO patterns based on the Euclidean distance can generally be expressed as:

$$d = \sqrt{(INTER^{FIRM}{}_{SD} - AiP\_INTER_{SD})^2 + (INTRA^{FIRM}{}_{SD} - AiP\_INTRA_{SD})^2} \quad [5]$$

where $INTER^{FIRM}{}_{SD}$ denotes the value of the firm's $INTER_{SD}$ component, AiP_INTER_{SD} the value of the $INTER_{SD}$ for the extreme case of AiPD, the $INTRA^{FIRM}{}_{SD}$ the value of the firm's $INTRA_{SD}$ component, and AiP_INTRA_{SD} the value of the $INTRA_{SD}$ for the extreme case of AiPD. In our specific case, where the AiPD reference profile is specified theoretically, the AiP_INTER_{SD} (measured by the

GiniI) equals 0, and the AiP_INTRA$_{SD}$ (measured by *num*) equals 1. Thus, our index is denoted by:

$$d\_num = \sqrt{(IGini^{FIRM} - 0)^2 + (num^{FIRM} - 1)^2} \qquad [6]$$

This Euclidean distance constitutes our index proposal to capture RO diversification patterns. It represents the degree of deviation of the firm's diversification path from the case of extreme AiPD. Therefore, the higher the index, the closer a firm's diversification profile is to the OD pattern; while the lower the index, the closer a firm's diversification profile is to the AiPD pattern.

4.2. RESEARCH DESIGN: DATA, VARIABLES AND EQUATIONS

4.2.1. Database, sample selection, and description

Our initial sample comprises the same panel of public U.S. companies described in section 3.1.1 in chapter 3. We also select the sample by applying Berger and Ofek's (1995) criteria to ensure that our results are comparable to prior literature. Finally, we detect and remove outlying observations of the main variables included in our analysis. Our final dataset for estimation purposes is an unbalanced panel sample of 16,554 firm-year observations, comprising a total of 3,165 companies for the 1998-2010 period.

Table 4.1 presents full-period general descriptive statistics concerning the financial profile of the companies in the final sample. As can be seen, there is substantial heterogeneity across firms in certain characteristics such as size (either approximated by total sales, total assets, or market capitalization), performance (measured by EBIT), and debt.

Table 4.1
[Descriptive statistics of the data (U.S. companies (1998-2010))]

This table contains descriptive statistics of general financial variables for the final sample of 16,554 firm-year observations, for both unisegment (12,047 firm-year observations) and multisegment companies (4,507 firm-year observations). Figures are expressed in million US$.

Variable	N	Mean	Median	STD	Min.	Max.	1st quartile	3rd quartile
Total Sales	16554	1475.991	308.7555	4265.445	20.01	98540	90.933	1120.056
Total Assets	16554	1400.56	320.502	2920.466	4.5800	21972	91.9698	1187.725
Common Equity	16554	612.1729	172.485	1250.963	0.2387	15835	52.312	556.082
EBIT	16554	113.9356	19.1145	352.1681	-6740.195	5039	1.522	94.724
Market capitalization	16554	1731.068	353.8434	4482.616	1.3400	78973.82	88.0205	1282.935
Total Debt	16554	367.2181	31.167	959.7748	0	12358.83	2.309	261.523
Total observations	16,554 observations after removing outliers [Unisegment firms: 12,047 obs. (72.77%); diversified firms: 4,507 obs. (27.23%)]							

4.2.2. Econometric approach, empirical models and variables

Our estimation methodology is the Heckman two-step procedure (Heckman, 1979) to control for self-selection[52]. There is selectivity in our sample since diversification is not assigned randomly across companies, with firms either self-selecting to diversify or to remain focused (Campa and Kedia, 2002; Villalonga 2004b; Miller, 2006). Factors affecting firms' propensity to diversify may also impact diversification value outcomes. If so, diversification variables would be correlated with the error term in the diversification-value models, and OLS estimators would not prove consistent. The Heckman two-stage method considers this self-selection bias as an omitted variable problem and corrects for it.

[52] See Note A.1 in the Appendix for an outline of the Heckman two-stage procedure.

The first step of the Heckman estimation involves a probit analysis to model the firm's propensity to diversify (*selection equation*). It enables us to obtain self-selection correction in the form of the inverse of Mill's ratio (λ) (Greene, 2003), which will be included at the second stage to correct for selection bias. The resulting estimators of this latter equation would thus reflect the net effect of the diversification strategy on the dependent variable once sample selectivity has been corrected.

Following Campa and Kedia (2002) and to ensure comparability of our results with prior research, we consider the following selection equation:

$$D_{it}= \gamma_0 + \gamma_1 LTA_{it} + \gamma_2 EBITsales_{it} + \gamma_3 CAPEXsales_{it} + \gamma_4 PNDIV_{it} + \gamma_5 PSDIV_{it} + \gamma_6 ChangeGDP_{it} + \gamma_7 CONTRACTION_{it} + \eta_{it} \quad [7]$$

$D_{it}=1$ if $D_{it}^*>0$, and $D_{it}=0$ if $D_{it}^*<0$, where D^*_{it} is an unobserved latent variable observed as $D_{it}=1$ if $D^*_{it}>0$ (diversified firm), and equalling zero otherwise (unisegment firm), and η_{it} is an error term. To ensure comparability with prior research, we assume the diversification decision to be driven by characteristics[53]:

- at firm-level: firm size, estimated by the natural logarithm of the book value of total assets (*LTA*); profitability, approximated by the ratio EBIT to sales (*EBITsales*); and the firm's level of investment in current operations, proxied by the capital expenditures to total sales ratio (*CAPEXsales*).

- at industry-level: industry attractiveness, based on both the fraction of firms in the firm's core industry that are diversified (*PNDIV*) and the proportion of the firm's core industry sales accounted for by diversifiers (*PSDIV*)[54].

[53] See Campa and Kedia (2002) for a further explanation of the variables selection.

[54] We calculate these two proxies at the 4-digit SIC level.

- and at the macro-economic level: economic cycle attractiveness, approximated by the real growth rates of gross domestic product, calculated as the GDP percent change based on 2005 dollars (*changeGDP*); and the number of months in the year the U.S. economy was in recession (*CONTRACTION*).

At the second stage of the Heckman procedure, our main models (*outcome equations*) are estimated by ordinary least squares (OLS)[55]. First, as preliminary analyses to test the validity of our index, we relate both the $INTER_{SD}$ (proxied by *GiniI*) and the $INTRA_{SD}$ (proxied by *num*) of our index to a firm's value (equations [8] to [10]):

$$\begin{aligned} EXCESS\_VALUE_{it} = {} & \alpha + \beta_1 GiniI_{it} + \beta_2 LTA_{it} + \beta_3 LDTA_{it} + \beta_4 EBITsales_{it} \\ & + \beta_5 CAPEXsales_{it} + \beta_6 LTA2_{it} + \beta_7 \lambda_{it} + \beta_8 dumINDUSTRY_{it} \\ & + \beta_9 dumYEAR_{it} + \nu_{it} \end{aligned} \qquad [8]$$

$$\begin{aligned} EXCESS\_VALUE_{it} = {} & \alpha + \beta_1 num_{it} + \beta_2 LTA_{it} + \beta_3 LDTA_{it} + \beta_4 EBITsales_{it} \\ & + \beta_5 CAPEXsales_{it} + \beta_6 LTA2_{it} + \beta_7 \lambda_{it} + \beta_8 dumINDUSTRY_{it} \\ & + \beta_9 dumYEAR_{it} + \nu_{it} \end{aligned} \qquad [9]$$

$$\begin{aligned} EXCESS\_VALUE_{it} = {} & \alpha + \beta_1 GiniI_{it} + \beta_2 num_{it} + \beta_3 LTA_{it} + \beta_4 LDTA_{it} + \beta_5 EBITsales_{it} \\ & + \beta_6 CAPEXsales_{it} + \beta_7 LTA2_{it} + \beta_8 \lambda_{it} + \beta_9 dumINDUSTRY_{it} \\ & + \beta_{10} dumYEAR_{it} + \nu_{it} \end{aligned} \qquad [10]$$

where i identifies each firm, t indicates the year of observation (from 1 to 13), α and β_p are the coefficients to be estimated, and v_{it} represents the random disturbance for each

[55] An alternative approach to the Heckman two-step estimator is the Heckman maximum likelihood (ML) estimator. Whereas in the former, the selection equation and the outcome equation are estimated separately by probit and OLS estimations respectively, in the Heckman ML estimator, both equations are estimated jointly in a single step by maximum likelihood. Assumptions for applying this ML approach are more restrictive than those required by the Heckman two-step estimator.

observation. The dependent variable is excess value (*ExcessValue*), calculated following the Berger and Ofek (1995) imputed value approach[56], based on comparing the firm's market value against the estimated value the firm would have if all its divisions operated as individual entities (imputed value).

We then estimate equation [11] to test our hypothesis regarding the effect of the diversification pattern on a firm's value. The explanatory variable is our proposed index (*d_num*), which measures how close the firm's diversification strategy is to an assets-in-place or to a real options investment philosophy.

$$\begin{aligned} EXCESS\_VALUE_{it} = {} & \alpha + \beta_1\, d\_num_{it} + \beta_2\, LTA_{it} + \beta_3\, LDTA_{it} + \beta_4\, EBITsales_{it} \\ & + \beta_5\, CAPEXsales_{it} + \beta_6\, LTA2_{it} + \beta_7 \lambda_{it} + \beta_8\, dumINDUSTRY_{it} \\ & + \beta_9 dumYEAR_{it} + \nu_{it} \end{aligned} \quad [11]$$

where i identifies each firm, t indicates the year of observation (from 1 to 13), α and β_p are the coefficients to be estimated, and v_{it} represents the random disturbance for each observation.

In line with prior research (Berger and Ofek, 1995; Campa and Kedia, 2002), we control for several firm-characteristics likely to impact excess value: firm size (*LTA*) and its squared term (*LTA2*), financial leverage (proxied by the ratio of long-term debt to total assets, *LDTA*), profitability (*EBITsales*), and level of investment (*CAPEXsales*). Following Santaló and Becerra (2008), we also incorporate the industry effect[57] (*dumINDUSTRY*). Additionally, we control for the year effect (*dumYEAR*) and self-

[56] See Berger and Ofek (1995) for more details. We calculate the "excess value" by dividing the enterprise's value by its imputed value, and then taking the natural logarithm of this ratio. Following Campa and Kedia's (2002) study, we compute a firm's market value (MV) as the sum of market value of equity (MVE), long-term (LtD), short-tem (StD) debt, and preferred stock (PrefStock).

[57] Industry dummies are calculated at the 2-digit SIC code level.

selection (λ). The estimated coefficient associated with the λ term is a key point in the analysis. A significant λ coefficient will mean that the correlation between the residuals of the selection equation and the outcome equation cannot be assumed to be zero, confirming the existence of selectivity.

We conduct a number of robustness tests. We specify the AiPD profile of reference empirically by using a calibration sample (Venkatraman, 1989; Venkatraman and Prescott, 1990), comprising the bottom ten per cent of firms according to growth opportunities[58]. Growth opportunities are proxied by either Tobin's Q[59] (Cao *et al.*, 2008) or the ratio of R&D expenses to total sales (Mehran, 1995). The AiPD reference point is determined by the median scores along the INTER_{SD} (*IGini*) and the INTRA_{SD} (*num*). See **Table 4.2** for a statistical summary of these dimensions for the calibration sample. We construct alternative proxies for our diversification profile index depending on the growth opportunities proxy used for defining the calibration sample. Thus, first, in equation [6], the vector of scores for the AiPD extreme profile (*IGini*=0, *num*=1) is replaced by the median scores of the proxies *IGini* and *num* in the calibration sample, this sample being determined by either Tobin's Q (*Q*) or the R&D expenses to total sales (*RDsales)* ratio. The index is denoted by $d\_num\_BOT_Q$ and $d\_num\_BOT_{RDsales,}$ respectively).

[58] The most extreme cases of AiPD should imply the lowest growth opportunities values as this pattern is primarily aimed at exercising growth options in one full-scale step.

[59] See Cao *et al*. (2008) for more details about proxy calculation.

Table 4.2
[Summary statistics of two-dimensional index component variables for the calibration sample (1998-2010)]

This table displays the summary statistics of the two-dimensional index component variables ($INTER_{SD}$ (*GiniI*) and $INTRA_{SD}$ (*num*)). *GiniI* denotes the Gini Index; and *num* is the ratio of a firm's segments displaying commitment ratios above or equal to 1, over the total number of a firm's segments. *dumQ_BOT* is a dummy variable which equals 1 if the firm belongs to the bottom ten percent of sample firms according to the variable *Q* (Tobin's Q (Cao *et al*. 2008)), and zero otherwise. *dumRDsales_BOT* is a dummy variable which equals 1 if the firm belongs to the bottom ten percent of sample firms according to the variable *RDsales* (the ratio of R&D expenses to total sales (Mehran, 1995)), and zero otherwise.

	Calibration sample defined by Q (dumQ_BOT=1)				Calibration sample defined by RDsales (dumRDsales_BOT=1)			
	N	**Mean**	**Median**	**STD**	**N**	**Mean**	**Median**	**STD**
IGini	1660	0.1426	0	0.2827	3433	0.1322	0	0.2872
num	1660	0.5945	1	0.4596	3433	0.5868	1	0.4649

We also check the robustness of the results of equation [11], restricting the study sample to diversified firms and then estimating by OLS[60]. In addition, we redefine equation [11] to include the level of diversification as a control variable, proxied by the modified Herfindahl index (*MHERF*) [$MHERF=1-\sum P_s^2$]:

$$\begin{aligned} EXCESS\_VALUE_{it} = {} & \alpha + \beta_1\, d\_num_{it} + \beta_2\, MHERF_{it} + \beta_3\, LTA_{it} + \beta_4\, LDTA_{it} \\ & + \beta_5\, EBITsales_{it} + \beta_6\, CAPEXsales_{it} + \beta_7\, LTA2_{it} + \beta_8 \lambda_{it} \\ & + \beta_9\, dumINDUSTRY_{it} + \beta_{10}\, dumYEAR_{it} + \nu_{it} \end{aligned} \qquad [12]$$

Finally, following prior research, we re-estimate equations [8] to [12] after dropping 'extreme' excess values (above 1.386 or below -1.386) from the sample (Berger and Ofek, 1995).

Table 4.3 offers a summary of the variables involved in this study:

[60] As unisegment firms are excluded, there is no reason to control for selectivity.

Table 4.3
[Description of the variables]

This table contains a summary of the variables used in the analysis. The first column indicates the label of each variable, the second column provides the definition of the variable, and the third column offers the source of that definition.

VARIABLE	DEFINITION	SOURCE
Excess Value	Natural log of the ratio Enterprise value to its imputed value (note: sales-based excess value measure)	Berger and Ofek (1995)
Growth options value to firm's total value (GOR)		
Q	Tobin's Q $Q = \frac{share\_price * common\_shares\_outstanding + preferred\_stock + current\_liabilities - current\_assets + long\_term\_debt}{total\_assets}$	Cao *et al.* (2008)
RDsales	The ratio of R&D expenses to total firm sales $RDsales = \frac{R\ \&\ D\ expenses}{Firm\ total\ sales}$	Mehran (1995)
AiPD & OD indexes		
GiniI	Inter-segment dimension proxy: Gini Index.	
num	Intra-segment dimension proxy: Number of the firm's segments displaying commitment ratios above or equal to 1 over the firm's total number of segments.	
d_num	Joint index: Euclidean distance calculated with the *GiniI* proxy for the $INTER_{SD}$ and the *num* proxy for the $INTRA_{SD.}$ The "extreme" profile of AiP diversification from which the deviation is calculated takes the value 0 for the GiniI and 1 for ratio *num.*	
$d\_num\_BOT_{Q}$	Joint index: Euclidean distance calculated with the *GiniI* proxy for the $INTER_{SD}$ and the *num* proxy for the $INTRA_{SD.}$ The "extreme" profile of AiP diversification (defined by num and IGini) from which the deviation is calculated takes the value of the median scores of the *num* and *GiniI*, respectively, of enterprises selected for the 'calibration sample'. The calibration sample comprises the bottom ten percent GOR enterprises, GOR being proxied by Q (in other words, the ten percent of firm-year observations displaying the lowest values for Q within each year).	Own elaboration
$d\_num\_TOP_{DTE}$	Joint index: Euclidean distance calculated with the *GiniI* proxy for the $INTER_{SD}$ and the *num* proxy for the $INTRA_{SD.}$ The "extreme" profile of AiP diversification (defined by num and IGini) from which the deviation is calculated takes the value of the median scores of the *num* and *GiniI*, respectively, of enterprises selected for the 'calibration sample'. The	

	calibration sample comprises the bottom ten percent GOR enterprises, GOR being proxied by RDsales (in other words, the ten percent of firm-year observations displaying the lowest values for RDsales within each year).	
Degree of diversification (DIVER)		
dummyDIVER	Dummy variable: Equals 1 if the firm is diversified, and zero otherwise.	
MHERF	Modified Herfindahl index $HERF = 1 - \sum_{n} P_i^2$, n being the number of business segments of the company, and Pi the proportion of a firm's sales in each segment.	Hirschman (1964)
Control variables		
LDTA	The ratio of long-term debt to total assets	Campa and Kedia (2002)
LTA	Natural log of the book value of assets	Campa and Kedia (2002)
EBITsales	The ratio EBIT to total firm sales	Campa and Kedia (2002)
CAPEXsales	The ratio capital expenditures to total firm assets	
dumINDUSTRY	Nine major divisions (excluding the financial division) → eight dummy variables	
dumYEAR	13 years (1998-2012 period) → twelve dummy variables.	
Control variables at the industry level		
PNDIV	Fraction of companies in the firm's core industry that are diversified.	Campa and Kedia (2002)
PSDIV	Proportion of the firm's core industry sales accounted for by diversifiers	
Control variables at the macroeconomic level		
ChangeGDP	The GDP per cent change based on chained 2005 dollars	Campa and Kedia (2002)
CONTRACTION	Number of months in the year the U.S. economy was in recession	

Table 4.4 provides a summary of the descriptive statistics of the variables involved in the analysis for the sample. Particularly noteworthy is the negative sign for the average excess value (-0.0574) reflecting a diversification discount. As regards the RO diversification pattern, companies display a balanced average position, which is not strongly inclined towards either of the two extreme models.

Table 4.4
[Summary statistics of variables for the full sample (1998-2010)]

This table shows descriptive statistics of the variables involved in our models for the final sample of 16,554 firm-year observations of unisegment (12,047 firm-year observations) and multisegment companies (4,507 firm-year observations). Some observations contain missing data for certain variables. *Excess Value* is the measure developed by Berger and Ofek (1995) to assess the value created by diversifying. $INTER_{SD}$ (measured by *GiniI*) and $INTRA_{SD}$ (measured by *num*) are the two-dimensional index component variables. *DIVPAT* represents the diversification pattern index (measured by the alternative specifications, developed either theoretically (*d_num*) or through the calibration sample ($d\_num\_BOT_Q$ and $d\_num\_BOT_{RDsales}$)). *MHERF* (the modified Herfindahl index) measures the level of diversification. Control variables: *LTA* (size), *EBITsales* (profitability), *CAPEXsales* (level of investment in current operations), *LDTA* (financial leverage), *PNDIV* (fraction of firms in the firm's core industry that are diversified), *PSDIV* (the proportion of the firm's core industry sales accounted for by diversifiers), *changeGDP* (real growth rates of gross domestic product), *CONTRACTION* (the number of months in the year the U.S. economy was in recession). Figures are expressed in million US$.

Variable	N	Mean	Median	STD	Min.	Max.	1st quartile	3rd quartile
Excess Value	16554	-0.0574	0.0000	0.7875	-2.8458	2.6628	-0.5338	0.4335
Excess Value (without extremes EV)	15104	-0.0141	0.0000	0.6126	-1.3846	1.3858	-0.4414	0.4113
$INTER_{SD}$								
IGini	16554	0.1554	0	0.2986	0	0.9999	0	0.1039
$INTRA_{SD}$								
num	16554	0.5037	0.5000	0.4692	0	1	0	1
DIVPAT								
d_num	16554	0.5644	0.8710	0.5111	0	1.4141	0	1
$d\_num\_BOT_Q$	16554	0.5561	0.5567	0.4664	0	1.4141	0	1
$d\_num\_BOT_{RDsales}$	16554	0.5559	0.5000	0.4538	0	1.4141	0	1
Degree of diversification (DIVER)								
MHERF	16554	0.0983	0	0.1853	0	0.7925	0	0.0683
Control variables								
LTA	16554	5.8406	5.7699	1.7308	1.5217	9.9975	4.5215	7.0798
EBITsales	16554	0.0543	0.0681	0.1843	-1.1784	1.1792	0.0143	0.1303
CAPEXsales	16554	0.0684	0.0332	0.1105	0	0.9348	0.0166	0.0677
LDTA	16554	0.1581	0.1187	0.1617	0	0.7391	0.0016	0.2687
PNDIV	16554	0.4364	0.4231	0.2194	0	1	0.2857	0.5714
PSDIV	16554	0.5549	0.5919	0.2973	0	1	0.3325	0.7960
changeGDP	16554	0.0222	0.0270	0.0195	-0.0260	0.0480	0.0180	0.0360
CONTRACTION	16554	1.6651	0	3.0931	0	9	0	0

4.3. EMPIRICAL FINDINGS

4.3.1. Propensity to diversify: a probit estimation of the selection equation

Table 4.5 contains the probit estimation for the selection equation (eq. [7]) as the first step in the Heckman method. Estimations in columns (2) to (4) extend probit specification (1) by incorporating lags and year dummies. Goodness-of-fit (Pseudo-R^2) ranges between 0.15 and 0.16, comparable to prior literature. Among firm-characteristics, *CAPEXsales* shows a negative and significant coefficient in all estimations. This result suggests that companies with low investment levels are more prone to diversify. *LTA* and its lag have a positive and highly significant coefficient, indicating that larger companies are more likely to incorporate multiple business units. Finally, *EBITsales* is only statistically significant in the models where lagged variables are omitted. Our results evidence that less profitable enterprises are more liable to engage in this strategy.

Table 4.5
[Firms' propensity to diversify [first stage of Heckman estimation] (Eq. 7)]

This table shows probit estimation results for the selection equation (eq. [7]) as the first stage of Heckman's procedure. The dependent variable takes the value 1 when the firm is diversified and zero otherwise. The pseudo-R square indicates the goodness of fit. Standard error is shown in parentheses under coefficients. ****, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

PROBIT	(1)	(2) with lags	(3) with dummy years	(4) with lags and dummy years
Constant	-2.6356***	-2.6479***	-2.7298***	-2.7800***
	(0.0602)	(0.0732)	(0.0713)	(0.0850)
Firm characteristics				
LTA	0.1108***	-0.0474	0.1134***	-0.0470
	(0.0069)	(0.0658)	(0.0069)	(0.0661)
EBITsales	-0.1592**	-0.0450	-0.1391**	-0.0192
	(0.0655)	(0.1075)	(0.0660)	(0.1083)
CAPEXsales	-0.7678***	-0.5510**	-0.7887***	-0.5599**
	(0.1115)	(0.2610)	(0.1122)	(0.2620)
LTA $_{t-1}$		0.1678***		0.1700***
		(0.0655)		(0.0658)
EBITsales $_{t-1}$		-0.0531		-0.0713
		(0.1018)		(0.1027)
CAPEXsales $_{t-1}$		-0.3274		-0.3357
		(0.2465)		(0.2482)
Industry characteristics				
PNDIV	2.1820***	2.1367***	2.1500***	2.1232***
	(0.0682)	(0.0810)	(0.0702)	(0.0835)
PSDIV	0.5856***	0.6358***	0.5770***	0.6252***
	(0.0492)	(0.0594)	(0.0495)	(0.0597)
Macroeconomic characteristics				
ChangeGDP	2.4047**	0.9054	1.4355	0.1500
	(0.9429)	(1.1328)	(1.4136)	(1.5901)
CONTRACTION	0.0074	-0.0049	0.0157*	0.0103
	(0.0058)	(0.0068)	(0.0084)	(0.0095)
dumYEAR	NO	NO	YES	YES
N. of obs.	16554	11745	16554	11745
Log. Likelihood	-8177.981	-5755.1745	-8167.4142	-5746.8648
Pseudo-R^2	0.1562	0.1590	0.1573	0.1602

Results concerning the effect of industry factors on the propensity to diversify are robust to the alternative estimations. Consistent with Campa and Kedia (2002) and

Villalonga (2004b), results yield evidence that a greater presence of diversified firms in the core industry positively impacts the decision to diversify.

Macroeconomic variables have no significant impact on diversification likelihood, *CONTRACTION* being only borderline significant in column (3). There is also weak evidence concerning the relevance of the *changeGDP* variable. In the probit specification in column (1), *changeGDP* is positively associated with the diversification decision, suggesting that companies are more likely to diversify during cycles of economic growth. However, this variable does not retain its statistical significance in the remaining specifications.

In sum, we find that characteristics at the firm-level and at the industry-level are the main drivers of the diversification decision. Moving on to the second step of Heckman's approach and performing the estimations of our outcome equations (Eq. [8] to [12]), we take the specification of the selection equation in column (1). In this way, we exclude lagged values of firm variables and time dummies which lack statistical significance in most cases, while minimizing loss of observations for subsequent analyses. This probit ensures at least four exclusion restrictions since the variables *PNDIV*, *PSDIV*, *changeGDP* and *CONTRACTION* are included in the selection equation but not in the outcome equations, thus mitigating potential collinearity problems.

4.3.2. Diversification pattern index dimensions and firms' value

As preliminary analyses, we test the impact each dimension of our index has on a firm's value, both separately and jointly (**Table 4.6**).

Table 4.6
[The dimensions of the index and Excess Value (Eq. [8] to [10])]

This table shows the Heckman second stage estimation by OLS (Heckman's two-step estimator) of equations [8] to [10]. The selection equation (column 1) (Table 4.5) models firms' propensity to diversify. *ExcessValue* is regressed on the $INTER_{SD}$ of the index (*GiniI*), the $INTRA_{SD}$ of the index (*num*), and both dimensions jointly. Firm size (*LTA*) (and its squared term (*LTA2*)), financial leverage (*LDTA*), profitability (*EBITsales*), level of investment (*CAPEXsales*), industry effect (*dumINDUSTRY*), and time effect (*dumYEAR*) are controlled in all estimations. The Inverse Mills Ratio ($(\lambda_i$) is included as an additional regressor to correct potential self-selection bias in the sample. The Wald test contrasts the null hypothesis of no joint significance of the explanatory variables. Standard error is shown in parentheses under coefficients. ****, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	Model ExcessValue = f($INTER_{SD}$, $INTRA_{SD}$, control variables)											
	Dependent variable: Excess Value						Dependent variable: Excess Value (without extremes)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
constant	-1.7733***	-1.8529***	-1.1200***	-1.1677***	-1.2203***	-1.2820***	-0.9891***	-1.0721***	-0.5802***	-0.6532***	-0.6713***	-0.7508***
	(0.1314)	(0.1446)	(0.1315)	(0.1452)	(0.1319)	(0.1450)	(0.1160)	(0.1266)	(0.1168)	(0.1275)	(0.1170)	(0.1275)
$INTER_{SD}$												
GiniI	0.1237***	0.1630***			0.2395***	0.2871***	0.1300***	0.1394***			0.2119***	0.2257***
	(0.0375)	(0.0373)			(0.0371)	(0.0371)	(0.0318)	(0.0318)			(0.0320)	(0.0321)
$INTRA_{SD}$												
num			-0.6570***	-0.6220***	-0.7077***	-0.6896***			-0.3967***	-0.3774***	-0.4479***	-0.4369***
			(0.0416)	(0.0418)	(0.0422)	(0.0424)			(0.0361)	(0.0363)	(0.0368)	(0.0370)
control variables												
LTA	0.3983***	0.3504***	0.3426***	0.2995***	0.3440***	0.3028***	0.1758***	0.1444***	0.1477***	0.1184***	0.1508***	0.1242***
	(0.0408)	(0.0403)	(0.0399)	(0.0395)	(0.0397)	(0.0393)	(0.0359)	(0.0355)	(0.0356)	(0.0351)	(0.0354)	(0.0349)
LDTA	-0.1674**	-0.1165	-0.1461*	-0.1348*	-0.1536**	-0.1395*	-0.1335**	-0.1449**	-0.1194*	-0.1573**	-0.1277*	-0.1621**
	(0.0797)	(0.0804)	(0.0777)	(0.0787)	(0.0774)	(0.0781)	(0.0671)	(0.0682)	(0.0662)	(0.0675)	(0.0659)	(0.0671)
EBITsales	0.5982***	0.6902***	0.6856***	0.7539***	0.6593***	0.7190***	0.5231***	0.5889***	0.5900***	0.6382***	0.5697***	0.6153***
	(0.0748)	(0.0733)	(0.0732)	(0.0719)	(0.0731)	(0.0716)	(0.0644)	(0.0637)	(0.0638)	(0.0631)	(0.0635)	(0.0629)
CAPEXsales	1.0004***	1.7592***	0.8943***	1.6257***	0.8197***	1.5391***	0.5956***	1.1035***	0.5632***	1.0559***	0.4947***	0.9850***
	(0.1269)	(0.1473)	(0.1242)	(0.1447)	(0.1243)	(0.1443)	(0.1050)	(0.1240)	(0.1037)	(0.1228)	(0.1037)	(0.1225)
LTA2	-0.0220***	-0.0175***	-0.0202***	-0.0160***	-0.0203***	-0.0164***	-0.0071**	-0.0036	-0.0064**	-0.0031	-0.0067**	-0.0037
	(0.0032)	(0.0032)	(0.0031)	(0.0031)	(0.0031)	(0.0031)	(0.0028)	(0.0028)	(0.0028)	(0.0027)	(0.0028)	(0.0027)
Inverse Mills Ratio (λ_i)	-0.0197	-0.0430	-0.1664***	-0.1545***	-0.1842***	-0.1725***	0.0140	-0.0068	-0.0773***	-0.0771***	-0.0941***	-0.0920***
	(0.0286)	(0.0318)	(0.0296)	(0.0322)	(0.0296)	(0.0321)	(0.0237)	(0.0267)	(0.0249)	(0.0273)	(0.0249)	(0.0273)
dumINDUSTRY	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
dumYEAR	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
No. of Obs.	16554	16554	16554	16554	16554	16554	15104	15104	15104	15104	15104	15104
No. Censored Obs.	12047	12047	12047	12047	12047	12047	11007	11007	11007	11007	11007	11007
No. Uncensored Obs.	4507	4507	4507	4507	4507	4507	4097	4097	4097	4097	4097	4097
Wald Chi2 χ^2	692.47***	1243.87***	959.15***	1493.62***	1007.89***	1571.25***	456.62***	889.74***	569.80***	995.38	618.91***	1055.94***

In line with our theoretical assumptions, greater inequality in the firm's level of participation in its businesses is closer to an options-driven strategy. We find clear evidence of a positive effect (statistically significant at the 1% level) of the *GiniI* (eq. [8]) sub-component on excess value (columns (1) and (2)). In addition, we find that *num* (eq. [9]) is negatively associated (p-value=0.000) with excess value (columns (3) and (4)). This result is consistent with our arguments since holding major commitments in many businesses is negatively related to a growth option strategy. Finally, we account for both dimensions simultaneously (eq. [10]). Results are robust, and both *GiniI* and *num* maintain statistical significant above the 1% level.

As can be seen, the λ coefficient is strongly statistically significant in all regressions (except for the estimations of equation [8]), thus allowing us to reject the null hypothesis that the correlation between the residuals of the selection equation and the outcome equation is zero. This evidence confirms that our sample suffers from self-selection bias and thus Heckman's two-step approach is justified. Furthermore, as indicated by the Wald test reported at the bottom of the tables, variables are jointly significant above the 1% level in all models.

4.3.3. Diversification pattern, scope and firms' value

Table 4.7 provides interesting insights into the relevance of the diversification pattern for explaining value creation or destruction from this strategy (eq. [11]). In regressions where indexes based on the calibration samples are used, both the bottom (calibration sample) as well as the top ten percent of firms according to their level of growth opportunities (proxied either by *Q* or *RDsales*) are excluded from the study sample (Vekatraman and Prescott, 1990).

Table 4.7
[Diversification pattern index and Excess Value (Eq. [11])]

This table shows the Heckman second stage estimation by OLS (Heckman's two-step estimator) of equation [11]. The selection equation (column 1) (Table 4.5) models firms' propensity to diversify. *ExcessValue* is regressed on the DIVPAT. d_num, $d\_num\_BOT_{Q}$ and $d\_num\_BOT_{RDsales}$, denote the alternative specifications for the DIVPAT based on the Euclidean distance. Firm size (*LTA*) (and its squared term (*LTA2*)), financial leverage (*LDTA*), profitability (*EBITsales*), level of investment (*CAPEXsales*), industry effect (*dumINDUSTRY*), and time effect (*dumYEAR*) are controlled in all estimations. The Inverse Mills Ratio ((λ_i) is included as an additional regressor to correct potential self-selection bias in the sample. The Wald test contrasts the null hypothesis of no joint significance of the explanatory variables. Standard error is shown in parentheses under coefficients. ****, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	Model ExcessValue = f(DIVPAT, control variables)											
	Dependent variable: Excess Value						Dependent variable: Excess Value (without extremes)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
constant	-2.1036***	-2.1576***	-1.6840***	-1.8309***	-1.9575***	-1.9357***	-1.2241***	-1.3081***	-0.9779***	-1.1923***	-1.1977***	-1.2171***
	(0.1286)	(0.1410)	(0.1330)	(0.1424)	(0.1444)	(0.1575)	(0.1149)	(0.1252)	(0.1209)	(0.1280)	(0.1312)	(0.1414)
DIVPAT												
d_num	0.7592***	0.7936***					0.5354***	0.5497***				
	(0.0470)	(0.0474)					(0.0413)	(0.0418)				
d_num_BOT$_Q$			0.4790***	0.7130***					0.3894***	0.5844***		
			(0.0445)	(0.0476)					(0.0396)	(0.0426)		
d_num_BOT$_{RDsales}$					0.4995***	0.6856***					0.3563***	0.4969***
					(0.0453)	(0.0510)					(0.0397)	(0.0454)
control variables												
LTA	0.3583***	0.3126***	0.3089***	0.2398***	0.3778***	0.3022***	0.1560***	0.1283***	0.1306***	0.0828**	0.1844***	0.1166***
	(0.0398)	(0.0392)	(0.0409)	(0.0392)	(0.0444)	(0.0438)	(0.0353)	(0.0348)	(0.0371)	(0.0356)	(0.0404)	(0.0395)
LDTA	-0.1642**	-0.1380*	-0.0389	-0.0204	-0.1341	-0.0595	-0.1327**	-0.1620**	-0.0583	-0.1011	-0.1353*	-0.1324*
	(0.0776)	(0.0782)	(0.0776)	(0.0761)	(0.0869)	(0.0873)	(0.0659)	(0.0669)	(0.0679)	(0.0668)	(0.0744)	(0.0753)
EBITsales	0.6201***	0.6919***	0.3736***	0.4761***	0.8921***	0.9641***	0.5521***	0.6032***	0.3221***	0.4093***	0.6903***	0.7420***
	(0.0730)	(0.0714)	(0.0766)	(0.0727)	(0.0899)	(0.0873)	(0.0633)	(0.0626)	(0.0678)	(0.0647)	(0.0779)	(0.0762)
CAPEXsales	0.8097***	1.5463***	0.6788***	1.4211***	0.8502***	1.4579***	0.4854***	0.9822***	0.4463***	1.0236***	0.5724***	0.9592***
	(0.1245)	(0.1442)	(0.1258)	(0.1427)	(0.1390)	(0.1602)	(0.1036)	(0.1222)	(0.1081)	(0.1236)	(0.1168)	(0.1366)
LTA2	-0.0208***	-0.0168***	-0.0175***	-0.0123***	-0.0221***	-0.0165***	-0.0069**	-0.0039	-0.0054*	-0.0014	-0.0089***	-0.0034
	(0.0031)	(0.0031)	(0.0032)	(0.0031)	(0.0035)	(0.0034)	(0.0028)	(0.0027)	(0.0029)	(0.0028)	(0.0031)	(0.0031)
Inverse Mills Ratio (λ_i)	-0.1631***	-0.1602***	-0.1247***	-0.1221***	-0.1433***	-0.1776***	-0.0897***	-0.0902	-0.0822***	-0.0821***	-0.0344	-0.0602*
	(0.0294)	(0.0319)	(0.0298)	(0.0316)	(0.0334)	(0.0372)	(0.0247)	(0.0271)	(0.0258)	(0.0275)	(0.0282)	(0.0318)
dumINDUSTRY	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
dumYEAR	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
No. of Obs.	16554	16554	13234	13234	12035	12035	15104	15104	12373	12373	11009	11009
No. Censored Obs.	12047	12047	9537	9537	8449	8449	11007	11007	8902	8902	7737	7737
No. Uncensored Obs.	4507	4507	3697	3697	3586	3586	4097	4097	3471	3471	3272	3272
Wald Chi2 χ^2	973.50***	1567.75***	567.28***	1308.16***	762.87***	1313.54***	621.96***	1072.88***	370.06***	1038.95***	479.43***	926.28***

Our research hypothesis receives strong support. Our evidence supports the idea that the diversification pattern explains part of the diversification discounts/premiums. We find a significant (at the 1% level) and positive effect of the diversification pattern index on excess value, indicating that a pattern of diversification further away from the 'extreme' AiPD profile implies higher excess values. Likewise, as a firm's diversification approaches an OD strategy (as measured by a longer Euclidean distance), diversification becomes a more value-enhancing strategy. These results suggest that a diversification pattern aimed not only at exploiting but also at seeding new opportunities in further businesses enhances a firm's value to a greater extent. Our results are robust to the alternative specifications of the two-dimensional index, the inclusion of industry and year dummies, elimination of extreme excess values, as well as Heckman's ML estimation. Our results also hold when equation [11] is estimated only on a subsample of diversified firms [see **Table 4.8**].

Table 4.8

[Diversification pattern index and Excess Value (Eq. [11]) – Diversified firms subsample]

This table shows the OLS estimations of equation [11] in the subsample of diversified firms. *ExcessValue* is regressed on the *DIVPAT*. *d_num*, $d\_num\_BOT_Q$ and $d\_num\_BOT_{RDsales}$, denote the alternative specifications for the DIVPAT based on the Euclidean distance. Firm size (*LTA*) (and its squared term (*LTA2*)), financial leverage (*LDTA*), profitability (*EBITsales*), level of investment (*CAPEXsales*), industry effect (*dumINDUSTRY*), and time effect (*dumYEAR*) are controlled in all estimations. The F- test contrasts the null hypothesis of no joint significance of the explanatory variables. Standard error is shown in parentheses under coefficients. ****, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Model ExcessValue = f(DIVPAT, control variables)												
	Dependent variable: Excess Value						Dependent variable: Excess Value (without extremes)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
constant	-2.3113***	-2.3997***	-1.8617***	-2.0157***	-2.1733***	-2.2179***	-1.3285***	-1.4385***	-1.0831***	-1.3075***	-1.2476***	-1.3083***
	(0.1235)	(0.1339)	(0.1265)	(0.1356)	(0.1358)	(0.1479)	(0.1115)	(0.1201)	(0.1166)	(0.1234)	(0.1249)	(0.1345)
DIVPAT												
d_num	0.6779***	0.7396***					0.4852***	0.5161***				
	(0.0448)	(0.0466)					(0.0390)	(0.0410)				
$d\_num\_BOT_Q$			0.4258***	0.6776***					0.3503***	0.5574***		
			(0.0428)	(0.0473)					(0.0377)	(0.0421)		
$d\_num\_BOT_{RDsales}$					0.4572***	0.6399***					0.3451***	0.4794***
					(0.0444)	(0.0507)					(0.0387)	(0.0449)
control variables												
LTA	0.3832***	0.3350***	0.3301***	0.2568***	0.4028***	0.3299***	0.1678***	0.1392***	0.1417***	0.0920***	0.1898***	0.1246***
	(0.0397)	(0.0394)	(0.0407)	(0.0394)	(0.0442)	(0.0440)	(0.0352)	(0.0350)	(0.0371)	(0.0357)	(0.0399)	(0.0397)
LDTA	-0.1090	-0.1124	0.0009	-0.0042	-0.0851	-0.0311	-0.1021	-0.1472**	-0.0313	-0.0895	-0.1234*	-0.1220
	(0.0773)	(0.0789)	(0.0773)	(0.0769)	(0.0864)	(0.0883)	(0.0655)	(0.0675)	(0.0676)	(0.0675)	(0.0738)	(0.0759)
EBITsales	0.6158***	0.6824***	0.3787***	0.4692***	0.8678***	0.9266***	0.5491***	0.5974***	0.3274***	0.4053***	0.6830***	0.7263***
	(0.0729)	(0.0718)	(0.0766)	(0.0733)	(0.0897)	(0.0875)	(0.0633)	(0.0631)	(0.0679)	(0.0653)	(0.0777)	(0.0765)
CAPEXsales	0.7187***	1.4143***	0.5890***	1.3033***	0.7393***	1.2952***	0.4392***	0.9111***	0.3896***	0.9480***	0.5471***	0.9071***
	(0.1234)	(0.1429)	(0.1240)	(0.1408)	(0.1366)	(0.1580)	(0.1028)	(0.1214)	(0.1067)	(0.1223)	(0.1150)	(0.1353)
LTA2	-0.0217***	-0.0175***	-0.0183***	-0.0129***	-0.0231***	-0.0175***	-0.0072***	-0.0041	-0.0057**	-0.0016	-0.0091***	-0.0036
	(0.0031)	(0.0031)	(0.0032)	(0.0031)	(0.0035)	(0.0035)	(0.0028)	(0.0027)	(0.0029)	(0.0028)	(0.0031)	(0.0031)
dumINDUSTRY	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
dumYEAR	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
No. of Obs.	4507	4507	3697	3697	3586	3586	4097	4097	3471	3471	3272	3272
F-test	166.36***	22.57***	100.99***	19.05***	134.67***	19.12***	105.03***	15.25***	63.69***	14.78***	81.34***	13.07***
Adjusted-R^2	0.1805	0.2510	0.1396	0.2547	0.1828	0.2613	0.1322	0.1958	0.0978	0.2175	0.1284	0.2053

Table 4.9[61] shows additional sensitivity tests to study the effect of the pattern index on excess value when the commonly studied dimension of diversification scope (proxied by the Herfindahl index $MHERF^m$) is taken into account (eq. [12]). In line with prior literature, our sample also shows a diversification discount, as displayed in columns (1) and (5) of **Table 4.9**. Results concerning the pattern index are robust across all estimations, once again bearing out that the closer a firm's diversification profile is to an OD, the higher the excess value. Interestingly, once the pattern of diversification is accounted for in the regressions, the documented discount becomes a premium, which is statistically significant in regressions where extreme excess values are not excluded (columns (2) to (4)). It appears that the conflicting evidence regarding the impact of diversification on firm value may partly be explained by the fact that prior analyses might be mixing the effects of different dimensions of the diversification strategy, namely scope and diversification pattern. This may require proper separate identification and measurement to investigate the overall impact of diversification more appropriately.

[61] Results in Tables 4.7 and 4.9 are also robust to the alternative Heckman ML approach. Results are available upon request.

Table 4.9
[Diversification pattern index and Excess Value (Eq. [12])
Additional sensitivity tests adding the dimension scope]

This table shows the Heckman second stage estimation by OLS (Heckman's two-step estimator) of equation [12]. The selection equation (column 1) (Table 4.5) models firms' propensity to diversify. *ExcessValue* is regressed on the DIVPAT and *MHERF*. d_num, $d\_num\_BOT_Q$ and $d\_num\_BOT_{RDsales}$, denote the alternative specifications for the DIVPAT based on the Euclidean distance. *MHERF* represents the Herfindahl index and measures the degree of diversification. Firm size (*LTA*) (and its squared term (*LTA2*)), financial leverage (*LDTA*), profitability (*EBITsales*), level of investment (*CAPEXsales*), industry effect (*dumINDUSTRY*), and time effect (*dumYEAR*) are controlled in all estimations. The Inverse Mills Ratio ((λ_i) is included as an additional regressor to correct potential self-selection bias in the sample. The Wald test contrasts the null hypothesis of no joint significance of the explanatory variables. Standard error is shown in parentheses under coefficients. ****, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	Model ExcessValue = f(DIVPAT, DIVER, control variables)							
	Dependent variable: Excess Value				Dependent variable: Excess Value (without extremes)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
constant	-1.6737***	-2.2248***	-1.9293***	-2.0420***	-0.9170***	-1.3141***	-1.2282***	-1.2521***
	(0.1433)	(0.1437)	(0.1454)	(0.1612)	(0.1252)	(0.1276)	(0.1312)	(0.1449)
DIVPAT								
d_num		0.8517***				0.5548***		
		(0.0533)				(0.0468)		
$d\_num\_BOT_Q$			0.8084***				0.6170***	
			(0.0561)				(0.0500)	
$d\_num\_BOT_{RDsales}$				0.7790***				0.5265***
				(0.0595)				(0.0527)
Degree of diversification (DIVER)								
MHERF	-0.3590***	0.1723**	0.2401***	0.2544***	-0.3180***	0.0151	0.0816	0.0805
	(0.0662)	(0.0724)	(0.0746)	(0.0838)	(0.0567)	(0.0624)	(0.0656)	(0.0730)
control variables								
LTA	0.3530***	0.3066***	0.2300***	0.2938***	0.1462***	0.1279***	0.0806**	0.1146***
	(0.0402)	(0.0393)	(0.0393)	(0.0438)	(0.0354)	(0.0349)	(0.0355)	(0.0395)
LDTA	-0.1299	-0.1326*	-0.0148	-0.0490	-0.1592**	-0.1614**	-0.0986	-0.1284*
	(0.0804)	(0.0782)	(0.0760)	(0.0873)	(0.0681)	(0.0670)	(0.0668)	(0.0753)
EBITsales	0.6809***	0.7056***	0.4902***	0.9804***	0.5803***	0.6044***	0.4138***	0.7475***
	(0.0733)	(0.0716)	(0.0728)	(0.0873)	(0.0637)	(0.0628)	(0.0648)	(0.0764)
CAPEXsales	1.7518***	1.5499***	1.4261***	1.4603***	1.0960***	0.9828***	1.0268***	0.9615***
	(0.1471)	(0.1441)	(0.1426)	(0.1601)	(0.1238)	(0.12222)	(0.1236)	(0.1366)
LTA2	-0.0176***	-0.0166***	-0.0119***	-0.0163***	-0.0036	-0.0039	-0.0014	-0.0033
	(0.0032)	(0.0031)	(0.0031)	(0.0034)	(0.0028)	(0.0027)	(0.0028)	(0.0031)
Inverse Mills Ratio (λ_i)	-0.0487	-0.1647***	-0.1306***	-0.1840***	-0.0119	-0.0906***	-0.0853***	-0.0625**
	(0.0318)	(0.0319)	(0.0317)	(0.0372)	(0.0267)	(0.0271)	(0.0276)	(0.0319)
dumINDUSTRY	YES	YES	YES	YES	YES	YES	YES	YES

dumYEAR	YES	YES	YES	YES		YES	YES	YES	YES
No. of Obs.	16554	16554	13234	12035		15104	15104	12373	11009
No. Censored Obs.	12047	12047	9537	8449		11007	11007	8902	7737
No. Uncensored Obs.	4507	4507	3697	3586		4097	4097	3471	3272
Wald Chi2 χ^2	1256.87***	1574.83***	1321.49***	1325.31***		904.47***	1072.92***	1040.78***	927.73***

Finally, with regard to our control variables, only *LTA*, *EBITsales*, and *CAPEXsales* show any statistical significance above the 1% level in all estimations, all of them displaying a positive impact on excess value (consistent with prior studies). The Wald test indicates that variables display joint significance in all regressions. In the vast majority of regressions, the λ coefficient contains statistical significance, even above 1% in certain cases, thus confirming the existence of self-selection bias in the sample.

4.4. DISCUSSION AND CONCLUSION

The present chapter goes a step ahead into the diversification-value relationship from an RO approach. As the creation and evolution of growth options are intrinsically linked to firm-specific capabilities, this RO perspective contributes to overcoming the traditional discount/premium dilemma and examining the nature of diversification *per se* more closely. The various ways of handling growth opportunities along the diversification strategy translate into different diversification profiles.

We investigate whether the pattern of diversification, which entails a different configuration of the firm's growth options portfolio, accounts for part of the diversification discounts/premiums. We perform our analysis on a sample of U.S. firms from 1998 to 2010. Our results confirm that how the firm diversifies is by no means a trivial issue when determining diversification value outcomes.

This evidence concurs with prior literature (such as Teplensky *et al.* (1993), Chang (1995), Williamson (2001), Miller (2006) or Borghesi *et al.* (2007)) and reaffirms the central role played by growth opportunities in diversification premiums/discounts. We show that more flexible handling of this strategy by also embarking on successive minor investments to open up new opportunities in further businesses enhances a firm's value, thereby contributing to the success of this strategy. These findings support the basic premise by Williamson (2001) concerning the relevance of creating strategic options for the future. Results reveal that firms are likely to enhance their value if they spread their current capabilities beyond their core businesses by engaging in underdeveloped participations in new industries for strategic or explorative purposes.

Our results also concur with works such as Andreou and Louca (2010), who document a premium in firms which diversify a number of times. This diversification profile may be closer to an options-based strategy, which continuously reconfigures the firm's diversification profile by multiple small-sized investments in other businesses. Such an investment path maximizes learning and promotes flexibility. This investment logic is in line with RO rationale, and emphasizes the importance of having *"a foot in the door*" to access future investment opportunities, enriching the firm's set of growth options, whilst at the same time limiting downside risk by delaying full commitment of resources in an effort to capitalise on uncertainty.

Several important contributions for diversification literature and application of the RO approach to strategic decision analysis emerge from our empirical findings. First, we offer a different approach to diversification. We delve more deeply into this growth strategy from RO logic, perceiving it as the purchase and subsequent exercise of growth options. Apart from the commonly studied dimensions of diversification (scope and relatedness), we suggest considering an additional dimension, the diversification pattern, since this might moderate the diversification-value linkage. In particular, our study defines diversification profiles on the basis of *how* diversification investments are carried out by the company. We identify two contrasting diversification paths, ranging from an assets-in-place diversification to an options-driven one, and we show the latter to be the more value-enhancing. We offer updated evidence on a post-1997 sample, after implementation of the new SFAS 131 reporting standard in the U.S.

These findings have far-reaching consequences. They tie in with recent streams of research which advocate the endogenous nature of the diversification decision, thus making value creation or destruction contingent on firm-specific characteristics rather than on generic characteristics attached to the strategy or the firms undertaking it. We provide evidence that diversification strategy is neither good nor bad intrinsically. Rather, our findings suggest that when exploring the *diversification puzzle*, what seems important is not only how much to diversify (scope) and where (relatedness between businesses), but also "how". Interestingly, our study sheds light on the need to explore further dimensions of diversifications. In this chapter, we study the diversification pattern and find that it accounts for the diversification discount/premium. Failing to consider different sides in this strategy may have given rise to such conflicting evidence in prior literature as a result of mixing the different dimensions of diversification, each of which has a different impact on a firm's value.

Furthermore, many papers call for the need to investigate further the validity of real options for strategic analysis in an effort to advance theory (Reuer and Tong, 2007). This study contributes to filling the gap in empirical works which apply the RO approach to strategy. On the RO basis, we articulate our research hypothesis, linking patterns of diversification and firm value, and seek to proxy for the diversification profiles drawn on the way growth opportunities and assets-in-place are handled. To the best of our knowledge, this constitutes the first attempt to capture and measure this dimension of corporate diversification. We develop a two-dimensional index based on the notion of *profile deviation* (Venkatraman, 1989), which has been applied in other areas in strategy.

This study has significant implications for business management since we show managers how important the way in which such a strategy is implemented may prove to be vis-à-vis value creation. In line with Williamson (2001), we advocate proactive managerial behaviour and stress the vital importance of combining expansion in a firm's core segments with the simultaneous opening of fresh strategic options in new businesses. Our results reveal that the pattern of diversification has a significant impact on a firm's market value.

Chapter 5

How is Corporate Diversification Coded into Real Option Language? The interaction between growth options, diversification scope, and relatedness

This chapter constitutes the empirical analysis of our model 3 (growth opportunities model), based on hypotheses 4 to 6. The goal of this chapter is to investigate the impact of corporate diversification on the firm's growth opportunities. Current inquiry has mostly addressed diversification at the one-dimensional level. Yet, insufficient attention has been paid to the nature of the diversification strategy itself, involving multiple dimensions combination of which may drive the divergences in value outcomes across firms. We aim to make a contribution to a multidimensional conception of corporate diversification, our arguments being developed on the basis of an RO line of reasoning. We join the thus far scant research grappling with the joint impact of several diversification dimensions, such as Simmonds (1990) who studies the combined effect of relatedness and mode of diversification (mergers and acquisitions, versus internal development). In our study, we deal with two dimensions of this strategy, namely level of diversification (scope) and relatedness between segments (related versus unrelated diversification). We assess how relatedness, both individually and jointly with the dimension scope, interacts with the firm's growth options portfolio. Additionally, we study how the impact of diversification on the growth options portfolio may be moderated by pre-emption threats.

The remainder of the chapter is organized as follows. The first section describes our sample, variables, models, and econometric approach. The following section presents our empirical findings, while the final section discusses the results and conclusions.

5.1. DATA AND RESEARCH METHODS

5.1.1. Data sources and sample selection

As in chapters 3 and 4, we start from an unbalanced panel sample of public U.S. firms during the period 1998-2010 (see section 3.1.1 for a more detailed explanation). Similarly, we apply Berger and Ofek's (1995) sample selection criteria to build a dataset consistent with prior diversification research and thereby ensure the comparability of our results. Finally, an additional restriction comes from the estimation methodology we use to estimate our empirical models: the generalized method of moments (GMM). This requires availability of data for at least four consecutive years per firm to test for the lack of second-order residual serial correlation, since GMM is based on this assumption. The final sample for estimation purposes comprises 5,569 firm-year observations corresponding to 813 companies.

5.1.2. Variables

In all models, our dependent variable is the firm's growth options value. More specifically, we define it in relative terms as a firm's growth options value ratio to total firm value (growth options ratio, denoted by *GOR*). *GOR* is proxied by either the market-to-book assets ratio (Adam and Goyal, 2008) or Tobin's Q (Cao *et al.*, 2008), calculated as:

$$MBAR = \frac{share\_price * common\_shares\_outstanding + preferred\_stock + current\_liabilities + long\_term\_debt - deferred\_taxes\_and\_investment\_tax\_credit}{total\_assets}$$

$$Q = \frac{share\_price * common\_shares\_outstanding + preferred\_stock + current\_liabilities - current\_assets + long\_term\_debt}{total\_assets}$$

We examine the effect of the two dimensions of diversification (degree of diversification and relatedness between segments) on *GOR*. We classified a firm as diversified if it has more than one segment at the 4-digit SIC level, and otherwise as a unisegment company. Degree of diversification is captured by three alternative measures to test the robustness of our empirical findings: the number of businesses, the Herfindahl index (Hirschman, 1964), and the entropy measure (Jacquemin and Berry, 1979). The former is the simple count of the number of segments at the 4-digit SIC code level (*NUM_4d*). The Herfindahl index (*HERF_4d*) is computed as:

$$\text{HERF\_4d} = 1 - \sum_{s=1}^{n} P_s^2$$

where 'n' is the number of a firm's segments (at the 4-digit SIC code level) and 'P_s' the proportion of the firm's sales from business 's'. Focused firms will show a *HERF_4d* equal to zero, and the closer this index is to one, the higher the degree of diversification. Finally, the entropy measure (*TENTROPY*) is calculated as follows:

$$\text{TENTROPY} = \sum_{s=1}^{n} P_s * \ln(\frac{1}{P_s})$$

where 'P_s' is the proportion of a firm's sales in business 's' for a corporation with 'n' different 4-digit SIC segments. The higher the *TENTROPY*, the higher the degree of diversification, although this index has no upper boundary.

The relatedness dimension can only be defined for firms with at least two businesses (diversified firms). We base our measures of relatedness on SIC classes given their broad use to approximate the degree of similarity between sectors. Generally, the literature considers a multisegment company as related diversified when its divisions belong to the same 2-digit SIC industries. Our relatedness measure is derived from the *TENTROPY* defined above, which considers diversification across different levels of industry aggregation and within them. Following Jacquemin and

Berry (1979), *TENTROPY* is split into two components: unrelated entropy (*UNRELATED*) and related entropy (*RELATED*), *UNRELATED* being defined as:

$$\text{UNRELATED} = \sum_{r=1}^{m} P_r * \ln\left(\frac{1}{P_r}\right)$$

where 'P_r' is the proportion of a firm's sales in business '*r*' for a corporation with '*m*' different 2-digit SIC segments. Next, our proxy for relatedness *RELATED* is calculated by subtracting *UNRELATED* from *TENTROPY*:

$$\text{RELATED} = \text{TENTROPY} - \text{UNRELATED}$$

In addition, we analyze the moderating effect of pre-emption on the effect that diversification has on *GOR*. Following Folta and Miller (2002b: 83), the risk of pre-emption is approximated by the number of rivals actively operating in the same product domain. We gather yearly data on total U.S. firms by NAICS codes from the U.S. Census Bureau and then match NAICS codes with SIC codes. Our variable to proxy risk of pre-emption is *PREEMPT*, calculated as the natural logarithm of the number of firms operating in the same 2-digit SIC code industry as the core business of the corresponding firm.

Additionally, we employ a number of control variables which may also affect our dependent variable *GOR*. Following prior literature, we control for size (Andrés *et al.*, 2005), leverage (Myers, 1977), industry, and year. Size (*LTA*) is estimated by the natural logarithm of the book value of total assets. Leverage (*DTA*) is measured by the ratio of total debt over total assets. We include a set of dummy variables to control for the industry effect[62] (*dumINDUSTRY*) and the year effect (*dumYEAR*).

[62] Major groups of industries as defined by the U.S. Department of Labor. The official website provides the matching of these major groups to the 2-digit SIC code classification: http://www.osha.gov/pls/imis/sic_manual.html. See Table A.1 in the Appendix. The industry dummy *j*

Table 5.1 displays a summary of the variables used in this study:

Table 5.1
[Description of the variables]

This table contains a summary of the variables used in the analysis. The first column indicates the label of each variable, the second column provides the definition of the variable, and the third column offers the source from which that definition is obtained.

VARIABLE	DEFINITION	SOURCE
Growth option value to firm total value (GOR)		
MBAR	The market to book assets ratio.	Adam and Goyal (2008)
Q	Tobin's Q	Cao *et al.* (2008)
Degree of diversification (DIVER)		
NUM_4d	Number of business segments at the 4-digit SIC code level.	
NUM_2d	Number of business segments at the 2-digit SIC code level.	
HERF_4d	Herfindahl index at the 4-digit SIC code level. $HERF = 1 - \sum_n P_i * W_i$	Hirschman (1964)
HERF_2d	Herfindahl index at the 2-digit SIC code level.	Hirschman (1964)
TENTROPY	Total entropy index. $TotalEntropy = 1 - \sum_n P_i * ln(\frac{1}{P_i})$	Jacquemin and Berry (1979)
Relatedness		
RELATED	Related entropy index	Jacquemin and Berry (1979)
Control variables		
PREEMPT	Risk of preemption: natural logarithm of the no. of firms operating in the same 2-digit SIC code as the firm core business.	Folta and Miller (2002b)
DTA	The ratio of total debt with cost to total assets.	Andrés *et al.* (2005)
LTA	Natural log of the book value of assets.	Campa and Kedia (2002); Andrés *et al.* (2005)
dumIndustries	Nine major divisions (excluding the financial division) → eight	The United States Department of Labour

(j=1,…, 8) takes 1 if the firm's core business operates in industry j and zero otherwise. The financial industry has been excluded as stated earlier.

	dummy variables.
dumYears	13 years (1998-2010 period) → twelve dummy variables.

Table 5.2 shows full-period descriptive statistics for our variables in the final sample. As shown in panel A, sample firms display a moderate diversifying profile. The sample mean of *NUM_4d* (*HERF_4d*) is two segments (0.2781). As observed, the level of data disaggregation (either at the 4-digit or 2-digit SIC code level) affects the number of segments and the Herfindhal diversification measures. *NUM_4d* and *HERF_4d* increase by about 16% and 27% (19% and 26% in the diversified firms subsample) respectively, in comparison to computation at the 2-digit SIC code level (*NUM_2d* and *HERF_2d*).

Table 5.2
[Summary statistics of variables (1998-2010)]

This table displays descriptive statistics of the variables involved in our models for the full sample (5,569 firm-year observations) and for the diversified firms subsample (3,817 firm-year observations). *MBAR* (the market to book assets ratio) and *Q* (Tobin's Q) are the two different proxies for growth opportunities. *NUM_4d* (number of business segments at the 4-digit SIC code level), *NUM_2d* (number of business segments at the 2-digit SIC code level), *HERF_4d* (the Herfindahl index at the 4-digit SIC code level), *HERF_2d* (the Herfindahl index at the 2-digit SIC code level), and *TENTROPY* (the Entropy index) are alternative measures for the level of diversification. *RELATED* (Related Entropy) captures relatedness between segments. Control variables: *PREEMPT* (risk of pre-emption), *LTA* (size), and *DTA* (financial leverage). Figures are expressed in million US$

Variable	N	Mean	Median	STD	Min	Max	1st quartile	3rd quartile
Panel A: FULL SAMPLE								
Growth opportunities								
MBAR	5,569	2.3624	1.5129	7.0633	0.1391	468.1636	1.0758	2.4533
Q	5,569	1.9064	1.1122	7.0425	0.0018	467.2499	0.6494	2.0152
Degree of diversification								
NUM_4d	5,569	2.0979	2	0.9761	1	7	1	3
NUM_2d	5,569	1.8054	2	0.7319	1	6	1	2
HERF_4d	5,569	0.2781	0.2847	0.2393	0	0.8309	0	0.4859
HERF_2d	5,569	0.2197	0.1860	0.2133	0	0.8004	0	0.4218
TENTROPY	5,569	0.4583	0.4701	0.4028	0	1.8582	0	0.6904
Control variables								
PREEMPT	5,569	10.3353	9.9283	1.5393	4.3307	13.1404	9.2810	11.2490
LTA	5,569	6.8169	6.8026	2.0335	1.7710	12.5269	5.2285	8.3207
DTA	5,569	0.2328	0.2278	0.1713	0	0.8393	0.0860	0.3487
Panel B: DIVERSIFIED FIRMS SUBSAMPLE								
Growth opportunities								
MBAR	3,817	2.2077	1.5018	2.5697	0.2600	78.1077	1.0820	2.3916
Q	3,817	1.7519	1.0851	2.5427	0.0018	77.3574	0.6572	1.9461
Degree of diversification								
NUM_4d	3,817	2.5481	2	0.8167	2	7	2	3
NUM_2d	3,817	2.1362	2	0.6217	1	6	2	2
HERF_4d	3,817	0.3930	0.4264	0.1908	0.0002	0.8309	0.2452	0.5094
HERF_2d	3,817	0.3122	0.3428	0.1903	0	0.8004	0.1460	0.4696
TENTROPY	3,817	0.6480	0.6415	0.3299	0.0010	1.8582	0.4180	0.8542
Relatedness								
RELATED	3,817	0.1520	0	0.2651	0	1.3594	0	0.2581
Control variables								
PREEMPT	3,817	10.3590	10.1859	1.4906	4.5539	13.1404	9.3248	11.0976
LTA	3,817	6.7899	6.8272	1.9532	1.7710	12.5269	5.2810	8.1419
DTA	3,817	0.2317	0.2265	0.1657	0	0.8380	0.0950	0.3443

5.1.3. Empirical models and robustness checks

To test hypothesis 4, we estimate the following empirical model:

$$MBAR_{it} = \alpha + \beta_1 RELATED_{it} + \beta_2 RELATED^2_{it} + \beta_3 LTA_{it} + \beta_4 DTA_{it} + \beta_5 dumINDUSTRY_{it} + \beta_6 dumYEAR_{it} + \eta_i + \varepsilon_{it} \quad [1]$$

where i identifies each firm, t indicates the year of observation (from 1 to 13), α and β_p are the coefficients to be estimated, η_i represents the firm-specific effect accounting for unobservable heterogeneity, and ν_{it} is the random disturbance for each observation.

To explore the moderating effect of the degree of diversification (hypothesis 5) on the relationship between *RELATED* and *MBAR* estimated in the previous equation, we use the regression specification below:

$$MBAR_{it} = \alpha + \beta_1 RELATED_{it} + \beta_2 RELATED^2_{it} + \beta_3 RELATED_{it} *dumNUM + \beta_4 RELATED^2_{it} *dumNUM + \beta_5 dumNUM + \beta_6 LTA_{it} + \beta_7 DTA_{it} + \beta_8 dumINDUSTRY_{it} + \beta_9 dumYEAR_{it} + \eta_i + \varepsilon_{it} \quad [2]$$

where i identifies each firm, t indicates the year of observation (from 1 to 13), α and β_p are the coefficients to be estimated, η_i represents the firm-specific effect accounting for unobservable heterogeneity, and ν_{it} is the random disturbance for each observation. The moderating effect of the degree of diversification is estimated by interacting *dumNUM* with *RELATED* and its squared term. *dumNUM* is a dummy variable which equals 1 if *NUM_4d* is above the sample mean, and null value otherwise. As a result, the nonlinear effect of *RELATED* on *MBAR* is captured by β_2 for below-mean diversified firms (dumNUM=0), and by ($\beta_2 + \beta_4$) for above-mean diversified firms (dumNUM=1). As robustness checks, we estimate the model replacing *dumNUM* by alternative proxies for diversification: *dumHERF* and *dumTENTROPY*. *dumHERF* is a dummy variable which equals 1 if the observation shows *HERF_4d* above the sample mean, and null value otherwise. Similarly, *dumTENTROPY* is a dummy variable which equals 1 if the observation has *TENTROPY* above the sample mean, and null value otherwise.

The starting point of our hypothesis 6 is based on the empirical evidence found in chapter 3 which reports a U-form relationship between the level of diversification and GOR. We replicate the analyses by estimating the following model:

$$MBAR_{it} = \alpha + \beta_1 NUM\_4d_{it} + \beta_2 (NUM\_4d)^2_{it} + \beta_3 LTA_{it} + \beta_4 DTA_{it} + \beta_5 dumINDUSTRY_{it} + \beta_6 dumYEAR_{it} + \eta_i + \varepsilon_{it} \quad [3]$$

where i identifies each firm, t indicates the year of observation (from 1 to 13), α and β_p are the coefficients to be estimated, η_i represents the firm-specific effect accounting for unobservable heterogeneity (time constant), and ν_{it} is the random disturbance for each observation. We perform robustness checks by approximating the degree of diversification by either *NUM_4d*, *HERF_4d* or *TENTROPY*. Additional robustness analyses are implemented by computing the number of a firm's segments and the Herfindahl index with 2-digit SIC code business segment data (variables denoted by *NUM_2d* and *HERF_2d*).

Then, we test our sixth hypothesis by introducing the moderating effect of *PREEMPT* on the level of diversification. Thus, equation [3] is extended as follows:

$$MBAR_{it} = \alpha + \beta_1 NUM\_4d_{it} + \beta_2 (NUM\_4d)^2_{it} + \beta_3 NUM\_4d*PREEMPT + \beta_4 (NUM\_4d)^2*PREEMPT + \beta_5 PREEMPT + \beta_6 LTA_{it} + \beta_7 DTA_{it} + \beta_8 dumINDUSTRY_{it} + \beta_9 dumYEAR_{it} + \eta_i + \varepsilon_{it} \quad [4]$$

where i identifies each firm, t indicates the year of observation (from 1 to 13), α and β_p are the coefficients to be estimated, η_i represents the firm-specific effect accounting for unobservable heterogeneity (time constant), and ν_{it} is the random disturbance for each observation. The multiplicative term $(NUM\_4d)^2$*PREEMPT captures the existence of a moderating effect in the quadratic relationship linking *NUM_4d* and *MBAR*. If it takes the same sign as the individual squared term (β_2 coefficient), it accentuates the curvilinear relationship. Otherwise, it attenuates it. We also verify the robustness of the results of equation [4] by measuring the degree of diversification (proxied by *NUM_4d* in the baseline model) by either *HERF_4d* or *TENTROPY*.

Additionally, all models are re-estimated by using an alternative proxy for GOR as the dependent variable, Tobin's Q (*Q*), to evaluate the robustness of our empirical findings. The models involving *RELATED* (equations [1] and [2]) are estimated on the diversified firms subsample since the relatedness dimension can only be defined for firms with at least two segments.

Table 5.3 presents the correlation matrix for our variables. As shown, degree of diversification and relatedness are two dimensions which have a correlation around 0.5 (0.5058 between *RELATED* and *NUM_4d*; 0.4696 between *RELATED* and *HERF_4d*; and 0.5226 between *RELATED* and *TENTROPY*), statistically significant at 1% level. Such relatively high correlations might drive multicollinearity problems[63] when introducing the diversification and relatedness proxies together with too many interaction effects built on these dimensions. Thus, we test our hypotheses individually and do not perform any estimation of a full model introducing all the hypothesized effects jointly. To test hypothesis 5, which estimates the moderating effect of the level

[63] Multicollinearity may amplify endogeneity bias, thus exacerbating the invalidity of the results (Roodman, 2008: 17).

of diversification on relatedness, we build dummy variables to identify high and low diversifiers (*dumNUM*, *dumHERF*, *dumTENTROPY*).

Table 5.3
[Correlation matrix]

This table lists pair-wise correlations for our study variables. *MBAR* (the market-to-book assets ratio) and *Q* (Tobin's Q) are the two different proxies for growth opportunities. *NUM_4d* (number of business segments at the 4-digit SIC code level), *HERF_4d* (the Herfindahl index at the 4-digit SIC code level), and *TENTROPY* (the Entropy index) are alternative measures for the level of diversification. *RELATED* (Related Entropy) captures relatedness between segments. Control variables: *PREEMPT* (risk of pre-emption), *LTA* (size), and *DTA* (financial leverage). ****, ** and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Note: Correlations between the variable *RELATED* with each of the remaining variables are computed on the diversified firms subsample (3,817 firm-year observations). The remaining correlations refer to the full sample (5,569 firm-year observations).

	MBAR	Q	NUM_4d	HERF_4d	TENTROPY	RELATED	PREEMPT	LTA	DTA
MBAR	1.0000								
Q	0.9995***	1.0000							
NUM_4d	-0.0278**	-0.0274**	1.0000						
HERF_4d	-0.0335**	-0.0332**	0.8159***	1.0000					
TENTROPY	-0.0320**	-0.0316**	0.8920***	0.9842***	1.0000				
RELATED	0.0202	0.0223	0.5058***	0.4696***	0.5226***	1.0000			
PREEMPT	0.0073	0.0023	0.0090	-0.0245*	-0.0208	0.0263	1.0000		
LTA	-0.0195	-0.0070	0.1035***	0.0553***	0.0829***	0.2460***	-0.1930***	1.0000	
DTA	-0.1049***	-0.0906***	-0.0033	-0.0017	-0.0014	-0.0069	-0.0653***	0.1877***	1.0000

5.1.4. Econometric approach and estimation strategy

We apply panel data methodology to address two potential problems: the existence of an unobservable individual heterogeneity effect and the presence of endogeneity. The former refers to certain firm-specific time-constant characteristics that also determine the value of the firm's set of growth opportunities. For instance, characteristics such as the firm's culture or managerial team may prove a crucial factor in the option generation process such as the sense of shadow options (Bowman and Hurry, 1993). We model such an individual effect by including the term η_i in all equations.

Secondly, as documented in prior studies (such as Campa and Kedia, 2002; Villalonga, 2004b), one key concern in diversification models is endogeneity. The causal relation between the diversification dimensions and GOR may not only run in the direction posited, but also in both directions. The firm's growth options portfolio may also influence the diversification decision since the firm is likely to build its strategy upon the type and breadth of investment opportunities available. To address this problem, we use the two-step system generalized method of moments (GMM) proposed by Blundell and Bond (1998). This is an instrumental variable estimator which uses the lags of explanatory variables as instruments. This estimator imposes further restrictions on the initial conditions process to improve the efficiency of the standard first-differenced GMM estimator (Blundell and Bond, 1998), which is subject to a weak instrument problem as a result of the low correlation between the instruments and the first-differenced endogenous variables (Alonso-Borrego and Arellano, 1999).

Below all the estimations, we include the Wald test which evaluates the joint significance of all independent variables. Additionally, we report two model specification tests for the validity of the GMM estimations. The GMM estimator is based on two assumptions: absence of second-order serial correlation and lack of correlation between instruments and residuals. First, Arellano and Bond's (1991) m_2 statistic[64] tests the absence of second degree serial correlations in the first-difference residuals. Since the GMM estimator uses lags as instruments under the assumption of white noise errors, it would lose its consistency if the errors were serially correlated (Arellano and Bond, 1991). Secondly, the Hansen J-test of over-identifying restrictions (Hansen, 1982), χ^2 distributed, evaluates the instrument exogeneity assumption. The null hypothesis is the joint validity of all the instruments, thus meaning they do not correlate with the residuals.

The conventional method for identifying U-form relationships draws on the inclusion of a quadratic term in the model (as specified in equations [1] to [4]). A nonlinear relationship is documented if that term is statistically significant and the inflection point of the curve lies on the data range. However, recent studies (Blanchflower, 2007; Lind and Mehlum, 2010) cast doubt on the sufficiency of this criterion. In cases when the true relationship is convex but monotone over relevant data values, the quadratic specification of the model can erroneously lead to an extreme point being derived and thus to the conclusion that there is a quadratic relationship (Lind and Mehlum, 2010: 110).

To assess further the validity of the inverted U-shape relationship between *RELATED* and *MBAR*, and the U-shape relationship between *NUM_4d* and *MBAR*, we check the robustness of our estimation results by performing Sasabuchi's (1980) t-test[65] which tests the significance of non-linear relationships. To test the presence of an

[64] We also report the m_1 statistic which tests the first-order residual serial correlation, although this correlation does not lead to invalid results.

[65] This test was computed using the ado-file utest for STATA developed by Lind and Mehlum, available at http://econpapers.repec.org/software/bocbocode/s456874.htm

inverse U-shape relationship (U-shape relationship), Sasabuchi tests the composite null hypothesis that the relationship is decreasing (increasing) at the left hand side of the interval and/or is increasing (decreasing) at the right hand side[66]. Moreover, we estimate the extreme point of the curve and compute its confidence intervals based on Fieller's (1954) standard error method (Lind and Mehlum, 2010). The extreme value must fall within the limits of the data.

5.2. EMPIRICAL FINDINGS

Below, we provide an overview of our empirical findings. Both the Hansen and m_2 tests reported below all the estimations support the validity of our GMM estimations. The Hansen J-statistic is not statistically significant and does not reject the null hypothesis of absence of correlation between the instruments and the residuals, thus confirming the instruments are valid. Furthermore, the m_2 statistic fails to reject the null hypothesis of no second-order residual serial correlation. The statistical significance (above the 1% level) of the Wald test indicates that the variables are jointly significant.

In addition, in all specifications models, *LTA* and *DTA* are included as controls. When significant, their signs are robust across all estimations. *LTA* is positively associated with the growth opportunity dependent variables *MBAR* and *Q*, consistent with prior literature. In line with Myers' (1977) seminal paper, *MBAR* and *Q* display an inverse relationship with a firm's leverage (*DTA*).

[66] Computing this test also allows us to obtain the estimated slopes for the lower and upper bound of the curves so as to subsequently test the moderating effects.

5.2.1. Relatedness and GOR

This section presents the results concerning how the relatedness dimension contributes to configuring the firm's portfolio of growth opportunities. **Table 5.4** contains the estimations results of the effect of relatedness on GOR (equation [1]).

Table 5.4

[Relatedness and growth opportunities, and the moderating effect of diversification (eq. [1] and [2])]

This table reports the two-step GMM system estimations of equations [1] and [2]. Different proxies for growth options ratio to the firm's total value (GOR) (either *MBAR* (the market-to-book assets ratio), or *Q* (Tobin's Q)) are regressed on the relatedness. Relatedness between segments is proxied by *RELATED* (Related Entropy index). When estimating the moderating effects, dummy variables are used to capture high and low levels of diversification (*dumNUM*, *dumHERF* and *dumTENTROPY*). *dumNUM* is a dummy variable which equals 1 if the observation display *NUM_4d* above the sample mean, and null value otherwise. *dumHERF* is a dummy variable which equals 1 if the observation shows *HERF_4d* above the sample mean, and null value otherwise. Similarly, *dumTENTROPY* is a dummy variable which equals 1 if the observation exhibits *TENTROPY* above the sample mean, and null value otherwise. Firm size (*LTA*), financial leverage (*DTA*), industry effect (*dumINDUSTRY*) and time effect (*dumYEAR*) are controlled in all estimations. The Wald test contrasts the null hypothesis of no joint significance of the explanatory variables. m_1 and m_2 are tests for no first-order and second-order serial correlation, respectively, in the first difference residuals. The Hansen J-statistic is the test of over-identifying restrictions. The Hansen test is distributed as χ^2-(degrees of freedom in parentheses). Standard error is shown in parentheses under coefficients. ****, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.
In the bottom part of the table, some additional tests of an inversely U-shaped relationship between GOR and relatedness are offered.

	Dependent variable: MBAR					Dependent variable: Q				
	Direct effects	Non linear effects	Moderating effects			Direct effects	Non linear effects	Moderating effects		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Constant	3.5462*** (0.2907)	3.0807*** (0.3398)	3.0531*** (0.3022)	3.8692*** (0.1939)	3.0758*** (0.2980)	2.7716*** (0.3204)	2.2916*** (0.3294)	3.1253*** (0.1738)	3.1490*** (0.1305)	2.2632*** (0.2854)
Direct effect										
RELATED	0.7501*** (0.1685)	1.0849** (0.4502)	8.1877*** (1.2534)	5.8968*** (0.6302)	8.6964*** (1.1184)	0.5651*** (0.1704)	0.9840** (0.4479)	5.8370*** (0.3715)	4.1170*** (0.1422)	8.4595*** (1.0462)
Non linear effects										
RELATED^2		-1.2886*** (0.5011)	-10.2397*** (1.7458)	-8.1768*** (1.0457)	-12.7229*** (1.7746)		-1.3925*** (0.5033)	-7.6579*** (0.5035)	-6.3748*** (0.2867)	-12.0714*** (1.7199)
Moderation effects										
RELATEDx dumNUM			-6.4806*** (1.4620)					-2.1477*** (0.5833)		
RELATED^{2}x dumNUM			9.0584*** (1.8079)					4.2450*** (0.6375)		
RELATEDx				-4.0803***					-3.1283***	

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
dumHERF				(0.6508)					(0.1743)	
RELATED²x dumHERF				6.6786***					5.3141***	
				(1.0967)					(0.2960)	
RELATEDx dumTENTROPY					-8.2022***					-8.0975***
					(1.162)					(1.1318)
RELATED²x dumTENTROPY					12.1920***					11.5234***
					(1.8779)					(1.8268)
Control variables										
dumNUM			-0.2870					-0.8711***		
			(0.2155)					(0.1200)		
dumHERF				-0.7430***					-0.6293***	
				(0.0828)					(0.0426)	
dumTENTROPY					-0.4428***					-0.4165***
					(0.1635)					(0.1540)
LTA	-0.0007	0.0397	0.0491	-0.0151	0.0608	0.0683	0.0801*	0.0398***	0.0543***	0.1084***
	(0.0410)	(0.0476)	(0.0401)	(0.0254)	(0.0381)	(0.0446)	(0.0456)	(0.0135)	(0.0126)	(0.0360)
DTA	-3.5530***	-2.9870***	-3.3008***	-3.4801***	-2.9535***	-3.5971***	-2.5007***	-3.7526***	-3.4764***	-2.7549***
	(0.2541)	(0.4528)	(0.3622)	(0.2223)	(0.3233)	(0.3130)	(0.4415)	(0.1526)	(0.1278)	(0.2777)
dumINDUSTRY	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
dumYEAR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	3,817	3,817	3,817	3,817	3,817	3,817	3,817	3,817	3,817	3,817
Wald test	1063.29***	412.77***	1016.80***	109618.76***	1307.17***	779.66***	394.97***	188951.43***	6.55e+06***	1513.88***
m_1	-2.38**	-2.38**	-2.44**	-2.62***	-2.40**	-2.40**	-2.39**	-2.51**	-2.59***	-2.40**
m_2	0.08	0.03	-0.12	0.10	-0.57	0.14	0.08	-0.04	0.16	-0.57
p-value m_2 test	0.934	0.977	0.907	0.922	0.567	0.892	0.936	0.970	0.871	0.571
Hansen test	219.71	145.38	143.56	245.44	146.58	186.89	145.35	245.00	298.63	156.82
	(219)	(139)	(146)	(223)	(160)	(186)	(139)	(223)	(279)	(160)
p-value Hansen test	0.474	0.338	0.542	0.145	0.769	0.468	0.339	0.149	0.200	0.556
Sasabuchi-test of inverse U-shape in relatedness	--	2.41***	--	--	--	--	2.20**	--	--	--
Estimated extreme point	--	0.4210	--	--	--	--	0.3533	--	--	--
95% confidence interval (CI)- Fieller method	--	[0.2190; 0.6537]	--	--	--	--	[0.1059; 0.4822]	--	--	--

Columns (1) and (6) offer a test for linear effects. We find that *RELATED* has a positive and significant impact (above the 1% level) on GOR, proxied either by *MBAR* or *Q*. Subsequently, we extend the model by including the squared term of *RELATED* to test the nonlinear relationship. The evidence from **Table 5.4** clearly suggests an inverted U-form relationship between *RELATED* and *MBAR*, thus supporting our first hypothesis. As reported in column (2), the main effect of *RELATED* is positive and statistically significant (β_1=1.0849, p-value=0.016) and its squared term is negative and significant (β_2=-1.2886, p-value=0.01).

To ensure the correct interpretation of this curvilinear effect of *RELATED* on *MBAR* derived from the significance of the linear and squared term of *RELATED* in the regressions, we further examine the validity of the inverted U-shape relationship at the bottom of **Table 5.4**. We conduct Sasabuchi's test (H_0: monotone or U shape; H_1: inverse U shape). Consistent with prior estimations, Sasabuchi's test is rejected (p-value=0.008), providing more evidence to support the inverted U-effect. Moreover, Fieller's confidence interval at the 95% level for the inflection point of the curve ranges between 0.2190 and 0.6537. This extreme point is within the limits of our data since, as reported in summary statistics in **Table 5.2**, the values for the *RELATED* variable in our sample range between 0 (minimum) and 1.3594 (maximum).

Overall, hypothesis 4 receives strong support. Our results provide meaningful evidence that the relationship between relatedness and GOR is quadratic rather than linear, and suggest the existence of a maximum (estimated in RELATED*=0.4210) after which relatedness proves detrimental to the value of the firm's growth opportunities. These results also hold when *Q* is used as a dependent variable (column (7)).

5.2.2. The interaction effect of degree of diversification and relatedness

Below, we evaluate whether the shape of the inverted U-form between *RELATED* and *MBAR* found previously differs at low and high levels of diversification. Columns (3) to (5) in **Table 5.4** offer a test for the interaction effects between the relatedness and degree of diversification dimensions proposed in hypothesis 5. We extend equation [1] to equation [2], with the addition of the moderating effect of the degree of diversification on the quadratic relationship linking *RELATED* and *MBAR*. The estimation results for the moderating effects are presented in columns (3) to (5) of **Table 5.4** using *MBAR* as the dependent variable (columns (8) to (10) display additional robustness checks of regressions on the *Q* proxy). Once again, these results corroborate the inverse U-form relationship between *RELATED* and *MBAR*, with an even greater statistical significance (both *RELATED* and $RELATED^2$ have p-value=0.000). The significance of the multiplicative term $RELATED^2$x*dumNUM* supports the idea that the degree of diversification moderates the relationship between *RELATED* and *MBAR*. The results reveal a negative interaction effect of the dummy *dumNUM* and the linear term of *RELATED* (β_3=-6.4806, p-value=0.000) and a positive interaction with its quadratic term (β_4=9.0584, p-value0.000). As a result, the absolute value of the coefficient associated with the curvilinear effect of relatedness is higher for below-mean diversifiers (β_2 = -10.2397) than for above-mean diversifiers ($\beta_2 + \beta_4$= -10.2397+9.0584=-1.1813), suggesting that the inverted U-curve is less pronounced in firms with high levels of diversification, and more pronounced otherwise.

Results are robust to several diversification proxies (*dumHERF* and *dumTENTROPY* estimated in columns (4) and (5)) and to the use of *Q* as a dependent variable (columns (8) to (10)), as shown **Table 5.4**. Clearly, these findings run contrary to our hypothesis 5, which predicted that the inverse U-form relationship between

MBAR and *RELATED* would be steeper in high diversifiers. Indeed, as hypothesized, there is a difference in the shape of the curvilinear relationship between *RELATED* and *MBAR*, although the degree of diversification attenuates the effect of *RELATED* rather than reinforcing it.

5.2.3. The moderating effect of risk of pre-emption on the degree of diversification

In this section, we examine whether the risk of pre-emption plays a moderating role in the impact which the degree of diversification has on a firm's growth opportunities. We first estimate equation [3] to ensure that the U-form relationship between diversification and GOR documented in prior research is also applicable in the context of our data. Regression results are summarized in **Table 5.5**.

Table 5.5
[Degree of diversification and growth opportunities (eq. [3])]

This Table reports the two-step GMM system estimations of equation [3]. Different proxies for growth options ratio to the firm's total value (GOR) (either *MBAR* (the market-to-book assets ratio), or *Q* (Tobin's Q)) are regressed on the degree of diversification. *NUM_4d* (number of business segments at the 4-digit SIC code level), *HERF_4d* (the Herfindahl index at the 4-digit SIC code level), and *TENTROPY* (the Entropy index) represent alternative measures for the level of diversification. Firm size (*LTA*), financial leverage (*DTA*), industry effect (*dumINDUSTRY*) and time effect (*dumYEAR*) are controlled in all estimations. The Wald test contrasts the null hypothesis of no joint significance of the explanatory variables. m_1 and m_2 are tests for no first-order and second-order serial correlation, respectively, in the first difference residuals. The Hansen J-statistic is the test of over-identifying restrictions. The Hansen test is distributed as χ^2- (degrees of freedom in parentheses). Standard error is shown in parentheses under coefficients. ****, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.
At the bottom of the table, some additional tests of a U-shaped relationship between GOR and degree of diversification are offered.

	Dependent variable: MBAR						Dependent variable: Q					
	Direct effects			Non linear effects			Direct effects			Non linear effects		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	3.9210*** (0.3979)	4.6447*** (0.4525)	4.5617*** (0.4525)	4.0570*** (0.4692)	4.1866*** (0.2894)	3.4330*** (0.3883)	3.2120*** (0.3854)	3.1147*** (0.3580)	3.0507*** (0.3592)	3.3363*** (0.4595)	3.4473*** (0.2766)	2.8659*** (0.3766)
Direct effects												
NUM_4d	-0.2190*** (0.0750)			-0.8364*** (0.1849)			-0.2148*** (0.0719)			-0.8132*** (0.1819)		
HERF_4d		-1.1417*** (0.3974)			-3.1360*** (0.5031)			-1.1238*** (0.2978)			-2.8308*** (0.4670)	
TENTROPY			-0.5935** (0.2442)			-1.6751*** (0.4233)			-0.5881*** (0.1789)			-1.3255*** (0.3998)
Non linear effects												
$(NUM\_4d)^2$				0.0954*** (0.0248)						0.0949*** (0.0244)		
$(HERF\_4d)^2$					2.9262*** (0.7190)						2.6187*** (0.6710)	
$(TENTROPY)^2$						0.8511*** (0.2848)						0.8068*** (0.2867)

Control variables												
LTA	0.0473 (0.0495)	-0.0793 (0.0607)	-0.0700 (0.0601)	0.1274** (0.0518)	0.0435 (0.0373)	0.1104** (0.0534)	0.0763 (0.0480)	0.0521 (0.0467)	0.0638 (0.0466)	0.1482*** (0.0507)	0.0606* (0.0349)	0.0879* (0.0486)
DTA	-4.3260*** (0.3697)	-4.4582*** (0.4772)	-4.4691*** (0.4710)	-4.1903*** (0.3486)	-5.1603*** (0.2729)	-4.2331*** (0.3625)	-3.9220*** (0.3586)	-3.6984*** (0.3688)	-3.8495*** (0.3675)	-3.7562*** (0.3439)	-4.5427*** (0.2603)	-3.7396*** (0.3924)
dumINDUSTRY	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
dumYEAR	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	5,569	5,569	5,569	5,569	5,569	5,569	5,569	5,569	5,569	5,569	5,569	5,569
Wald test	531.82***	442.92***	447.81***	541.72***	1090.69***	462.81***	545.41***	545.70***	543.26***	527.10***	1052.37***	492.22***
m_1	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
m_2	0.96	0.94	0.94	0.97	0.95	0.95	0.96	0.95	0.95	0.97	0.95	0.96
p-value m_2 test	0.339	0.346	0.345	0.334	0.344	0.340	0.338	0.343	0.342	0.334	0.342	0.338
Hansen test	233.49 (255)	197.13 (219)	191.54 (219)	236.55 (239)	320.18 (331)	211.59 (203)	238.98 (255)	236.86 (255)	238.37 (255)	235.78 (239)	316.08 (331)	213.28 (219)
p-value Hansen test	0.829	0.853	0.910	0.533	0.655	0.325	0.756	0.786	0.765	0.547	0.713	0.596
Sasabuchi-test of U-shape in degree of diversification	--	--	--	2.88***	2.24**	2.12**	--	--	--	3.02***	2.09**	2.30**
Estimated extreme point	--	--	--	4.3842	0.5358	0.9840	--	--	--	4.2866	0.5405	0.8215
95% confidence interval (CI)-Fieller method	--	--	--	[3.9176; 5.3878]	[0.4414; 0.7633]	[0.7620; 1.6829]	--	--	--	[3.8318; 5.1970]	[0.4400; 0.7953]	[0.6070; 1.4049]

Columns (1) to (3) estimate a direct effect of diversification on GOR. As shown, results reveal a negative impact of *NUM_4d* on *MBAR*, statistically significant at the 1% level. We conduct several robustness tests using alternative proxies for the level of diversification (*HERF_4d* and *TENTROPY*). Results again show a negative relationship with *MBAR*.

We now estimate equation [3] in which we examine the nonlinear relationship between the degree of diversification and GOR (columns (4) to (6)). Consistent with Chapter 3 findings, our results strongly support the existence of a curvilinear relationship between *NUM_4d* and *MBAR*. More specifically, our empirical findings suggest a U-shaped effect between *NUM_4d* and *MBAR* with a negative linear term (β_1=-0.8364, p-value=0.000) and a positive quadratic term (β_2=0.0954, p-value=0.000). Columns (5) and (6) further support these results by showing that the U-form effect persists when alternative diversification indexes such as *HERF_4d* and *TENTROPY* are used. Moreover, we assess the robustness of these empirical findings by computing the degree of diversification at the 2-digit SIC code level (measured by either *NUM_2d* or *HERF_2d*). Results are similar to those reported[67].

The last three rows of **Table 5.5** contain additional robustness analyses to check the correct specification of the curvilinear relationship. First, we perform Sasabuchi's test to check the presence of a U-form relationship (H_0: Monotone or inverse U shape; H_1: U shape). Sasabuchi's test is rejected across all proxies (p-value<0.02), thus providing more evidence to support the U-form effect. Results are statistically stronger when *NUM_4d* is used (p-value=0.002). We estimate that the inflection point occurs at approximately four segments (*NUM_4d**=4.3842). Fieller's confidence interval

[67] Results available upon request.

(estimated at [3.9176; 5.3878]) indicates that the estimated *NUM_4d* inflection point values are within the limits of our data (as displayed in summary statistics of Panel A in **Table 5.2**, the *NUM_4d* variable in our sample ranging between 1 (minimum) and 7 (maximum)). All the empirical findings presented thus far in this section prove robust to *Q* as an alternative dependent variable to proxy for growth opportunities (columns (7) to (12) of **Table 5.5**).

Table 5.6 contains the results of the interaction effects between the degree of diversification and the risk of pre-emption. We extend equation [3] to [4], in which we include the moderating effect of the risk of pre-emption. A significant interaction term for $(NUM\_4d)^2*PREEMPT$ suggests that the curve capturing the relationship between the level of diversification and GOR is statistically different under high versus low pre-emption threats (column (1)). As can be seen, the estimation results display a negative interaction between *PREEMPT* and the squared term of *NUM_4d* (β_4=-0.0701, p-value=0.000). This negative sign reveals that risk of pre-emption reduces the strength of the overall impact of the quadratic term NUM_4d^2 ($\beta_2 + \beta_4 < \beta_2$ since $\beta_4 < 0$), thus generally making the U-form relationship between *NUM_4d* and *MBAR* flatter in contexts with high risk of pre-emption than those with low risk of pre-emption. These findings are robust across estimations with alternative diversification proxies (*HERF_4d* and *TENTROPY*, shown in columns (2) and (3) respectively) and with alternative proxies for growth opportunities (estimations with *Q*, columns (4) to (6)). In the *NUM_4d* regressions, the control variable *PREEMPT* displays statistical significance and a negative sign, consistent with our arguments that pre-emption is likely to be detrimental for growth option value through either a shorter option lifespan or an increase in option exercise price.

Table 5.6
[The moderating effect of preemption on the diversification and growth opportunities linkage (eq. [4])]

This table reports the two-step GMM system estimations of equation [4]. Different proxies for growth options ratio to the firm's total value (GOR) (either *MBAR* (the market to book assets ratio), or *Q* (Tobin's Q)) are regressed on the degree of diversification and pre-emption. *NUM_4d* (number of business segments at the 4-digit SIC code level), *HERF_4d* (the Herfindahl index at the 4-digit SIC code level), and *TENTROPY* (the Entropy index) represent alternative measures for the level of diversification. *PREEMPT* captures the risk of pre-emption. Firm size (*LTA*), financial leverage (*DTA*), industry effect (*dumINDUSTRY*), and time effect (*dumYEAR*) are controlled in all estimations. The Wald test contrasts the null hypothesis of no joint significance of the explanatory variables. m_1 and m_2 are tests for no first-order and second-order serial correlation, respectively, in the first difference residuals. The Hansen J-statistic is the test of over-identifying restrictions. The Hansen test is distributed as χ^2- (degrees of freedom in parentheses). Standard error is shown in parentheses under coefficients. ****, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Dependent variable: MBAR			Dependent variable: Q		
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	10.1857***	3.9723***	4.0758***	8.1681***	3.4337***	3.4785***
	(1.6038)	(0.5657)	(0.5568)	(1.5561)	(0.5552)	(0.5492)
Direct effect						
NUM_4d	-4.6585***			-3.6598***		
	(1.1414)			(1.1005)		
HERF_4d		-10.5183***			-9.7845***	
		(2.5188)			(2.4576)	
TENTROPY			-3.8899***			-3.4044***
			(1.2731)			(1.2483)
RELATED						
Non linear effects						
$(NUM\_4d)^2$	0.8483***			0.6943***		
	(0.1991)			(0.1924)		
$(HERF\_4d)^2$		18.6926***			17.6885***	
		(3.4293)			(3.3656)	
$TENTROPY^2$			4.0682***			3.6808***
			(0.8994)			(0.8810)
Moderation effects						
NUM_4d x PREEMPT	0.3619***			0.2688***		
	(0.1072)			(0.1034)		
$(NUM\_4d)^2$ x PREEMPT	-0.0701***			-0.0555***		
	(0.0186)			(0.0179)		
HERF_4d x PREEMPT		0.6261***			0.5612**	
		(0.2311)			(0.2251)	
$(HERF_4d)^2$x PREEMPT		-1.4782***			-1.3888***	
		(0.3184)			(0.3118)	
TENTROPY x PREEMPT			0.1377			0.0926
			(0.1178)			(0.1157)
$TENTROPY^2$ x PREEMPT			-0.2734***			-0.2360***
			(0.0850)			(0.0832)
Control variables						
PREEMPT	-0.4916***	0.0251	0.0300	-0.3778***	0.0134	0.0213
	(0.1432)	(0.0463)	(0.0460)	(0.1391)	(0.0459)	(0.0459)
LTA	-0.0185	0.0552*	0.0457	0.0141	0.0685**	0.0635**
	(0.0508)	(0.0297)	(0.0308)	(0.0497)	(0.0296)	(0.0305)
DTA	-4.1660***	-4.7668***	-5.0004***	-3.7385***	-4.2918***	-4.5055***
	(0.3990)	(0.2132)	(0.2139)	(0.3803)	(0.2123)	(0.2134)
dumINDUSTRY	Yes	Yes	Yes	Yes	Yes	Yes
dumYEAR	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	5,569	5,569	5,569	5,569	5,569	5,569
Wald test	681.74***	1439.83***	1701.91***	683.21***	1301.20***	1527.07***
m_1	0.95	0.95	0.95	0.95	0.95	0.95

m_2	0.96	0.94	0.94	0.96	0.94	0.95
p-value m_2 test	0.336	0.347	0.346	0.335	0.346	0.345
Hansen test	233.87 (244)	372.30 (398)	381.91 (398)	236.44 (244)	377.46 (398)	385.86 (398)
p-value Hansen test	0.668	0.818	0.710	0.624	0.763	0.659

In this case, to test hypothesis 6, we need to go deeper than such an attenuating effect of *PREEMPT* on the relationship between *NUM_4d* and *MBAR*. We distinguish two subsamples according to the risk of pre-emption: firm-year observations that display values of *PREEMPT* above the sample mean (high pre-emption) and firm-year observations that show values of *PREEMPT* below the sample mean (low pre-emption). We run the regression of equation [3] separately in each of the two subsamples and characterize the U-form relationship in each context. For this, we calculate Sasabuchi's test and Fieller's confidence interval to test the validity of the quadratic function in both cases, and we estimate the slope of each curve at the upper and lower bound. This enables us to discern in greater detail whether the declining relationship or the increasing relationship of the curve accentuates or attenuates. Results are shown in **Table 5.7**.

Table 5.7
[The moderating effect of preemption on the U-relationship between the degree of diversification and growth opportunities]

This table reports additional tests of the shape of the U-relationship between diversification and GOR in above-mean and below-mean pre-emption subsamples of observations. *MBAR* (the market-to-book assets ratio), and *Q* (Tobin's Q) proxy for the growth options ratio to the firm's total value (GOR). *NUM_4d* (number of business segments at the 4-digit SIC code level), *HERF_4d* (the Herfindahl index at the 4-digit SIC code level), and *TENTROPY* (the Entropy index) represent alternative measures for the level of diversification. *PREEMPT* captures the risk of pre-emption. Firm size (*LTA*), financial leverage (*DTA*), industry effect (*dumINDUSTRY*), and time effect (*dumYEAR*) are controlled in all estimations (GMM system two-step estimator). In the slopes of the lower and upper bound the t-statistic is in parentheses under slope value.
****, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Dependent variable: MBAR		Dependent variable: Q	
	ABOVE MEAN PREEMPT	BELOW MEAN PREEMPT	ABOVE MEAN PREEMPT	BELOW MEAN PREEMPT
Panel A: NUM_4d proxy				
Sasabuchi-test of U-shape in degree of diversification	2.01**	4.74***	3.19***	2.16**
Estimated extreme point	5.8067	3.1340	5.4470	3.0080
95% confidence interval (CI)- Fieller method	[5.0364; 6.9650]	[2.7742; 3.3521]	[4.8432; 6.2590]	[1.5520; 3.6832]
Slope-lower bound (t.statistic)	-0.5818 (-9.4451***)	-0.2810 (-4.7353***)	-0.5804 (-9.7895***)	-0.1792 (-2.1585**)
Slope-upper bound (t.statistic)	0.1444 (2.0060**)	0.3774 (8.0155***)	0.2027 (3.1906***)	0.2670 (2.9163***)
Panel B: HERF_4d proxy				
Sasabuchi-test of U-shape in degree of diversification	3.02***	5.83***	2.43***	2.34***
Estimated extreme point	0.6414	0.4136	0.6920	0.2939
95% confidence interval (CI)- Fieller method	[0.5756; 0.7444]	[0.3748; 0.4681]	[0.6236; 0.7967]	[0.1258; 0.4007]
Slope-lower bound (t.statistic)	-6.3844 (-14.1311***)	-2.2508 (-9.7324***)	-2.9502 (-17.5070***)	-1.1085 (-2.3434***)
Slope-upper bound (t.statistic)	1.8867 (3.0220***)	2.1861 (5.8268***)	0.5922 (2.4326***)	1.9663 (2.8933***)
Panel C: TENTROPY proxy				
Sasabuchi-test of U-shape in degree of diversification	3.28***	3.37***	2.03**	2.75***
Estimated extreme point	1.4118	0.6970	1.3914	0.6866

95% confidence interval (CI)- Fieller method	[1.2634; 1.6327]	[0.4809; 0.9115]	[1.1679; 1.8342]	[0.3983; 0.9595]
Slope-lower bound (t.statistic)	-3.3390 (-18.7826***)	-0.8912 (-3.3734***)	-2.3394 (-9.3718***)	-0.6909 (-2.7515***)
Slope-upper bound (t.statistic)	1.0559 (3.2822***)	1.3280 (3.6012***)	0.7848 (2.0289**)	1.0556 (2.9995***)

Table 5.7 estimation results corroborate that the U-form relationship between the degree of diversification dimension and GOR persists in low and high risk of pre-emption. Sasabuchi's test is rejected at above the 5% level, and Fieller's confidence interval confirms that the turning point of the U curve is within the limits of our data. It is important to note that the slope of the lower bound of the curve is greater in absolute value in the above-mean pre-emption subsample than in the below-mean pre-emption subsample, whereas the slope of the upper bound of the curve in below-mean exceeds that of the above-mean pre-emption subsample. As a result, we may conclude that pre-emption strengthens the decreasing relationship between *NUM_4d* and *MBAR*, while attenuating the positive relationship region of the curve between *NUM_4d* and *MBAR*.

Following Wales, Parida and Patel (2013), we evaluate the inflection points of the diversification-GOR relationship in both subsamples. We observe that in high pre-emption, the turning point of the curve is reached at higher levels of diversification, thus shifting to the right. Again, this evidence supports our hypothesis. Pre-emption reinforces the negative relationship between *NUM_4d* and *MBAR*, extending it along upper diversification levels.

All these results are robust to the use of *Q* as the dependent variable as well as to the measurement of the level of diversification by the alternative proxies *HERF_4d* (panel B of **Table 5.7**) and *TENTROPY* (panel C of **Table 5.7**). Overall, our empirical evidence is consistent with our expectations and strongly supports hypothesis 6.

5.3. DISCUSSION AND CONCLUSIONS

This study offers fresh insights into the analysis of a multidimensional view of corporate diversification from an RO approach, exploring the effect of corporate diversification on the growth options portfolio (more specifically, on the growth options value ratio to a firm's total value, GOR) in a dataset of U.S. firms between 1998 and 2010. We perceive diversification as a multidimensional strategy, primarily defined by two dimensions: degree of diversification and relatedness between business segments. Based on an RO line of reasoning, we offer a deeper insight into how each of these dimensions configures the firm's set of growth opportunities. Consistent with a variety of prior studies (such as Bettis, 1981; Rumelt, 1982; Simmonds, 1990; Markides and Williamson, 1994; Palich *et al.*, 2000), we find evidence of the value-enhancing effects of related diversification, in our case via the generation of growth opportunities. Relatedness accelerates and magnifies the option-generating process as a result of synergies and complementarities from background related experience. Moreover, these synergies can decrease the 'exercise price' of subsequent projects or enhance the value of the underlying assets. However, our findings suggest an inverted U-form relationship rather than a linear one, which ties in with previous papers such as Palich *et al.* (2000). This implies that when diversifying relatedly beyond a certain limit, the company is likely to reach a break point after which certain counter value effects of relatedness (such as mutually competitive options and overlapping growth opportunities) dominate.

Our results also tie in with a set of RO papers which point out the interdependence of options value in a portfolio (McGrath and Nerkar, 2004; Vassolo *et al.*, 2004). The statistical significance of the relatedness dimension in the growth options value and the quadratic nature of such a relationship suggest the existence of a portfolio effect based on internal interplay mechanisms across options.

Our study advances beyond existing work by analysing the joint effect of two diversification dimensions: scope and relatedness. We build on and complement prior evidence such as Fan and Lang (2000), which posits the notion that relatedness impacts low and high diversifiers differently. We hypothesize that degree of diversification may accentuate the inverted U-form relationship between relatedness and GOR, firstly because broader business activity may offer more possibilities to capitalise on relatedness (for example, via synergies and economies of scope), and secondly because interdependencies across businesses may have a potential 'domino effect' that could heighten complexity and coordination costs. Surprisingly, contrary to our expectations, our results yield evidence that diversification attenuates the inverted U-form relationship. These findings may be driven by the limits imposed upon the materialization of the benefits of relatedness, as discussed before. The spillover value-enhancing effects of relatedness cannot be extended to further business infinitely. This evidence concurs with prior literature such as Gary (2005) who points out that drawing on related diversification excessively may overstretch shared resources and thus prevent further synergies from materializing. In addition, it may reduce the availability of resources to continue exploring, designing, and identifying new investment opportunities, slowing down the creation of new options and thus weakening the effect on GOR. In summary, so far, our results show that after a certain level, relatedness also comes at a price.

In line with chapter 3, the level of diversification and GOR exhibit a U-shaped relation. We extend prior findings by exploring the moderating role of risk of pre-emption on such a nonlinear relationship. As expected, we find that pre-emption threats potentiate the decreasing section of the curve and weaken its positive slope. Pre-emption poses a major threat to option-based strategies since a competitor may more easily snatch a business opportunity that is open to the firm but to which it is not yet fully committed. Under preemptive forces, the lifespan of an option is shorter. Moreover, certain strategic actions undertaken by rivals may impose additional costs for subsequent actions, thereby increasing option exercise price (Folta and Miller, 2002a). Our results concur with prior RO literature showing the detrimental effects of the risk of pre-emption of growth option value in a variety of contexts (such as licensing (Jiang *et al.*, 2009), or buyouts in equity partnerships (Folta and Miller, 2002b)).

This chapter makes several contributions to diversification literature and application of the RO approach to strategic decision analysis. Firstly, our study offers new insights into the characterization and understanding of corporate diversification from an RO logic, perceiving this expansion strategy as the purchase and subsequent exercise of growth options. Secondly, we emphasize the multidimensional nature of this strategy. In particular, we focus our analyses on two dimensions: scope and relatedness. Our results confirm that these dimensions interact with growth option value, both individually and jointly. We offer updated evidence on a post-1997 sample, after implementation of the new SFAS 131 reporting standard in the U.S. Furthermore, many papers call for the need to investigate further the validity of real options for strategic analysis in an effort to advance theory (Reuer and Tong, 2007). This study contributes to filling the gap in empirical works which apply the RO approach to strategy.

In addition, we tie in with recent streams of research which advocate the endogenous nature of the diversification decision, thus making value creation or destruction contingent on firm-specific characteristics rather than on generic characteristics related to strategy or the firms undertaking it. First, we control for endogeneity in all regressions by using an instrumental estimation technique (GMM). Furthermore, we provide evidence that the risk of pre-emption shapes the U-effect of the level of diversification on GOR. This result shows that additional research is needed into the impact of contingency factors on the diversification-value relationship.

This study also opens up interesting new perspectives for business management. In practical terms, our evidence provides some guidance on how and under which conditions corporate diversification should be implemented. Interestingly, our study sheds light on the need to explore further those contingent factors which may play a crucial role in the success or failure of the diversification strategy.

CONCLUSIONS

Corporate diversification has proven to be a popular research topic over the decades, particularly in strategic management and finance. The diversification-value relationship has emerged as an intriguing enigma that has caught the attention of researchers and managers alike but which has yet to be solved. The bulk of existing research evidence suggests that this strategy destroys value for firms. However, how can the abundance of diversifiers observed in real business environments thus be accounted for? Why do so many firms continue to embark on this strategy if it seems to perform poorly? The debate goes on.

Recent strands of research offer updated evidence and revisit the impact of corporate diversification on firm value by using more sophisticated econometric techniques to address widespread methodological concerns, such as endogeneity, found in diversification research. Some of these recent papers have unearthed fresh findings such as a premium or a non-significant relation, casting doubt on the prominence of the diversification discount. Rather, they show the complexity of the diversification-value relationship, in which additional factors from the environment as well as firm specific characteristics may contribute to determining the outcomes of this strategy. As a result, they advocate reviewing the impact of corporate diversification on firm value from a contingent perspective, allowing further variables to be included in the analyses which may affect the sign and strength of the diversification-value linkage.

Overall, the state of the art in the diversification-value relationship resembles a puzzle, pieces of which are still missing. Thinking in terms of discount/premium, based on an analysis of the diversification effect on corporate value in aggregated terms, proves too narrow a perspective. Around us, we see how some diversified companies succeed whereas others fail. Thus, what is important to managers and what would herald progress in the field would be to ascertain under which conditions business diversification proves value-enhancing for firms.

This dissertation joins such a contingent-based perspective and introduces an additional piece in the controversial puzzle: firms' growth opportunities. As for our theoretical framework for dealing with our research purpose, we adopt a real options (RO) approach, which has opened up fresh avenues for strategic research over the last few decades. The RO approach is closely linked to a firm's growth opportunities and its specific resources and capabilities, making it a helpful guide for our research. This theoretical framework emerges as an interesting investment theory to reconcile the conflicting evidence surrounding the diversification-value relationship. Applying this investment theory may prove interesting in the field in order to establish a more direct connection between diversification, strategic analysis, and market value. More specifically, RO analysis underlines the growth opportunities component of firm value, as pointed out by Myers (1977). Insofar as the creation and evolution of growth options are intrinsically linked to firm-specific capabilities, this RO perspective also contributes to overcoming the traditional discount/premium dilemma by examining the nature of diversification *per se* more closely.

Furthermore, this innovative RO approach to diversification aims to provide a closer perspective of real investment decision-making under uncertainty. It offers strategic reasoning under which dynamic decision-making and flexibility prove paramount to capitalizing on uncertainty. Under this RO framework, corporate strategies will no longer be conceived as now-or-never decisions but rather as gradual investment processes involving chained purchase and exercise of growth options. Through the RO lens, certain managerial investment decisions which are counter-valuable for a firm's assets-in-place may, however, be justified in terms of options value. Certain real options may be embedded in those investments, thus opening up possible future paths in the long run to readjust the strategy depending on how uncertainty evolves.

From an RO approach, the key issue moves beyond the dilemma of whether 'to diversify or not to diversify'. Corporate diversification and its implications for corporate performance are not merely a question of how much to diversify, but also of *how* to diversify. Since certain firms displaying the same degree of diversification may perform differently, there may be additional factors that make the difference. From an RO perspective, firm value does not only stem from the expected current of free cash flow but also from other intangible assets emerging along the way, such as growth options and flexibility, whose value is derived from the range of possibilities which remain open to the firm in uncertain contexts (many of which the firm would otherwise have had accessed later). The RO approach focuses on the investment process throughout the implementation of corporate strategies, perceived as the gradual acquisition and exercise of options to expand.

Our study sheds further light on RO thinking of corporate strategies, expanding it to the analysis of corporate diversification. Through the RO lens, diversification translates into a series of connected growth options, exercise which enables enterprises to move their diversification status forward. We revisit the diversification-value puzzle and join this open debate in the literature drawing on RO language. Using a final panel sample of U.S. firms from 1998 to 2010, this dissertation offers empirical evidence concerning firms' growth opportunities as a fundamental pillar around which the diversification-value is shaped.

Chapter 3 of this dissertation explores the role that a firm's growth opportunities play in such a relationship. Firstly, we find that corporate diversification impacts a firm's portfolio of growth options differently, depending on the scope of the strategy. At lower levels, exercising growth opportunities dominates, and adding a new segment to a firm's portfolio reduces the portion of market value accounted for by its growth options. Thus, each diversification investment consumes part of the firm's growth options. However, we find a diversification level after which this strategy materializes into new growth options to a greater extent, thus enhancing a firm's portfolio of growth opportunities. At such a diversification stage, cumulated learning, exploration, and expansion into new business areas serve as a platform to future investment opportunities. Secondly, we report evidence concerning the partial mediating role of growth opportunities in the diversification-value relationship. Apart from the direct linkage of this strategy to corporate value, part of the impact of diversification on firm value emerges through the firm's growth options portfolio, making this strategy less value-destroying insofar as it boosts a firm's growth opportunities. Growth opportunities arising from the interplay of multiple businesses within a single organization, as well as their optimal joint exercise, cannot be replicated by individual investors, making diversification at the corporate level an efficient strategy.

Based on this relevant role of growth opportunities in the diversification-value linkage, chapter 4 goes one step further. Apart from the commonly studied dimensions of corporate diversification dealt with in prior literature (degree of diversification and relatedness between segments), we consider an additional one: the way the investment is undertaken. Hence, we distinguish two contrasting diversification patterns from an RO approach: on the one hand, an assets-in-place diversification aimed primarily at exploiting growth opportunities and enabling faster diversification so as to take advantage of potential synergies and economies of scope, at the expense of reducing a firm's flexibility and which entails greater risk in each individual commitment; and on the other hand, options-based diversification, grounded on the sequential commitment of resources while exploring further options, renouncing potential full first mover advantages in return for limiting downside risk and preserving some flexibility to mould the strategy dependent on the changeable conditions of an uncertain environment. Taking the concept of fit as *profile deviation*, we first develop a two-dimensional index to reflect the extent to which a firm's diversifying profile fits in with the previously mentioned diversification patterns. We find strong evidence to support the belief that these two contrasting ways of managing diversification drive divergences in value outcomes. This research shows that a diversification profile in which the company holds small-scale participations in certain businesses aimed at seeding future strategic options emerges as a more value-creating strategy.

Finally, and given the clear evidence concerning the importance of a firm's growth opportunities to explain the diversification discounts/premiums, chapter 5 examines in greater detail how corporate diversification, devised as a multidimensional strategy, interacts with the firm's growth options portfolio. More specifically, we focus on two dimensions of this strategy: degree of diversification and relatedness between segments. First, we document that relatedness configures a super-additive portfolio of growth opportunities as a result of the multiplicative effects among the options, by either reducing the exercise price of subsequent options due to synergies and economies of scope, or by enhancing the value of the underlying investment as a result of the cumulated connected experience. However, our study also points out that relatedness should be implemented with caution. Excessive related diversification may prove detrimental to growth opportunities as a result of the over-cost of maintaining redundant and mutually competitive options, and the increase of complexity stemming from highly connected options. The relationship between growth opportunities and relatedness is less marked in high diversifiers. Again, this points to the limits of materializing the benefits of relatedness, which cannot be expanded to further businesses indefinitely. Relatedness also comes at a price. Overstretching shared resources, particularly certain intangible assets such as knowledge or exploratory capabilities, becomes extremely important and runs counter to the potential benefits of relatedness, nullifying or even exceeding them. As a result, generating further options slows down. Finally, our analyses reveal that pre-emptive forces pose a serious threat to option-based strategies. We document that risk of pre-emption accelerates the depletion process of growth opportunities at lower degrees of diversification, since many expire as a result of the pre-emptive action undertaken by competitors. Additionally, we show that at higher levels of diversification, when this strategy primarily becomes a source of growth options, pre-emption weakens the option-creation process. Further options are likely to be less valuable due to pre-emption, which imposes additional costs on subsequent expansions (increasing option exercise price) and curtailing option lifespan.

This dissertation makes several contributions to both corporate diversification literature as well as real options literature. As for the former, this research examines the diversification puzzle from a fresh theoretical perspective, the RO approach, which enables us to provide further insights. Corporate diversification is no longer seen as a "now or never" strategy but rather as a dynamic strategy based on a sequence of growth options.

By way of a second contribution to diversification literature, we find further evidence to support the contingent nature of the diversification-value relationship and we show that the configuration of a firm's growth opportunities drives part of the diversification discounts/premiums. More specifically, the more this strategy promotes options-creation, the higher the excess values from diversification, since such an option-based diversification is not within individual investors' reach. Thus, the diversification undertaken by the company could not have been replicated at a lower cost in external capital markets.

Thirdly, we shed light on the multidimensional nature of this growth strategy. We demonstrate that the degree of diversification and relatedness interact (both individually and jointly) with the growth options portfolio, which in turn is directly related to firm value. Moreover, the RO approach guides us to include an additional dimension of corporate diversification into the analyses which needs to be accounted for, namely how the firm diversifies (pattern of diversification). We identify two contrasting diversification paths, ranging from an assets-in-place diversification to an options-driven one. We also develop a two-dimensional index based on the strategic notion of profile deviation to capture and proxy for diversification patterns. Again, we show that a pattern aimed not only at exploiting a firm's current opportunities but also at building further investment options for the future proves more beneficial for value creation.

Fourth, our study offers updated evidence on a post-1997 sample, after implementation of the new SFAS 131 reporting standard in the U.S. In addition, we contribute to recent streams of research which advocate the endogenous nature of the diversification decision, viewing diversification performance as dependent on a firm's intrinsic characteristics (in our case, a firm's growth opportunities portfolio). In our analyses, we control for endogeneity of the diversification decision to avoid contaminated results.

In addition, this dissertation also responds to recent demands from RO literature for further empirical research into the application of RO to strategic analysis in an effort to support the validity of real options. More specifically, we extend the RO view to corporate diversification, on which the literature remains scarce.

This dissertation also has significant implications for management practice. We show managers that how diversification strategy is implemented is by no means a trivial issue vis-à-vis value creation. When designing diversification strategy, managers must bear in mind that diversification involves multiple dimensions (many of which are interrelated) and that each dimension contributes towards the eventual sign of the diversification impact on a firm's value. It is important not only to exploit the investment opportunities they hold but also to avoid lapsing into a myopic analysis, failing to seek and explore further options. A dynamic and flexible oriented strategy, aimed at promoting the creation of further options throughout the investment process makes a difference and makes corporate diversification a strategy which cannot be replicated by stockholders in their individual portfolios.

Finally, we point to certain limitations in our research and to questions which remain for future study. First, our sample comprises exclusively U.S. firms. It might prove interesting to evaluate the consistency of our empirical findings in an international setting. Secondly, the lack of observability in real options complicates their value estimation. Additional robustness analyses should be carried out with alternative proxies for growth opportunities. Moreover, further checks should be conducted to verify the robustness of our proposed index and its suitability for reflecting RO patterns of diversification, since its application may open up numerous avenues of research. Similarly, the relatedness dimension has proved difficult to measure in prior literature. Certain works point out the insufficiency of SIC-coded data. Thus, further research might seek to refine existing measures and develop alternative ones to capture relatedness. Papers such as Lien and Klein (2009), and Lee and Lieberman (2010) constitute recent contributions to this issue.

Thirdly, further research should go deeper in a contingency approach to diversification and seek additional factors which might shape the value effects of such a strategy. Our results leave the door open for other possible mediating or moderating variables in the diversification-performance relationship, which might provide a deeper insight into the conditions under which companies may implement this strategy more successfully. Diversification may be a value-destroying strategy under certain conditions but not under others. Our study reveals that this corporate strategy has a positive impact on firm value in enterprises whose diversification is primarily geared towards generating new growth options. How firms deal with them when implementing diversification strategy may give rise to different diversification patterns which, in turn, may spark different value outcomes.

Finally, further research should focus on dealing with the diversification-value relationship in the current financial crisis. The implications of both AiPD and OD for corporate value may become more marked in a context of crisis, thus reinforcing the moderating role of the diversification pattern in the diversification-value relationship.

By way of a final reflection, this dissertation reveals that the corporate diversification area is more alive than ever and is still able to offer potential for future research. Much remains to be said and done. It may prove enlightening to examine the diversification puzzle from alternative theoretical approaches, or even to complement traditional theories with alternative ones so as to breathe fresh life into the diversification debate.

APPENDIX

Table A.1
[Standard Industrial Classification Division Structure]

This table shows the major groups of industries (as defined by the United States Department of Labor) and their correspondence with the 2-digit SIC codes groups.

DIVISION	MAJOR GROUPS (2-digit SIC codes in parentheses)
A Agriculture, Forestry and Fishing	Agricultural Production Crops (01); Agriculture production livestock and animal specialties (02); Agricultural Services (07); Forestry(08); Fishing, hunting, and trapping (09).
B Mining	Metal Mining (10); Coal Mining (12); Oil And Gas Extraction (13); Mining And Quarrying Of Nonmetallic Minerals, Except Fuels (14).
C Construction	Building Construction General Contractors And Operative Builders (15); Heavy Construction Other Than Building Construction Contractors (16); Construction Special Trade Contractors (17).
D Manufacturing	Food And Kindred Products (20); Tobacco Products (21); Textile Mill Products (22); Apparel And Other Finished Products Made From Fabrics And Similar Materials (23); Lumber And Wood Products, Except Furniture (24); Furniture And Fixtures (25); Paper And Allied Products (26); Printing, Publishing, And Allied Industries (27); Chemicals And Allied Products (28); Petroleum Refining And Related Industries (29); Rubber And Miscellaneous Plastics Products (30); Leather And Leather Products (31); Stone, Clay, Glass, And Concrete Products (32); Primary Metal Industries (33); Fabricated Metal Products, Except Machinery And Transportation Equipment (34); Industrial And Commercial Machinery And Computer Equipment (35); Electronic And Other Electrical Equipment And Components, Except Computer Equipment (36); Transportation Equipment (37); Measuring, Analyzing, And Controlling Instruments; Photographic, Medical And Optical Goods; Watches And Clocks (38); Miscellaneous Manufacturing Industries (39).
E Transportation, Communications, Electric, Gas, And Sanitary Services	Railroad Transportation (40); Local And Suburban Transit And Interurban Highway Passenger Transportation (41); Motor Freight Transportation And Warehousing (42); United States Postal Service (43); Water Transportation (44); Transportation By Air (45); Pipelines, Except Natural Gas (46); Transportation Services (47); Communications (48); Electric, Gas, And Sanitary Services (49).
F Wholesale Trade	Wholesale Trade-durable Goods (50); Wholesale Trade-non-durable Goods (51).
G Retail Trade	Building Materials, Hardware, Garden Supply, And Mobile Home Dealers (52); General Merchandise Stores (53); Food Stores (54); Automotive Dealers And Gasoline Service Stations (55); Apparel And Accessory Stores (56); Home Furniture, Furnishings, And Equipment Stores (57); Eating And Drinking Places (58); Miscellaneous Retail (59).
H Finance, Insurance, And Real Estate	Depository Institutions (60); Non-depository Credit Institutions (61); Security And Commodity Brokers, Dealers, Exchanges, And Services (62); Insurance Carriers (63); Insurance Agents, Brokers, And Service (64); Real Estate (65); Holding And Other Investment Offices (67).
I Services	Hotels, Rooming Houses, Camps, And Other Lodging Places (70); Personal Services (72); Business Services (73); Automotive Repair, Services, And Parking (75); Miscellaneous Repair Services (76); Motion Pictures (78); Amusement And Recreation Services (79); Health Services (80); Legal Services (81); Educational Services (82); Social Services (83); Museums, Art Galleries, And Botanical And Zoological Gardens (84); Membership Organizations (86); Engineering, Accounting, Research, Management, And Related Services (87); Private Households (88); Miscellaneous Services (89).
J Public Administration	Executive, Legislative, And General Government, Except Finance (91); Justice, Public Order, And Safety (92); Public Finance, Taxation, And Monetary Policy (93); Administration Of Human Resource Programs (94); Administration Of Environmental Quality And Housing Programs (95); Administration Of Economic Programs (96); National Security And International Affairs (97); Nonclassifiable Establishments (99).

Source: United States Department of Labor: Occupational Safety & Health Administration website (http://www.osha.gov/pls/imis/sic_manual.html)

Note A.1
[An outline of the Heckman two-stage procedure]

In the diversification research area, conventional models to estimate the impact of this corporate strategy on firms' value are usually specified as follows:

$$V_{it} = \delta_0 + \delta_1 X_{it} + \delta_2 D_{it} + e_{it}$$

where V_{it} is the excess value measure, X_{it} are several firm-specific characteristics, D_{it} is a dummy variable which equals 1 if the firm is diversified and zero otherwise, and e_{it} is the random disturbance. If diversification is not a random status but rather firms self-select to diversify encouraged by certain underlying characteristics, the dummy diversification variable will be correlated with the error term. In this case, the Ordinary Least Squares (OLS) estimators of δ_i would not be consistent (Greene, 2003; Li and Prabhala, 2007). This bias when applying OLS to the estimation of self-selection models is characterized as a simple specification error or an omitted variable problem (Heckman, 1979). Heckman (1979) proposes a two-stage estimation methodology to correct for this sample selection.

The first stage involves a probit analysis for the full sample so as to model the firm's propensity to diversify. It explains why certain firms decide to undertake the diversification strategy whereas others decide to remain focused. The model is estimated by maximum likelihood to obtain estimates of γ (Greene, 2003). Thus, this so-called **selection equation** can be formally expressed as:

$$D^*_{it} = \gamma Z_{it} + \eta_{it}$$

$$D_{it} = 1 \text{ si } D_{it}^* > 0$$
$$D_{it} = 0 \text{ si } D_{it}^* < 0$$

where D^*_{it} is an unobserved latent variable that is observed as $D_{it}=1$ if $D^*_{it}>0$, and zero otherwise, Z is a vector of firm-specific and industry-specific characteristics which influence the diversification decision and η_{it} is an error term. The latent variable D^*_{it} ranges between $-\infty$ and $+\infty$. When this latent variable rises above a certain level (in this case, the reference value is zero), it takes the value of 1 and null value otherwise.

This first stage of the Heckman analysis is performed to obtain the estimates of self-selection correction, λ_i, which is the inverse of Mill's ratio (Heckman, 1979). λ_i constitutes a proxy for the likelihood of diversifying, being a monotone decreasing function of the probability that an observation is selected in the sample (Heckman, 1979). Thus, in our particular case, the lower the probability that a firm-year observation corresponds to a diversifier, the greater the value of its estimated λ_i.

The second stage of the Heckman procedure evaluates the impact of diversification on performance as conventional OLS models used to do. The key difference lies in the introduction of the λ_i, previously estimated in the selection equation, as a regressor to correct for self-selection (Heckman, 1979). Thus, the coefficient on the diversification variable (δ_2) would provide an estimation of the net effect of the diversification strategy on firm value once self-selection has been corrected. In this stage, we estimate by least squares (Greene, 2003) the **outcome equation** defined as:

$$V_{it} = \delta_0+\delta_1*X_{it}+ \delta_2*D_{it}+ e_{it}$$

where V_{it} is the excess value measure, X_{it} are several firm-specific characteristics, D_{it} is a dummy variable which equals 1 if the firm is diversified and zero otherwise, and e_{it} is the random disturbance.

If lambda were not included as a regressor in the outcome equation, we would be assuming that the diversification status is randomly assigned within the sample. The sign of the estimated coefficient on λ_i, becomes a key point in the analysis. A positive coefficient on λ_i implies a greater likelihood of diversifying implies higher excess values since the characteristics encouraging firms to diversify are positively correlated with performance. In this case, OLS estimators, which fail to account for selectivity, would be upward biased, and thus cause overestimation of the outcomes derived from the diversification strategy. Otherwise, obtaining a negative coefficient on λ_i would mean a negative relationship between the probability of diversifying and the excess value (Dastidar, 2009).

However, the Heckman two-stage procedure is by no means free of limitations. Applying this econometric technique to model self-selection requires two specification issues (Nawata, 1993; Li and Prabhala, 2007): the assumption that the error terms are bivariate normal and the need for exclusion restrictions. Assumptions regarding the statistical distribution of the error terms are deemed to influence the sensitivity of the estimated coefficients (Puhani, 2000). This latter requirement has caused particular concerns in research. Z_{it} and X_{it} proved to be many variables in common. The existence of exclusion restrictions requires the existence of at least one variable included in the selection equation which is not contained in the outcome equation (Puhani, 2000). In practice, finding such a variable which drives a firm's decision to diversify while being uncorrelated with firm value proves a difficult task[68] (Puhani, 2000). The lack of exclusion restrictions is likely to give rise to collinearity problems (Puhani, 2000), and the Heckman estimator performs poorly in this case (Nawata, 1993, 1994). As Winship and Mare (1992) state, the accuracy of the estimates depends not only on the variance of

[68] It is worth mentioning here that it is not only necessary to have extra instruments in Z which are not contained in X, but that also the quality of the instruments is important: *"Near multicollinearity could still arise when the extra instruments in Z are weak and have limited explanatory power"* (Li and Prabhala, 2007: 46).

λ_i but also on the collinearity between X and λ_i, which in turn is determined by the existence of exclusion restrictions.

Note: For our research, we employ a modified Heckman procedure since the excess value data is available both for diversified and undiversified firms.

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