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DEPARTAMENTO DE DIRECCIÓN Y ECONOMÍA DE LA EMPRESA

Tesis Doctoral

"Essays on capital structure: Life cycle and debt specialization"

Paula Castro Castro

León, diciembre de 2015

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Doctoranda: **Paula Castro Castro**

Directores: **Alberto de Miguel Hidalgo**
Catedrático de Universidad, Economía Financiera y Contabilidad
Universidad de Salamanca
María Teresa Tascón Fernández
Profesora Titular de Universidad, Economía Financiera y Contabilidad
Universidad de León
Borja Amor Tapia
Profesor Contratado Doctor, Economía Financiera y Contabilidad
Universidad de León

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Los Dres. D. **Alberto de Miguel Hidalgo**, Dña. **María Teresa Tascón Fernández** y D. **Borja Amor Tapia**, como Directores de la Tesis Doctoral titulada ***Investigaciones sobre estructura de capital: ciclo de vida y especialización de deuda*** realizada por Dña. **Paula Castro Castro** en el programa de doctorado **Economía de la Empresa**, informan favorablemente el depósito de la misma, dado que reúne las condiciones necesarias para su defensa.

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El órgano responsable del programa de doctorado “Economía de la Empresa”, con Mención de Calidad (BOE de 12 de octubre de 2007) y Mención hacia la Excelencia (BOE de 20 de octubre de 2011) en su reunión celebrada el día 19 de octubre de 2015 ha acordado dar su conformidad a la admisión a trámite de lectura de la Tesis Doctoral titulada “***Investigaciones sobre estructura de capital: ciclo de vida y especialización de deuda***”, dirigida por los Dres. D. **Alberto de Miguel Hidalgo**, Dña. **María Teresa Tascón Fernández** y D. **Borja Amor Tapia**, elaborada por Dña. Paula Castro Castro y cuyo título en inglés es el siguiente “*Essays on capital structure: Life cycle and debt specialization”*.

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Vº Bº El Presidente de la Comisión Académica,

Fdo.: Dr. D. Mariano Nieto Antolín

A los pilares de mi vida:

mi abuelo, mi madre, y mi compañero de viaje,

por dar sentido a todo

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“Para conseguir grandes cosas, debemos no solo actuar, sino también soñar, no solo planear, sino también creer.”

Anatole France.

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ABSTRACT

The main objective of this dissertation is to provide empirical evidence about the influence of firms' life cycle stages on the capital structure in different environments. This objective is analyzed in the first part of this dissertation, divided into three chapters.

In the first chapter, we adopt a dynamic standpoint to contribute to the debate on how and why firms choose their capital structure to approximate the life cycle of the firm and financing decisions. Employing Dickinson's (2011) life cycle stages of firms, based on the distinction between operating, investing and financing cash flow types, we examine the different behavior of the traditionally found explanatory variables across the stages. Taking a wide sample of public companies form the UK, Germany, France and Spain, we find that the capital structure explanatory factors evolve across the life cycle stages, changing or rebalancing the prevalence of the static models in play, i.e., trade-off, pecking order, or market timing.

The second chapter of this dissertation analyses the effect of a firm's life cycle stages on the capital structure in tech versus non-tech firms using a wide sample of public companies from Europe. An innovative approach based on operating, investing, and financing cash flows allows us to analyze differences in leverage and specify the differential role of significant drivers of capital structure across stages in both sectors. Our results point to the information asymmetry factor posed by the pecking order as the predominant driver behind the differences in the effect of intangible assets and growth opportunities for tech firms in

some stages, mainly maturity. Frank and Goyal's (2003) test of the pecking order theory confirms the lower use of debt by tech firms during all life cycle stages. In addition, we find that the results obtained for tech firms are largely attributable to the behavior of high-tech firms with the highest growth opportunities.

The third chapter of the dissertation examines differences in target leverage and speed of adjustment across three life cycle stages of the firm: introduction, growth and maturity. We determine that profitability and tangibility are the most stable determinants, whereas growth opportunities and size exhibit changing effects across stages. The speed of adjustment increases as the firms evolve, although firms in the introduction stage are able to adjust the fastest. Firms that are changing stages adjust leverage at a lower speed, and their target is more affected by profitability, primarily when the change is from growth to maturity. Finally, we confirm the existence of long-term debt targets by providing evidence that the next-year target is a relevant factor to explain current debt when firms change from one stage to another.

The second objective of this dissertation, collected in Chapter 4, is to analyze in detail the debt structure of the firm, specifically, the increase in the concentration of the lending relationships with borrowing firms as a strategy that facilitates monitoring by creditors. Employing a sample of US listed companies; we extend the literature on how executive compensation influences a firm's capital structure. We show that an increase in any form of risk-taking incentives in CEO pay leads to a greater concentration in lending relationships (measured by the specialization of a firm's debt structure by debt type). When the risk-taking incentives are in the form of a higher sensitivity of CEO compensation to equity volatility, the tendency toward an increasing debt specialization becomes stronger in riskier firms. We also demonstrate that a higher degree of debt specialization neutralizes the loss in the market value of debt produced when CEO risk-taking incentives increase and acts as a substitute for shorter debt maturity in facilitating creditor monitoring. Overall, the results point towards creditors responding to CEO compensation schemes (designed to align the interests of CEOs and shareholders) through increased debt specialization.

Keywords

Capital structure, firm's life cycle, technology firms, pecking order theory, trade-off theory, growth opportunities, target leverage, speed of adjustment, debt specialization, executive compensation, asset substitution, corporate governance

JEL Classification

D22, D91, D92, F34, G30, G32, J33, L6, M12.

INTRODUCTION

The financing decisions and how firms develop their capital structure over time have been discussed intensively in past decades. Capital structure refers to the main sources of financing employed by a firm: debt and equity. Many factors influence strongly on the firm's capital structure being decisive to the overall risk and the cost of capital. The proportion of financing sources employed by a firm might condition its value and therefore the shareholder wealth.

The modern theory of capital structure started with the influential paper of Modigliani and Miller (1958), who showed that the firm value is independent of the capital structure under the strict assumptions of perfect and frictionless capital markets, such as no taxes, no transaction costs, no asymmetric information or expectations in homogeneous markets. Therefore, the capital structure chosen by managers cannot vary the cost of capital or the firm value. In addition, shareholder's value is not enhanced by financing decisions, which are deemed to be irrelevant.

However, ever since the irrelevance theorem of Modigliani and Miller (1958), this topic has drawn strong interest in examining and developing the theory of capital structure as well as the factors and decisions that determine it. One of the main reasons could be the role of the capital structure on the maximization of the wealth of shareholders, by decreasing the firm's weighted average cost of capital with a proper selection of financing sources.

In general, the literature on capital structure has been widely studied, providing a comprehensive discussion about the financial theory that tries to explain the corporate financial strategies, policies, and decisions taken by firms.

During past decades, the factors expected to have an impact on the capital structure decisions have been highlighted as one of the most studied topics. According to prior studies, the main factors that affect capital structure decisions are associated with the following types of frictions: taxes, bankruptcy costs, and asymmetric information.

The empirical evidence concerning the factors explaining capital structure have been analyzed around different countries (mainly the US and some European countries), varying considerably in terms of the different legal systems, the financial structures, and the economic development levels of the countries studied. These differences can be significant, especially those stemming from the cost of capital and the financial strategies in firms operating in diverse countries. Although the results of the factors explaining leverage cannot be considered conclusive, the numerous studies have provided some concurrent results. Profitability has been one of the most common factors employed to explain the firm's debt level. Myers (1984) and Myers and Majluf (1984) indicate that internal financing is preferred to debt in firms with a higher level of internally generated resources, thus supporting a negative relation between leverage and profitability. The effect of size on leverage is not so general. On the one hand, Titman and Wessels (1988) argue that relatively large firms tend to be more diversified and less likely to go bankrupt, suggesting that large firms should be more leveraged. However, the adverse selection problems are noticeably reduced in large firms (Frank and Goyal, 2003), implying a negative relation between size and leverage. Tangible assets can be used as collateral to guarantee the payment of the debt to creditors. The effect of tangibility on leverage might be positive because of the lower expected costs of distress and the fewer debt-related agency problems (Harris and Raviv, 1991). According to Jensen and Meckling (1976) and Myers (1977), firms with more investment opportunities have less leverage because they prefer to avoid the agency costs of debt (underinvestment and asset substitution) that might arise from the conflict between stockholders and bondholders.

The capital structure literature has posed two main theories, the trade-off theory and the pecking order theory (Myers 1984). The pecking order theory is explained by the notion of asymmetric information between the firm's insiders and outsiders, implying adverse selection problems (Myers and Majluf, 1984; Myers, 1984). Fama and French (2005) indicate that based on the pecking order theory, information asymmetry is an important determinant of the firms' capital structure. According to this theory, firms will not have an optimal capital structure, but first, they will use internally generated funds, then financing debt, and finally, external equity. For instance, Lemmon and Zender (2009) indicate that debt appears to be preferred to equity in the absence of debt capacity concerns. The trade-off theory explains the dependence of debt on tax policies and bankruptcy costs (DeAngelo and Masulis, 1980). Shareholders might benefit from firms having debt in their capital structure because they can use the tax shield on interest paid on debt. Chapters 1 and 2 study how and why firms choose their capital structure based on the life cycle stages of firms. According to Teixeira and Coutinho (2014), firms tend to adopt particular financing strategies as they evolve over their lifetimes; therefore, the life cycle of the firm explains the changing economic and financial behavior of the firm over its lifetime (Strebulaev, 2007). In the first two chapters, we show how the prevalence of the theories (pecking order and trade-off) changes as the firm evolves. Moreover, as industry effects are important factors for capital structure decisions, the specific characteristics of one sector can condition the choice of the capital structure. Therefore, due to the importance of industry in the study of the capital structure, Chapter 2 studies the effect of a firm's life cycle stages on the capital structure in tech versus non-tech firms.

In recent literature, there is an interesting discussion about observing which of the capital structure theories (the trade-off versus the pecking order) better describes the firms' financing choices. Shyam-Sunder and Myers (1999) test the pecking order theory, finding a better comprehensive explanation of this model on the time-series variance in actual debt ratios than a target adjustment model based on the static trade-off theory. In addition, Frank and Goyal (2003) test the pecking order theory against the static trade-off theory, not finding strong support for the pecking order model but showing robust evidence of mean reversion in leverage. Chapter 2 tests the pecking order model in tech and non-tech firms by stage, confirming the lower use of debt by tech firms during all life cycle stages.

On the other hand, the trade-off theory indicates that firms choose a target debt-equity ratio by trading off their costs and benefits of leverage. There has been strong interest in recent research to study the process of adjusting the capital structure toward the target ratio. For instance, Byoun (2008) tests the target adjustment model for firms above and below the target debt ratio, as well as for financial deficit or surplus, showing that most of the adjustments occur when firms are below the target debt with a financial deficit or above the target with a financial surplus. The results about the speed of capital structure adjustment are not conclusive in the literature. Fama and French (2002) find slow adjustments, while Gonzalez and Gonzalez (2008), using a sample of 39 countries, find variations in the partial-adjustment across countries. According to Leary and Roberts (2005), deviations from the target can then be gradually removed over time. Chapter 3 analyzes differences in target leverage and speed of adjustment across three life cycle stages of the firm: introduction, growth and maturity.

The integration between finance and corporate strategy is highlighted as one of the most important topics examined on the capital structure. In general, this literature studies how the strategic decisions of shareholders, creditors or managers, among others might affect firm value. The interactions between a firm's management and its financial (shareholders or debtholders) and nonfinancial stakeholders (competitors, suppliers, or employees, among others) may influence the corporate strategy and the capital structure, generating information asymmetries and agency problems that can alter the optimal mix between debt and equity. The prior literature discusses those interactions and the consequences for the value creation process. The relationships among managers, shareholders and debtholders and their conflicts of interest influence the capital structure and investment decisions, creating inefficient managerial decisions and suboptimal investments. The agency problems caused by the conflicts of interest among managers, debtholders and shareholders, such as underinvestment and overinvestment, have been widely studied in the capital structure literature. Underinvestment problems are the agency costs of debt linked to the relation between shareholders and debtholders or between new and old shareholders. Myers (1977) indicates that the presence of risky debt might motivate managers to reject positive net present value (NPV) projects; therefore, they underinvest, and the firm value decreases. Underinvestment might cause an asset substitution problem because shareholders refuse to invest in low-risk assets to avoid shifting wealth from themselves to debtholders. However, overinvestment might modify the risk preference of managers;

therefore, they engage in investments for their own benefit. This can produce asset substitution problems when managers replace safe activities with riskier ones or undertake new and riskier investment projects, thus transferring wealth from debtholders to shareholders (Jensen 1986; Jensen and Meckling 1976). In Chapter 4, we focus on the role of debt specialization as a tool to reduce the agency costs of debt, particularly, the asset substitution problems.

However, the interactions between non-financial stakeholders and the capital structure have been studied primarily in relation to diversification, market structure and competitiveness. Many authors have studied the link between corporate strategy and capital structure through diversification strategies, such as product diversification (Titman, 1984).

A large body of research suggests that the capital structure has important consequences for firm risk. According to Jensen and Meckling (1976) and Myers (1977), agency costs increase with the probability of financial distress; therefore, firms with higher financial leverage will perform more costly investing. There are several factors that cause the positive relationship between risk and financial leverage, such as financial distress (Titman, 1984), industry deregulation (Zingales, 1998), and market entry (Khanna and Tice, 2000).

The greatest empirical challenge in the study of capital structure is the potential endogeneity driven by the causality between financial leverage and either life cycle or managerial incentives because they may be simultaneously determined. We address the endogeneity problems by applying the two-step GMM estimator or estimating a system of simultaneous equations with the dependent and endogenous variables (Brockman et al., 2010). Furthermore, we address the reverse causality by estimating the models with instrumental variables and estimating the dependent variable on lagged values of the potentially endogenous explanatory variables (Boone et al., 2007; Faleye, 2015; Faleye et al., 2014).

Despite the extensive research on capital structure in past decades, there are still unsolved controversial issues in modern corporate finance. This doctoral dissertation, which analyzes some of them, is divided into two parts and structured in four different chapters. The first part contains chapters 1, 2 and 3 and focuses on analyzing the capital structure theories over the life cycle stages of the firm. The second part consists of chapter 4 and examines the debt structure role in mitigating the agency costs of debt by constraining managerial risk preferences.

Chapter 1, "The role of life cycle on the firm's capital structure", discusses the conventional capital structure study in the strategic dynamics of the firm and provides a review of the literature to offer an entire vision of capital structure. Specifically, in this chapter, we adopt a dynamic standpoint to contribute to the debate on how and why firms choose their capital structure. We examine the different behaviors of the traditionally found explanatory variables across the stages using Dickinson's (2011) life cycle stages of firms (introduction, growth, maturity, shake-out, and decline), based on the distinction between operating, investing, and financing cash flow types. Taking a wide sample of public companies form the UK, Germany, France and Spain for the period 1980-2011, we perform Fama-MacBeth regressions and a GMM estimator (Generalized Method of Moments). The life cycle stage factor is included either as an indicator of the stage in the general model or by performing regressions in a by-stage analysis. Our results show that the capital structure explanatory factors evolve across the life cycle stages, changing or rebalancing the prevalence of the static models in play, pecking order or trade-off theories, identifying what part of the theories appears to explain leverage in each specific life cycle stage. We contribute by analyzing why firms choose different levels of debt in different stages of their life cycles, and adding a dynamic factor (life cycle) to explain the choice of leverage by managers.

Chapter 2, "Dynamic analysis of the capital structure in technological firms based on their life cycle stages", examines the effect of a firm's life cycle on the capital structure in a specific sector: tech versus non-tech firms. We analyze differences in leverage and specify the differential role of significant drivers of the capital structure across stages in both sectors. Our sample contains firms from Austria, Belgium, France, Germany, Italy, Netherlands, Spain, and the UK from 2000 to 2012. We estimate the leverage regression as the dependent variable and the pecking order model by using the two-step GMM estimator and fixed effects, respectively. The analyses allow us to check the prevalence of the pecking order and trade-off across stages for non-tech, tech and high-tech firms. The results point to the information asymmetry factor posed by the pecking order as the predominant driver behind the differences in the effect of intangible assets and growth opportunities for tech firms in some stages, primarily maturity. Moreover, we show the potential of growth opportunities to identify smaller groups of high-tech firms concerning the capital structure. Therefore, this chapter contributes to the literature by extending the analysis of a dynamic framework, by placing the capital structure models in the changing life cycle stages of the firms. Furthermore, we present the use of growth opportunities as a discriminant factor to distinguish high-tech firms.

Chapter 3, "Target leverage and speed of adjustment along the life cycle of the firm", extends the first and second chapters by analyzing the target determinants and their speed of adjustment across three life cycle stages (introduction, growth, and maturity) of quoted firms from 14 European countries covering the period 1990-2012. With this chapter, we show how the main factors of target leverage as well as the speed of adjustment vary along the stages of the life cycle. We determine that profitability and tangibility are the most stable determinants, whereas growth opportunities and size exhibit changing effects across stages. The speed of adjustment increases as the firms evolve, although firms in the introduction stage using operating debt are able to adjust the fastest. Firms changing stage adjust leverage at a lower speed, and their target is affected more by profitability, primarily when the change is from growth to maturity. Finally, we confirm the existence of long-term debt targets by providing evidence that the next-year target is a relevant factor to explain current debt when firms change from one stage to another.

Chapter 4, "Debt specialization and managerial incentives", focuses on the role of the degree of debt specialization as a creditors' tool to mitigate the asset substitution problem. In particular, we analyze how executive compensation influences debt specialization because managerial risk preferences affect executives' portfolio sensitivities to changes in stock prices (Delta) and stock return volatility (Vega). A high degree of debt concentration might mitigate agency costs of debt by constraining managerial risk preferences. Using a large sample of listed US firms for the period 2001-2012, we analyze the impact of CEO's equity-based compensation on debt specialization. Specifically, we hypothesize and find evidence of a positive relationship between CEO portfolio Vegas and debt specialization, and a negative relationship between CEO portfolio Deltas and debt specialization. This chapter indicates that when managers are supposed to have greater incentives for asset substitution, the degree of debt specialization increases. Therefore, we show the role of the debt specialization in moderating the agency costs of debt. In addition, we show that debt maturity and debt specialization act as alternative tools in reducing the potential agency costs of debt generated by managerial incentives. Moreover, our results suggest that an increase in Vega leads to a higher degree of debt specialization in riskier firms. Using Tobit, Probit, and OLS methodologies as well as some additional robustness checks, this chapter extends the literature on the role of executive compensation in influencing a firm's capital structure. In particular, we examine the potential negative effect of equity-based compensation on creditors and their consequent potential reaction in terms of asset substitution problems by focusing on debt structure.

Finally, a summary of the main conclusions obtained from the four studies presented and future lines of research are presented.

CHAPTER ONE

THE ROLE OF LIFE CYCLE ON THE FIRM'S CAPITAL STRUCTURE*

* An earlier version of this chapter was presented at the following congresses: XV Encuentro AECA (Esposende, 2012), XIV seminario luso-español de economia empresarial CIBECEM (Salamanca, 2012), and the 36th Annual Congress EAA (Paris, 2014)

1.1. Introduction to the first chapter

The theory on why firms choose differing combinations of debt and equity to finance their operations is one of the most contentious issues in finance, but research on capital structure has not proved conclusive. The main theories in play have identified some general factors to explain the level of equity or debt, even though their predictions for some of the factors are the opposite. In fact, empirical evidence has generally converged in very scarce relations, such as the negative effect of profitability or liquidity on leverage. Frequently, when empirical analyses are performed, results find weak or no support concerning the economic effect of specific variables or the resulting effect may be different from previous evidence.

Graham and Leary (2011) point to ‘capital structure dynamics not adequately considered’ as one of the empirical shortcomings in this area. Frank and Goyal (2009) suggest that different theories of capital structure apply to firms under different circumstances and each factor could be dominant for some firms or in some circumstances, yet unimportant elsewhere.

On the other hand, in the last years a theory on the firm’s life cycle is being developed in finance, to explain the changing economic and financial behavior of the firm along its life (Strebulaev, 2007), even though the life cycle theory has traditionally been developed in strategic management.

Our work starts from the idea of a dynamic evolution of the firm: across the stages, investment/disinvestment needs, profitability, cash flow generation or risk change; consequently, financing needs and motivations are different, as well as the firm’s debt capacity with banks or in financial markets.

Our objective is to integrate a conventional capital structure study into the strategic dynamics of the firm. The question is if the combination of factors explaining each life stage is behind non lineal relations of leverage with firm characteristics. A comprehensive analysis of the relevant factors explaining the firm's capital structure in the classical theories, that is, the tradeoff and the pecking order, offers size, age, tangible assets, growth, profitability, risk, R&D as the main elements. And, precisely, investment/disinvestment, growth, profitability, together with a parsimonious increase in age and size, are key factors to distinguish the life cycle stages of the firm. Therefore, a high grade of coincidence among variables are found significant by empirical works in approximating both life cycle and leverage.

A difficulty in raising this conceptually simple test is the empirical definition of life cycle stages. Previous literature has not agreed on the number of stages, their names and conditions. To cope with this problem, we have followed the novel work of Dickinson (2011) in which life cycle stages are built starting from accounting information on operating, investing, and financing cash flows, as the author carefully explores the relation with life cycle fundamentals.

Using an international sample (UK, Germany, France and Spain), extracted from the Worldscope database, for the period 1980-2011 we perform Fama-MacBeth regressions as well as GMM to test our hypotheses about the role of the life cycle stages on the firms' leverage. Our results confirm the relevant role of the factor and provide information on the differential effect of variables across stages. This constitutes our main contribution: why firms choose different levels of debt in different stages of their life-cycles. Unlike the previous study by La Rocca et al. (2011) in which age is the criterion to distinguish between three life cycle stages, we use a measure that considers the ability of generating cash flows at the different business levels of the firm (operating, investing, and financing). And this criterion allows us to identify five stages. Even though age is a good proxy of the life cycle stage in many cases, some operating, investing and financing events induce the change from one stage to another independently of the age of the firm, what gives a higher discriminant potential to the variable we use. Besides, our work is applied to quoted firms while in La Rocca et al. (2011) only small and medium-sized firms are considered.

Therefore, we contribute to two main research lines (capital structure and business life cycle), by adding a dynamic factor to explain the choice of leverage by managers. Our results support fundamental theories of capital structure, namely tradeoff, pecking order, and market timing, but in addition we show how the prevalence of the theories changes as the firm evolves.

The chapter is structured as follows: Section 2 reviews the related literature on life cycle theory and capital structure, and develops our hypotheses. Section 3 explains the life cycle stages measurement, poses the model, and introduces the selected variables starting from previous evidence. Section 4 discusses the sample and descriptive statistics. Section 5 shows the results, Section 6 presents the robustness analyses and finally the conclusions are reported in Section 7.

1.2. Theoretical background and hypotheses

We synthesize related insights from two distant academic fields, strategic management and corporate finance. As for the organizational life stage of firms, we focus on the changing role of some features of the firm along the life cycle, with more interest in those related to leverage. Concerning the capital structure, we make a brief review of the main theories and the empirical results obtained on firms' leverage choices in order to identify which economic forces are found more explanatory in different stages of the firms.

1.2.1. Leverage in the life cycle theory

The firms' life cycle has been widely treated since the 1970s within the area of organization. But the notion of life stage seems to be elusive, and empirical literature has used a varied number of classifications, ranging from two (Bulan and Yan, 2010) or three stages to as many as ten (Adizes, 1999). This varied number of stages is the first reason for some lack of consistence in results across studies. The second, and more relevant, reason is the different criteria in classifying the stages. Thus, for two classifying models a firm may be placed in close but non-equivalent stages.

A good work of reference in the search of common stages in the early literature is Miller and Friesen (1984). They find convergence in five life stages: birth, growth, maturity, revival, and decline. Fundamentals changes in key internal and/or external factors distinguish and identify each firm life cycle stage. This conceptual model is followed by Dickinson (2011) who empirically demonstrates that, consistent with theory, profitability and growth vary, cross-sectionally and over time, as the firm progresses through life stages.

Most part of the varied proxies for life cycle indicate changes in specific factors of the operating activities of the firms, such as investment (Wernerfelt, 1985), or product efficiency (Spence, 1977). Concerning the changes in the financial activities of the firms, retained earnings has been used by DeAngelo et al. (2006) or Kim and Suh (2009). But Miller and Friesen (1984) find that inter-stage differences come from the interaction among the strategy, the structure, the environment, and the decision-making style, what suggests that several factors should be considered jointly in defining stages. That is why we use as reference the comprehensive model by Dickinson (2011).

Concerning the relation with leverage, there is very little theory to explain the differences in financing across the stages of the firms' life cycles, as Fluck (1999) points out. The empirical evidence is nowadays incipient, being still scarce even in grey literature. Factors such as size, age, profitability, tangible assets, retained earnings (all of them used by Bulan and Yan, 2010), or dividends (DeAngelo et al., 2006), show different leverage patterns when firms are mature, as the maturity effect is related to debt capacity or affordability.

Bulan and Yan (2010) identify firms in two stages, growth and maturity, finding that the pecking order theory (based on the information asymmetry between investors and firm managers) better describes the financing behavior of mature rather than growing firms. Using a different life stage model, both Frielinghaus et al. (2005) and Teixeira and Coutinho (2014) find results consistent with the pecking order theory and confirm that firms tend to adopt specific financing strategies as they progress along their lives. And analyzing why small firms have different capital structure from large firms, in a theoretical model of optimal financial contracting, Fluck (1999) points to the stage-dependency of the control rights of claimholders.

Unlike the little (and mostly implicit) reference given to different life stages in previous theoretical and empirical literature on capital structure, the non-linear behavior of the explanatory variables, frequently pointed out, let us pose our first hypothesis.

H1: The life cycle stages of the firm, measured from the accounting cash flow, is a relevant explanatory factor in the change of the capital structure of the firm, proxied by its leverage.

1.2.2. Leverage in certain life stages according to the static capital structure theories

There are two traditional theories on capital structure choice, namely the pecking order theory and the trade-off theory, generally considered mutually exclusive. A more recent third theory, called market timing, is applied as complementary to any of the two.

The trade-off theory postulates that firms choose leverage by balancing benefits and costs of using debt, being taxation and bankruptcy costs the key features. Some of previous empirical results on the trade-off theory are implicitly related to life stages. They suggest that firms in pre-mature (introduction and growth) stages cannot afford debt as their bankruptcy costs are high, their earnings are too low to use the tax benefit of increasing interest payments, and earnings are not stable yet[1]. At the end of firms' life cycle, when they are likely to suffer a decrease in earnings (and consequently a decrease in the tax shield benefit from using debt) Frielinghaus et al. (2005) derive a lower use of debt. Hence, the static trade-off theory would suggest a low-high-low pattern across the life cycle stages of the firm.

According to the pecking order theory, the firm has no optimal capital structure. The theory upholds a financing hierarchy of retained earnings, debt, and then equity, in order to minimize adverse selection costs of security issuance. This is the result of the existence of asymmetric information.

Some previous empirical results on the pecking order theory are also implicitly related to life stages. The inverse relation between leverage and profitability (Fama and French, 2002) supports the view that debt is only issued when retained income is insufficient to finance investment. Helwege and Liang (1996) find that the least risky firms are the most likely to issue public bonds, but those firms that issue equity are not riskier than firms that obtain bank debt. Frank and Goyal (2003) and Lemmon and Zender (2010) confirm that the greatest support for the pecking order is found among larger and mature firms[2], while frequent issues by small high-growth firms are consistent with debt capacity concerns. Fama and French (2005) find that in listed US firms, net issuers of equity are less profitable and grow faster, while low-growth firms with positive profitability do not issue or retire much equity, though large fractions of firms of all types seem to make equity decisions inconsistent with the pecking order. In short, the pecking order theory suggests a high-low-high pattern of debt ratio across stages (in contrast to the static trade-off theory).

[1]Graham (2000) finds that those firms with unique products, low asset collateral or large future growth opportunities –presumably at introduction or growth stages- tend to show lower levels of leverage. Besides, the group of larger, more liquid, and more profitable firms with fewer expected distress costs use debt conservatively. Opler and Titman (1994) find that more leveraged firms engaged in R&D -presumably in pre-mature stages- suffer economically distressed periods in a more intense way. Bradley et al. (1984) identify volatility of firm earnings as a relevant, inverse determinant of firm leverage, which points out to lower leverage in less stable firms (likely, younger firms).

[2]It has to be highlighted that the original theory was geared towards mature low growth-option firms.

As for the equity market timing, two different ways have been put forward to supply conditions affecting the equity issuance (Graham and Leary, 2011). On the one hand, managers can exploit deviations of market prices from fundamental value (Baker et al., 2003). On the other, the issue costs would be lower when prices are higher, if adverse selection costs are negatively correlated with market returns (Bayless and Chaplinsky, 1996). Previous literature findings may be useful in our subsequent life cycle analysis, such as the positive correlation between equity issuance and market returns (Hovakimian et al., 2001) or the fact that issuance decisions are much more sensitive to estimated risk premium (Huang and Ritter, 2009).

Therefore, different but economically sound theories explain the firm's relation among explanatory factors and capital structure giving often rise to contrary signs (for samples differing in aspects such as period, geographical zone, industry, size, age, etc.). The coincidence of those changes in variables related to the life cycle of the firm with those other changes in the capital structure of the firm, let us pose our second and third hypotheses.

H2: The prevalence of the traditional capital structure theories changes as the firm evolves through its life cycle.

H3: The trade-off / pecking order / market timing theory is better (less) able to explain the determinants of firm leverage in each of the five life cycle stages identified by the accounting cash flows.

1.3. Research design

To distinguish among the different life cycle stages the firms go through, we follow the Dickinson's (2011) approach, which is explained in section 3.1. Then, we proceed to propose our model and to explain the variables in it.

1.3.1. Measure of life cycle stages

Based on previous classifications of life cycle stages of the company, Dickinson (2011) establishes five stages of life. The first stage is called introduction. In it the firm produces an innovation. In the second stage, called growth, the firm rises rapidly, as a lot of figures, such as assets, equity, or sales, indicate. During the third stage, maturity, the company reaches its maximum number of producers. In the fourth stage, shake-out, the firm loses part of its producers. And, finally, during the fifth stage, decline, the company shows virtually no entries.

But the model used to discriminate among the life cycles is innovative. Dickinson (2011) uses accounting information extracted from the Cash Flow Statement. The three net cash flow activities (operating, investing, and financing) can take a positive or negative sign, resulting in eight possible combinations, which are regrouped by the author into the five stages previously selected in accordance with literature giving rise to the model showed in Table 1.

Table 1. Life Cycle Stage Model

Cash Flow Type	Introduction	Growth	Mature	Shake-Out	Decline
Operating	-	+	+	+/-	-
Investing	-	-	-	+/-	+
Financing	+	+	-	+/-	+/-

As Dickinson (2011) states, the combination of those cash flow patterns represents the firm's resource allocation and operational capabilities interacted with the firms' choice in strategy. One of the most appealing aspects of this model is that the author's predictions about each cash flow component as a proxy for life cycle are challenged to be consistent with economic theory. That is, the author confirms that economic characteristics vary with life stages as determined by cash flow patterns, but also by a previous classification of reference (Anthony and Ramesh, 1992).

1.3.2. Model on capital structure across life cycle stages

Our model starts from the conventional empirical analysis, in which leverage is regressed on several explanatory factors. In our case, the selected factors are: profitability (denoted Prof), market to book (denoted MtoB), liquidity, size, non-debt tax shields (denoted NDTS), tangible assets (denoted Acttan), and Age. In addition, the equation includes a new factor, life cycle stage (denoted LCSR).

$$TDA_{it} = \alpha + \beta_1 LCSR_{it} + \beta_2 Prof_{it} + \beta_3 MtoB_{it} + \beta_4 Liquidity_{it} + \beta_5 Size_{it} + \beta_6 NDTS_{it} + \beta_7 Acttan_{it} + \beta_8 Age_{it} + \varepsilon_{it} \quad (1)$$

Where TDA_{it} is the leverage of firm *i* in year *t*, α_0 is the independent term and β are the coefficients of the variables taken as explanatory factors. LCSR ranges from 1 to 5 indicating the stage of the life cycle, according to Dickinson (2011): introduction (1), maturity (2), growth (3), shake-out (4), and decline (5).

The variables included in our model have been selected after considering the factors that the traditional capital structure theories have posed as explanatory variables of leverage, and the factors that determine the firms' stages according to the life cycle theory. In this section we examine the previous behavior of those factors when used in capital structure models even if they were proxied by similar but not the same variables.

Financial leverage is our proxy for capital structure and works as the dependent variable in our model. We have selected book leverage, computed as the ratio of total debt over total assets.

Profitability and growth are key factors of the financing deficit (Fama and French, 2005). Profitability is computed as the ratio of earnings before interest, taxes, depreciation, depletion, and amortization over total assets. As seen in section 2, profitability plays a role in determining the firm's leverage in both models, tradeoff and pecking order. Given that profitable firms face lower expected bankruptcy costs and are in better conditions to take advantage of interest tax shields, the tradeoff theory predicts the use of more debt. Also, as profitable firms could face free cash flow problems (Jensen, 1986), they will appreciate the discipline provided by debt, from the agency cost perspective. But, after examining the reasoning developed by authors incorporating the life cycle dynamic point of view, a low-high-low pattern is expected across the stages. That is, the prediction of the static tradeoff theory should work mainly in mature firms. Notwithstanding, the empirical evidence shows a pervasive regularity in the inverse relation between leverage and profitability (Myers, 1993), consistent with the pecking order idea that higher profitability enables firms to use less debt (considering investment fixed). The inverse relation has also been confirmed by the recently applied dynamic models of optimal structure (Strebulaev, 2007).

We proxy expected growth by using market to book, computed as market value of equity plus debt in current liabilities plus long-term debt plus preferred stocks, minus deferred taxes and investment tax credit over total assets. For the tradeoff theory, growth means higher bankruptcy costs, lower free cash flow problems, and exacerbated debt agency problems, that imply less debt (Frank and Goyal, 2009). Consistently, empirical evidence has found lower debt in firms with future growth opportunities (Rajan and Zingales, 1995 and Bauer, 2004) and more volatility in earnings (Bradley et al., 1984). On the contrary, the pecking order theory would predict more debt when firms expect to grow, as new investments require additional funds, holding profitability fixed. This variable is the most reliable as proxy for growth opportunities (Adam and Goyal, 2008), although it can be biased by stock mispricing. Considering the third capital structure theory in play, market timing, with higher values of the market-to-book ratio, firms would issue more equity in order to exploit the favorable market conditions, what would mean less debt proportion.

Liquidity is computed as the ratio of current assets to current liabilities. The reasoning behind the relation between liquidity and leverage is twofold. On the one hand, more liquidity reduces the need to take on debt. Also, Ozkan (2001) puts down this negative relationship to the potential conflicts between shareholders and bondholders, as liquidity of the firm's assets may proxy the opportunistic behavior by shareholders at the expense of debtholders. On the other, liquidity can induce more debt, as a positive sign for lenders on the debt capacity of the firm. Previous empirical results point out to a negative relation as prevalent.

Size is computed as the logarithm of total assets. Considering the lower bankruptcy costs due to higher diversification in larger firms, the trade-off theory predicts relatively more debt, though the issue costs decrease with firm size, both for equity and bonds (Lemmon and Zender, 2010). In addition, size is a sign of the firms' strength for lenders, since assets are considered as collateral (Fama and French, 2002). On the contrary, the pecking order theory predicts an inverse relation to leverage, as the adverse selection problems considerably decrease in large firms (Frank and Goyal, 2003). Most empirical evidence has supported the positive relation between size and leverage (Rajan and Zingales, 1995 and Bauer, 2004) though others do not find this relation significant (Teker et al., 2009).

Non-debt tax shield is computed as the ratio of depreciation, depletion and amortization to total assets. Some authors (DeAngelo and Masulis, 1980; Ramlall, 2009) suggest that the non-debt tax shields are a substitute for the tax benefits of debt financing. Thus, for the trade-off theory a negative relation to leverage is predicted. An alternative explanation can be posed from the pecking order theory. In it, a positive relation with leverage would be predicted since non-debt tax shields work as a proxy for the firms' assets, indicating affordability or debt capacity of the firm. Several empirical works (Bradley et al., 1984) identify a direct relation between firm leverage and the relative amount of non-debt tax shields, while others find a negative relation (for example Ozkan, 2001).

Tangibility is computed as the ratio of property, plant and equipment to total assets. The trade-off theory predicts a positive relation between tangible assets and leverage, considering the lower expected costs of distress and fewer debt-related agency problems. On the contrary, the pecking order theory points to low information asymmetry associated with tangible assets as a cause of less costly equity issuances. The lower proportion of debt would imply a negative relation to leverage. Rajan and Zingales (1995) take into consideration that tangibility increases adverse selection (about assets in place) which would result in higher debt. This way tangibility would be a form of secured collateral. Frank and Goyal (2009) attribute the ambiguity under the pecking order theory to the fact that tangibility can act as a proxy for different economic forces. In this line, Faulkender and Petersen (2006) reason out that the firms with higher tangibility ratios are more likely to have a bond rating, what would induce higher leverage. Empirical works find evidence of the positive relation between tangible assets and leverage (Rajan and Zingales, 1995), however, others find a negative relation (Weill, 2004).

Age is computed as the logarithm of the difference between the year t and the year in which the firm was founded. In the trade-off theory, age is considered to reflect a stronger firm's market base. The firm better manages its cash flows, requiring less debt (Ramlall, 2009). Concerning the pecking order, age is considered as a proxy for the informational transparency of the firm, the lower risk, and also for the predictability of its cash flow, being the three indicators of debt capacity (Bolton and Freixas, 2000). Previous empirical evidence is not conclusive about the relation between the firm's age and its leverage. Perhaps, the reason behind is that capital structure may be a non-linear function of the firm's age, as found in Brewer et al. (1996).

1.4. Sample and descriptive statistics

1.4.1. Sample

We take from Worldscope database all the non-financial firms from UK, Germany, France and Spain from 1980 to 2011 (57,195 firm-year observations). As life cycle is proxied using the information extracted from the Cash Flow Statements, and these data are not available before 1989, our resulting sample has been reduced to those firms with required data in the period 1989-2011. In order to avoid the effects of outliers, we winsorize variables with a higher standard deviation (profitability, market to book, liquidity and non-debt tax shield) at the bottom and top 1% of their distributions.

1.4.2. Descriptive statistics

Table 2 reports the descriptive statistics by countries. Mean leverage ranges from 22.5% in Germany to 26.5% in Spain, while median values range from 12.6% in UK to 25.9% in Spain. Spain shows the highest values not only in leverage, but also in size, and tangible assets, and the lowest values in liquidity and age. We can see that profitability median values converge to 10-11% in the countries analyzed. Looking at the mean values of the dummies representing the life cycle stages, we have to highlight that the growth and mature stages group most companies in every country, ranging from 58% in Great Britain to 75% in France. A stable 9% of firms are classified in the shake-out stage. A higher and more variable proportion belongs to the introduction stage. And the lowest proportion of firms is classified in the decline stage in every country.

Table 2. Descriptive Statistics by Country (Germany, Spain, France, and UK)

Country	Variable	Obs.	Mean	St.Dev	p50	p90	p10	Max	Min
DEU	TDA	10932	0.2247	0.9088	0.1622	0.4740	0.0000	62.7115	0.0000
	Prof	10678	0.0803	0.2199	0.1130	0.2434	-0.0787	0.4917	-1.6004
	MtoB	6784	1.3195	1.5996	0.8569	2.5326	0.4068	12.4257	0.1057
	Liquidity	10578	2.5430	3.2509	1.6787	4.5460	0.7799	27.3972	0.1718
	Size	10932	11.5865	2.3066	11.4153	14.5367	8.8893	19.3928	-6.9078
	NDTS	10795	0.0601	0.0484	0.0488	0.1157	0.0145	0.2558	0.0000
	Acttan	10905	0.2504	0.2051	0.2092	0.5404	0.0222	0.9862	0.0000
	Age	10917	2.4733	1.3681	2.3026	4.5433	0.6931	4.9416	0.0000
	Introduction	7436	0.1787	0.3831	0.0000	1.0000	0.0000	1.0000	0.0000
	Growth	7436	0.2639	0.4407	0.0000	1.0000	0.0000	1.0000	0.0000
	Maturity	7436	0.4130	0.4924	0.0000	1.0000	0.0000	1.0000	0.0000
	Shake-out	7436	0.0917	0.2886	0.0000	0.0000	0.0000	1.0000	0.0000
	Decline	7436	0.0527	0.2235	0.0000	0.0000	0.0000	1.0000	0.0000
ESP	TDA	1952	0.2649	0.1771	0.2588	0.4845	0.0368	2.0575	0.0000

	Prof	1933	0.1093	0.1029	0.1098	0.2045	0.0250	0.4917	-0.9856
	MtoB	1584	1.1758	1.0897	0.8829	2.0436	0.4797	12.4257	0.1057
	Liquidity	1892	1.4249	1.0935	1.2140	2.2842	0.6734	20.0841	0.1718
	Size	1952	13.2065	1.9200	13.0214	15.8463	10.8067	18.6365	5.9022
	NDTS	1940	0.0411	0.0280	0.0380	0.0694	0.0123	0.2558	0.0000
	Acttan	1951	0.3733	0.2335	0.3481	0.6917	0.0833	0.9703	0.0002
	Age	386	1.9815	1.3424	1.9459	3.8918	0.0000	4.7362	0.0000
	Introduction	740	0.1189	0.3239	0.0000	1.0000	0.0000	1.0000	0.0000
	Growth	740	0.3649	0.4817	0.0000	1.0000	0.0000	1.0000	0.0000
	Maturity	740	0.3824	0.4863	0.0000	1.0000	0.0000	1.0000	0.0000
	Shake-out	740	0.0892	0.2852	0.0000	0.0000	0.0000	1.0000	0.0000
	Decline	740	0.0446	0.2066	0.0000	0.0000	0.0000	1.0000	0.0000
FRA	TDA	10220	0.2169	0.2217	0.1895	0.4291	0.0137	6.9331	0.0000
	Prof	9811	0.1005	0.1622	0.1112	0.2292	-0.0053	0.4917	-1.6004
	MtoB	8377	1.1941	1.2972	0.8252	2.2121	0.4158	12.4257	0.1057
	Liquidity	10045	1.7480	1.7177	1.3725	2.7555	0.8464	27.3972	0.1718
	Size	10220	11.8131	2.4951	11.4387	15.4759	8.9028	19.2912	2.9877
	NDTS	10130	0.0490	0.0416	0.0403	0.0911	0.0115	0.2558	0.0000
	Acttan	10205	0.1866	0.1773	0.1334	0.4228	0.0188	0.9986	-0.0081
	Age	12989	2.5472	1.0405	2.7081	3.7842	1.0986	4.5109	0.0000
	Introduction	6859	0.1161	0.3203	0.0000	1.0000	0.0000	1.0000	0.0000
	Growth	6859	0.2967	0.4568	0.0000	1.0000	0.0000	1.0000	0.0000
	Maturity	6859	0.4578	0.4983	0.0000	1.0000	0.0000	1.0000	0.0000
	Shake-out	6859	0.0959	0.2945	0.0000	0.0000	0.0000	1.0000	0.0000
	Decline	6859	0.0335	0.1800	0.0000	0.0000	0.0000	1.0000	0.0000
GBR	TDA	19542	0.2483	2.1644	0.1260	0.4248	0.0000	170.20	0.0000
	Prof	19260	0.0060	0.3441	0.1003	0.2416	-0.3112	0.4917	-1.6004
	MtoB	17496	1.7342	2.0401	1.0825	3.4377	0.4740	12.4257	0.1057
	Liquidity	19212	2.5257	4.0282	1.4170	4.3796	0.6169	27.397	0.1718
	Size	19542	11.0702	2.4396	10.8988	14.3372	8.2037	19.436	-5.9227
	NDTS	19405	0.0430	0.0401	0.0346	0.0841	0.0050	0.2558	0.0000
	Acttan	19314	0.2690	0.2441	0.2100	0.6509	0.0153	2.5541	0.0000
	Age	21735	2.6165	1.2982	2.5649	4.3944	0.6931	4.8828	0.0000
	Introduction	16375	0.2493	0.4326	0.0000	1.0000	0.0000	1.0000	0.0000
	Growth	16375	0.2294	0.4205	0.0000	1.0000	0.0000	1.0000	0.0000
	Maturity	16375	0.3571	0.4791	0.0000	1.0000	0.0000	1.0000	0.0000
	Shake-out	16375	0.0962	0.2949	0.0000	0.0000	0.0000	1.0000	0.0000
	Decline	16375	0.0680	0.2518	0.0000	0.0000	0.0000	1.0000	0.0000
Total	TDA	42646	0.2355	1.5400	0.1557	0.4445	0.0000	170.20	0.0000
	Prof	41682	0.0521	0.2751	0.1075	0.2376	-0.1550	0.4917	-1.6004

MtoB	34241	1.4941	1.7782	0.9534	2.8965	0.4418	12.426	0.1057
Liquidity	41727	2.2930	3.3257	1.4451	3.8213	0.7156	27.397	0.1718
Size	42646	11.4784	2.4483	11.2776	14.7684	8.5794	19.436	-6.9078
NDTS	42270	0.0487	0.0429	0.0391	0.0947	0.0091	0.2558	0.0000
Acttan	42375	0.2492	0.2234	0.1945	0.5762	0.0187	2.5541	-0.0081
Age	46027	2.5577	1.2516	2.5649	4.3307	0.6931	4.9416	0.0000
Introduction	31410	0.2004	0.4003	0.0000	1.0000	0.0000	1.0000	0.0000
Growth	31410	0.2555	0.4361	0.0000	1.0000	0.0000	1.0000	0.0000
Maturity	31410	0.3929	0.4884	0.0000	1.0000	0.0000	1.0000	0.0000
Shake-out	31410	0.0949	0.2931	0.0000	0.0000	0.0000	1.0000	0.0000
Decline	31410	0.0563	0.2305	0.0000	0.0000	0.0000	1.00000	0.0000

Notes: TDA is book leverage (total debt / total assets); Prof is profitability (EBITDA / total assets); MtoB is market to book (market value of equity + debt in current liabilities + long-term debt + preferred stocks - deferred taxes and investment tax credit to total assets); Liquidity is current assets to current liabilities; Size is the logarithm of total assets; NDTS is non-debt tax shield (depreciation, depletion and amortization to total assets); Acttan is tangibility (property, plant and equipment / assets); Age is the logarithm of the years after the firm foundation; LifeD1-5 are dummy variables indicating the stage of the life cycle, according to Dickinson (2011): introduction (1), maturity (2), growth (3), shake-out (4), decline (5). LifeD1-5 takes the value 1 if the firm is in the stage and 0 otherwise.

Table 3 provides the correlations between variables for the whole sample. None of the variables are strongly correlated. We can appreciate that profitability appears as the most influential factor on leverage, with a negative relation; and market to book is the second influential factor with positive relation. Also, the variables most influential in certain life stages are age, profitability, market to book, and size.

Table 3. Correlation analysis.

Panel A. Comprehensive Correlation Analysis.

	TDA	Prof	MtoB	Liquidity	Size	NDTS	Acttan	Age	LCSR
TDA	1								
Prof	-0.1216*	1							
MtoB	0.1113*	-0.2764*	1						
Liquidity	-0.0483*	-0.1122*	0.1749*	1					
Size	-0.0473*	0.3516*	-0.3040*	-0.1949*	1				
NDTS	0.0264*	-0.0555*	-0.0038	-0.1734*	-0.0576*	1			
Acttan	0.0123*	0.1446*	-0.1558*	-0.2121*	0.2749*	0.2064*	1		
Age	0.0052	0.2105*	-0.1984*	-0.1762*	0.2596*	-0.0004	0.2181*	1	
LCSR	0.0256*	0.1533*	-0.1264*	-0.0994*	0.1071*	0.0218*	0.0368*	0.1921*	1

* indicates significance at the 0.05 level.

Panel B1. By-Stage Correlation Analysis: Introduction.

	TDA	Prof	MtoB	Liquidity	Size	NDTS	Acttan	Age
TDA	1							
Prof	-0.1952*	1						
MtoB	0.0807*	-0.3923*	1					
Liquidity	-0.1667*	0.0306*	0.1496*	1				
Size	-0.1108*	0.5086*	-0.3956*	-0.0633*	1			
NDTS	0.1667*	-0.2656*	0.0398*	-0.2548*	-0.1635*	1		
Acttan	0.1120*	0.0301*	-0.1457*	-0.2309*	0.1465*	0.1624*	1	
Age	0.1004*	0.1481*	-0.1425*	-0.2157*	0.2153*	0.014	0.1216*	1

* indicates significance at the 0.05 level.

Panel B2. By-Stage Correlation Analysis: Growth.

	TDA	Prof	MtoB	Liquidity	Size	NDTS	Acttan	Age
TDA	1							
Prof	-0.1454*	1						
MtoB	-0.1432*	0.1473*	1					
Liquidity	-0.0752*	-0.011	0.1747*	1				
Size	0.0290*	0.0613*	-0.1941*	-0.1597*	1			
NDTS	0.0026	0.1062*	-0.0428*	-0.1316*	-0.0895*	1		
Acttan	0.0861*	0.0266*	-0.1201*	-0.1757*	0.2331*	0.0962*	1	
Age	0.1013*	0.0440*	-0.1511*	-0.1454*	0.2492*	-0.0092	0.1417*	1

* indicates significance at the 0.05 level.

Panel B3. By-Stage Correlation Analysis: Mature.

	TDA	Prof	MtoB	Liquidity	Size	NDTS	Acttan	Age
TDA	1							
Prof	-0.1096*	1						
MtoB	-0.0637*	0.4299*	1					
Liquidity	-0.3027*	0.0747*	0.0644*	1				
Size	0.2293*	-0.0368*	-0.0800*	-0.1872*	1			
NDTS	0.1484*	0.1244*	-0.0078	-0.1179*	-0.0621*	1		
Acttan	0.2450*	0.0502*	-0.0923*	-0.1693*	0.2202*	0.2375*	1	
Age	-0.0563*	-0.0272*	-0.1347*	0.0198*	0.1422*	-0.0538*	0.1568*	1

* indicates significance at the 0.05 level.

Panel B4. By-Stage Correlation Analysis: Shake-out.

	TDA	Prof	MtoB	Liquidity	Size	NDTS	Acttan	Age
TDA	1							
Prof	0.0514*	1						
MtoB	0.1678*	-0.1534*	1					
Liquidity	-0.1274*	-0.0756*	0.0927*	1				

Size	0.0206	0.3310*	-0.2643*	-0.1766*	1			
NDTS	0.0235	-0.2014*	0.0179	-0.1333*	-0.1129*	1		
Acttan	0.1142*	0.1267*	-0.1124*	-0.1920*	0.2391*	0.1609*	1	
Age	0.0017	0.1869*	-0.1170*	-0.1041*	0.2662*	-0.1233*	0.1692*	1

* indicates significance at the 0.05 level.

Panel B5. By-Stage Correlation Analysis: Decline.

	TDA	Prof	MtoB	Liquidity	Size	NDTS	Acttan	Age
TDA	1							
Prof	-0.1785*	1						
MtoB	0.2574*	-0.4388*	1					
Liquidity	-0.0583*	0.0600*	0.0426	1				
Size	-0.1682*	0.5011*	-0.5730*	-0.0750*	1			
NDTS	0.0285	-0.2293*	0.0173	-0.2446*	-0.0527*	1		
Acttan	-0.0432	0.1193*	-0.1230*	-0.2195*	0.1524*	0.2134*	1	
Age	0.0523	0.1630*	-0.0971*	-0.1930*	0.1429*	-0.0959*	0.1838*	1

* indicates significance at the 0.05 level.
Notes: TDA is book leverage (total debt / total assets); Prof is profitability (EBITDA / total assets); MtoB is market to book (market value of equity + debt in current liabilities + long-term debt + preferred stocks - deferred taxes and investment tax credit to total assets); Liquidity is current assets to current liabilities; Size is the logarithm of total assets; NDTS is non-debt tax shield (depreciation, depletion and amortization to total assets); Acttan is tangibility (property, plant and equipment / assets); Age is the logarithm of the years after the firm foundation.

Significant correlations point to interesting linkings. Size and age correlate positively in every stage. However the correlation with leverage shows different patterns (more leveraged firms seem to be smaller but nothing can be stated about their age), indicating that a deeper analysis is needed. When we go through correlations across the life cycle stages of the firm, a non-lineal relation of size and age with leverage is suggested. And even more interesting, size and age do not behave similarly across stages. Smaller firms are more leveraged just in the introduction and decline stages while younger firms are more leveraged just in maturity.

Contrary to logical expectations, profitability and expected growth are negatively correlated. But this is not a stable relation across stages. During growth and maturity, profitable firms are expected to grow, as market prices reflect. The more profitability, the more liquidity is expected; and the more liquidity the firm gets, the less indebtedness needed. Though this commonly accepted idea is supported in general by data, the by-stage analysis shows some relevant nuances:

- During the growth stage, the relation between profitability and liquidity is not significant, suggesting that those resources obtained with profitability are being used mostly in the growing process. Therefore, in this certain stage, more profitability (value creation) does not mean more spare money (affordability).

- During the shake-out stage, the profitability-liquidity relation is negative, but in this case these variables show an opposite-sign relation with leverage. More profitability does not mean more liquidity, indicating that the shake-out process is only developed when the firm is profitable.

The tangible assets variable shows a consistent positive relation with size, age, profitability, and non-debt tax shield, while negative with market-to-book and liquidity across stages. As for the relation with leverage, more tangible assets imply more debt except for the decline stage, where the firm is expected to reduce its tangible assets.

Concerning market-to-book, consistently, more ability to grow is showed by companies with fewer tangible assets or less size and age. The relation with liquidity is positive, except in the decline. There is also a positive relation with debt (in general) except in growth and maturity in which companies need less debt. And it is precisely in these stages when market-to-book shows a negative relation with leverage. Descriptive statistics suggest that as a general standpoint the market expectation of growth allows the company to get more debt. But during growth and maturity, the higher profitability makes the company able to finance new investments by its own, not requiring additional leverage.

Finally, non-debt tax shield shows a stable negative relation across stages with size, age, and liquidity, and a positive relation with tangible assets. This is consistent with more depreciation of assets every year: when the company gets older and bigger the proportion between tangible assets and liquidity changes, proportionally reducing depreciation items.

1.5. Results

In this section, we document the role played in the evolution of leverage by the life cycle stages of the firm. Fama and MacBeth regressions (1973) are used to study the effects of commonly found relevant factors on the leverage of firms. Then, we perform a second group of regressions using the comprehensive model by life stage.

Table 4 shows that adding the life cycle stage variable to the rest of selected factors makes a contribution in the explanatory ability of the model (column 2). Unlike univariate analysis, in which all the variables but age showed a significant relation with leverage, using the Fama-MacBeth multivariate analysis, significance is different: size, non-debt tax shield, and tangible assets seem to exert no relevant influence on leverage, while age is significant at 10%. When we run regressions by stage (columns 3 to 7) we observe that all the variables play a role in explaining leverage, consistently with previous literature on capital structure, though the role is different depending on the stage. As expected, non-linear relations can explain the lack of significance of some relevant factors, when general regressions are performed.

By stage (columns 3-7), the higher R2 indicates a considerable improvement in the model specification in respect to the general model (column 1), even in respect of that general model including the life cycle stage variable as explanatory variable (column 2). This way, we confirm our first hypothesis. Thus, if we examine by-stage coefficients in detail we can better analyze the effect of explanatory factors on profitability. General regressions leave those relations with non-linear patterns across stages partially unexplained (in the best case).

Consistent with previous evidence, profitability shows a strong inverse relation with leverage in the general regression (Table 4, column 1), consistent with Bauer´s (2004) results. By stages, we find that the inverse relation is significant during growth and maturity, but not during introduction, shake-out, or decline. Also, the relation is more intense during maturity, against the low-high-low pattern hypothesized in section 3.2 according to tradeoff. Therefore, our results support the pecking order theory of less debt with higher profitability, for firms in growth and maturity. During the introduction, shake-out, and decline stages, the effect of profitability is not relevant, perhaps due to the offset of contrary-signs effects: a group of firms would take advantage of less bankruptcy cost and interest tax shields, and/or avoid free cash flow problems, to take more debt following the trade off, while others would decrease debt due to higher profitability.

With more growth opportunities (MtoB), our results show higher leverage during introduction, shake out and decline. This can be framed into the pecking order, meaning more debt required by additional investments. As seen in the correlation analysis, during growth and maturity firms with growth opportunities are profitable and generate liquidity, what would make additional debt unnecessary. This is also consistent with growth and mature firms taking advantage of higher market prices to issue new shares, reducing the proportion of leverage, as predicted by the market timing theory.

Liquidity is perhaps the factor that showed a more regular tendency in its negative relation with leverage, in the correlation analysis. In Table 5, the regressions show that this negative relation is less significant during the decline stage. As indicated in the correlation analysis, during decline, we can appreciate that the profitability coefficient has considerably increased (column 7) while the correlation between liquidity and profitability is the highest among stages. It suggests that during decline, liquidity is adding less explanatory ability once profitability is included in the model.

Size shows a significant positive effect over leverage during growth, maturity, and shake-out. In these phases, in which the firm has access to diverse sources of funds, the less costs and higher debt affordability can explain the choice of more debt, as predicted by the tradeoff theory. In both introduction and decline, opposite influences in place would make the coefficient non-significant. For instance, new entrants in financial markets can issue equity as they grow, but they have the opportunity to issue bonds instead, and they can also obtain bank debt in good conditions. Our non-significant coefficient for size during introduction is consistent with Helwege and Liang's (1996) results for IPO firms.

Our results for non-debt tax shield during introduction, maturity and shake-out support the pecking order prediction that considers this variable as a proxy for debt capacity or affordability. However, during growth, correlation coefficients suggest that a subtle effect of market valuation (of non-debt tax shield) offsets the positive relation to make it non-significant. During decline, results suggest again that the inclusion of this variable is unnecessary once another one (MtoB) has been included. The coefficient for MtoB considerably increases in decline compared to the other stages preempting the effect of NDTS on leverage.

Results on the influence of tangible assets over leverage are the same as in our previous correlation analysis. The positive relation found for introduction[3], growth, maturity, and shake-out supports tradeoff when this theory links tangibility with lower costs of distress or fewer debt related agency problems. In addition, our results support the pecking order reasoning about tangible assets as a form of secured collateral. During decline, tangible assets are expected to decrease at the same time that profitability and size do. In these conditions tangibility is not an explanatory factor of leverage.

Age shows a clear non-linear pattern across stages. During the introduction stage, more age explains higher leverage. By contrast, during maturity and shake-out younger firms are more leveraged. The fact that, according to the correlation analysis, this factor appeared as significant during growth, and that

[3]Tangible assets exert the same effect as size on the firms' leverage, except during the introduction stage. Our results suggest that firms tend to finance tangible assets with debt also during the introduction stage, though other increases of size in this stage may be financed by debt or equity, but none of them prevails over the other.

the relation during shake-out was opposite, suggests that a more in-depth analysis is needed.

Table 4. By-Stage Determinants of Leverage. Fama-MacBeth Regressions.

Variables	Fama and MacBeth procedure. Dependent TDA	With Life cycle. Dependent TDA	Stage 1 of Life Cycle. Dependent TDA	Stage 2 of Life Cycle. Dependent TDA	Stage 3 of Life Cycle. Dependent TDA	Stage 4 of Life Cycle. Dependent TDA	Stage 5 of Life Cycle. Dependent TDA
$LCSR_t$		0.133*					
		[0.0647]					
$Prof_t$	-1.410***	-1.347*	0.0504	-0.163**	-0.144***	-0.0225	-3.448
	[0.495]	[0.701]	[0.120]	[0.0741]	[0.0407]	[0.0323]	[2.009]
$MtoB_t$	0.108***	0.0918**	0.0150**	0.00965	0.00555	0.0145**	0.561**
	[0.0302]	[0.0426]	[0.00537]	[0.00598]	[0.00629]	[0.00654]	[0.227]
$Liquidity_t$	-0.0616***	-0.107**	-0.0118***	-0.0216***	-0.0349***	-0.0240***	-0.988*
	[0.0195]	[0.0376]	[0.00319]	[0.00374]	[0.00631]	[0.00613]	[0.550]
$Size_t$	0.00620	-0.000545	0.0140	0.0270***	0.0117*	0.0150***	-0.307
	[0.00749]	[0.0126]	[0.0101]	[0.00614]	[0.00572]	[0.00231]	[0.253]
$NDTS_t$	0.568	-0.473	0.537**	0.0547	0.455***	0.611***	-29.43
	[0.715]	[1.548]	[0.250]	[0.0791]	[0.0993]	[0.200]	[24.28]
$Acttan_t$	-0.0594	-2.07e-05	0.162***	0.141***	0.0918***	0.214***	-5.560
	[0.0692]	[0.0941]	[0.0360]	[0.0176]	[0.0201]	[0.0350]	[4.319]
Age_t	0.0381*	0.0399*	0.0474**	0.000630	-0.00911***	-0.0133**	0.256
	[0.0191]	[0.0231]	[0.0191]	[0.00243]	[0.00174]	[0.00489]	[0.373]
Constant	0.128	-0.0495	-0.111	-0.0887	0.0782	0.00678	5.957
	[0.0778]	[0.104]	[0.144]	[0.0730]	[0.0681]	[0.0428]	[3.578]
Obs.	27,145	22,287	4,047	5,597	9,412	2,090	1,141
R-squared	0.208	0.219	0.328	0.335	0.292	0.370	0.403
Years	32	20	20	20	20	19	18
F test	20.98	50.08	27.55	123.5	119.1	17.12	4.035

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Notes: TDA is book leverage (total debt / total assets); Prof is profitability (EBITDA / total assets); MtoB is market to book (market value of equity + debt in current liabilities + long-term debt + preferred stocks - deferred taxes and investment tax credit to total assets); Liquidity is current assets to current liabilities; Size is the logarithm of total assets; NDTS is non-debt tax shield (depreciation, depletion and amortization to total assets); Acttan is tangibility (property, plant and equipment / assets); Age is the logarithm of the years after the firm foundation; LifeD1-5 are dummy variables indicating the life cycle stages, according with Dickinson (2011): introduction (1), maturity (2), growth (3), shake-out (4), and decline (5). LifeD1-5 takes the value 1 if the firm is in the stage and 0 otherwise.

1.6. Robustness analyses

We evaluate the robustness of our results using the generalized-method-of-moments (GMM). Specifically, we apply the generalized-method-of-moments estimators developed by Arellano and Bond (1991) for panel data models. This methodology is designed to cope with three specific econometric problems: the existence of unobserved firm-specific effects, avoided by taking first differences of variables; the autoregressive process in the leverage data; and the presence of endogeneity in the explanatory variables. We control for potential endogeneity of the variables Prof, LCSR, MtoB, Liquidity, Size, NDTS, Acttan, and Age in the GMM estimations by using the same variables as instruments in almost all regressions. The country and the interest rate growth variables are considered exogenous initially.

Table 4-bis. By-Stage Determinants of Leverage. GMM Procedure.

Variables	**GMM procedure Dependent: TDA**	**GMM procedure With Life Cycle. Dependent: TDA**	**Stage 1 of Life Cycle. Dependent TDA**	**Stage 2 of Life Cycle. Dependent TDA**	**Stage 3 of Life Cycle. Dependent TDA**	**Stage 4 of Life Cycle. Dependent TDA**	**Stage 5 of Life Cycle. Dependent TDA**
TDA_{t-1}	0.787***	0.200***	0.00755***	0.324***	0.00281***	-0.0154***	1.054***
	[0.00227]	[0.00511]	[8.72e-05]	[0.0576]	[1.78e-06]	[0.000790]	[3.43e-05]
$LCSR_t$		0.168***					
		[0.0195]					
$Prof_t$	-2.013***	-0.565***	-0.193***	-2.211***	-0.286***	-0.803***	-0.858***
	[0.0394]	[0.0727]	[0.000254]	[0.170]	[1.93e-05]	[0.0535]	[0.000857]
$MtoB_t$	0.178***	0.0629***	0.0329***	0.125***	-0.00837***	0.112***	0.221***
	[0.00818]	[0.0111]	[1.72e-05]	[0.0126]	[1.73e-06]	[0.00952]	[0.000137]
$Liquidity_t$	-0.180***	-0.00677	-0.00718***	-0.0306***	-0.0211***	0.00225	0.0124***
	[0.00995]	[0.00777]	[1.27e-05]	[0.00757]	[2.42e-06]	[0.00269]	[0.000122]
$Size_t$	0.0172***	0.0648***	-0.0176***	0.0480***	0.0213***	0.0468***	-0.250***
	[0.00436]	[0.0100]	[7.00e-05]	[0.00778]	[3.80e-06]	[0.00491]	[0.000530]
$NDTS_t$	1.847***	-0.571	0.916***	0.547	0.748***	3.346***	11.18***
	[0.239]	[0.368]	[0.00160]	[0.356]	[9.97e-05]	[0.302]	[0.00718]
$Acttan_t$	0.350***	0.441***	0.0924***	0.230***	0.0314***	0.785***	-2.120***
	[0.0575]	[0.0725]	[0.000258]	[0.0644]	[2.03e-05]	[0.0451]	[0.00319]
Age_t	0.0995***	-0.0201**	0.0591***	0.0400***	-0.0280***	0.124***	0.678***
	[0.00905]	[0.00947]	[9.59e-05]	[0.0101]	[6.89e-06]	[0.0111]	[0.000983]
Constant	-0.315***	-1.114***	0.0826***	-0.498***	0.0415***	-1.176***	0.130***
	[0.0675]	[0.161]	[0.000684]	[0.102]	[4.15e-05]	[0.0868]	[0.00561]

Obs.	18,937	15,054	2,975	3,749	9,354	1,426	784
# Firms	2,124	2,047	1,066	1,331	1,836	784	466
F test	24076	259.2	2.570e+07	36.34	9.350e+08	133.3	2.030e+11
Hansen test	390.6	164.8	804.8	177.4	1476	204.7	449.3
Sig. Hansen	0.0494	1.000	0.853	1.000	0.838	0.999	1.000
m2	0.120	-0.500	-1.190	1.140	2.230	-1.460	-0.860
Sig. m2	0.904	0.619	0.235	0.253	0.025	0.144	0.391

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1
Notes: TDA is book leverage (total debt / total assets); Prof is profitability (EBITDA / total assets); MtoB is market to book (market value of equity + debt in current liabilities + long-term debt + preferred stocks - deferred taxes and investment tax credit to total assets); Liquidity is current assets to current liabilities; Size is the logarithm of total assets; NDTS is non-debt tax shield (depreciation, depletion and amortization to total assets); Acttan is tangibility (property, plant and equipment / assets); Age is the logarithm of the years after the firm foundation; LifeD1-5 are dummy variables indicating the life cycle stages, according with Dickinson (2011): introduction (1), maturity (2), growth (3), shake-out (4), and decline (5). LifeD1-5 takes the value 1 if the firm is in the stage and 0 otherwise.

To obtain the results displayed in Table 4-bis, we use different options for each regression. In the regression without the life cycle variable, we can consider the efficiency of the leverage model, taking into consideration only the 1% significance, because we need non-significance in Hansen and m2 tests. This regression uses independent variables as instruments, and country and interest rate growth as exogenous variables.

In our general regression with life cycle, both tests show that the model is well specified. The Hansen test confirms the joint validity of the instruments in the GMM estimation. The model is also well specified for the introduction, the growth, the shake-out and the decline stages with independent variables as instruments, and country and interest rate growth as exogenous variables. It is different in the case of the maturity stage because we can accept the model only at the 1% level of significance, due to the autocorrelation coefficient. The instruments are the independent variables plus LCSR, interest rate, GDP growth, and insiders, and a year dummy is the exogenous variable.

1.7. Conclusions to the first chapter

For an international sample (UK, Germany, France and Spain) over the 1980-2011 period, we provide empirical evidence on the introduction of the business life cycle as explanatory factor of the firms' capital structure.

Using the innovative model of Dickinson (2011) to distinguish among the life cycle stages of the firm, we have run several groups of Fama and MacBeth (1973) regressions. The life cycle stage factor is included either as an indicator of stage in the general model, or performing regressions in a by-stage analysis. Furthermore, all the regressions have been re-run by using GMM (Arellano and Bond, 1991), finding no significant changes in results concerning the hypotheses tests.

Our results document a remarkable improvement of models when life cycle stages are considered. The explanatory ability of the general model increases when the variable is included; and the improvement is much higher when the general model containing all the explanatory variables selected is performed by stage.

Consistent with the trade-off theory, we identify: a positive relation with size during growth, maturity, and shake-out; a parallel positive relation with tangible assets during the same stages but also during the introduction; a positive relation with age during the introduction but a negative one during maturity and shake-out. Therefore, during the introduction tangible assets would imply lower costs of distress or fewer debt related agency problems, while age would be a sign of a stronger market base, inducing higher debt. During growth, maturity, and shake-out, bigger firms would get more debt taking advantage of their lower bankruptcy costs due to higher diversification, and the sign of strength that size sends to lenders; and firms with more tangible assets would obtain more debt for the same reasons as in the introduction. However, during maturity and shake-out, the negative relation between age and leverage poses a puzzle difficult to solve by both trade-off and pecking order.

Consistent with the pecking order theory, we identify: an inverse relation of leverage with profitability, during growth and maturity; a positive relation with growth opportunities (proxied by market-to-book), during introduction, shake-out and decline; a negative relation with liquidity, during all the stages; a positive relation with non-debt tax shield, during introduction, maturity, and shake-out; a positive relation with tangible assets during introduction, growth, maturity, and shake-out; and a negative relation with age during maturity and shake-out. Therefore, during the introduction stage, more growth opportunities would imply new investments, less liquidity would increase the necessity to take on debt, higher non-debt tax shield, more tangible assets and age would act as a sign of debt capacity, giving rise to more debt. During growth, profitability would let the firm to take less debt, but more tangible assets would increase debt. Mature firms seem to get more debt when they are less profitable and less liquid, while non-debt tax shield and tangible assets would act as a sign of debt capacity. During shake-out, less liquidity and more growth opportunities would imply higher debt necessities, while non-debt tax shield and tangible assets would act as a sign of debt capacity. During decline, growth opportunities seem to be the only relevant factor in pushing the firm to increase leverage.

In line with the market timing theory, we identify: higher market to book values positively related to leverage, during introduction, shake-out and decline. It indicates that exploiting favorable market conditions can be a prevailing reason in capital structure choices.

As we connect two main strands of literature, we make contributions to both of them. To the line of research on capital structure, our work adds a dynamic explanatory factor, the business life cycle, which contributes with more precise knowledge on the choice of leverage, disentangling a portion of those non lineal relations identified between leverage and firm characteristics.

Our study provides support for several reasonings from both trade-off and pecking order theories. Furthermore, the main contribution of this work is identifying what part of the theories explains leverage in each specific life cycle stage. As hypothesized, the prevalence of the theories changes as the firms do.

To the line of research on the business life cycle, we provide new international evidence of a very recent model designed to distinguish among the life cycle stages. Our results confirm that Dickinson's (2011) model is consistent with the life cycle theory by applying it to a new theoretical framework, the evolution of debt within the widely studied static theories on capital structure.

Our results have important implications for business managers, as capital structure is the prime financial decision to be taken by firms, and show that the life cycle stage is a discriminant element of this decision. Also, our findings may help business assessors, financial analysts or investors to better understand different behavior patterns concerning firms financing.

CHAPTER TWO

DYNAMIC ANALYSIS OF CAPITAL STRUCTURE IN TECHNOLOGICAL FIRMS BASED ON THEIR LIFE CYCLE STAGES*

* An earlier version of this chapter was presented at the following congresses: the XXIII Congreso Nacional ACEDE (Málaga, 2013), the XVII Congreso AECA (Pamplona, 2013), where the paper was selected as one of the best papers, and the XXI Finance Forum (Segovia, 2013).

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2.1. Introduction to the second chapter

The main theories on capital structure, pecking order and trade-off highlight a few factors that explain the level of equity and debt. In fact, there are some generally accepted factors, such as the negative effect of profitability on leverage. Frank and Goyal (2009) indicate that explanatory factors for different theories of capital structure might be significant, regardless of whether the sign is positive or negative, in firms under some circumstances but irrelevant in others. Thus, both the environment and the characteristics of firms might affect their capital structure. Recent papers have addressed some aspects of the technology sector related to financing or capital structure (Hogan and Hutson, 2005; Hyytinen and Pajarinen, 2005). Our main contributions to this growing literature are as follows: 1) the introduction of a dynamic framework, by placing the capital structure models in the changing life cycle stages of the firms, and 2) the use of growth opportunities as a discriminant factor to distinguish high-tech firms. These analyses allow us to check the prevalence of pecking order and trade-off across stages for non-tech, tech and high-tech firms.

This chapter attempts to check how the capital structure theories (trade-off and pecking order) change their prevalence along the life cycle stages. Furthermore, the chapter attempts to demonstrate that remarkable differences in the life cycle of specific sectors are behind part of the by-industry differences in capital structure patterns. Our dynamic standpoint in examining capital structure is inspired by Fischer's, et al. (1989) model. Berger and Udell (1998) and La Rocca, et al. (2011) can be considered the main reference points, as they identify life cycle stages as determinants of firms' financial requirements, the availability of financial resources, and the related cost of capital.

Certain factors, such as growth, profitability, size, and age, are considered key to distinguishing between the life cycle stages of a firm. More precisely, Graham and Leary (2011) argue that the trade-off and the pecking order theory define the following as strategic elements for capital structure: profitability, R&D, age, risk, growth, size, and tangible assets. That is, certain characteristics are important for distinguishing between the life cycle stages of the company, on the one hand, and defining the capital structure, on the other. Therefore, we hypothesize that there is a core connection between capital structure and life cycle through these factors. As previous authors do not agree on an accurate measure of the life cycle variable, we find Dickinson's (2011) proposal advantageous as a proxy for the life cycle stages, as it focuses on several relevant aspects of the business by using accounting information on operating, investing, and financing cash flows.

Concerning the technology sector, the empirical evidence indicates that the rapid development, the complexity of the technology, the relevant intangible component of the business, and the presence of network effects might have implications for its financing patterns (Hogan and Hutson, 2005; Hyytinen and Pajarinen, 2005). Studies on small high-tech firms have reported less leverage than in other small businesses. Hyytinen and Pajarinen (2005) link this result to R&D, whereas Hogan and Hutson (2005) attribute this result to information asymmetries between the founders and banks, which require fixed assets as collateral. The greater degree of asymmetric information in tech firms makes the sector particularly sensitive to financing because of the vested interest of the shareholders and managers of the firm.

Furthermore, authors such as Gul (1999) relate growth opportunities with debt issuance, whereas others, such as Rajan and Zingales (1995), suggest high growth opportunities as a source of the costs of financial distress, inclining firms toward equity financing when the stocks are overvalued, which is consistent with the trade-off theory. Considering that growth opportunities in tech firms can rapidly improve high performance, we test growth opportunities as a key factor in distinguishing high-tech firms to observe the capital structure along their lives.

Using a panel data approach, we find that the pecking order theory offers the prevalent reasoning behind the lower leverage used by tech firms along their life cycle. Information asymmetry turns growth opportunities and intangibles into the most differential drivers. In addition, differences in tech firms' strategic behavior induce changes in capital structure by stage, mainly during maturity but also during introduction and decline. These differences are closely related to the differential effect of the age variable, a sign of success, considering not only the rapid development but also the rapid decline of tech firms, both of which are linked to changes in growth rates. In fact, we find that growth opportunities are a key factor for discriminating between groups of high-tech firms when studying their capital structure. Our results have relevant implications for researchers both in the selection of the sample to be analyzed and the interpretation of results depending on the distribution of the sample over the life cycle stages. Due to the evolution of the capital structure patterns along the life cycle, a sample consisting of firms in different stages of their life cycles would produce some non-significant or spurious results, whereas different samples could produce opposite results, depending on the life cycle stage in which most firms are included.

This chapter is different from the existing literature in several ways. First, we explain the capital structure through the firms' life cycle stages and observe the differences by stage, contributing to both research streams, i.e., capital structure and business life cycle, as this is the first time that Dickinson's (2011) approach is used in a capital structure paper. Second, our work contributes to a very small group of works comparing tech firms to non-tech firms concerning capital structure. Unlike the two most comparable studies (Hogan and Hutson, 2005; Hyytinen and Pajarinen, 2005), using a one-country SME sample, we study an international sample of listed companies. Moreover, the two works referenced adopt a static standpoint without considering life cycle stages. Third, we use the differences in growth opportunities to discriminate between high-tech firms to further analyze their capital structures.

The remainder of the chapter proceeds as follows. Section 2 reviews the theory of capital structure and the life cycle model, in relation to the technological sector, to develop our hypotheses. Section 3 describes the research design, explaining the measure of the life cycle and the classification of tech firms, as well as the methodology. Section 4 contains a discussion of the sample and descriptive statistics. Section 5 presents the results and, finally, the study's conclusions.

2.2. Theoretical background and hypotheses

The trade-off theory postulates that firms choose leverage by balancing the benefits and costs of using debt (Titman and Wessels, 1988; Rajan and Zingales, 1995), and its key features are taxation (Fama and French, 1998) and bankruptcy costs (Opler and Titman, 1994). On the other hand, Myers and Majluf (1984) develop the pecking order theory, indicating that due to the existence of asymmetric information between corporate insiders and outside investors, the firm upholds a financing hierarchy of retained earnings, debt, and then equity to minimize the adverse selection costs of security issuance. Less profitable companies issue debt because they lack adequate internal funds to finance investment and because debt financing is first in the order of choices of external financing. We argue that the trade-off and the pecking order play different roles across life cycle stages in tech firms compared to non-tech firms, considering the evolution of the distinctive elements of firms in the tech sector. Furthermore, we argue that growth opportunities are a key driver of capital structure patterns for tech firms.

2.2.1. Life cycle stages in tech firms

Many authors have studied firm life cycles, and more specifically, the evolution of some features of the business along the life cycle. As the theory of firms life cycles was originally developed as an extension of the product life cycle theory, firms are considered to progress through four main life cycle stages, namely, start-up, growth, maturity, and decline, as described by Frielinghaus et al. (2005). Corporate life cycle models have been applied in organization studies since the 1960s. According to a few authors, such as Chandler (1962), the stages change, as do firms’ strategies and structures. Organizational life cycle models differ extensively in a number of features, ranging from two (Bulan and Yan, 2010) or three stages to as many as ten (Adizes, 1999).

A relevant study in the examination of common stages in the early literature is that by Miller and Friesen (1984). They find convergence in five life stages: birth, growth, maturity, revival, and decline. The proxies used for the life cycle stages have changed quite a bit over time: investment (Wernerfelt, 1985), production behavior (Wernerfelt, 1985), learning and experience (Spence, 1981). In the context of financing decisions, Hirsch and Walz (2011) analyze SME's cycle considering two stages: start-up (defined as the period of product development) and expansion (defined as the period of market entry for the firm's product) Additionally, Pfaffermayr, et al. (2013) use age to analyze the evolution of taxation and capital structure. Our reference in the distinction of life stages, Dickinson (2011), uses the signs of operating, investing and financing cash flows. By considering these three aspects of the business jointly, this method of classifying the life cycle stages overcomes the partiality of using just one discriminant variable, which is common place in the literature. This criterion allows us to place each firm into a life cycle stage to test our first set of hypotheses.

Several authors (Klepper, 1996; Audretsch and Feldman, 1996) point to innovation as a proxy for the life cycle of tech firms. The amount of innovation is high during the early stages of the industry life cycle, decreases during the maturity stage, although established large enterprises tend to maintain the innovative activity, and plays a much less important role during the latter stages. In addition, new products and services may work as barriers to entry or market demand factors that improve firms' performance and future growth opportunities. This close relationship between innovation and growth opportunities as a differential explanatory factor of the strategic positioning of the firm supports our second hypothesis.

2.2.2. Capital structure in tech firms

Concerning the evolution of leverage across the firm's life cycle, there is no evidence for tech firms and only very little empirical evidence for non-tech firms. Factors such as size, age, tangible assets, retained earnings, profitability (all used by Bulan and Yan, 2010), or dividends (DeAngelo et al., 2006) follow different leverage patterns when firms are mature, as the maturity effect is related to debt capacity. Bulan and Yan (2010) find that the pecking order theory better describes the financing behavior of mature rather than growing firms. Both Frielinghaus et al. (2005) and Teixeira and Coutinho (2014) observe that the pecking order theory explains how firms tend to adopt specific financing strategies as they progress along their lives. The changes in the adverse selection costs and information asymmetry in the pecking order offer signs of a high-low-high general pattern in firms' leverage. On the contrary, the benefits and costs of using debt, considered by the trade-off, give signs of a low-high-low general pattern.

Tech firms are often built upon new and proprietary products or applications to be sold into untested markets, which creates information asymmetries and adverse selection: the insiders of an ICT[4] firm might know more about the possibility of the firm's success than outside investors (Hyytinen and Pajarinen, 2005). Information asymmetry can be interpreted by the pecking order theory as a cause to obtain less external debt or less equity. However, Halov and Heider (2011) and Frank and Goyal (2008) argue that with greater asymmetric information concerning risk (instead of value), debt has a more severe selection problem, and firms would only issue equity. In addition, as information asymmetry is linked to growth opportunities for this type of firm, in which high growth rates are reached for a relevant part of the life cycle, a positive relation with debt is expected when internally generated funds are insufficient to finance all needs (Michaelas et al., 1999). In Table 1, the expected signs of some variables of interest are included, considering the reasoning posed by the pecking order and trade-off theories. Note that the signs expected for tech firms in both theories are the result of the exacerbation of some aspects of the reasoning.

[4]Information and Communication Technology.

Table 1. Predicted Sign of Variables by Pecking Order Theory vs. Trade-Off Theory

Variable	Proxy	Pecking Order Theory	Trade-Off Theory	Tech Firms
PROF	Profitability	-	+	+/-
GROWTH	Growth Opportunities	+/-	-	-
LIQ	Liquidity	+/-	+/-	+/-
SIZE	Size	-	+	+/-
NDTS	Non-Debt Tax Shield	+	-	**+/-**
TANG	Tangible Assets	-	+	+
AGE	Age	-	+	+
AMINTAN	Intangible Assets	+	-	-

Notes: The definitions of the variables are provided in Appendix A.

Furthermore, tech firms face particular difficulties associated with their higher dependence on intangible assets (products or applications that have little or no track record) that cannot be used as collateral (Brierley, 2001). According to the trade-off theory, firms with more intangible assets tend to borrow less (Rajan and Zingales, 1995). Intangible assets are more likely to lose value in financial distress, thus increasing the expected cost of bankruptcy (Myers, 1984). The pecking order theory makes predictions in the opposite direction: higher financing needs are required, and high information asymmetry linked to intangible assets makes equity issuances more costly (Frank and Goyal, 2009), inducing higher leverage. However, considering the higher proportion of asymmetric information about risk as well as less information about value attributable to small, young, and high-growth firms (Halov and Heider, 2011), a higher reliance on equity can be expected for tech firms. As the ICT business needs technical people for developing knowledge, the intangible technological component of the ICT business is remarkable. Consequently, during the first stages, tech firms rely more on equity financing, as indicated by lower debt to assets ratios and a higher equity base (for example, Hogan and Hutson (2005) found evidence of it in Irish software companies). It is sound that the tangible component of assets is used as collateral to obtain debt, especially in this type of firm. Whereas the trade-off theory predicts higher leverage for tech firms with more tangibles, like in any other type of firm, the pecking order theory would not affect tech firms to the same extent as non-tech firms. In tech firms, higher tangibles are not expected to reduce leverage due to the less costly equity issuances because equity is already used as the primary source of funds, and therefore, the assets are expected to be used to obtain an additional source of financing.

Moreover, tech firms are under pressure to develop rapidly along their life cycle. Tech knowledge is accumulated throughout the life cycle[5], but the ageing of technologies makes them increasingly vulnerable to obsolescence. Kazanjian (1988) indicates that if a product is technically feasible and achieves market acceptance, a period of high growth will typically result for the product and hence for the firm. Otherwise, as the growth rate slows down to a level consistent with market growth, the venture enters a new stage, that is, maturity. Introduction and decline are less important stages, as they are frequently shorter. For the trade-off theory, age is a positive inductor of debt, considering it as a proxy for reputation (Frank and Goyal, 2009). By contrast, the pecking order theory predicts a negative relation, based on the greater opportunities of older firms to retain earnings (Frank and Goyal, 2009). However, in line with the previous reasoning, during the most important stages for tech firms, growth is high enough to require more funds than those generated. Therefore, we expect age to work as a positive inductor of leverage.

Freear and Wetzel (1990) find that sources of equity capital shift when tech firms mature. Thus, while private investors are in control in the earliest stages of firm development, venture capitalists play a more prominent role in later rounds of financing. Bozkaya and Van Pottelsberghe De La Potterie (2008) demonstrate that as Belgian firms mature and move through different life cycle stages, their sources of financing change. Therefore, we argue that the life

[5]We distinguish tech firms' life cycles (the time span between a firm's introduction and its decline) and the tech sector's life cycles (the time span between a technology generation's emergence and its decline).

cycle of a firm affects the financing strategies of both tech firms and non-tech firms, resulting in different capital structure patterns. The different business characteristics highlighted allow us to pose the following hypotheses, in line with the sign predictions posited for tech firms in Table 1:

H1a: Higher levels of information asymmetry will induce less debt in tech firms than in non-tech firms along the firms' life cycle.
H1b: Growth opportunities and intangible assets will induce less debt in tech firms than in non-tech firms.
H1c: Older age and higher tangible assets induce more debt in tech firms than in non-tech firms.

Although common technology reflects similar opportunities (Castellacci, 2007), firms in the same industry can follow different strategies, depending on their growth opportunities, which are different along the business life (Caves and Porter, 1977). In tech firms, growth is favored or conditioned by at least three features (Hyytinen and Pajarinen, 2005). First, network effects lead particularly to demand-side economies of scale. Second, in good intermediate ICT industries, such as software and ICT equipment, where the main form of innovation is the development of higher quality products, the appropriability of innovations can be high (Martin and Scott, 2000). Third, in some ICT industries, the costs of entry are fixed, whereas marginal and transportation costs are low because of the nature of the products.

In tech firms, future growth opportunities are proxied by the market-to-book ratio because of the effect of the R&D item, which indicates innovation. According to the pecking order theory, growth opportunities foster problems of information asymmetry between investors and firm managers. In addition, firms with more growth opportunities should need more debt. Michaelas et al. (1999) find support for both short-term and long-term debt, indicating that rapidly growing firms are likely to have insufficient earnings to finance all of their growth internally. In non-tech firms, financing needs tend to increase as the firms grow and evolve, but nothing has been reported for the tech sector yet.

The trade-off theory of capital structure postulates that firms with high growth opportunities will tend to be less leveraged, as Rajan and Zingales (1995) and González and González (2008) demonstrate for the seven major industrialized countries. Bruinshoofd and Haan (2011) indicate that this choice is to prevent the cost of future underinvestment associated with high leverage. Myers (1977) argues that as growth opportunities push firms to take more risks, and they have higher financial distress costs, additional financing in the form of equity instead of debt contributes to mitigate the moral hazard problem. Furthermore, Halov and Heider (2011) demonstrate that the adverse selection costs are stronger when the outside market knows little about firms' risk. In addition, growth causes variability of the firm's value, which is interpreted as higher risk, preventing the firm from raising debt capital under favorable terms. Therefore, firms use internal capital to finance new projects until these funds run out, and only then do firms finance growth opportunities with debt.

Therefore, taking into account that characteristic factors of high-tech firms such as innovation and technology affect the growth opportunities of those firms, we can form homogeneous groups within our sample by taking growth opportunities as a second-level separation criterion. Consistent with the sign prediction posed in Table 1, we argue that the growth opportunities variable is a strategic factor for distinguishing between capital structures of high-tech firms and observing leverage behavior over the life cycle of the firms.

H2: Higher levels of information asymmetry induce lower leverage in high-tech firms with high levels of growth opportunities than in high-tech firms with low levels of growth opportunities.

2.3. Research design

2.3.1. Measure of life cycle stages

We follow the approach by Dickinson (2011) to distinguish among the different life cycle stages of firms using information extracted from the Cash Flow Statement. The three net cash flow activities (operating, investing, and financing) can take a positive or negative sign, resulting in eight possible combinations, which are reorganized by the author into the five stages selected in line with the literature, as presented in Table 2.

Table 2. Life Cycle Stage Model

Cash Flow Type	**Introduction**	**Growth**	**Mature**	**Shake-out**	**Decline**
Operating	-	+	+	+/-	-
Investing	-	-	-	+/-	+
Financing	+	+	-	+/-	+/-

The combination of those cash flow patterns characterizes the interaction between the firm's resource allocation and operational capabilities and the firm's choice in strategy. Cash flows from operating activities are produced by the (core) business of the firm. Cash flows from investing activities come from the purchase or sale of long-term assets. Finally, cash flows from financial activities refer to the flow of cash between the firm and its shareholders and creditors.

2.3.2. Classification of tech firms

We distinguish between tech (including low and high) and non-tech firms following Francis and Schipper (1999), based on the three-digit SIC code (Standard Industrial Classification) and taking into account the classification by

Kwon et al. (2006)[6]. The high-tech group includes, among others, computer-related services, electronic components and accessories, drugs, business services, computer and office equipment, telephone communications, and communications equipment, which are the industries that contain a higher number of firms in our sample of the high-tech sector. The industries in the low-tech sector with a higher number of firms in our sample are motor vehicles and equipment, general industrial machinery and equipment, air transportation, and miscellaneous plastics products.

To test our second hypothesis, we calculate the median of the growth opportunities variable by year and life cycle. Then, we create a variable as the difference between the growth opportunities and the median of this variable by year and life stage. If the result is higher (lower) than zero, those companies are considered to have more (fewer) growth opportunities. Thus, we only select high-tech firms with the highest growth opportunities (HGO) and the high-tech firms with the lowest growth opportunities (LGO).

2.3.3. Methodology

This study controls for the endogeneity problem and avoids significant bias in estimates by employing a more advanced method of GMM (Arellano, 2003; Baltagi, 2005; Wooldridge, 2007). We apply the system GMM in panel data, outlined by Arellano and Bover (1995) and fully developed by Blundell and Bond (1998). Specifically, we apply the two-step GMM estimator, included in the *xtabond2* Stata routine written by Roodman (2009), that uses one-step residuals to construct the asymptotically optimal weighting matrix and addresses the heterogeneity and endogeneity problems. This estimator could be more efficient because it may control the correlation of errors overtime as well as the heteroscedasticity across firms and the measurement errors, due to the utilization of the orthogonality conditions on the variance-covariance matrix.

[6]Based on the SIC, we have high-technology firms, including 272, 283, 355, 357, 360-367, 369, 381, 382, 386, 481, 484, 489, 573, 596, 621, 679, 733, 737, 738 and 873, and low-technology firms, including 020, 160, 170, 202, 220, 240, 245, 260, 300, 308, 324, 331, 356, 371, 399, 401, 421, 440, 451 and 541.

In addition, panel data increase the degrees of freedom due to the availability of a large number of observations and reduce collinearity among explanatory factors, which leads to a more efficient estimation. Moreover, according to Hsiao (2003), the efficiency of GMM improves by adding new nonlinear functions of the exogenous variables to the instruments (even under the homoscedasticity hypothesis). Arellano and Bover (1995) propose the use of instruments in first differences for equations in levels and instruments in levels for equations in first differences. Blundell and Bond (1998) support the efficiency of Arellano and Bover's (1995) estimator, especially for short sample periods and persistent data. The specification tests for the GMM estimator are the Hansen test, the test of lack of residual serial correlation, and the Wald test.

Considering the main factors that the traditional capital structure theories have proposed to explain leverage and the factors that determine the firms' stages according to the life cycle theory, we selected a group of variables to be included in our model. For hypotheses H1b and H1c, leverage (*LDEBT*) is the dependent variable and the selected independent factors are: profitability (*PROF*); growth opportunities (*GROWTH*); liquidity *(LIQ*); size (*SIZE*); non-debt tax shields (*NDTS*); tangible assets (*TANG*); age (*AGE*); and intangibility (*AMINTAN*). We study leverage considering a dynamic factor not previously analyzed in this line of research: the evolution along the life cycle stages.

$$LDEBT_{it} = \alpha + \beta_1 LDEBT_{it-1} + \beta_2 PROF_{it} + \beta_3 GROWTH_{it} + \beta_4 LIQ_{it} + \beta_5 SIZE_{it} + \beta_6 NDTS_{it} + \beta_7 TANG_{it} + \beta_8 AGE_{it} + \beta_9 AMINTAN_{it} + \sum_{k=1}^{m} C_k + \sum_{t=2000}^{2012} Y_t + \mu_{it} + \gamma_i \quad (1)$$

We used a dummy variable that equals one if the firm is in one stage and zero otherwise. Thus, the model was applied five times, obtaining different coefficients for the groups of firms in introduction, growth, maturity, shake-out, and decline. In all models, we control for potential endogeneity of the independent variables in the GMM estimations by using the same variables as instruments in all regressions. C_k is the set of country dummy variables controlling for other aspects beyond those explicitly included in the equation; Y_t

is a set of time dummy variables for each year, capturing any unobserved firm time effect not included in the regression. μ_{it} is the error term, and γ_i is the firm effect, which is assumed to be constant for firm i over t.

To test the pecking order hypothesis (required for H1a and H2 in this study) we use the model developed by Shyam-Sunder and Myers (1999) and partly modified by Frank and Goyal (2003). The variation of debt (*ΔD*) is a function of the funds flow deficit (*DEF*) and an error term (ε_{it}).

$$\Delta D_{it} = a + b_{PO} DEF_{it} + \varepsilon_{it} \quad (2)$$

With all stock variables measured at the end of period *t,* the funds flow deficit is:

$$DEF_t = DIV_t + I_t + \Delta W_t - C_t \quad (3)$$

We defined the notation as follows:

DIV_t: cash dividends in year t

I_t: net investment in year t

ΔW_t: change in working capital in year t

C_t: cash flow after interest and taxes

According to the simplest version of the pecking order theory, *a* is expected to be 0 and *b* should be 1 because, after the use of self-generated funds, the firm is expected to use debt to cover its fund needs and use equity only as a last resort.

The pecking order theory is based on how information asymmetry addresses capital structure decisions. For non-tech firms, the safest security may mean deciding without revealing managers' inside information (Shyam-Sunder and Myers, 1999), that is, what makes them prefer debt rather than equity. On the contrary, with higher perceived distress risk from external funders and sufficiently favorable manager information (Fama and French, 2002), the issue price of equity will be lower for tech firms. A broader pecking order hypothesis considers that a preference for equity may occur.

2.4. Sample and descriptive analysis

We used data from the Worldscope database of all listed[7] firms from Austria, Belgium, France, Germany, Italy, Netherlands, Spain, and the UK from 2000 to 2012. To avoid the effects of outliers, we winsorized all continuous variables at the bottom and the top 3% of their distributions. All firm-year observations with SIC codes 6000-6999 (financial firms) and 4900-4999 (regulated firms) are excluded. To be included in the final sample, all variables used in the chapter rmust be available. Initially, we separated the sample into tech firms (6,945 firm-year observations) and non-tech firms (10,861 firm-year observations), then we distinguished between HGOs (3,139 firm-year observations) and LGOs (2,647 firm-year observations).

Table 3 reports the descriptive statistics by country (Panel A and Panel B), showing average values for long-term debt ratios[8] between 10 and 20%, that turn into a 48-60% range when the total liabilities to total assets ratio is considered. Panel C shows the mean, standard deviation, median, and the mean difference for tech and non-tech firms by variable. We find significant differences between tech and non-tech firms. Non-tech firms have higher mean values for leverage, profitability, size, tangible assets and age. In contrast, according to the literature, tech firms have the highest values in market to book value, liquidity, and amortization of intangible assets. Remarkable differences

[7]There are two reasons for focusing only on quoted firms: (1) the Dickinson model is generally applicable only to firms issuing the cash flow statement, and this is not mandatory for a significant portion of non-quoted firms; and (2) the definition of the life-cycle stages may vary considerably for quoted vs. non-quoted firms, specially concerning introduction and growth.

[8]González and González (2008) obtain a similar range (10-20%) for the long-term debt ratio in the European countries of our sample, even though they divide by the market value instead of the book value of assets.

indicated that tech firms are less leveraged, less profitable, smaller, and younger, have more intangible and fewer tangible assets, and have more growth opportunities and liquidity.

Table 3. Descriptive Statistics

Panel A. Leverage by Country I

Leverage (LDEBT = Long Term Debt / Total Assets)

Country	Obs.	Firms	Mean	St.Dev.	Median	Min.	Max.
AUT	422	53	0.1397	0.1192	0.1148	0.0000	0.5387
BEL	483	70	0.1700	0.1408	0.1472	0.0000	0.5387
DEU	3,409	452	0.1253	0.1327	0.0870	0.0000	0.5387
ESP	125	48	0.2017	0.1433	0.1776	0.0000	0.5387
FRA	2,360	380	0.1340	0.1206	0.1094	0.0000	0.5387
GBR	10,749	1,289	0.1044	0.1389	0.0343	0.0000	0.5387
ITA	86	9	0.1087	0.0677	0.1005	0.0000	0.2871
NLD	172	25	0.1948	0.1493	0.1883	0.0000	0.5387
TOTAL	17,806	2,326	0.1165	0.1362	0.0666	0.0000	0.5387

Panel B. Leverage by Country II

Leverage (LEV = Total Liabilities / Total Assets)

Country	Obs.	Firms	Mean	St.Dev.	Median	Min.	Max.
AUT	422	53	0.5571	0.1933	0.5457	0.0424	1.0000
BEL	483	70	0.5863	0.1838	0.5921	0.0468	1.0000
DEU	3,409	452	0.5521	0.2147	0.5768	0.0424	1.0000
ESP	125	48	0.5787	0.1776	0.5810	0.1068	0.9093
FRA	2,360	380	0.5931	0.1881	0.6056	0.0424	1.0000
GBR	10,749	1,289	0.4796	0.2513	0.4823	0.0424	1.0000
ITA	86	9	0.6237	0.2107	0.7105	0.2097	0.9165
NLD	172	25	0.4959	0.1937	0.5064	0.1226	1.0000
TOTAL	17,806	2,326	0.5148	0.2373	0.5288	0.0424	1.0000

Panel C. Summary Statistics

Variable	Obs.	Mean	St.Dv.	Median	Min.	Max.	Mean (Tech)	Mean (Non-Tech)	Mean Diff.
LDEBT	17,806	0.12	0.14	0.07	0.00	0.54	0.10	0.13	-0.02***
PROF	17,806	0.05	0.19	0.10	-0.6	0.33	0.03	0.07	-0.04***
GROWTH	17,806	1.36	1.17	0.95	0.22	5.42	1.56	1.23	0.33***
LIQ	17,806	2.12	2.05	1.46	0.38	10.27	2.21	2.06	0.15***
SIZE	17,806	11.90	2.29	11.73	7.35	17.38	11.66	12.05	-0.38***
NDTS	17,806	0.03	0.03	0.03	0.00	0.11	0.03	0.03	-0.0008*
TANG	17,806	0.23	0.21	0.16	0.00	0.87	0.16	0.27	-0.10***
AGE	17,806	2.62	1.19	2.56	0.00	4.68	2.47	2.72	-0.26***
AMINTAN	17,806	0.26	0.27	0.16	0.00	0.91	0.34	0.20	0.14***

Notes: The definitions of the variables are provided in Appendix A. Mean diff. indicates the mean difference test (t-test) between tech and non-tech firms. *, ** and *** indicate significance at the 5%, 1% and 0.1% level, respectively.

Looking at the growth opportunities across life stages in high- and low-tech firms (Table 4), we noticed significant differences in median and mean values. They are higher for high-tech firms, remarkably so during the introduction, growth, and decline stages. The mean difference test shows significant differences in all of the stages except shake-out. In both types of tech firms, the introduction stage shows the most significant growth opportunities. These results confirm the potential role of the growth opportunities variable in classifying firms.

Table 4. Growth Opportunities and Life Cycle in Tech Firms

	High Tech Firms				Low Tech Firms				
Life Cycle	**Obs.**	**Mean**	**St.Dv.**	**Med.**	**Obs.**	**Mean**	**St.Dv.**	**Med.**	**Mean Diff.**
Introduction	1,310	2.46	1.77	1.84	95	1.77	1.57	1.09	0.69***
Growth	1,339	1.55	1.16	1.20	333	0.92	0.61	0.75	0.63***
Maturity	2,271	1.40	1.06	1.05	634	0.90	0.57	0.76	0.49***
Shake-Out	510	1.25	1.09	0.86	78	1.08	1.00	0.79	0.17
Decline	356	1.69	1.49	1.10	19	0.74	0.94	0.56	0.95**
Total	5,786	1.68	1.38	1.17	1,159	0.99	0.79	0.76	0.69***

Table 5, Panel A reports correlations of tech firms (above the diagonal) versus non-tech firms (below the diagonal), and Panel B reports correlations of LGOs (above the diagonal) versus HGOs (below the diagonal). All VIF factors are below the benchmark of 10, which is indicative of the absence of multicollinearity between the independent variables. The table with VIF factors is reported in Appendix A (Table V). In all cases, size and tangibility are the most influential factors, with a positive relation, followed by liquidity with a negative relation. The main differences between tech and non-tech firms concern intangibles, non-debt tax shields, tangible assets, age, and growth opportunities. Tech differential behavior reduces debt when firms are more intangible and younger and have more growth opportunities and less tangible assets, in line with the signs predicted by both the pecking and the trade-off theories for tech firms (Table 1). Stronger positive correlations with leverage are also found for non-debt tax shields, although the previous literature has not offered support for differential behavior in tech firms. In Panel B, we appreciate that HGO firms address the differential effect of most factors, with LGO firms being more similar to that observed with non-tech firms. Intangibles appear as a negative differential factor in both HGOs and LGOs with respect to non-tech firms.

Table 5. Correlation Analysis
Panel A. Correlations in Tech (above diagonal) and Non-Tech Firms (below diagonal)

	LDEBT	PROF	GROWTH	LIQ	SIZE	NDTS	TANG	AGE	AMINTAN
LDEBT	1	0.1140*	-0.1007*	-0.2818*	0.3745*	0.2189*	0.3644*	0.0963*	-0.1258*
PROF	0.1242*	1	-0.2739*	-0.2562*	0.4569*	-0.0027	0.2037*	0.2512*	-0.0310*
GROWTH	-0.0788*	-0.1293*	1	0.2902*	-0.3415*	-0.0349*	-0.1791*	-0.1934*	-0.0125
LIQ	-0.2652*	-0.2163*	0.2361*	1	-0.2730*	-0.1983*	-0.2340*	-0.1847*	-0.0525*
SIZE	0.3627*	0.4002*	-0.2403*	-0.2679*	1	0.1109*	0.3748*	0.2702*	-0.1296*
NDTS	0.1409*	0.1948*	-0.0594*	-0.2386*	0.0502*	1	0.6077*	0.0724*	-0.4387*
TANG	0.3279*	0.1842*	-0.1103*	-0.2470*	0.1708*	0.5049*	1	0.1925*	-0.4681*
AGE	0.0552*	0.2469*	-0.2281*	-0.1866*	0.2301*	0.1425*	0.1336*	1	-0.1625*
AMINTAN	0.0076	-0.0918*	0.0499*	-0.0729*	-0.0623*	-0.3643*	-0.3975*	-0.1467*	1

Panel B: Correlations in High Tech Firms by Growth Opportunities (HGO, above; LGO, below)

	LDEBT	PROF	GROWTH	LIQ	SIZE	NDTS	TANG	AGE	AMINTAN
LDEBT	1	0.0713*	-0.1174*	-0.2833*	0.3061*	0.2229*	0.3522*	0.0799*	-0.0646*
PROF	0.1248*	1	-0.3865*	-0.2597*	0.5390*	-0.0526*	0.1873*	0.2453*	0.0846*
GROWTH	0.1287*	-0.0163	1	0.2594*	-0.3939*	0.0184	-0.1373*	-0.1781*	-0.1372*
LIQ	-0.2219*	-0.2107*	0.1344*	1	-0.2327*	-0.2555*	-0.2443*	-0.1923*	-0.0935*
SIZE	0.3283*	0.3336*	-0.0217	-0.1949*	1	0.0212	0.2863*	0.2424*	0.0420*
NDTS	0.1767*	-0.0692*	-0.0275	-0.0759*	0.0801*	1	0.6313*	0.0069	-0.4127*
TANG	0.3158*	0.1154*	-0.0348	-0.1271*	0.2278*	0.6061*	1	0.0799*	-0.3695*
AGE	0.0691*	0.2299*	-0.1737*	-0.1369*	0.1758*	0.0500*	0.1458*	1	0.0036
AMINTAN	-0.1125*	-0.0614*	0.0085	-0.1061*	-0.0840*	-0.4222*	-0.4343*	-0.2075*	1

Notes: The definitions of the variables are provided in Appendix A. In Panel A, tech firms are above and non-tech firms are below the diagonal. In Panel B, LGOs are above and HGOs are below the diagonal. * indicates significance at the 5% level.

2.5. Results

2.5.1. Estimation of capital structure along the life cycle

Table 6 shows that all of the variables considered play a role in explaining leverage, both for tech and non-tech firms, consistent with previous empirical literature. Our results indicate that profitability has a negative influence, and tangibility a positive influence on leverage across the five stages of the life cycle in both tech and non-tech firms. The negative effect of profitability is the most prevalent result across different models and specifications in the literature, supporting the pecking order theory (Myers 1993), whereas the positive effect of tangible assets is a more general finding when the dependent factor is measured as the book value of debt (Shyan-Sunder and Myers, 1999), but it is not so stable when other specifications of leverage are used (Welch, 2011). The positive sign is consistent with the trade-off theory and with hypothesis H1c, related to lower costs of distress, as tangible assets are a form of secured collateral. As for the coefficient of the lagged leverage variable, it shows similar results to those obtained by González and González (2008) and Rubio and Sogorb (2011; 2012), but lower than those obtained by Flannery and Rangan (2006), Lemmon et al. (2008), and Öztekin and Flannery (2012)[9]. By stage, all of the coefficients for tech firms are higher, except during maturity.

When examining firms by stage, the highest number of opposite patterns is observed during maturity, consistent with the different perspectives that tech firms have during this stage. Tech firms show significant changes to negative

[9]Our coefficient without distinguishing stages is 0.58 for non-tech firms and 0.60 for tech firms, whereas the range of coefficients obtained in the comparable works are: 0.16-0.62 by González and González (2008), for the countries included in our sample; 0.69-0.91 by Öztekin and Flannery (2012), for the countries included in our sample; 0.69 by Rubio and Sogorb (2011); 0.31-0.72 by Rubio and Sogorb (2012); 0.62-0.65 by Flannery and Rangan (2006); and 0.75-0.78 by Lemmon et al. (2008). González and González (2008) and Öztekin and Flannery (2012) analyze similar periods (1995-2004 and 1991-2006, respectively). Both samples are international, including the European firms taken in our sample (except The Netherlands in the second work). Rubio and Sogorb (2011; 2012) analyze Spanish firms during a similar period (1995-2003 and 1995-2007, respectively). Flannery and Rangan (2006) and Lemmon et al. (2008) study US firms in a remarkable longer period (1965-2001 and 1965-2003, respectively), very different from ours. In addition, the leverage variable used by these works is a market debt ratio, except for Öztekin and Flannery (2012) and Lemmon et al. (2008) that use both market and accounting debt ratios.

signs for growth opportunities, age, and intangibles. In addition, the maintaining of a negative sign for non-debt tax shields contrasts with the coefficient found for non-tech firms (positive though non-significant). During maturity, the shorter duration of the stage for tech firms joined with the strong reduction of growth opportunities implies remarkable lower investment needs in tangible, intangible, and other operating assets. Considering the generation of positive operating cash flows that characterizes maturity, the specific features of tech firms exacerbates the effect of these factors to avoid/reduce debt. As a source of information asymmetry, intangibles and growth opportunities cause tech firms to rely more on equity financing (H1b). Furthermore, the higher dependence on intangible assets of tech firms prevents them from using assets as collateral to obtain banking debt (Brierley, 2001). Non-debt tax shield can proxy for the current business activity of tech firms, becoming an indicator of the capacity of the firm to generate cash flows, making debt less necessary. Finally, our differential results regarding the age factor confirm the effect of the rapid development of tech firms (Kazanjian, 1988) (H1c).

The other two stages in which differences are exacerbated are introduction and decline. In both stages, size shows opposite behavior, as it is a significant positive driver for non-tech firms, but a significant negative one for tech firms. In addition, non-debt tax shields, tangibility, age, and intangibles are significant differential drivers of debt (whether positive or negative) for tech firms.

The variable that better characterizes tech firms in our study is amortization of intangible assets. Unlike non-tech firms, during maturity, shake-out, and decline, more intangibles induce less debt in tech firms (H1b), providing support for the trade-off theory, consistent with its poor worth as collateral (Titman and Wessels, 1988), as well asfor the pecking order theory in respect to the higher reliance on equity by high-growth firms with asymmetric information about risk (Halov and Heider, 2011). During introduction, intangibles induce more debt, in line with their role as a source of information asymmetry as posited by the pecking order theory. During growth, the negative relation is non-significant, pointing to the joint effect of the opposite forces in place.

The growth opportunities factor follows a general trend of inducing more debt in non-tech firms (though not significant during maturity). In tech firms, the positive relation is only significant during introduction and shake-out. The positive effect on debt is consistent with higher fund needs originated by the new investments required to grow, as posited by the pecking order theory. The significant negative relation for mature tech firms points to the prevalence of greater bankruptcy costs and exacerbated debt agency problems (information asymmetry between managers and investors especially concerns the firm's future growth opportunities[10]), according to the trade-off theory (Frank and Goyal, 2009). During growth and decline, the tech firms' non-significant coefficient would result from the offset of both opposite effects. Thus, tech firms would increase debt to finance growth opportunities only when their generation of cash flows is insufficient to cover the higher investment needs. Consistent with both opposite effects showing different prevalence by stage, the scarce previous evidence (in which samples do not distinguish stages) is not conclusive. Bruinshoofd and Haan (2011) found significant negative coefficients for the US, but weaker ones for the UK. In continental Europe, they found this negative effect for ICT firms, especially during the ICT boom.

Although age follows a similar pattern in both sectors along the life cycle stages, we highlight the stronger positive effect during introduction, the weaker effect during growth, and the negative effect during maturity for tech firms. We appreciate how the results for tech firms' growth and maturity stages are similar to those of the subsequent stages for non-tech firms. The stronger coefficient during introduction suggests that age may be a proxy for notoriety, know-how, and reliability in obtaining debt (H1c). Consistent with the required success of tech firms to maintain their position in the market, Bruinshoofd and Haan (2011) note that innovation and speed in tech projects are necessary for business growth. The change to a negative effect one stage before, for tech firms than for non-tech firms, confirms the change of strategic perspectives when a tech firm enters maturity, much closer to shake-out or decline than in non-tech firms.

[10]Maturity is the stage in which debt is used in a higher proportion, as evidenced in Table 7, for both tech and non-tech firms. However, we can appreciate in Table 6 that tech firms' inductors of debt during maturity are only tangible assets and size.

Our results for size indicate a significant positive effect over leverage during all stages for non-tech firms and during growth, maturity, and shake-out for tech firms. Consistent with the trade-off theory, with less direct bankruptcy costs, in these stages, the firm has access to a variety of funds, and size acts as a sign of debt capacity, allowing the firm to increase debt (Titman and Wessels, 1988). However, the relation is negative during introduction and decline for tech firms. As detected in our correlation analysis, tech firms' size is linked to profitability, which implies less need for debt financing.

A Chow test was performed (Table IV of Appendix A), comparing the stages and the sectors (non-tech versus tech firms). The highly significant values obtained indicate that the coefficients of the independent variables are different across the stages as well as for both sectors.

Table 6. By-Stage Determinants of Leverage

Panel A. Determinants in Non-Tech Firms. GMM

Variables	All Sample	Intro.	Growth	Maturity	Shake-Out	Decline
$LDEBT_{t-1}$	0.580***	0.381***	0.398***	0.868***	0.498***	0.630***
	[0.000485]	[0.000407]	[0.000639]	[0.0218]	[0.00364]	[0.00307]
$PROF_t$	-0.0437***	-0.048***	-0.116***	-0.0490**	-0.0405***	-0.0571***
	[0.000307]	[0.000135]	[0.000277]	[0.0209]	[0.00207]	[0.00222]
$GROWTH_t$	0.00115***	0.0020***	0.0004***	0.00230	0.0055***	0.00175***
	[5.49e-05]	[1.57e-05]	[5.52e-05]	[0.00297]	[0.000495]	[0.000350]
LIQ_t	-0.0006***	-0.002***	0.0045***	-0.00202	0.0023***	-0.0009***
	[3.92e-05]	[1.32e-05]	[2.59e-05]	[0.00229]	[0.000143]	[0.000144]
$SIZE_t$	0.0159***	0.0116***	0.0273***	0.00494***	0.00951***	0.00682***
	[0.000108]	[6.58e-05]	[9.03e-05]	[0.00119]	[0.000410]	[0.000268]
$NDTS_t$	-0.310***	0.00256*	-0.534***	0.193	0.134***	-0.263***
	[0.00272]	[0.00155]	[0.00328]	[0.122]	[0.0186]	[0.0165]
$TANG_t$	0.108***	0.0749***	0.126***	0.0529***	0.148***	0.0780***
	[0.000725]	[0.000315]	[0.000372]	[0.0149]	[0.00318]	[0.00275]
AGE_t	-0.0031***	0.0050***	0.00254***	-0.000307	-0.0025***	0.000571
	[9.92e-05]	[6.83e-05]	[0.000122]	[0.00206]	[0.000498]	[0.000505]
$AMINTAN_t$	0.0332***	0.0354***	0.0593***	0.0624***	0.00441***	0.0564***
	[0.000356]	[0.000130]	[0.000243]	[0.0145]	[0.00165]	[0.00146]

Constant	-0.189***	0.0427***	-0.246***	-0.0709***	-0.121***	-0.0410***
	[0.00162]	[0.00778]	[0.00386]	[0.0180]	[0.00994]	[0.00652]
Country Eff.	YES	YES	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES	YES	YES
Obs.	10,731	1,769	2,607	4,895	1,032	428
# Firms	1,427	658	987	1,047	592	288
F Test	149545	2.140e+07	483360	144	3328	3.025e+06
Sig. F Test	0	0	0	0	0	0
Hansen Test	1297	559.7	927.7	251.7	462.9	216.4
Sig. Hansen	0.348	0.679	0.487	0.107	0.441	0.647
m2	2.113	0.0454	1.372	1.482	1.167	0.837
Sig. m2	0.0346	0.964	0.170	0.138	0.243	0.403

Panel B. Determinants in Tech Firms. GMM

Variables	**All Sample**	**Intro.**	**Growth**	**Maturity**	**Shake-Out**	**Decline**
$LDEBT_{t-1}$	0.596***	0.549***	0.495***	0.569***	0.500***	0.902***
	[0.000889]	[0.00318]	[0.0113]	[0.00495]	[0.00185]	[0.0127]
$PROF_t$	-0.0494***	-0.0349***	-0.0767***	-0.0501***	-0.0314***	-0.028***
	[0.000458]	[0.00215]	[0.00697]	[0.00495]	[0.00108]	[0.00994]
$GROWTH_t$	-0.00022***	0.00277***	0.000345	-0.00127**	0.00701***	0.00219
	[6.62e-05]	[0.000335]	[0.000931]	[0.000531]	[0.000186]	[0.00197]
LIQ_t	-0.00221***	-0.0039***	0.00177***	-0.0028***	-0.0086***	-0.000856
	[5.50e-05]	[0.000216]	[0.000602]	[0.000543]	[0.000140]	[0.000914]
$SIZE_t$	0.00457***	-0.0047***	0.0157***	0.0131***	0.00935***	-0.0046**
	[0.000136]	[0.000770]	[0.00110]	[0.000609]	[0.000216]	[0.00222]
$NDTS_t$	-0.0314***	0.359***	-0.453***	-0.192***	0.269***	-0.519***
	[0.00492]	[0.0268]	[0.0690]	[0.0397]	[0.0136]	[0.163]
$TANG_t$	0.185***	0.0968***	0.104***	0.0547***	0.149***	0.0574***
	[0.00182]	[0.00713]	[0.0138]	[0.00716]	[0.00330]	[0.0192]
AGE_t	0.000435***	0.0123***	0.00213*	-0.0075***	-0.0028***	0.0108*
	[0.000139]	[0.000587]	[0.00117]	[0.000745]	[0.000339]	[0.00565]
$AMINTAN_t$	0.0155***	0.0238***	-0.00272	-0.0109***	-0.0083***	-0.0275**
	[0.000430]	[0.00227]	[0.00612]	[0.00264]	[0.000798]	[0.0133]
Constant	-0.00826	0.181***	-0.176***	-0.0926***	0.234***	0.0837
	[0.0204]	[0.0214]	[0.0180]	[0.0133]	[0.00435]	[0.0725]

Country Eff.	YES	YES	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES	YES	YES
Obs.	6,876	1,372	1,656	2,899	585	364
# Firms	892	454	602	647	339	212
F Test	62113	1819	191.1	1265	273100	76368
Sig. F Test	0	0	0	0	0	0
Hansen Test	819.2	350.3	358.2	489.7	303.4	64.89
Sig. Hansen	0.404	0.366	0.262	0.155	0.912	1
m2	-0.307	-0.565	-0.650	1.467	1.206	1.635
Sig. m2	0.759	0.572	0.516	0.142	0.228	0.102

Notes: Regressions are estimated using the Arellano and Bover (1995) and Blundell and Bond (1998) two-step GMM difference estimator for panel data with lagged dependent variable. The definitions of the variables are provided in Appendix A. We include country dummies and year dummies in all specifications. *m2* is a serial correlation test of the second order using residuals in first differences, asymptotically distributed as N(0, 1) under the null of no serial correlation. Hansen is a test of the overidentifying restrictions, asymptotically distributed as χ^2 under the null of no correlation between the instruments and the error term. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively. Standard errors in brackets.

Table 7. Pecking Order Theory Test. Non-Tech vs. Tech

Panel A. All Firms. Fixed Effects

Variables	All Sample	Introduction	Growth	Maturity	Shake-Out	Decline
DEF	0.188***	0.0166***	0.188***	0.749***	0.580***	0.123***
	[0.00348]	[0.00633]	[0.0110]	[0.00725]	[0.0214]	[0.0197]
Constant	-0.0074***	0.0173***	0.0226***	-0.0056***	-0.015***	-0.016***
	[0.000422]	[0.00169]	[0.00126]	[0.000255]	[0.000845]	[0.00240]
Obs.	17,806	3,247	4,309	7,809	1,630	811
R-sq.	0.158	0.003	0.097	0.636	0.516	0.117
# Firms	2,326	1,123	1,603	1,697	940	513
F Test	2905	6.909	289.3	10693	734.6	39.23

Panel B. Non-Tech Firms. Fixed Effects

Variables	All Sample	Introduction	Growth	Maturity	Shake-Out	Decline
DEF	0.230***	0.0253***	0.225***	0.788***	0.816***	0.167***
	[0.00469]	[0.00875]	[0.0142]	[0.00852]	[0.0231]	[0.0354]
Constant	-0.008***	0.0182***	0.022***	-0.0048***	-0.0098***	-0.015***
	[0.000530]	[0.00223]	[0.00163]	[0.000303]	[0.000895]	[0.00368]

Obs.	10,861	1,842	2,637	4,904	1,042	436
R-sq.	0.203	0.007	0.134	0.689	0.738	0.134
# Firms	1,430	666	996	1,048	598	292
F Test	2400	8.345	252.8	8543	1246	22.22

Panel C. Tech Firms. Fixed Effects

Variables	All Sample	Introduction	Growth	Maturity	Shake-Out	Decline
DEF	0.139***	0.00730	0.131***	0.684***	0.279***	0.0997***
	[0.00514]	[0.00917]	[0.0175]	[0.0131]	[0.0322]	[0.0227]
Constant	-0.0067***	0.0159***	0.023***	-0.007***	-0.021***	-0.018***
	[0.000689]	[0.00257]	[0.002]	[0.000452]	[0.00132]	[0.00319]
Obs.	6,945	1,405	1,672	2,905	588	375
R-sq.	0.108	0.001	0.05	0.549	0.235	0.112
# Firms	896	457	607	649	342	221
F Test	730.1	0.633	55.81	2745	75.2	19.32

Notes: Regressions are estimated using a fixed-effects model to obtain a better comparison with the pecking order model. The definitions of the variables are provided in Appendix A. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively. Standard errors in brackets.

Table 7 shows the results for the pecking order theory tests. The highly significant values obtained with the Chow Test (Table IV of Appendix A) indicate that the coefficients of DEF are different across the stages as well as for both sectors. In every stage, tech firms get lower coefficients for DEF than non-tech firms, thus confirming hypothesis H1a. In this line, Hogan and Hutson (2005) indicate that new technology-based firms rely on outside equity more than debt. Maturity and shake-out are the stages in which both sectors cover financing needs with a higher proportion of debt, though the higher values of debt are found during growth (untabulated statistics by stage). These results are consistent with the pecking order reasoning. Along the firms' life cycle, higher information asymmetries during introduction impede or hamper the access to debt; during growth, the positive generation of funds covers a large part of financing needs, though the growth is so high that a part of needs have to be covered with debt (information asymmetry should be lower than in the previous stage); during maturity, information asymmetry is the lowest, as the growth rate is remarkably lower, while the generation of funds is positive and more steady; during shake-out, information asymmetry increases, but the firm is in a good position to obtain debt to finance the new investments and projects; and during decline, the financing needs decrease considerably due to the disinvestment process, although the generation of operating cash flows is negative.

In line with the results displayed in Table 6, the tech firms' coefficient for maturity is the highest whereas the coefficient for non-tech firms is that for shake-out, indicating the additional needs of financing when the firm reduces generation of funds but is planning new projects and investments. Our results confirm that this is a strategic behavior that tech firms already undertake during maturity.

2.5.2. Growth opportunities as a discriminant factor on the capital structure of high tech firms

We have separated high-tech firms by their market to book medians into firms with high and low growth opportunities (Table 8). As a general result, we can appreciate how high-tech firms address the coefficients of tech firms along the whole life cycle. Furthermore, high-tech firms with high growth opportunities address the coefficients for DEF of high-tech firms and can be considered the group of firms inducing the coefficients of the comprehensive group of tech firms. Consequently, growth opportunities are a good discriminant factor for high-tech firms concerning their capital structures.

For HGOs, the lower use of debt by stage is exacerbated in respect to non-tech firms. Moreover, LGOs are very close to non-tech firms in their use of debt across all of the stages, except the slightly higher use of debt during maturity than during shake-out, in contrast to non-tech firms. These differential effects over the capital structure of HGOs versus LGOs confirm our second hypothesis.

Table 8. Pecking Order Theory Test. HGOs vs. LGOs

Panel A. All High-Tech Firms. Fixed Effects

Variables	**All Sample**	**Introduction**	**Growth**	**Maturity**	**Shake-Out**	**Decline**
DEF	0.120***	0.00645	0.106***	0.628***	0.277***	0.0941***
	[0.00534]	[0.00926]	[0.0189]	[0.0154]	[0.0335]	[0.0225]
Constant	-0.0069***	0.0151***	0.023***	-0.0081***	-0.020***	-0.018***
	[0.000772]	[0.00264]	[0.00223]	[0.000550]	[0.00143]	[0.00330]
Obs.	5,786	1,310	1,339	2,271	510	356
R-sq.	0.091	0.001	0.036	0.489	0.237	0.106
# Firms	753	417	500	530	290	208
F Test	501.8	0.484	31.12	1667	68.07	17.45

Panel B. HGO Firms. Fixed Effects

Variables	**All Sample**	**Introduction**	**Growth**	**Maturity**	**Shake-Out**	**Decline**
DEF	0.0945***	0.00783	0.0601**	0.539***	0.159***	0.112***
	[0.00692]	[0.0113]	[0.0261]	[0.0225]	[0.0541]	[0.0341]
Constant	-0.00642***	0.0118***	0.0256***	-0.0088***	-0.024***	-0.021***
	[0.00116]	[0.00386]	[0.00346]	[0.000842]	[0.00265]	[0.00709]
Obs.	3,139	734	730	1,246	256	173
R-sq.	0.069	0.001	0.013	0.403	0.107	0.165
# Firms	626	255	335	394	183	118
F Test	186.3	0.479	5.281	574	8.617	10.70

Panel C. LGO Firms. Fixed Effects

Variables	**All Sample**	**Introduction**	**Growth**	**Maturity**	**Shake-Out**	**Decline**
DEF	0.201***	0.0229	0.248***	0.809***	0.716***	0.121**
	[0.00986]	[0.0209]	[0.0332]	[0.0210]	[0.0380]	[0.0535]
Constant	-0.00794**	0.0163***	0.0150***	-0.0051***	-0.0082***	-0.018***
	[0.000996]	[0.00398]	[0.00301]	[0.000648]	[0.00115]	[0.00325]
Obs.	2,647	576	609	1,025	254	183
R-sq.	0.167	0.004	0.161	0.683	0.805	0.079
# Firms	575	303	317	338	167	122
F Test	414.3	1.202	55.90	1480	355	5.116

Notes: Regressions are estimated using a fixed-effects model to obtain a better comparison with the pecking order model.The definitions of the variables are provided in Appendix A. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively. Standard errors in brackets.

Again, we have applied the Chow Test (Table IV of Appendix A) to check that the coefficients obtained are significantly different for each group and across stages.

2.6. Robustness analyses

We have performed several additional regressions to check the robustness of our results.

2.6.1. Alternative measure of life cycle

We re-estimate Tables 6 and 7 using an alternative classification of firms into the life cycle stages that discards the use of the signs of the financing cash flows to avoid a possible bias in the capital structure behavior found by stage. In addition to the signs of the operating and financing cash flows proposed by Dickinson, we have used a variable considering deciles of firms' growth and risk by year and country. The variable takes the value 1 if average decile (for growth and risk) is equal or higher than 5, and 0 otherwise. We use the yearly growth of sales to proxy for growth and compute the yearly standard deviation of monthly returns as a proxy for risk. In line with the literature on life cycle stages, we assign firms that scored 1 to the introduction and growth stages, firms that scored 0 to maturity and decline, and the rest of firms are assigned to the shake-out stage.

In Table 9, we observe that the general patterns for profitability (negative) and tangibility (positive) are confirmed, as are the high-low-high effects of growth opportunities and age. The negative coefficients of growth opportunities found for tech firms during growth and maturity and the negative (or lower) coefficients of intangibles during the whole life cycle support our findings in respect to the stronger effect of information asymmetry (H1b). The different role of age across stages (especially introduction and maturity) and the remarkable differences for several factors during maturity support the idea of different strategic perspectives for tech firms related to their rapid development linked to high growth rates.

Table 10 shows that all coefficients for DEF of tech firms are lower than those of non-tech firms, supporting our results in Table 7 to confirm hypothesis H1a. The pecking order theory is behind the lower leverage of tech firms along the whole life cycle as well as behind the differences of leverage by stage in both tech and non-tech firms.

Table 9. By-Stage Determinants of Leverage. Alternative Measure of Life Cycle

Panel A. Determinants in Non-Tech Firms. GMM

Variables	**Introduction**	**Growth**	**Maturity**	**Shake-Out**	**Decline**
$LDEBT_{t-1}$	0.422***	0.484***	0.493***	0.484***	0.732***
	[0.000747]	[0.00149]	[0.000689]	[0.00685]	[0.0223]
$PROF_t$	-0.00615***	-0.0703***	-0.0843***	-0.0506***	-0.0812***
	[0.000226]	[0.000924]	[0.000529]	[0.00302]	[0.00841]
$GROWTH_t$	0.00123***	-0.000485**	0.00892***	0.00253***	-0.000858
	[4.02e-05]	[0.000188]	[0.000142]	[0.000585]	[0.00162]
LIQ_t	-0.000452***	0.000289**	0.00640***	-0.00136***	0.000702
	[5.21e-05]	[0.000128]	[8.34e-05]	[0.000183]	[0.000818]
$SIZE_t$	0.0111***	0.0220***	0.0202***	0.0128***	0.00547***
	[0.000173]	[0.000257]	[0.000166]	[0.000665]	[0.00135]
$NDTS_t$	0.453***	-0.245***	-0.630***	-0.339***	-0.0727
	[0.00760]	[0.00775]	[0.00712]	[0.0254]	[0.0750]
$TANG_t$	0.00969***	0.0944***	0.111***	0.212***	0.0930***
	[0.000836]	[0.00151]	[0.00134]	[0.00572]	[0.0113]
AGE_t	0.00231***	-0.00154***	-0.00134***	-0.00175***	0.00304*
	[0.000156]	[0.000288]	[0.000134]	[0.000642]	[0.00168]
$AMINTAN_t$	0.0402***	0.0424***	0.0249***	0.0263***	0.0236***
	[0.000619]	[0.00122]	[0.000559]	[0.00325]	[0.00838]
Constant	-0.138***	-0.224***	-0.225***	-0.141***	-0.0416*

	[0.00415]	[0.00871]	[0.00548]	[0.0135]	[0.0240]
Country Eff.	YES	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES	YES
Obs.	1,084	4,174	3,107	1,345	162
# Firms	508	1,097	851	669	130
F Test	1.476e+06	8039	1.721e+06	598.9	6563
Sig. F Test	0	0	0	0	0
Hansen Test	482.8	934.8	826.4	464	102
Sig. Hansen	0.998	0.422	1	0.426	1
m2	0.902	0.524	1.645	1.210	1.290
Sig. m2	0.367	0.600	0.0999	0.226	0.197

Panel B. Determinants in Tech Firms. GMM

Variables	Introduction	Growth	Maturity	Shake-Out	Decline
$LDEBT_{t-1}$	0.541***	0.561***	0.647***	0.523***	0.781***
	[0.00302]	[0.00957]	[0.00118]	[0.00140]	[0.0731]
$PROF_t$	-0.0169***	-0.0409***	-0.0250***	-0.0308***	0.00259
	[0.00175]	[0.00622]	[0.00157]	[0.000460]	[0.0181]
$GROWTH_t$	0.00102***	-0.00204**	-0.00203***	-0.000262***	0.00582**
	[0.000243]	[0.000862]	[0.000176]	[6.66e-05]	[0.00270]
LIQ_t	-0.00314***	0.000539	-0.00353***	-0.00566***	-0.00526**
	[0.000171]	[0.000690]	[0.000134]	[5.92e-05]	[0.00218]
$SIZE_t$	-0.00166***	0.00698***	0.0129***	0.00402***	0.000562
	[0.000638]	[0.000979]	[9.84e-05]	[0.000134]	[0.00582]
$NDTS_t$	0.431***	-0.614***	0.0967***	0.111***	-0.759**
	[0.0237]	[0.0711]	[0.00706]	[0.00435]	[0.342]
$TANG_t$	0.0445***	0.166***	-0.0178***	0.170***	0.171**
	[0.00600]	[0.0145]	[0.00140]	[0.00133]	[0.0720]
AGE_t	0.0106***	0.000775	-0.00788***	-0.00201***	0.00831
	[0.000597]	[0.00107]	[0.000149]	[0.000105]	[0.00555]
$AMINTAN_t$	0.00364**	-0.00941*	-0.00963***	0.0189***	-0.0216
	[0.00171]	[0.00526]	[0.000718]	[0.000370]	[0.0239]
Constant	0.211***	-0.0274*	-0.144***	0.0211***	0.0520
	[0.0222]	[0.0161]	[0.00188]	[0.00363]	[0.118]
Country Eff.	YES	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES	YES
Obs.	1,143	2,823	1,621	881	94
# Firms	451	706	518	457	75

F Test	2752	306.4	73056	7.162e+06	936.1
Sig. F Test	0	0	0	0	0
Hansen Test	349.3	335.6	470.3	431.8	47.50
Sig. Hansen	0.381	0.587	0.347	0.724	1
m2	-0.104	0.382	-1.261	1.637	-0.294
Sig. m2	0.917	0.702	0.207	0.102	0.769

Notes: Regressions are estimated using the Arellano and Bover (1995) and Blundell and Bond (1998) two-step GMM difference estimator for panel data with lagged dependent variable. The definitions of the variables are provided in Appendix A. We include country dummies and year dummies in all specifications. m2 is a serial correlation test of the second order using residuals in first differences, asymptotically distributed as N(0, 1) under the null of no serial correlation. Hansen is a test of the overidentifying restrictions, asymptotically distributed as χ^2 under the null of no correlation between the instruments and the error term. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively. Standard errors in brackets.

Table 10. Pecking Order Theory Test. Alternative Measure of Life Cycle

Panel A. All Firms. Fixed Effects

Variables	All Sample	Introduction	Growth	Maturity	Shake-out	Decline
DEF	0.262***	0.0496***	0.435***	0.743***	0.208***	0.149***
	[0.00395]	[0.00882]	[0.00718]	[0.00830]	[0.0130]	[0.0551]
Constant	-0.0074***	0.0109***	-0.0065***	-0.0032***	-0.019***	-0.02***
	[0.000402]	[0.00185]	[0.000535]	[0.000366]	[0.00113]	[0.00417]
Obs.	16,451	2,230	7,004	4,729	2,232	256
R-sq.	0.237	0.024	0.414	0.704	0.19	0.127
# Firms	2,218	960	1,803	1,369	1,129	205
F Test	4413	31.61	3680	8007	258.1	7.301

Panel B. Non-Tech Firms. Fixed Effects

Variables	All Sample	Introduction	Growth	Maturity	Shake-out	Decline
DEF	0.348***	0.0786***	0.462***	0.765***	0.309***	0.395***
	[0.00533]	[0.0141]	[0.00910]	[0.00989]	[0.0183]	[0.0875]
Constant	-0.0075***	0.0120***	-0.0063***	-0.0029***	-0.018***	-0.02***
	[0.000484]	[0.00270]	[0.000687]	[0.000433]	[0.00132]	[0.00440]
Obs.	9,880	1,085	4,178	3,108	1,347	162
R-sq.	0.333	0.051	0.456	0.726	0.297	0.396
# Firms	1,334	508	1,097	851	669	130
F Test	4259	31.1	2578	5983	285.4	20.35

Panel C. Tech Firms. Fixed Effects

Variables	All Sample	Introduction	Growth	Maturity	Shake-out	Decline
DEF	0.178***	0.0288**	0.393***	0.701***	0.115***	0.0727
	[0.00573]	[0.0112]	[0.0116]	[0.0150]	[0.0174]	[0.0748]
Constant	-0.0069***	0.00950***	-0.007***	-0.0037***	-0.017***	-0.028***
	[0.000673]	[0.00253]	[0.000847]	[0.000673]	[0.00195]	[0.00817]
Obs.	6,571	1,145	2,826	1,621	885	94
R-sq.	0.145	0.009	0.351	0.665	0.094	0.05
# Firms	884	452	706	518	460	75
F Test	964.4	6.621	1148	2184	43.75	0.945

Notes: Regressions are estimated using a fixed-effects model to obtain a better comparison with the pecking order model. The definitions of the variables are provided in Appendix A. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively. Standard errors in brackets.

2.6.2. Alternative measure of leverage

We have used an alternative measure of leverage as the dependent variable, that is, total liabilities to total assets. The inclusion of financial and non-financial liabilities has important implications for the results, as found by Welch (2011). Thus, in both tech and non-tech firms, the negative effect of profitability is stronger, tangibility is a less stable inductor, but, in exchange, liquidity is a stronger and stable negative inductor of leverage. The reasons are that non-financial liabilities can vary quickly in response to higher or lower financing needs, and the role as collateral played by tangibility is unnecessary for non-financial liabilities. In addition, the information asymmetry problem can be mitigated by using short-term rather than long-term liabilities (Myers, 1977). Consequently, and consistent with Welch (2011), most variables are sensible to the leverage specification. Notwithstanding, our results confirm the differential role of intangibles along the life cycle, the different function of the drivers during the maturity stage, and the more intense role of age as a positive inductor of leverage.

Table 11. By-Stage Determinants of Leverage. Alternative Measure of Leverage

Panel A. Determinants in Non-Tech Firms. GMM

Variables	Introduction	Growth	Maturity	Shake-Out	Decline
LEV_{t-1}	0.378***	0.461***	0.627***	0.522***	0.601***
	[0.000487]	[0.00794]	[0.00342]	[0.00411]	[0.00342]
$PROF_t$	-0.164***	-0.308***	-0.233***	-0.313***	-0.283***
	[0.000275]	[0.00753]	[0.00488]	[0.00339]	[0.00567]
$GROWTH_t$	-0.0107***	-0.0116***	0.00176***	0.00321***	0.00781***
	[2.90e-05]	[0.00134]	[0.000680]	[0.000674]	[0.000617]
LIQ_t	-0.0328***	-0.0285***	-0.0366***	-0.0384***	-0.0413***
	[4.79e-05]	[0.000754]	[0.000668]	[0.000290]	[0.000856]
$SIZE_t$	0.00243***	0.0171***	0.00949***	0.0191***	0.0214***
	[9.03e-05]	[0.00113]	[0.000655]	[0.000845]	[0.000975]
$NDTS_t$	2.171***	-0.316***	-0.0791**	0.821***	0.104**
	[0.00551]	[0.0714]	[0.0328]	[0.0387]	[0.0445]
$TANG_t$	0.0245***	-0.0323***	0.00509	-0.0179**	0.0422***
	[0.000672]	[0.00859]	[0.00552]	[0.00751]	[0.0110]
AGE_t	0.0155***	0.0211***	-0.00262***	0.00284***	0.00869***
	[0.000220]	[0.00158]	[0.000669]	[0.000978]	[0.00140]
$AMINTAN_t$	0.0859***	0.0453***	0.0232***	-0.0270***	-0.0180***
	[0.000353]	[0.00616]	[0.00320]	[0.00367]	[0.00504]
Constant	0.268***	0.101***	0.146***	0.0226	0.135***
	[0.0292]	[0.0219]	[0.0128]	[0.0154]	[0.0197]
Country Eff.	YES	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES	YES
Obs.	1,769	2,607	4,895	1,032	428
# Firms	658	987	1,047	592	288
F Test	2.060e+07	632.5	1936	3462	4.872e+06
Sig. F Test	0	0	0	0	0
Hansen Test	573.8	618.3	832.4	477.6	206.3
Sig. Hansen	0.518	0.108	0.285	0.265	0.809
m2	0.515	1.627	-1.062	-0.420	1.203
Sig. m2	0.607	0.104	0.288	0.674	0.229

Panel B. Determinants in Tech Firms. GMM

Variables	Introduction	Growth	Maturity	Shake-Out	Decline
LEV_{t-1}	0.333***	0.421***	0.691***	0.580***	0.516***
	[0.00448]	[0.00540]	[0.00763]	[0.0138]	[0.00819]
$PROF_t$	-0.185***	-0.241***	-0.218***	-0.160***	-0.226***
	[0.00445]	[0.00497]	[0.0109]	[0.0109]	[0.00700]
$GROWTH_t$	0.0178***	-0.00524***	0.00184*	0.000821	-0.00190
	[0.000783]	[0.000774]	[0.00104]	[0.00145]	[0.00127]
LIQ_t	-0.0473***	-0.0535***	-0.0341***	-0.0363***	-0.0477***
	[0.000398]	[0.000616]	[0.00116]	[0.00111]	[0.000729]
$SIZE_t$	0.00466***	0.00938***	0.00982***	-0.00629***	0.0162***
	[0.00172]	[0.000973]	[0.000870]	[0.00162]	[0.00161]
$NDTS_t$	2.151***	-0.0418	0.709***	0.892***	1.209***
	[0.0509]	[0.0552]	[0.0784]	[0.155]	[0.0757]
$TANG_t$	0.143***	-0.0519***	-0.0541***	0.0728***	0.0723***
	[0.0152]	[0.0106]	[0.0128]	[0.0242]	[0.0167]
AGE_t	0.0320***	0.00765***	0.00283***	0.0149***	0.0129***
	[0.00168]	[0.00117]	[0.000920]	[0.00281]	[0.00184]
$AMINTAN_t$	-0.00739	-0.0836***	-0.0119**	-0.000994	-0.0429***
	[0.00520]	[0.00422]	[0.00465]	[0.0118]	[0.00961]
Constant	0.142***	0.283***	0.0881***	0.309***	0.0932***
	[0.0270]	[0.0209]	[0.0174]	[0.0342]	[0.0260]
Country Eff.	YES	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES	YES
Obs.	1,372	1,656	2,899	585	364
# Firms	454	602	647	339	212
F Test	3224	1332	1101	1747	39367
Sig. F Test	0	0	0	0	0
Hansen Test	341.6	486.3	488.4	237.7	176.2
Sig. Hansen	0.495	0.183	0.166	0.267	0.993
m2	-0.0365	-1.599	-0.907	1.353	1.148
Sig. m2	0.971	0.110	0.364	0.176	0.251

Notes: Regressions are estimated using the Arellano and Bover (1995) and Blundell and Bond (1998) two-step GMM difference estimator for panel data with lagged dependent variable. The definitions of the variables are provided in Appendix A. We include country dummies and year dummies in all specifications. m2 is a serial correlation test of the second order using residuals in first differences, asymptotically distributed as N(0, 1) under the null of no serial correlation. Hansen is a test of the overidentifying restrictions, asymptotically distributed as χ^2 under the null of no correlation between the instruments and the error term. ***, ** and * indicate significance at the 1%, 5%, and 10% level, respectively. Standard errors in brackets.

2.6.3. Intangible assets measure

Considering the relevance of the intangible assets in the differential behavior of tech firms, we check that results do not change when a different proxy for intangibles is used. Instead of amortization of intangibles, we have taken research and development (R&D), which is considered a good proxy for innovation in tech firms. It is a twofold partial proxy: it alludes only to a specific part of intangibles, and significantly fewer firms have this type of asset in their balance sheets. With these limitations in mind, it is expected that other variables partially change their effects to cover that portion of intangibility not reflected in R&D, such as growth opportunities or non-debt tax shield. In general, most coefficients are similar (reported in Table II in Appendix A), supporting the results displayed in Table 6. Like in our main regressions, intangibles show an opposite pattern during most stages of the life cycle, growth opportunities produce lower or more negative influences on leverage, age is a stronger high-low-high inductor, and maturity is the stage in which the change of patterns is more pronounced.

2.6.4. Institutional and legal controls

We have added additional control variables to check that factors such as the crisis period included in the period under study, the legal origin of the countries in the sample, or creditor rights are not addressing a part of our results. The inclusion of these control variables leaves all our results unchanged, as we show in the Table III in Appendix A. As for the control variables included, for non-tech firms, the crisis appears as a positive inductor of debt during introduction and a negative one during the other stages, though it is only significant during shake-out and decline. For tech firms, it is a weaker inductor, only significant during introduction (positive) and shake-out (negative). The creditor rights variable is also a weaker inductor, except during maturity.

2.6.5. Complete panels

To check that our results are robust to the effect of attrition, we replicate all our analyses for the subsample of firms that remain along the whole period under study (untabulated results). The dramatic reduction of the sample produces a lower number of significant coefficients, though most signs and patterns are maintained in our by-stage analysis. As for the pecking order hypothesis test, all coefficients are remarkably higher, consistent with the sample bias (related to longer age and higher stability). However, all our results confirm hypotheses H1a and H2 during all of the stages of the life cycle.

2.7. Conclusions to the second chapter

This chapter examined the capital structure of the tech sector in a dynamic framework by exploring the sensitivity of firms' leverage to a set of commonly used factors as well as by applying a pecking order test. To distinguish among the life cycle stages of the firm, we used the innovative model of Dickinson (2011). Our results indicate different capital structures along the firms' life cycle for tech and non-tech sectors over a European sample of quoted firms.

The specific characteristics of the businesses in the tech sector produce pronounced differences in financial behavior, mainly during maturity, followed by introduction and decline. Consistent with our first set of hypotheses, growth opportunities, amortization of intangibles, and age are the main discriminant factors for these stages, complemented by non-debt tax shields. The negative (or lower) effect of intangible assets during the whole life cycle except introduction, and that of growth opportunities during growth and maturity, confirm the link between information asymmetry and risk in inducing tech firms to use more equity instead of debt. Non-tech firms' positive coefficients support the pecking order theory, and the differential tech firms' coefficients (lower or negative) for intangibles and growth opportunities are also addressed by the pecking order theory.

During introduction and decline, age acts as a stronger and positive inductor of debt, pointing to the trade-off reasoning of reputation as prevalent. In these stages, the generation of internal funds is remarkably insufficient to cover the funding needs due to the negative operating cash flows. By contrast, age becomes a negative inductor of debt during maturity, in line with the pecking order reasoning, because unlike non-tech firms, the sharp reduction of growth opportunities in tech firms takes place as firms maintain the positive generation of operating cash flows.

The above-mentioned results on the effect of leverage drivers by life cycle stages confirm the role of information asymmetries to differentiate tech firms' capital structure patterns from those of non-tech firms. Furthermore, our results using Frank and Goyal's (2003) test of the pecking order theory confirm the significant lower use of debt by tech firms than by non-tech firms across all of the life cycle stages. In addition, the coefficients obtained for maturity support the previous results on the differential strategic role of this stage for tech firms, closer to that of shake-out for non-tech firms.

Finally, we found that growth opportunities are a key feature for further distinguishing high-tech firms into smaller homogeneous groups to better explain their capital structure. Consequently, the pecking order is even more prevalent for LGOs across all of the stages, and we found that LGOs are closer to non-tech firms, in line with our second hypothesis.

The study contributes to the empirical literature on capital structure in two ways. First, it explains the capital structure of tech versus non-tech firms along the life cycle stages. By doing so, our work confirms that Dickinson's (2011) model provides the research community with a new proxy for the life cycle that allows us to apply capital structure models within a new dynamic framework, giving rise to much more detailed analyses either on general or specific sector samples. Our results highlight the relevance of selecting homogenous groups in respect to the life cycle stage to form the sample under analysis to better explain the capital structure theories. Thus, by using by-stage samples, the offsetting effect of some drivers that evolve along the life cycle is avoided, and some mixed effects found in the literature can be disentangled. Second, we show the potential of growth opportunities to identify smaller groups of high-tech firms concerning capital structure.

2014).

CHAPTER THREE

TARGET LEVERAGE AND SPEED OF ADJUSTMENT ALONG THE LIFE CYCLE OF THE FIRM*

* An earlier version of this chapter was presented at the following scientific meetings: the 6th International Finance and Banking Society conference (Lisbon, 2014), the XXIV Congreso Nacional ACEDE (Castellón, 2014) and the XXII Finance Forum (Zaragoza, 2014).

3.1. Introduction to the third chapter

Since the seminal work of Fischer et al. (1989), which proposed a model of dynamic capital structure choice considering the adjustment costs, target leverage has become an important concept for research on capital structure. In addition to the identification of the determinants of the target leverage, the model computes the speed of adjustment to the target. Depending on the cost of transactions relative to the changes toward the new capital structure, the speed of adjustment varies across companies and over time (Hovakimian et al., 2001). Recent papers have studied the target leverage as a function of firm-level (Byoun, 2008; Chang and Dasgupta, 2009; Hovakimian and Li, 2011; Aybar-Arias et al., 2012; Faulkender et al., 2012) or country-level variables (Cook and Tang, 2010; Rubio and Sogorb, 2011), as well as in relation to firms´ legal and institutional environment (González and González, 2008; Öztekin and Flannery, 2012). Our work adds a new factor to this growing literature: the firm life cycle. We contribute in terms of the dynamic behavior of the target leverage along the life cycle stages of the firm as well as the differences in the speed of adjustment to the optimal capital structure when the firm changes from one stage to another. Furthermore, we demonstrate that a change of stage has an effect in the leverage target of the previous period.

The empirical literature suggests the existence of changing patterns of capital structure across the life stages (La Rocca et al., 2011; Teixeira and Coutinho, 2014) and a time-varying target leverage ratio (Myers, 1984; Elsas and Florysiak, 2011) in response to changing circumstances and conditions. Several authors (Hackbarth et al., 2006; Drobetz et al., 2007) exhibit interesting relations between the speed of adjustment and well-known business cycle variables, indicating the impact of macroeconomic factors. However, there is no empirical evidence about the capital structure adjustment along the life cycle of the firm.

After using a classification model partially based on Dickinson (2011) that allows us to consider the comprehensive behavior of the firm to distinguish between firms in introduction, growth or maturity, we investigate a panel data of quoted firms from fourteen European countries to analyze their target determinants and their speed of adjustment across the stages.

Our work makes several contributions. First, we demonstrate that the main factors of target leverage as well as the speed of adjustment vary along the stages of the life cycle. Our findings suggest that firms adjust to the target ratio faster during introduction or maturity than during growth. Second, we observe differential effects of some determinants and a lower speed of adjustment in firms that have changed stage. We attribute this result to the increase of asymmetric information resulting in an intensification of transaction costs. Finally, we provide evidence that next-stage target leverage induces the level of current leverage, consistent with firms involved in the process of leverage adjustment previously (in advance) to carry out their planned investments.

The rest of the chapter is organized as follows. Section 2 discusses the concepts of target leverage, adjustment speed, life cycle, and the relation between them to derive the hypotheses tested. The following Section describes the research design including the measure of life cycle, the dynamic models of capital structure, the factors of target leverage, and the methodology used. Section 4 presents the sample and the descriptive statistics. Section 5 discusses empirical results and robustness checks. Finally, Section 6 presents the conclusions.

3.2. Theoretical background and hypotheses

The optimal capital structure has been related to the trade-off theory (TOT), as it poses that a firm’s target leverage is driven by competing forces that originate the benefits and costs of debt, mainly the agency cost of financial distress and the tax-deductibility of debt finance (Myers, 1977). Under this dominant explanation, adjustment costs generate lags between the actual debt ratio and the optimal level by slowing down the speed at which firms adjust deviations (Myers, 1984; Titman and Tsyplakov, 2007). For example, if there are fixed transactions costs for issuing or retiring debt, a firm only rebalances when its debt ratio crosses an upper or lower hurdle (Fischer et al., 1989). Consistent with the trade-off reasoning, the following factors have been found crucial to determine the speed of adjustment (Elsas and Florysiak, 2011): high opportunity costs of deviating from a target, for example, in firms with high financing deficits or in small firms; and high default risk.

However, for Shyam-Sunder and Myers (1999), the existence of a target debt ratio does not invalidate the pecking order theory (POT). Flannery and Rangan (2006) find that although more than half of the observed changes in debt ratios are from targeting behavior, pecking order considerations account for part of them (less than 10%). Under the POT, managers do not attempt to maintain a particular target; instead, the leverage ratio is defined as the gap between operating cash flows and investment requirements over time (Barclay and Smith, 1999). In this line, Byoun's (2008) results suggest that many adjustments occur when firms have above-target debt with a financial surplus or when they have below-target debt with a financial deficit. Hovakimian and Li (2009) find asymmetric adjustment costs depending on whether the firm is above or below its target leverage. They find particularly low incremental costs when the firm pays off the excess debt with internal funds. Consistent with the pecking order reasoning, some factors appear as crucial to determine the speed of adjustment: the level of information asymmetry between insiders and outsiders (Öztekin and Flannery, 2012); a variable related to debt capacity, size (Drobetz et al., 2007; Aybar-Arias et al., 2012); other variables indicating current or future additional investments, such as growth (Drobetz and Wanzenried, 2006; Drobetz et al., 2007) or growth opportunities (Aybar-Arias et al., 2012); and cash flow (Faulkender et al., 2012).

We argue that the TOT and the POT change their prevalence along the introduction, growth, and maturity stages of the firm life cycle, giving rise to changing patterns of both debt targets and adjustment speeds. Costs and benefits of adjusting debt, adduced by the TOT, such as bankruptcy costs and tax shields, depend on firm-specific factors that evolve along life cycles as the firms do. Concerning the POT, factors behind the firm financing needs, ability to produce cash flows, financing alternatives, debt capacity, and information asymmetries evolve along the life cycle as well.

3.2.1. Target leverage and life cycle

Considering the trade-off reasoning, the costs and benefits of debt financing are expected to change over the life cycle, thus allowing or forcing firms to modify their financing strategies. As firms grow and develop, they are usually more profitable and have more tangible assets that can act as collateral (Titman and Wessels, 1988), whereas their size allows them to be more diversified (González and González, 2008), and these three factors contribute to a reduction in bankruptcy costs. As for growth opportunities, the literature attributes this factor an increase of bankruptcy costs, that would reduce leverage (Frank and Goyal, 2009), however, some authors find that firms with more growth opportunities have relative cost advantages in external growth funding (Drobetz et al., 2007; Elsas and Florysiak, 2011). During maturity, the trust of shareholders and the market is greater, easing the transaction of these firms and decreasing their costs with regard to the growth stage. As for the benefits of debt, the possibility of using tax shields effectively varies depending on net income or profitability (Frielinghaus et al., 2005; Pfaffermayr et al. 2013). In sum, according to the TOT, taxes, and bankruptcy costs drive more profitable firms toward greater leverage; rather low bankruptcy costs through collateralization drive firms with high proportions of tangible assets toward high target leverage ratios; and lower probability of bankruptcy through higher diversification drive big firms toward higher leverage ratios. Therefore, as transaction costs of financing and bankruptcy costs decrease whereas more tax shields can be used effectively, we can expect higher target leverage and higher levels of debt in larger and more mature firms, in line with Frielinghaus et al. (2005). We derive our hypotheses H.1a and H.1b:

H1a: As firms grow and mature, profitability becomes a stronger positive driver of the target leverage.

H1b: As firms grow and mature, size and tangibles become stronger positive drivers of the target leverage.

As posed by the POT, the information asymmetries between insiders and outsiders tend to be higher during the earlier stages of firm life cycles, whereas debt capacity is lower (Teixeira and Coutinho, 2014; Pfaffermayr et al. 2013). Start-up equity financing should become more probable than start-up debt financing in an information asymmetry setting/scenario, as Hirsch and Walz (2011) find for boom periods, when economies and industries grow rapidly. On the one hand, factors that increase as the firms evolve, such as age or size, indicate bigger debt capacity (due to know-how, notoriety, and collateral). In the same direction, growth and growth opportunities indicate more fund needs (higher investment requirements). On the other hand, during growth and maturity firms hold cash to undertake their profitable investment projects deprived of raising outside funds at high transaction costs (Saddour, 2006). In sum, according to the POT, higher profitability enables firms to use less debt; low information asymmetry as a reason of less costly debt issuances drive firms with more tangible assets toward greater leverage; and know-how, notoriety and collateral, working as an indication of debt capacity drive firms with bigger size toward higher leverage ratios. Therefore, the POT supports the hypothesis H.1b but an additional hypothesis H.1c is derived.

H1c: As firms grow and mature, profitability contributes as a stronger negative driver of target leverage[11]*.*

Finally, from Jalilvand and Harris (1984), a number of works allude to long-run target capital structures, finding that the rate of annual convergence toward the target is lower than 40% for the typical firm (Flannery and Rangan, 2006; Huang and Ritter, 2009) or lower than 20% once the methodological bias has been avoided (Hovakimian and Li, 2009). Furthermore, Leary and Roberts (2005) attribute to some firm shocks lasting effects despite active rebalancing. In this

[11]Note that H1c, posed according to the POT, predicts an opposite behavior for profitability as a driver of the target leverage than H1a, posed according to the TOT.

line, we have considered the magnitude of investments when a large firm changes from one stage to another. For listed firms, the process to adjust the current capital structure to the future target may be longer than a period. This is consistent with a relevant fraction of major financing transactions associated with adjustments away from the target or adjustments beyond the target, even in cases in which the speeds of adjustment are substantially higher (Hovakimian and Li, 2009). In line with the possible use of the financial structure to sign higher expected performance[12] in the next future (Ross, 1977), those drivers concerned by the improved expected returns, such as profitability, size, or tangibles could shift the intensity or even the sign of their effect on the current leverage when future values are taken instead of the current values. Given that the capital structure is the first decision a firm has to take before starting a new investment project, we hypothesize that during the period previous to a changing of life stage, the firm's leverage is not only explained by the contemporaneous target but by the target leverage of the next stage, leading to a new hypothesis not previously tested in this line of research.

H2: When the firm changes from one stage to another, the target leverage of the next stage is an explanatory factor of the current capital structure.

3.2.2. Speed of adjustment and life cycle

Unlike the previous works, we study the speed of adjustment to target leverage in a dynamic way by taking into consideration how the speed of adjustment changes by life cycle stages and how the speed changes when firms evolve from one stage to another. Considering the trade-off reasoning, during introduction, transaction costs are higher because of the limited possibilities of financing, as they have not projected a fully reliable and strong position in the market. During growth, additional needs of external financing (Saddour, 2006) and/or bargaining fight (Delmas and Marcus, 2004) may generate transaction

[12]Changes in the financial structure alter the external perception of the firm's risk. The higher bankruptcy costs derived from the leverage increase implies that the managers are discouraged to give false signals on the future expected returns (Ross, 1977).

costs, though firms with more growth opportunities have relative cost advantages in external growth funding (Drobetz et al., 2007; Elsas and Florysiak, 2011) and adjust faster. During maturity, firms can choose among alternative types of financing, which implies lower transaction costs, such as the cost of paying dividends to a wider number of shareholders or the cost of issuing bonds to a wider number of bondholders; furthermore, they frequently have less cash flow volatility which decreases the possible costs of distress increasing the expected speed of adjustment. Consistent with this reasoning, Hovakimian and Li (2009) identify firms in the highest maturity debt group as the ones with the highest speed of adjustment.

Both Hackbarth et al. (2006) and Drobetz et al. (2007) relate the speed to the economic cycle. Using common business cycle variables linked to the current or future state of the economy, they conclude that the adjustment is faster during booms than in recession periods, that is, with low interest rates and negligible risks of disruption in the global financial system. They attribute their results to the importance of these determinants of default risk. Therefore, the fewer transaction costs of financing and the fewer bankruptcy costs during maturity lead to our third hypothesis:

H3: As firms mature, an increase of the speed of adjustment is expected.

Concerning the POT, as growth starts leveling off during maturity earnings and cash flows will continue to increase rapidly, reflecting past investments, but the investment in new projects will decline, decreasing the financing needs. Larger firms often have lower information asymmetry, which would indicate a lower cost of financing and faster adjustment. Thus, better analyst coverage reduces information asymmetry upon announcement of debt or equity issues (Hovakimian and Li, 2009). In this line, Bulan and Yan (2010) find that the POT better explains the financing decisions of mature firms compared to growth firms. Therefore, the pecking order reasoning provides us with factors pushing the speed of adjustment up. Lower information asymmetry and financing needs reduce adjustment costs, favoring a higher speed of adjustment and reinforcing our third hypothesis.

However, firms changing from one stage to another will suffer higher levels of information asymmetry between the firm managers and the financing market, generating higher transaction costs. Both, the change from introduction to growth and the change from growth to maturity, take place in a period for which the firm's information talks about the previous situation when the firm's managers need financing for the following stage. The information asymmetry concerns the variations of risk, profitability and generation of cash flows, from one stage to another. Furthermore, for firms that change from introduction to growth, certain transaction costs such as those stemming from cash flow volatility are expected to be higher than for firms that advance from growth to maturity. Consequently, the speed of adjustment should be slower in the last case. Hence, we pose two new hypotheses:

H4a: Firms changing stage have a lower speed of adjustment.
H4b: The speed of adjustment is faster for firms changing from growth to maturity than for firms changing from introduction to growth.

3.3. Research design

3.3.1. Measure of life cycle

To consider different aspects of the business by assigning firms to the proper stage of their life cycle, we have started from the model by Dickinson (2011). The author empirically demonstrates that, consistent with theory, profitability and growth differ as the firm progress through life stages taking into consideration the signs of the operating, investing and financing cash flows disclosed in the Cash Flow Statement. The combinations of these signs allow us to establish five possible stages, of which we focus on the first three:

introduction, growth and maturity[13], as presented in Table 1, considering only what concerns the operating and investing activities.

Table 1. Life Cycle Stage Model

Cash Flow Type	Introduction	Growth	Mature
Operating	-	+	+
Investing	-	-	-
Financing	+	+	-

Given that our study concerns the evolution of firm leverage across the life cycle, we have discarded that part of the Dickinson model that uses financial cash flows. The operating and investing signs are exactly the same for the growth and maturity stages; therefore, we have introduced an alternative discriminant criterion, based on previous empirical literature, to assign firms either to introduction/growth or to maturity. The first discriminant factor is growth because relatively young firms are fast growing (Mueller, 1972) both in sales and assets (Miller and Friesen, 1984), considering for this study the growth of sales with respect to the previous year. The second discriminant measure is risk, which is found to be remarkably higher during the birth, growth and revival stages, in contrast with the more conservative maturity and decline stages (Miller and Friesen, 1984). In this study, we use the yearly standard deviation of monthly returns. Then, we consider the joint effect of these variables. We calculate the decile of the risk and growth variables by year and country. Then, we create a new variable that takes the average value of the deciles in which these two factors are placed. Consequently, the firm is in the introduction or growth stage when the resulting value is equal or higher than 5; meanwhile, it is in the maturity stage when the value is lower than 5.

[13]We have to consider that shake-out is a difficult stage to delimitate, and companies move into decline directly from a lower stage.

3.3.2. Dynamic models of capital structure

We have used a target adjustment model in the line proposed by Miguel and Pindado (2001), which takes into account the role of transaction costs when firms change their debt level and furthermore computes the target debt level as a function of the determining factors of capital structure. The model tests how quickly the debt level (D_{it-1}) moves toward the target (D_{it}^{*}) in one period.

$$\left(D_{it} - D_{it-1}\right) = \alpha\left(D_{it}^{*} - D_{it-1}\right) \tag{1}$$

The transaction costs impede firms from fully adjusting their levels of indebtedness to the target level. Therefore, the coefficient α varies between 0 and 1 and is inversely related to adjustment costs. In the extremes, firms completely adjust their leverage to the optimal level (α = 1) when transaction costs are zero; on the contrary, transaction costs may be so high that no firm adjusts its debt level (α = 0), maintaining the previous debt level.

$$D_{it} = \alpha D_{it}^{*} + (1-\alpha)D_{it-1} \tag{2}$$

Following González and González (2008) and Rajan and Zingales (1995), profitability (*PROF*), growth opportunities (*GROWTH*), tangible assets (*TANG*) and size are included in the model as determinants of the target debt.

$$D_{it}^{*} = a_0 + a_1 PROF_{it} + a_2 GROWTH_{it} + a_3 TANG_{it} + a_4 SIZE_{it} + \mu_{it} \tag{3}$$

$$D_{it} = \alpha\left[a_0 + a_1 PROF_{it} + a_2 GROWTH_{it} + a_3 TANG_{it} + a_4 SIZE_{it} + \mu_{it}\right] + \\ +(1-\alpha)D_{it-1} \tag{4}$$

$$D_{it} = \alpha a_0 + (1-\alpha)D_{it-1} + \alpha a_1 PROF_{it} + \alpha a_2 GROWTH_{it} + \alpha a_3 TANG_{it} + \alpha a_4 SIZE_{it} + \sum_{k=1}^{m} S_k + \sum_{k=1}^{m} C_k + \sum_{t=1990}^{2012} Y_t + \gamma_i + \mu_{it} \quad (5)$$

where D_{it} is the leverage of firm *i* in year *t*, α_0 is the independent term and *a* are the coefficients of the variables taken as explanatory factors, S_k is the set of 49 sector dummies to control for sector effects, C_k is the set of country dummy variables controlling for other aspects beyond those explicitly included in the equation, and Y_t is a set of time dummy variables for each year capturing any unobserved firm time effect not included in the regression. γ_i is the firm effect, which is assumed to be constant for firm *i* over *t*; and μ_{it} is the error term. In our empirical analysis, we run several groups of regressions using diverse combinations of these variables.

Our proxy for leverage is the ratio of total debt (long term debt plus short term debt) to total assets, in book values. Profitability is computed as the ratio of earnings before interest, taxes, depreciation, depletion, and amortization over total assets. Growth opportunities is the market to book ratio, defined as the market value of equity plus debt in current liabilities plus long-term debt plus preferred stocks minus deferred taxes and investment tax credit over total assets. We proxy tangible assets by the rate of property, plant, and equipment over total assets (*TANG*). Finally, size is measured as the logarithm of total assets.

To consider the life cycle of the firm jointly with this dynamic model of capital structure, we test the model for the group of companies placed inside the introduction, growth, and maturity stages. According to the classification criteria explained in section 3.1., we have used a dummy variable, that equals one if the firm is in one stage and zero otherwise, to select the specific group of firms belonging to each stage when needed to applying the models. Thus, we test if the different financing strategies of the firm across the stages change the drivers' effect on the target and modify the speed of adjustment.

Concerning the second and fourth hypotheses, we study how the next-year target leverage affects the current debt and how the speed of adjustment varies when the firms change of stage. We run the regression with five different samples depending on the situation of the firms in two consecutive years: firms remaining in introduction, firms changing from introduction to growth, firms remaining in growth, firms changing from growth to maturity, and firms remaining in maturity.

To test the second hypothesis, we model current debt as a function of the next-year target instead of the contemporaneous target. The modified model is as follows:

$$D_{it} = \alpha \cdot D^*_{it+1} + (1-\alpha)D_{it-1} \tag{6}$$

$$D^*_{it+1} = a_0 + a_1 PROF_{it+1} + a_2 GROWTH_{it+1} + a_3 TANG_{it+1} + a_4 SIZE_{it+1} + \mu_{it} \tag{7}$$

$$\begin{aligned} D_{it} = {} & \alpha \left[a_0 + a_1 PROF_{it+1} + a_2 GROWTH_{it+1} + a_3 TANG_{it+1} + a_4 SIZE_{it+1} \right] \\ & + (1-\alpha)D_{it-1} + \sum_{k=1}^{m} S_k + \sum_{k=1}^{m} C_k + \sum_{t=1992}^{2012} Y_t + \gamma_i + \mu_{it} \end{aligned} \tag{8}$$

We use the panel data methodology to alleviate the endogeneity concerns driven by unobservable heterogeneity; specifically, our models are estimated by using the two-step GMM estimator, included in the xtabond2 Stata routine written by Roodman (2009) that uses one-step residuals to construct the asymptotically optimal weighting matrix and addresses the heterogeneity and endogeneity problems. The GMM estimator addresses the heterogeneity problem by modelling it as an individual effect, which is removed by taking first differences of the variables used in the regression. Besides, the endogeneity problem is mitigated by using the lags of all the right-hand side variables. As explained in the previous section, we use predetermined variables that have been carried out using the system GMM in panel data, developed by Arellano and Bover (1995) and Blundell and Bond (1998).

We use the m statistic, which tests for lack of second-order serial correlation in the two first-difference residuals, as this condition is required for the proper functioning of the estimator. An additional test of specification used is the Hansen's statistic of over-identifying restrictions, which tests for the absence of correlation between the instruments and the error term. The use of panel data improves the efficiency of econometric estimates and is more flexible in the choice of variables to be used as instruments to control for endogeneity.

3.4. Sample and descriptive analysis

3.4.1. Sample

In our analysis, we have used firm balance-sheet, income-statement and cash-flow-statement annual data from Worldscope database. As indicated in Table 1, the signs of the Worldscope variables 'Net Cash Flow, Operating Activities' and 'Net Cash Flow, Investing', jointly with a complementary criterion concerning growth and risk, allow us to assign firms into the three life cycle stages studied. The cash flow statement is generally not available prior to 1989. Therefore, our sample covers the period 1990-2012. The panel data contain all quoted[14] firms from Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Portugal, Spain, Sweden and UK (11,553 firm-year observations). For our second, and fourth hypotheses, we work with five subsamples, firms that change from introduction to growth (453 firm-year observations), firms that move from growth to maturity (1,363 firm-year observations) and firms that maintain in the same stage (837 firm-year observations in introduction; 2,700 in growth; and 1,683 in maturity). We exclude financial and regulated firms (SIC codes 6000-6999 and 4900-4999) from the sample. Moreover, we winsorize all variables at the 3% level to avoid the influence of outliers.

[14]There are two reasons to select quoted firms for our study: (1) the Dickinson model is generally applicable only to firms issuing the Cash Flow Statement, and this is not mandatory for a main part of non-quoted firms; and (2) The definition of the life cycle stages may vary considerably for quoted vs. non-quoted firms, specially concerning introduction and growth.

3.4.2. Descriptive statistics

Table 2 reports the descriptive statistics by life cycle stage. The total sample indicates a mean leverage ratio of 20.6%; being higher for firms during growth and maturity than for introduction firms. The mean profitability of 6.8% hides strong differences between the negative mean for firms in introduction and around 12% during growth and maturity. Profitability is higher for firms changing stage (untabulated results). Property, plant and equipment to total assets, and size exhibit growing numbers across the stages, as expected, in line with La Rocca et al. (2011). By contrast, growth opportunities exhibit a sound decreasing pattern as the firms evolve, as in La Rocca et al. (2011) and Teixeira and Coutinho (2014).

Table 2. Descriptive statistics. General
PANEL A. Descriptive Statistics

Life Cycle	Variable	Obs.	Firms	Mean	St.Dev.	Median	Min.	Max.
Introduction	TDEBT	2,189	1,013	0.190	0.209	0.120	0.000	0.703
	PROF	2,189	1,013	-0.159	0.238	-0.089	-0.555	0.330
	GROWTH	2,189	1,013	2.059	1.934	1.227	0.232	6.971
	TANG	2,189	1,013	0.178	0.205	0.096	0.000	0.875
	SIZE	2,189	1,013	10.101	1.854	9.896	7.373	17.161
Growth	TDEBT	5,541	2,007	0.210	0.175	0.189	0.000	0.703
	PROF	5,541	2,007	0.119	0.112	0.121	-0.555	0.330
	GROWTH	5,541	2,007	1.300	1.136	0.934	0.232	6.971
	TANG	5,541	2,007	0.285	0.236	0.237	0.000	0.875
	SIZE	5,541	2,007	12.165	2.079	12.057	7.373	17.161
Mature	TDEBT	3,823	1,532	0.209	0.169	0.187	0.000	0.703
	PROF	3,823	1,532	0.122	0.096	0.122	-0.555	0.330
	GROWTH	3,823	1,532	1.149	0.873	0.923	0.232	6.971
	TANG	3,823	1,532	0.310	0.232	0.271	0.000	0.875
	SIZE	3,823	1,532	12.719	2.239	12.456	7.373	17.161
Total	TDEBT	11,553	2,681	0.206	0.180	0.177	0.000	0.703
	PROF	11,553	2,681	0.068	0.178	0.104	-0.555	0.330
	GROWTH	11,553	2,681	1.394	1.299	0.966	0.232	6.971
	TANG	11,553	2,681	0.273	0.234	0.217	0.000	0.875

SIZE	11,553	2,681	11.958	2.291	11.823	7.373	17.161

PANEL B. Mean Differences

	Mean diff. (Growth minus Introduction)	Mean diff. (Maturity minus Growth)	Mean diff. (Stage Change minus Unchange)
TDEBT	0.0202***	-0.000949	0.00706
PROF	0.278***	0.00332	0.0261***
GROWTH	-0.759***	-0.151***	-0.215***
TANG	0.107***	0.0250***	-0.0124
SIZE	2.064***	0.554***	0.0569

Notes: TDEBT is book leverage (total debt / total assets); PROF is profitability (EBITDA / total assets); GROWTH is market to book (market value of equity + debt in current liabilities + long-term debt + preferred stocks - deferred taxes and investment tax credit to total assets); TANG is tangibility (property, plant and equipment / assets);and SIZE is the logarithm of total assets. Mean dif. indicates the difference of means test (t-test); *, ** and *** indicate significance at the 5%, 1% and 0.1% level, respectively.

In the Table I of Appendix B we show the correlation matrix. Looking to these correlations and some untabulated results by stage, tangibility and size appear as the most important factors for leverage. According to much of the previous empirical evidence, debt ratios are negatively correlated with profitability and positively correlated with size and tangibility in the majority of stages. The maximum value for the relation with profitability appears during growth. Remarkable differences can be appreciated along the life cycle of the firm. Besides, we have calculated the VIF factors (Table II at the Appendix B), showing the absence of multicollinearity.

3.5. Results

3.5.1. Empirical results

Table 3 compares the results on the determinants of firm leverage and the speed of adjustment across the three life cycle stages studied. In this table, we observe that the traditional determinants of capital structure are significant drivers of the target leverage, but coefficients, signs, and significance change along the three stages. The main explanatory factors of target leverage from introduction to maturity are profitability and tangible assets. Growth opportunities and size are relevant determinants but show changes of signs across stages. Our results are consistent with economic changes and corporate actions moving firms either away or towards their target (Titman and Tsyplakov, 2007); however, it is consistent with the leverage target varying in response to the evolution of market imperfections, such as taxes, financial distress costs (TOT), or asymmetric information (POT).

Profitability exhibits a negative contribution to the target leverage, in line with the most common result in the previous literature. According to our results, the POT would support the behavior of leverage with respect to profitability along the three life stages considered, suggesting that higher profitability increases retained earnings, thus reducing the target debt. The higher values during growth and maturity confirm our hypothesis H.1c.

High growth opportunities during pre-mature stages of the life cycle usually involve new projects (much better known by insiders), indicating higher information asymmetry. Thus, during earlier stages, the access to new external financing is hampered, and firms are forced to use retained earnings. In addition, low current free cash flows imply little need of debt to provide a tax shield or to control managerial spending. On the other hand, growth opportunities increase both debt capacity and funding needs. During the introduction and growth stages, the negative sign suggests that firms can finance their new investments with retained earnings without using additional debt. During maturity, the positive coefficient for growth opportunities indicates higher debt capacity and lower asymmetric information. The small coefficients are consistent with growth opportunities exerting opposite effects on leverage. The mixed evidence found for growth opportunities in previous works (González and González, 2008) would be explained by heterogeneous samples made up of firms in different stages of their life cycles, as well as by the mentioned opposite forces in place during the stages.

As for tangible assets, we obtain a positive relation with leverage, indicating the effect of tangibles as collateral to reduce costs of distress and debt-related agency problems. Contrary to our hypothesis H.1b, during introduction, our results suggest a stronger effect of tangibility on leverage. During growth, and particularly maturity, the coefficient is lower (similar to La Rocca et al., 2011). This is likely because mature firms have access to diverse sources of financing. For example, profitable firms are able to finance the increase of tangible assets with internal funds, as suggested by the correlation matrix.

Size exhibits a different relation with leverage through the life cycle. During introduction, the coefficient is negative. The positive and significant coefficient during growth and maturity is consistent with the traditional arguments of both the TOT and the POT. Distress costs decrease, according to the TOT, while debt capacity increases in larger and mature firms due to their know-how, notoriety and collateral, in line with the POT, supporting our hypothesis H.1b. The access to diverse sources of funds give firms the option for cheaper sources of debt. In addition, transaction costs decrease due to the reduction of information asymmetry.

Table 3. By-Stage Determinants of Firm Leverage. System GMM

Variables	**All Firms**	**Introduction**	**Growth**	**Maturity**
$TDEBT_{t-1}$	0.599***	0.537***	0.706***	0.661***
	[0.00778]	[0.00327]	[0.0198]	[0.00246]
$PROF_t$	-0.122***	-0.0266***	-0.172***	-0.161***
	[0.00680]	[0.00118]	[0.0274]	[0.00148]
$GROWTH_t$	0.00190**	-0.00319***	-0.00719***	0.00978***
	[0.000757]	[0.000161]	[0.00241]	[0.000113]
$TANG_t$	0.183***	0.228***	0.0985***	0.0710***
	[0.00759]	[0.00482]	[0.0220]	[0.00165]
$SIZE_t$	0.0120***	-0.0131***	0.00951***	0.0118***
	[0.000966]	[0.000755]	[0.00269]	[0.000345]
Constant	-0.0761***	-0.574	-0.0732	-0.0634***
	[0.0143]	[0.632]	[0.0786]	[0.0177]
Industry Eff.	YES	YES	YES	YES
Country Eff.	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES
Obs.	11,553	2,189	5,541	3,823
# Firms	2,681	1,013	2,007	1,532

F Test	783.5	776536	95.89	29394
Sig. F Test	0	0	0	0
Hansen Test	682	486.8	217.5	765.2
Sig. Hansen	0.335	0.999	0.129	0.361
m2	1.444	0.337	1.234	-0.344
Sig. m2	0.149	0.736	0.217	0.731

Notes: Regressions are estimated using the system GMM estimator for panel data with lagged dependent variables. TDEBT is book leverage (total debt / total assets); PROF is profitability (EBITDA / total assets); GROWTH is market to book (market value of equity + debt in current liabilities + long-term debt + preferred stocks - deferred taxes and investment tax credit to total assets); TANG is tangibility (property, plant and equipment / assets); and SIZE is the logarithm of total assets. Heteroskedasticity consistent asymptotic standard error is in brackets. ***, ** and * represent the significance at the 1%, 5% and 10% levels, respectively.

Concerning the speed of adjustment, our comprehensive coefficient on lagged leverage (0.6) is similar to those obtained for literature references using a comparable methodology, such as Flannery and Rangan (2006) or Chang and Dasgupta (2009) who obtain 0.62, and Cook and Tang (2010), with most coefficients between 0.5 and 0.67. The column 2 (introduction) indicates a coefficient of 0.537 for $Debt_{t-1}$, which implies a value of 0.463 for α. As a result, the adjustment to the target leverage is the highest, suggesting a lower effect of transaction costs than during other stages. However, growth and maturity (columns 3 and 4) exhibit higher coefficients, meaning α closer to zero (0.294 and 0.339, respectively) and hence higher transaction costs. The coefficients suggest different levels of transaction costs in the three stages of the life cycle, remarkably higher during growth in comparison with introduction and maturity. Thus, our results support our third hypothesis except for with regard to introduction. The results for growth and maturity are consistent both with the trade-off and the pecking order reasoning. Concerning the TOT, additional needs of external financing (Saddour, 2006) and/or bargaining fight (Delmas and Marcus, 2004) generate transaction costs during growth, whereas mature firms can choose among a wider variety of financing options and suffer lower levels of default risk, which reduce their financing costs. As for the POT, lower information asymmetry and more stable cash flows in mature firms can contribute to an increase in the speed of adjustment. We have applied the Chow Test (Table V Appendix B) to check that the coefficients obtained are significantly different across stages.

In Table 4, we compare the target leverage determinants between the firms that change and those that remain in the same life stage. Moreover, we distinguish the change from introduction to growth and from growth to maturity.

Table 4. Determinants of Firm Leverage According to the Stage Change. System GMM

Variables	**Introduction: Unchange**	**Change: Intro to Growth**	**Growth: Unchange**	**Change Growth-Mat**	**Maturity: Unchange**
$TDEBT_{t-1}$	0.533***	0.740***	0.595***	0.704***	0.686***
	[0.00300]	[0.0244]	[0.0108]	[0.00184]	[0.00104]
$PROF_t$	-0.0324***	-0.232***	-0.201***	-0.237***	-0.185***
	[0.00221]	[0.0208]	[0.0126]	[0.00179]	[0.00170]
$GROWTH_t$	0.00120***	0.0102***	0.00166	0.0155***	0.0158***
	[0.000219]	[0.00240]	[0.00104]	[0.000145]	[0.000169]
$TANG_t$	0.202***	0.170***	0.114***	0.110***	0.102***
	[0.0104]	[0.0259]	[0.0134]	[0.00223]	[0.00145]
$SIZE_t$	-0.00699***	0.00172	0.0185***	0.00848***	0.00952***
	[0.000842]	[0.00247]	[0.00177]	[0.000454]	[0.000204]
Constant	0	0.145	-0.179***	-0.0326***	0.0725
	[0]	[0.468]	[0.0365]	[0.0108]	[0.0548]
Industry Eff.	YES	YES	YES	YES	YES
Country Eff.	YES	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES	YES
Obs.	837	453	2,700	1,363	1,683
# Firms	437	395	1,230	977	821
F Test	49073	3254	187.9	4.373e+06	1.520e+07
Sig. F Test	0	0	0	0	0
Hansen Test	378	130.2	406.4	652.6	582.7
Sig. Hansen	1	0.972	0.0664	0.769	1
m2	-1.102	-0.295	1.978	1.570	0.205
Sig. m2	0.270	0.768	0.0480	0.116	0.838

Notes: Regressions are estimated using the system GMM estimator for panel data with lagged dependent variables.TDEBT is book leverage (total debt / total assets); PROF is profitability (EBITDA / total assets); GROWTH is market to book (market value of equity + debt in current liabilities + long-term debt + preferred stocks - deferred taxes and investment tax credit to total assets); TANG is tangibility (property, plant and equipment / assets);and SIZE is the logarithm of total assets. Heteroskedasticity consistent asymptotic standard error is in brackets. ***, ** and * represent the significance at the 1%, 5% and 10% levels, respectively.

For firms changing stage, profitability seems to play a more relevant role as a negative determinant of target debt. If we analyze size, we can observe a significant evolution through the stages. During introduction, the relation is negative, which supports the POT because the adverse selection problems considerably decrease in large firms. Then, the relation is not significant during the transition from introduction to growth up to the point of turning positive and considerable higher during growth. The TOT considers size as a sign of the firms' strength for lenders, in parallel with assets as collateral.

The lowest speed takes place when firms change from introduction to growth (α=0.260) followed by those changing from growth to maturity (α=0.296). These results support our hypotheses H.4a and H.4b and are consistent with higher information asymmetries increasing transaction costs for firms in transitions, being even higher costs when the transition is from introduction to growth.

In addition, the change in the life cycle stage involves new strategies, for which new financing may be necessary, implying different and more difficult ways to access to the market, resulting in higher transaction costs. A change of stage always brings about riskier strategies and decisions, with which the stakeholders may not agree, producing a conflict of interest that noticeably increase the transaction costs. Moreover, asymmetric information can affect all dealings of the firm, hindering their accomplishment or increasing their cost. For example, administrative, enforcement, or fiscal procedures may be delayed by several conflicts.

The coefficient in the second column suggests that the strategies or transactions made by a firm evolving from introduction to growth cause distrust in the market, leading to higher costs in accessing additional financing. Consistent with Hovakimian and Li (2009), firms adjusting to pay off the excess of debt exhibit lower adjustment costs. The presence of both types of firms in this group, those who reduce debt and those who increase it, explains the small difference in adjustment costs with respect to firms that remain in maturity. Again, the highly significant values obtained with the Chow Test (Table V

Appendix B) show that the coefficients of target leverage are different by group of firms.

Then, we perform a third group of regressions to test if the target leverage of the next stage acts as a key factor to explain the current leverage when firms have changed life stage. Table 5 indicates how some drivers of the next-year debt target are acting in a completely different way than the same drivers of the current target to explain current debt. This is the case of profitability and size for firms that change from introduction to growth; meanwhile profitability and tangibility are different for the next change.

Table 5. Influence of the Next Target Leverage on Firm Leverage. System GMM

Variables	**Change: Introduction to Growth**	**Change: Growth to Maturity**
$TDEBT_{t-1}$	0.683***	0.725***
	[0.0119]	[0.0174]
$PROF_{t+1}$	0.0468***	0.0217
	[0.00638]	[0.0154]
$GROWTH_{t+1}$	0.00121	0.0161***
	[0.000870]	[0.00256]
$TANG_{t+1}$	0.0863***	0.0736***
	[0.0114]	[0.0154]
$SIZE_{t+1}$	-0.00353**	0.0102***
	[0.00169]	[0.00168]
Constant	0.0295	-0.0654
	[0.0652]	[0.0607]
Industry Eff.	YES	YES
Country Eff.	YES	YES
Time Eff.	YES	YES
Obs.	395	1,296
# Firms	345	947
F Test	25514	170.6
Sig. F Test	0	0
Hansen Test	205.4	248.9
Sig. Hansen	0.958	0.400
m2	-0.966	1.537
Sig. m2	0.334	0.124

Notes: Regressions are estimated using the system GMM estimator for panel data with lagged dependent variables.TDEBT is book leverage (total debt / total assets); PROF is profitability (EBITDA / total assets); GROWTH is market to book (market value of equity + debt in current liabilities + long-term debt + preferred stocks - deferred taxes and investment tax credit to total assets); TANG is tangibility (property, plant and equipment / assets);and SIZE is the logarithm of total assets. Heteroskedasticity consistent asymptotic standard error is in brackets. ***, ** and * represent the significance at the 1%, 5% and 10% levels, respectively.

In contrast with the results using the current target debt, the next-year profitability factor is positively related to debt in all cases, supporting the TOT. Consistent with Ross (1977), considering the new perspectives offered by the changes of stage, higher levels of debt can be used by managers to signal an optimistic future for the firm. In addition, more profitable firms can hold up a higher leverage ratio.

Concerning our third hypothesis, the coefficients indicate a less stable target debt during the growth stage and a more stable target debt during maturity. One year later, growth firms will have a quite different target debt; therefore, the firm contracting its debt with a long-term perspective will exhibit a higher adjustment to the current target. Our results support the findings by Hovakimian and Li (2009), as firms changing from introduction to growth would make adjustments closer to the next-year target than to the current target. Firms changing from growth to maturity will exhibit more stable target debt. Therefore, their speed of adjustment is similar using either the current target or the next-year target (0.296 vs. 0.275). This confirms that the debt target is a strategic decision that addresses the debt policy during several years. Besides, the highly significant values obtained indicate that the coefficients of the target leverage are different for firms changing from introduction to growth than for firms changing from growth to maturity (Table V Appendix B).

3.5.2. Robustness analyses

We have checked the robustness of our results by replicating estimations with a different measure of leverage, by using an alternative classification of firms into life cycle stages, and by including several additional control variables.

3.5.2.1. Alternative measure of leverage

Following Welch (2011), we determine that non-financial liabilities should be considered debt. Hence, our proxy for leverage is the ratio of total liabilities to total assets, in book values. The results are very similar to those obtained with total debt. Differences indicate a slightly lower speed of adjustment along the life cycle stages (Table 6, panel A), both for firms remaining in the same stage and for firms changing from one stage to another (panel B). This result suggests that operating liabilities adjust toward the target in a more progressive way. In addition, we can appreciate that profitability is a better driver of leverage during introduction and growth whereas tangibility and size are weaker inductors of debt, mainly during growth and maturity. The lack of significance for the growth coefficient during introduction and the lower significance during growth are consistent with growth opportunities exerting opposite effects on leverage in these stages. Finally, debt exhibits different target determinants when we consider the next year target (panel C), remarkably in the case of profitability, tangibility, and size. Given that traditional theories pay little attention to operating debt, differences suggest an open research question concerning the use of different sources of funds along the firm life cycle. The stronger effect of tangibility as a determinant of target debt is consistent with the role of tangible assets as collateral in obtaining mainly debt.

Table 6. Alternative Measure of Leverage. System GMM Procedure

PANEL A. By-Stage Determinants of Leverage -LEV-

Variables	**All Firms**	**Introduction**	**Growth**	**Maturity**
LEV_{t-1}	0.649***	0.616***	0.775***	0.612***
	[0.0209]	[0.0174]	[0.0227]	[0.00267]
$PROF_t$	-0.116***	-0.162***	-0.188***	-0.299***
	[0.0264]	[0.0295]	[0.0327]	[0.00222]
$GROWTH_t$	-0.00751**	0.000275	-0.00796*	0.0107***
	[0.00380]	[0.00358]	[0.00452]	[0.000183]
$TANG_t$	0.155***	0.0693**	0.0612**	0.0474***
	[0.0280]	[0.0270]	[0.0280]	[0.00157]
$SIZE_t$	0.00742**	-0.00657	0.0158***	0.0242***
	[0.00359]	[0.00556]	[0.00316]	[0.000529]

Constant	0.0239	-0.522	-0.0650	0.127***
	[0.0978]	[1.038]	[0.0684]	[0.0354]
Industry Eff.	YES	YES	YES	YES
Country Eff.	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES
Obs.	11,616	2,209	5,564	3,843
# Firms	2,684	1,016	2,012	1,535
F Test	353.8	231.9	94.64	14249
Sig. F Test	0	0	0	0
Hansen Test	365.4	210.3	199.5	801.7
Sig. Hansen	0	0.174	0.303	0.126
m2	-0.0426	0.764	0.252	-0.958
Sig. m2	0.966	0.445	0.801	0.338

PANEL B. Determinants of Leverage according to the Stage Change

Variables	Introduction: Unchange	Change: Intro to Growth	Growth: Unchange	Change: Growth-Mat	Maturity: Unchange
LEV_{t-1}	0.554***	0.795***	0.576***	0.705***	0.687***
	[0.00377]	[0.0159]	[0.00126]	[0.00559]	[0.000927]
$PROF_t$	-0.288***	-0.317***	-0.315***	-0.390***	-0.280***
	[0.00468]	[0.0209]	[0.00168]	[0.00600]	[0.00125]
$GROWTH_t$	0.00223***	0.0207***	0.00246***	0.00772***	0.0190***
	[0.000459]	[0.00264]	[8.81e-05]	[0.000547]	[0.000114]
$TANG_t$	0.327***	0.0607***	0.00865***	0.0953***	0.0687***
	[0.0107]	[0.0228]	[0.00102]	[0.00970]	[0.00134]
$SIZE_t$	-0.0120***	0.00442*	0.0149***	0.0152***	0.0129***
	[0.00156]	[0.00268]	[0.000307]	[0.00105]	[0.000233]
Constant	0.582***	-0.124	0.0139	0.0226	0.125***
	[0.164]	[0.445]	[0.0190]	[0.0264]	[0.0152]
Industry Eff.	YES	YES	YES	YES	YES
Country Eff.	YES	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES	YES
Obs.	845	455	2,708	1,369	1,691
# Firms	441	396	1,233	979	825
F Test	2.488e+06	2665	3.751e+06	3852	9.580e+07
Sig. F Test	0	0	0	0	0
Hansen Test	351.4	126.1	810.2	551.1	626.1
Sig. Hansen	0.890	0.985	0.982	0.160	1
m2	0.156	-0.448	0.626	-0.520	-0.900

Sig. m2	0.876	0.654	0.531	0.603	0.368

PANEL C. Influence of the Next Target on Firm Leverage

Variables	**Change: Introduction to Growth**	**Change: Growth to Maturity**
LEV_{t-1}	0.659***	0.828***
	[0.0133]	[0.0165]
$PROF_{t+1}$	0.0793***	0.0445*
	[0.0118]	[0.0268]
$GROWTH_{t+1}$	-0.000785	0.00592*
	[0.00126]	[0.00331]
$TANG_{t+1}$	-0.0487***	0.0768***
	[0.0149]	[0.0196]
$SIZE_{t+1}$	-0.0158***	-0.00289
	[0.00251]	[0.00182]
Constant	0.264***	0.114
	[0.0829]	[0.0763]
Industry Eff.	YES	YES
Country Eff.	YES	YES
Time Eff.	YES	YES
Obs.	396	1,309
# Firms	345	953
F Test	210769	132.7
Sig. F Test	0	0
Hansen Test	216.8	263.3
Sig. Hansen	0.876	0.255
m2	-0.804	0.372
Sig. m2	0.421	0.710

Notes: Regressions are estimated using the system GMM estimator for panel data with lagged dependent variables.LEV is book leverage (total liabilities / total assets); PROF is profitability (EBITDA / total assets); GROWTH is market to book (market value of equity + debt in current liabilities + long-term debt + preferred stocks - deferred taxes and investment tax credit to total assets); TANG is tangibility (property, plant and equipment / assets);and SIZE is the logarithm of total assets. Heteroskedasticity consistent asymptotic standard error is in brackets. ***, ** and * represent the significance at the 1%, 5% and 10% levels, respectively.

3.5.2.2. Alternative classification of firms into life cycle stages

We have checked that our main results do not change when we use the whole Dickinson (2011) model to classify firms into the three life cycle stages. In this case, the signs taken by operating, investing, and financing cash flows are considered (Table 1).

We observe that the speed of adjustment is lower during growth followed by maturity (Table 7, panel A) and that the lower speed of adjustment is found for firms changing from introduction to growth (panel B). The same patterns are maintained in the coefficients of the target leverage factors in the three panels, except for growth opportunities in some stages. The opposite effects of growth opportunities supported by both the trade-off and the pecking order reasoning cause variation of signs and significance depending on the life cycle stage, but also on the subsample of firms analyzed.

Table 7. Alternative Measure of Life Cycle -Dickinson. System GMM

PANEL A. By-Stage Determinants of Debt

Variables	**Introduction**	**Growth**	**Maturity**
$TDEBT_{t-1}$	0.538***	0.642***	0.577***
	[0.00652]	[0.0329]	[0.000776]
$PROF_t$	-0.112***	-0.183***	-0.196***
	[0.00392]	[0.0346]	[0.000582]
$GROWTH_t$	-0.00742***	-0.00748**	0.000476***
	[0.000597]	[0.00378]	[0.000106]
$TANG_t$	0.152***	0.0483*	0.0660***
	[0.00870]	[0.0246]	[0.000884]
$SIZE_t$	-0.00644***	0.0218***	0.00502***
	[0.00117]	[0.00256]	[0.000211]
Constant	-0.741	-0.191***	0.240***
	[1.049]	[0.0714]	[0.0264]
Industry Eff.	YES	YES	YES
Country Eff.	YES	YES	YES
Time Eff.	YES	YES	YES
Obs.	3,420	3,615	6,058
# Firms	1,243	1,691	1,943
F Test	44938	79.82	2.080e+07
Sig. F Test	0	0	0
Hansen Test	417.7	289.6	1031
Sig. Hansen	0.860	5.23e-07	0.0178

m2	-0.257	1.419	1.297
Sig. m2	0.797	0.156	0.195

PANEL B. Determinants of Debt according to the Stage Change

Variables	Introduction: Unchange	Change: Intro to Growth	Growth: Unchange	Change Growth-Mat	Maturity: Unchange
$TDEBT_{t-1}$	0.511***	0.702***	0.552***	0.579***	0.575***
	[0.00617]	[0.0226]	[0.00201]	[0.0180]	[0.000281]
$PROF_t$	-0.0313***	-0.116***	-0.148***	-0.295***	-0.162***
	[0.00295]	[0.0160]	[0.00207]	[0.0202]	[0.000265]
$GROWTH_t$	-0.00829***	0.00847***	0.0134***	0.00578***	-0.000784***
	[0.000567]	[0.00242]	[0.000356]	[0.00206]	[3.69e-05]
$TANG_t$	0.209***	0.238***	0.181***	0.154***	0.178***
	[0.00533]	[0.0280]	[0.00515]	[0.0243]	[0.000504]
$SIZE_t$	-0.00616***	0.0203***	0.0156***	0.0150***	0.00742***
	[0.00101]	[0.00369]	[0.000491]	[0.00261]	[0.000145]
Constant	0.0760	-0.835**	-0.153	-0.0774*	-0.00298
	[0.0889]	[0.360]	[0.281]	[0.0465]	[0.00683]
Industry Eff.	YES	YES	YES	YES	YES
Country Eff.	YES	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES	YES
Obs.	2,049	456	1,421	1,409	3,496
# Firms	752	407	785	1,027	1,306
F Test	41021	632.7	4.670e+07	261.4	7.943e+06
Sig. F Test	0	0	0	0	0
Hansen Test	221.2	109.5	415.8	319.9	1005
Sig. Hansen	1	0.995	0.780	3.57e-10	0.902
m2	-0.192	-0.916	0.478	1.996	-1.111
Sig. m2	0.847	0.359	0.633	0.0459	0.267

PANEL C. Influence of the Next Target on Firm Debt

Variables	Change: Introduction to Growth	Change: Growth to Maturity
$TDEBT_{t-1}$	0.623***	0.391***
	[0.0208]	[0.00469]
$PROF_{t+1}$	0.0714***	0.0675***
	[0.0130]	[0.00293]
$GROWTH_{t+1}$	0.0229***	0.000959**
	[0.00258]	[0.000407]
$TANG_{t+1}$	0.132***	0.119***

	[0.0236]	[0.00461]
$SIZE_{t+1}$	0.00512	-0.00489***
	[0.00386]	[0.000765]
Constant	0.573*	0.186***
	[0.345]	[0.0698]
Industry Eff.	YES	YES
Country Eff.	YES	YES
Time Eff.	YES	YES
Obs.	415	1,322
# Firms	376	978
F Test	2080	351490
Sig. F Test	0	0
Hansen Test	139.5	556.1
Sig. Hansen	0.998	0.192
m2	-0.926	2.938
Sig. m2	0.355	0.00331

Notes: Regressions are estimated using the system GMM estimator for panel data with lagged dependent variables.TDEBT is book leverage (total debt / total assets); PROF is profitability (EBITDA / total assets); GROWTH is market to book (market value of equity + debt in current liabilities + long-term debt + preferred stocks - deferred taxes and investment tax credit to total assets); TANG is tangibility (property, plant and equipment / assets);and SIZE is the logarithm of total assets. Heteroskedasticity consistent asymptotic standard error is in brackets. ***, ** and * represent the significance at the 1%, 5% and 10% levels, respectively.

3.5.2.3. Additional control variables

We have controlled by the effect of some legal and institutional factors as well as by the effect of the crisis. We have added the following control variables: creditor rights, legal origin (English, French, German, and Scandinavian), efficiency of debt enforcement, and crisis. The creditor rights are measured using the index developed by LaPorta et al. (2008). The legal origin dummies are constructed following LaPorta et al. (2008). Efficiency of debt enforcement is defined as the present value of the terminal value of the firm after bankruptcy costs (Djankov et al., 2008). The crisis factor is a dummy variable built following Laeven and Valencia (2013). We report the results in Table III in Appendix B, showing that all the patterns for speed of adjustment remain unchanged and almost all signs and patterns for leverage drivers maintain. Again, growth opportunities appear as the less stable factor. For the effect of creditor rights, legal origin, and efficiency of debt enforcement we do not obtain conclusive results as coefficients show changes of significance and sign. The crisis factor shows a more consistent effect, showing a positive influence on leverage across the life cycle stages, though significance is weaker (or null) in some cases. We have controlled by the firm age, variable measured as log of the number of years of the firms since its foundation. In general the results are consistent with the patterns for speed of adjustment and leverage observed previously. We show the results in Appendix B in Table IV.

3.6. Conclusions to the third chapter

We conclude that the target leverage and the speed of adjustment to the optimal capital structure vary across the life cycle stages of the firms in a study using a panel database of non-financial firms in fourteen European countries during the period 1990-2012.

To distinguish life cycle stages, we start from Dickinson's (2011) innovative methodology, based on the signs of operating, investing and financing cash flows, but we substitute the financing cash-flow part by an alternative criterion based on a combination of growth and risk factors to separate the firms in introduction and growth from the mature firms.

Taking total debt to assets as a proxy for leverage, our results indicate a high-low-high pattern for the speed of adjustment across the life cycle stages. During introduction and maturity, the speed of adjustment is higher, meaning considerably lower transaction costs. During growth, quoted firms usually enter into other businesses or increase their investments to reach a higher growth, thus increasing the asymmetric information and hindering the access to capital markets.

Analyzing the determinants of target leverage by stage, we conclude that profitability and tangibility are the main drivers from introduction to maturity, whereas growth opportunities and size are less relevant determinants.

Profitability has a negative relation along the life of a firm, less influential during introduction, supporting its role as a source of retained earnings posed by the POT. Tangible assets have a positive contribution, in line with its effect as collateral posed by the POT, being this factor remarkably relevant during introduction. The growth opportunities variable exhibits small coefficients and a change of sign from growth to maturity, suggesting opposite effects derived from this factor: bigger funding needs and debt capacity in contrast with generation of more cash flows. The negative coefficient during introduction and growth is in line with higher information asymmetry hampering new external funding (POT), whereas the positive relation during maturity suggests that the retained earnings produced by profitable firms are insufficient to cover the additional funding needs. The size factor is positive during growth and maturity, which is supported by both the TOT and the POT reasoning.

A lower speed of adjustment is observed in firms that change life stage with respect to those remaining in the same stage, consistent with higher asymmetric information and transaction costs associated with strategy changes. Concerning the target leverage, profitability exhibits a stronger effect for firms changing stage. We conclude that new strategies cause frictions on the market affecting costs and capital structure. In addition, our results indicate a lower increase of costs for firms changing from growth to maturity than for firms changing from introduction to growth. This result is consistent with a mixed group of firms concerning adjustments of debt: those reducing debt and those increasing it, considering the asymmetric costs of both types of adjustment (Hovakimian and Li, 2009).

Finally, our results confirm that firms changing from one life stage to another use long-term targets. Furthermore, during the change from introduction to growth, the adjustment to the next-year target is faster than to the current target. In this case, factors proxying for debt target suffer relevant changes from year to year, and debt changes are likely to adjust to needs expected two or three years ahead. By contrast, firms changing from growth to maturity would expect more stable financial needs, and firms are able to perform financing changes in shorter periods. Therefore, next-year targets do not improve the adjustment speed.

Our contribution to the line of research on optimal capital structure is twofold. First, we demonstrate that the capital structure determinants as well as the speed of adjustment to target levels depend on the stage of the firm, as the capital structure theories play different roles along the life cycle stages of firms. Furthermore, we provide evidence for differences in firms changing from one stage to another, both in targets and speed of adjustment. Second, we contribute to the target leverage literature by adding a new explanatory factor: the next-year target debt. Our results confirm that the next-year target is also a relevant factor to explain the current debt and the adjustment behavior of the firms differs between different stages.

CHAPTER FOUR

THE INCENTIVES OF CREDITORS TO MONITOR VIA DEBT SPECIALIZATION: THE IMPACT OF CEO COMPENSATION*

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4.1. Introduction to the fourth chapter

It is a widely accepted view that the design of executive compensation contributes to aligning the interests of managers with those of shareholders (Coles et al., 2006; Brockman et al., 2010; Dow and Raposo, 2005; Lo, 2003). In this respect, a pivotal role is played by equity-based incentives that link the value of executive pay to stock return volatility and to stock price. These incentives aim at reducing the agency costs rooted in the potential conflicts between managers and shareholders by aligning the risk-appetite of managers to the purpose of maximizing shareholder value (Low, 2009).

However, another effect produced by the presence of equity-based incentives in executive pay is the potential increase in the agency costs of debt related to asset substitution problems (Brockman et al., 2010; Cassell et al., 2012), commonly defined as risk-shifting (Eisdorfer, 2008; Leland, 1998). In particular, equity-based incentives that favor risk-taking might induce managers to replace safe activities with riskier ones thus transferring wealth from debtholders to shareholders. Nevertheless, it has been shown that creditors understand the risk incentives offered to managers via their compensation and the related potential negative effects for debtholders (Brockman et al., 2010; Kabir et al., 2013; John and John, 1993; Liu and Mauer, 2011; Ortiz-Molina, 2007). Creditors are, therefore, expected to take actions to curtail the impact of these incentives on their wealth.

In this paper we show that one such action is the increase in the concentration of the lending relationships with borrowing firms as this facilitates monitoring by creditors. Our point of departure is the evidence reported in Brockman et al. (2010) that an increasing presence of risk-taking incentives in CEO compensation, and the related risk of asset substitution problems, leads to a growing share of short-term debt in the capital structure. Essentially, the debt structure becomes characterized by an increasing presence of debts that provide creditors with a powerful monitoring tool (Barclay and Smith, 1995;

Stulz, 2000) and that offer additional flexibility to monitor managers with minimum effort (Rajan and Winton, 1995).

The maturity of debt contracts is not, however, the only characteristic of a firm's debt structure that the literature has identified as having the potential to facilitate the effectiveness of the monitoring activity by creditors (see Diamond, 1984; Allen, 1990). Specifically, the concentration of debt claims in fewer lenders is supposed to alleviate information collection problems for creditors (and the related agency costs), and reduce free-rider problems amongst creditors and the risk of duplicating monitoring effort (Diamond, 1984; Allen, 1990; Platikanova and Soonawalla, 2014). This is because debtholders have incentives to effectively monitor corporate borrowers provided that they have a sufficient claim in the firm (Diamond, 1991; Park, 2000). In contrast, the dispersion of creditors increases the risk of mutual free-riding (Holmström, 1982). Furthermore, and crucially for our analysis, multiple creditors have been shown to suffer from coordination problems that might facilitate expropriation by shareholders (Bernardo and Talley, 1996; Bris and Welch, 2005; Gertner and Scharfstein, 1991). Overall, the concentration of debt claims appears preferable to creditors when they have incentives to effectively monitor managerial actions, as is the case of when managers receive high risk-taking incentives in executive pay.

We build our analysis around the theoretical framework above to show that the potential negative effects that the design of executive compensation might produce in terms of asset substitution problems do not influence only the maturity of the lending relationships - as shown by Brockman et al. (2010) - but they also affect the degree of concentration of these relationships.

We base our analysis on a sample of listed US firms for the period 2001-2012 and we rely on two widely known measures of equity-based incentives in executive pay, the sensitivity of compensation to stock return volatility (Vega) and the sensitivity of compensation to stock price (Delta), to capture the risk-taking incentives embedded in executive pay. Both Vega and Delta have the potential to affect the risk appetite of CEOs, though in opposite ways. A higher Vega has been usually linked to higher risk-taking as it signals the possibility to gain in compensation in the presence of a more volatile business (Cohen et al., 2000; Coles et al., 2006; Dong et al., 2010; Gormley et al., 2013; Guay, 1999). In contrast, a higher Delta, linking compensation to changes in equity prices, should increase the propensity of managers to generate value but also to be more prudent in their risk taking given they hold relatively undiversified portfolios with respect to firm-specific wealth (Coles et al., 2006). We compute Vega and Delta for each firm CEO. The focus on CEOs is a common choice in the literature on executive compensation (see, among others, Brockman et al., 2010; Coles et al., 2006; Fich et al., 2014; Liu and Mauer, 2011) given the centrality of this executive role in driving business choices at the firm level.

We relate these measures of equity-based incentives to proxies of the degree of concentration of the lending relationships that we construct following the approach proposed by Colla et al. (2013) and employed by Platikanova and Soonawalla (2014). These proxies are based on the degree of concentration of the debt structure across different types of debt (henceforth debt specialization) and are motivated by the idea that firms using a lower number of types of debt (indicating higher specialization) are also more likely to have a lower number of creditors (see Colla et al., 2013; Li et al., 2014).

While, admittedly, debt specialization is an imperfect measure of the degree of concentration of the lending relationships in fewer creditors, it has been shown to be significantly higher in companies where creditors have more incentives to monitor - such as those characterized by a higher degree of information asymmetry (Colla et al., 2013; Li et al., 2014; Platikanova and Soonawalla, 2014). In essence, debt specialization is higher when the presence of a lower number of creditors is expected to facilitate the monitoring of borrowing firms.

We start our analysis by finding consistently an increase (decrease) in debt specialization when the compensation package's sensitivity to stock return volatility (stock price) increases (decreases). Our empirical results are robust to the addition of controls that have been shown to explain debt specialization, to changes in the econometric method and, in particular, remain unchanged when we control for the potential endogeneity of equity-based incentives under an instrumental variable setting.

We then proceed by evaluating how the nexus between debt specialization and equity-based incentives is influenced by a firm's default risk. We conjecture that there are at least two reasons that motivate greater debt specialization in more risky companies when executive pay might lead to more severe asset-substitution problems. First, in the presence of a default, a dispersed group of creditors tends to be inefficient in organizing and coordinating negotiation efforts (Bolton and Scharfstein, 1996; Hart and Moore, 1995; Hubert and Schfer, 2002; Ivashina and Scharfstein, 2010). Second, asset substitution problems are also more likely to occur when firms are closer to financial distress (Black and Scholes, 1973; Gavish and Kalay, 1983; Green and Talmor, 1986; Leland, 1998). In such a case shareholders might benefit from risky investments if these investments go well, while debtholders will bear the costs in the case of a negative scenario (Eisdorfer, 2008). By using different proxies for firm default risk, we find support for the validity of our conjecture but only in the case of Vega; namely for the most direct proxy of risk-taking incentives that are present in executive-pay. An increase in Vega raises the degree of debt specialization significantly more in riskier firms while an increase in Delta tends to produce a similar decrease in the degree of debt specialization in both low and high risk firms.

While the analyses summarized above generally indicate that creditors perceive a higher degree of debt specialization as being beneficial in the presence of more pronounced agency costs of debt, they say little as to what extent these costs are reduced when the debt structure becomes more concentrated. To quantify the potential benefits for creditors we, therefore, rely on a similar empirical setting as in Eisdorfer (2008) and relate the percentage change of the market value of debt to Vega and Delta. In effect, this approach implies that the agency costs of debt materialize via a reduction in the market value of debt when Vega (Delta) increases (decreases). By comparing the impact of Vega and Delta on the percentage change of the market value of debt in firms with low and high degree of debt specialization, we find that the negative influence of equity-based incentives on debtholder wealth is limited to the group of firms with a less concentrated debt structure. This result is, therefore, in line with the view that debt specialization is an effective tool to curtail asset substitution problems.

Finally, we extend the evidence presented in Brockman et al. (2010) by assessing whether debt maturity and debt specialization act as complement or substitute tools in reducing the potential agency costs of debt generated by executive compensation. To this end, we estimate a system of equations that allows us to control for the simultaneity in the decisions concerning debt maturity and the degree of debt specialization. Under this empirical framework, we show that the degree of debt specialization acts as an alternative tool to a decrease in the maturity of debt to curtail risk-taking incentives in executive pay. In short, we find that, controlling for risk-taking incentives in executive pay, the degree of debt specialization is significantly higher in firms characterized by longer debt maturity, while an increase in debt specialization reduces the need to shorten the maturity of debt. Hence, debt maturity and specialization are perceived by creditors as playing a similar role against the agency cost of debt, but they tend to operate as substitutes rather than complements.

Our analysis offers a number of contributions to the extant literature. First, our study extends the existing evidence on the role of executive compensation in influencing a firm’s capital structure. While several analyses have generally linked executive incentives to firm leverage (Berger et al., 1997; Coles et al., 2006), to the types of debt (straight debt versus convertible debt) (Ortiz-Molina, 2007) and to the maturity of the debt contracts (Brockman et al., 2010), we are the first to find evidence of a strong relationship between the degree of specialization of corporate debt structures and executive compensation as motivated by the agency costs of debt.

Second, we extend the empirical evidence on the drivers of debt-specialization in Colla et al. (2013) and Platikanova and Soonawalla (2014) and, in particular, on the importance of the monitoring incentives of creditors. Essentially, we show how debt specialization might be used as a tool to curtail the agency costs of debt produced by the design of executive compensation and how this is especially the case in riskier firms. Finally, we contribute to the literature on the creditor perception of pay incentives in executive compensation. Previous studies have observed a positive (negative) bond price reaction in the presence of an increase in Delta (Vega) (Billett et al., 2010), and a higher cost of debt when compensation risk is higher (Brockman et al., 2010; Daniel et al., 2004). Crucially, we extend the evidence in Brockman et al. (2010) by showing that the creditors' assessment of the relationship between executive compensation and risk-seeking behavior by managers leads to debt specialization having a similar, but alternative role, to the use of short term debt.

The rest of the paper is organized as follows. Section 2 conducts a review of the related literature and develops testable hypotheses. In Section 3 we describe our data, the measurement of the key variables and our econometric method. Section 4 presents the empirical results while Section 5 concludes the paper.

4.2. Theoretical background and hypotheses

4.2.1. Executive compensation and the incentives of creditors to monitor

The incentives to monitor by creditors are influenced by the design of executive compensation in the borrowing firms and the related managerial incentives to engage in asset substitution (risk-shifting) that might favor shareholders (Brockman et al., 2010).

Specifically, the sensitivity of executive compensation to stock return volatility (Vega) should favor riskier business choices by managers as it implies that executives gain in compensation when the business becomes more volatile (Cohen et al., 2000; Coles et al., 2006; Dong et al., 2010; Gormley et al., 2013;

Guay, 1999). For instance, the literature has associated a higher Vega with more R&D expenditures and fewer investments in fixed assets (Coles et al., 2006), higher leverage (Coles et al., 2006; Dong et al. (2010), less cash reserves (Gormley et al., 2013), and less hedging with derivative securities (Knopf et al., 2002). In contrast, the sensitivity of compensation to stock price (Delta) should favor value-increasing investments but it is also expected to lead undiversified managers to be more prudent in their risk taking (see Brockman et al., 2010; Coles et al., 2006; Knopf et al., 2002). Accordingly, a higher Delta has been associated with decreases in R&D expenditures, increases in capital expenditures (Coles et al., 2006), decreases in leverage (Coles et al., 2006; Cohen et al., 2013) and more hedging with derivative securities (Knopf et al., 2002). Overall, a higher (lower) Vega (Delta) is expected to amplify the agency costs of debt due to asset substitution problems and lead to greater monitoring by creditors (Brockman et al., 2010).

Creditors understand and rationally price the managers' risk incentives. For instance, Billett et al. (2010) show that the bond price reaction to an increase in Vega (Delta) is negative (positive). Similarly, Daniel et al. (2004) provide evidence of a positive relationship between credit spreads and CEO risk-taking compensation, while Liu and Mauer (2011) show that CEOs with a high Vega are required to hold excess cash balances to diminish bondholder risk. Furthermore, an increase in Vega (Delta) has been linked to a shorter (longer) maturity of the debt structure (Brockman et al., 2010). This finding offers clear support for a nexus between monitoring incentives and executive compensation. Shorter-term debt can reduce managerial incentives to increase risk and reduce or even eliminate agency costs associated with asset substitution (Barnea et al., 1980; Leland and Toft, 1996) as it provides creditors with a powerful monitoring tool (Rajan and Winton, 1995; Stulz, 2000). Under short-term contracts lenders are in the position to frequently review whether to continue providing credit and to restrict borrowers from increasing the riskiness of the underlying assets (Barnea et al., 1980).

However, numerous theoretical studies demonstrate that the monitoring activity by lenders is also facilitated by an increase in the degree of concentration of the debt claims (Diamond, 1984; Allen, 1990). In essence, debt providers have incentives to effectively monitor corporate borrowers provided that they have a sufficient claim in the firm (Diamond, 1991; Park, 2000), while the dispersion of creditors increases the risk of mutual free-riding (Holmström, 1982). Furthermore, the diversification of the claims over the assets of a borrower might increase coordination problems amongst lenders with a consequent higher risk of suffering from costly debt renegotiation and liquidations (Bris and Welch, 2005; Platikanova and Soonawalla, 2014). More generally, coordination problems have been shown to facilitate expropriation by shareholders (Bris and Welch, 2005; Bernardo and Talley, 1996; Gertner and Scharfstein, 1991).

Empirical support for a nexus between debt concentration and the incentives of creditors to monitor is offered by Sufi (2007) who finds that debtholders form a more concentrated lending syndicate if the firm requires stronger monitoring and due diligence. In a similar vein, using the specialization of debt types as a proxy for concentrated debt claims, Colla et al. (2013) and Platikanova and Soonawalla (2014) show that when creditors suffer from larger information asymmetry the borrowing firms exhibit a more specialized debt structure. Furthermore, Li et al. (2014) show that firms with a weak internal control system are characterized by a higher degree of debt specialization.

The highlighted role of the concentration of the lending relationships as a tool to facilitate effective monitoring by creditors, and the established impact of executive compensation on the monitoring incentives by creditors, lead us to formulate the following first hypothesis:

H1: An increase in the sensitivity of a CEO's compensation to stock return volatility (Vega), and a decrease in the sensitivity to stock prices (Delta), increases the degree of debt specialization in a firm's capital structure.

Essentially, as in Colla et al. (2013) and Platikanova and Soonawalla (2014), we employ measures of the degree of specialization of the debt structure by debt types as a proxy for the presence of concentrated lending relationships.

Accordingly, we expect that when executive compensation is designed in a way that amplifies the agency costs of debt linked to asset substitution problems, the degree of specialization in the debt structure increases given the higher incentives for creditors to monitor.

4.2.2. Debt specialization, firm risk and the incentive of creditors to monitor

The relationship between debt specialization and executive pay incentives postulated above is unlikely to be independent from firm default risk. In fact, there are at least two reasons that lead to a higher firm default risk amplifying the increase in debt specialization in the presence of risk-taking incentives in executive compensation.

First, a dispersed group of creditors is supposed to be inefficient in organizing and coordinating negotiation efforts in the presence of a default (Hart and Moore, 1995; Hubert and Schfer, 2002; Ivashina and Scharfstein, 2010). This conclusion finds support in the theoretical models proposed by Bolton and Scharfstein (1996) and by Bris and Welch (2005). Though these models offer some contrasting empirical predictions on the potential effects produced by a more concentrated debt structure, they both suggest that creditors benefit from more concentrated lending relationships in the case of firm liquidations. For instance, Bris and Welch (2005) focus on creditors that must proactively seek to enforce their claims and show that, in the presence of team free-riding and of a fixed level of debt, a distressed firm with a number of uncoordinated small creditors is less likely to be forced to pay its obligations than a firm with only one creditor. It follows that creditors should be more inclined to impose a more specialized debt structure on a firm when asset substitution problems, which might be generated by executive pay, are more likely to lead to the default of the company.

Second, asset substitution problems are also more likely to occur when firms are closer to financial distress (Black and Scholes, 1973; Leland, 1998). In such a case shareholders might benefit from risky investments if these investments go well, while debtholders will bear the costs in the case of a negative outcome. In line with this view, Eisdorfer (2008) shows that an increase in the investment intensity increases asset volatility in distressed firms while it reduces asset volatility in healthier firms. In a similar vein, Gavish and Kalay (1983) and Green and Talmor (1986) show that the incentive to shift risk is increasing in a firm's exposure to risky debt.

Taken together, the two arguments above lead us to formulate the following second hypothesis:

H2: An increase in the sensitivity of the CEO's compensation to stock return volatility (Vega), and a decrease in the sensitivity to stock prices (Delta), increases the degree of debt specialization in a firm's capital structure, especially in riskier firms.

In general, we argue that an increasing firm default risk amplifies creditor concerns over asset substitution problems and consequently the incentives to monitor as reflected in a firm's debt structure.

4.3. Data overview and variable measurement

4.3.1. Data sources and sample selection

We use four main data sources in this paper: Capital IQ, Execucomp, Compustat, and CRSP. We begin our sampling process by obtaining data on the debt structure of firms (needed to compute the degree of debt specialization as detailed in section 3.3) from Capital IQ for the period from 2001 to 2012. Following previous studies on debt specialization, we remove financial firms (SIC codes from 6000 to 6999) from the list of selected firms given their specificities in terms of capital structure and debt composition.

Next, we match the initial sample with the firms included in the Standard and Poor´s ExecuComp database that we employ to collect CEO compensation data and compute the sensitivities of CEOs' compensation to the volatility of stock returns (Vega) and to stock price (Delta). For the firms with available data on debt structure and executive compensation we then obtain firm level characteristics from Compustat and market data from CRSP.

The final sample excludes observations with missing or zero values for total assets or total debt, firm-years with market or book leverage outside the unit interval, and observations where the difference between total debt, as reported in Compustat, and the sum of the different debt types reported in Capital IQ exceeds 10% of total debt (as in Colla et al., 2013). Furthermore, we remove the few observations where the debt maturity ratio is less than 0 or greater than 1, since they are potentially erroneous (Brockman et al., 2010).

Table 1. Sample Distribution by Year and by Industry.

Panel A. Sample Distribution by Year

Year	**Observations**	
	N.	**%**
2001	279	4.429
2002	401	6.365
2003	446	7.079
2004	474	7.524
2005	480	7.619
2006	533	8.460
2007	589	9.349
2008	606	9.619
2009	593	9.413
2010	620	9.841
2011	644	10.222
2012	635	10.079
Total	6300	100.000

Panel B. Sample Distribution by Industry

Industries	**Fama-French 49 sectors**	**N**	**%**
Agriculture	1	23	0.365
Food Products	2	162	2.571
Candy & Soda	3	23	0.365
Beer & Liquor	4	15	0.238
Tobacco Products	5	22	0.349
Toys Recreation	6	35	0.556
Fun Entertainment	7	68	1.079

Books Printing and Publishing	8	60	0.952
Consumer Goods	9	139	2.206
Clothes Apparel	10	79	1.254
Healthcare	11	116	1.841
Medical Equipment	12	183	2.905
Drugs Pharmaceutical Products	13	206	3.270
Chemicals	14	273	4.333
Rubber and Plastic Products	15	44	0.698
Textiles	16	34	0.540
Construction Materials	17	167	2.651
Construction	18	116	1.841
Steel Works, etc.	19	146	2.317
Fabricated Products	20	6	0.095
Machinery	21	363	5.762
Electrical Equipment	22	104	1.651
Automobiles and Trucks	23	128	2.032
Aircraft	24	72	1.143
Ships, Shipbuilding, Railroad Equipment	25	16	0.254
Guns Defence	26	26	0.413
Precious Metals	27	14	0.222
Mines, Non-Metallic and Industrial Metal Mining	28	43	0.683
Coal	29	33	0.524
Oil, Petroleum and Natural Gas	30	354	5.619
Utilities	31	512	8.127
Communication	32	168	2.667
Personal Service	33	96	1.524
Business Service	34	292	4.635
Computer Hardware	35	119	1.889
Computer Software	36	233	3.698
Electronic Equipment	37	368	5.841
Measuring and Control Equipment	38	159	2.524
Paper, Business Supplies	39	172	2.730
Shipping Containers	40	78	1.238
Transportation	41	252	4.000
Wholesale	42	249	3.952
Retail	43	304	4.825
Meals, Restaurants, Hotels, Motels	44	129	2.048
Others	49	99	1.571
Total		6300	100.000

Notes: Table 1 shows the sample distribution by year for the period ranging from 2001 to 2012. The final sample contains 6,300 observations from 49 industry sectors.

In Panel A of Table 1, we report the sample distribution by year. Our final sample contains 6,300 firm-year observations for 1,006 unique firms. The number of firms ranges from a minimum of 279 in year 2001 to a maximum of 644 in year 2011. In Panel B of the same Table we report the sample distribution by industry breakdown based on the Fama and French industry classification. Overall, we observe that none of the industries has a share of the sample in terms of total observations larger than 8.2%.

4.3.2. Measuring risk-taking incentives in CEO pay

Vega and Delta are two conventional measures of risk-taking incentives in executive pay widely employed in the literature (see Brockman et al., 2010; Coles et al., 2006; Core and Guay, 2002, among others). Vega captures the change in the value of a CEO’s stock and option portfolio due to a 1% increase in the standard deviation of the firm’s stock returns. In essence, Vega should express the incentives for CEOs to undertake investments that increase firm risk. Delta is the sensitivity of a CEO’s portfolio to stock price (Delta) defined by the change in the value of a CEO’s stock and option portfolio in response to a 1% increase in the price of the firm’s common stock. As a consequence, Delta is a measure of the incentives for CEOs to undertake value-enhancing investments but indirectly also of the exposure of undiversified managers to firm risk. Therefore, an increase in Delta is often associated with a decline in managerial risk-taking.

The computation of Vega and Delta is based on the Black and Scholes (1973) option-pricing model adjusted for dividends by Merton (1973) and on the methodology proposed by Coles et al. (2006) and Core and Guay (2002). Details of the methodology employed to compute the two measures are reported in the Appendix C. To reduce the skewness of the distribution of the measures of equity pay-incentives, we follow Kim et al. (2011) and Brockman et al. (2010) and employ the log transformation of Vega (LNVEGA) and Delta (LNDELTA) and not the raw measures in the empirical tests.

4.3.3. Measures of firm debt specialization

Following Colla et al. (2013) and Platikanova and Soonawalla (2014) we use measures of debt specialization based on debt types as proxies of the degree of concentration of the debt claims in a firm's capital structure.

Our preferred proxy of debt specialization is the normalized Herfindahl-Hirschman Index (**HHI**) of debt sources usage. To compute this index, we first calculate the total sum of the squares of the share of the seven mutually exclusive debt types reported in Capital IQ over the total volume of debt for firm *i* in year *t* as shown below:

$$SS_{it} = \left(\frac{CP_{it}}{TD_{it}}\right)^2 + \left(\frac{DC_{it}}{TD_{it}}\right)^2 + \left(\frac{TL_{it}}{TD_{it}}\right)^2 + \left(\frac{SBN_{it}}{TD_{it}}\right)^2 + \left(\frac{SUB_{it}}{TD_{it}}\right)^2 + \left(\frac{CL_{it}}{TD_{it}}\right)^2 + \left(\frac{Other_{it}}{TD_{it}}\right)^2 \quad (1)$$

Where TD refers to total debt, CP refers to commercial paper, DC to drawn credit lines, TL to term loans, SBN to senior bonds and notes, SUB to subordinated bonds and notes, CP to capital leases, and Other (including securities sold under an agreement to repurchase, securities debt, total trust-preferred stock and other unclassified borrowing) to the remaining debt in a firm's capital structure. The normalized Herfindahl-Hirschman Index (HHI) of debt types is then computed as follows:

$$HHI_{it} = \frac{SS_{it} - 1/7}{1 - 1/7} \quad (2)$$

This index ranges from zero to one. HHI equals one when a firm employs exclusively one single debt type, whereas if a firm simultaneously employs all seven types of debt in equal proportion, HHI equals zero. Therefore, higher HHI values indicate a firm's tendency to specialize in fewer debt types (that is, lower borrowing diversity) while lower values of HHI indicate a lower debt specialization (namely, a higher borrowing variety).

Following Colla et al. (2013), we also employ an alternative measure of debt specialization defined for firm *i* in year *t* by the dummy variable **Excl90** as follows:

Excl90$_{it}$= 1 if a firm obtains at least 90% of its debt from one debt type, = 0 otherwise.

Table 2 presents summary statistics of the share of each debt type and for the two related measures of debt specialization. The majority of the debt is in the form of senior bonds and notes (with a sample mean of approximately 55.9% of total debt) followed by drawn credit lines (14.1%) and term loans (11.9%). The shares for the remaining types of debt are quite low, ranging from 7.3% for subordinated bonds and notes, to 2.2% for commercial paper[15]. The measure of debt specialization has a mean value of 0.697 for HHI and 0.440 for Excl90, which are similar to the reported means over time (0.676-0.718 in HHI and 0.424-0.487 in Excl90) in Table II of Colla et al. (2013). Overall, on average firms are likely to show a high degree of debt specialization.

[15]Total adjustment is the difference between total debt obtained from Compustat and the sum of seven debt types from Capital IQ. We show that the mean and median of total adjustment to total debt are nearly zero.

Table 2. Summary Statistics of Debt Types and Debt Specialization

Variable	Definition	Obs.	Mean	5th perc.	25th perc.	Median	75th perc.	95th perc.	Std. Dev.
CP	Commercial paper/Total Debt	6300	0.022	0.000	0.000	0.000	0.000	0.157	0.078
DC	Drawn credit line/Total Debt	6300	0.141	0.000	0.000	0.000	0.134	0.923	0.269
TL	Term loans/Total Debt	6300	0.119	0.000	0.000	0.000	0.085	0.819	0.250
SBN	Senior bonds and notes/Total Debt	6300	0.559	0.000	0.067	0.681	0.917	1.000	0.386
SUB	Subordinated bonds and notes/Total Debt	6300	0.073	0.000	0.000	0.000	0.000	0.681	0.220
CL	Capital leases/Total Debt	6300	0.034	0.000	0.000	0.000	0.005	0.118	0.146
OTHER	Other debt plus total trust-preferred stock/Total Debt	6300	0.052	0.000	0.000	0.000	0.024	0.273	0.157
Total Adjustment	Total debt − (CP + DC + TL + SBN + SUB + CL + Other)	6300	-0.001	-0.025	0.000	0.000	0.000	0.019	0.018
HHI	$\{[[CP/(Total\ debt)]^2 + [DC/(Total\ debt)]^2 + [TL/(Total\ debt)]^2 + [SBN/(Total\ debt)]^2 + SUB/(Total\ debt)]^2 + [CL/(Total\ debt)]^2 + [(Other)/(Total\ debt)]^2] - (1/7)\}/(1 - (1/7))$	6300	0.697	0.281	0.463	0.719	0.966	1.000	0.254
Excl90	Dummy equal 1 if a firm has more than 90% of its total debt in one debt type (CP, DC,TL, SBN, SUB, CL, or OTHER), and 0 otherwise	6300	0.440	0.000	0.000	0.000	1.000	1.000	0.496

Notes: This table shows summary statistics for the ratios of different debt types to total debt, as well as for the two measures of debt specialization HHI and Excl90

In the Appendix C (Table B.I.) we report the sample distribution of debt specialization by industry. There is a considerable variation in the degree of debt specialization across the industrial categories. For instance, companies in the “Fabricated products” sector show an average degree of debt specialization of approximately 43.9%, while for companies in the “Computer Software” sector the average increases to above 86.7%. All estimated specifications, therefore, contain industry dummies to limit the risk that our results are driven by omitted industry controls.

4.3.4. Estimation method and control variables

To estimate how risk-taking incentives in executive compensation impact on the degree of debt specialization, following Colla et al. (2013) we initially select an econometric approach that is appropriate to deal with the censored nature of our preferred measure of debt specialization (HHI). We estimate, therefore, a pooled Tobit regression model with standard errors clustered at the industry-year level. More precisely, the Tobit model is specified as follows:

$$HHI_{it} = \beta_0 + \beta_1 LNVEGA_{it} + \beta_2 LNDELTA_{it} + \beta_3 X_{it} + \beta_4 Z_{it} + \sum_{k=1}^{49} S_k + \sum_{t=2001}^{2012} Y_t + \varepsilon_{it} \qquad (3)$$

Where HHI_{it} is the degree of debt specialization of firm *i* in year *t*, $LNVEGA_{it}$ and $LNDELTA_{it}$ are the measures of equity incentives, X_{it} is a vector of firms’ financial characteristics, Z_{it} is a vector of CEO control variables, β_0 is the constant term and β are the coefficients of the explanatory variables, S_k is the set of industries dummies, Y_t is a set of time dummy variables and ε_{it} is the error term. All variables are winsorized at the 1% and 99% in order to remove possible bias due to the presence of outliers. When we employ Excl90 as the dependent variable, we estimate a similar equation via a Probit model as in Colla et al. (2013).

The control variables are divided into two different categories: firm characteristics and CEO controls. Details on how all variables are constructed are presented in Table 3. The vector of firm characteristics *(X)* that, based on Colla et al. (2013), are considered determinants of debt specialization, includes book leverage (LEVERAGE), size (SIZE), the market to book ratio (MTOB), firm profitability (PROF), the degree of asset tangibility (TANG), a dummy equal to one if a firm is a dividend payer (DIV_PAYER), cash flow volatility (CF_VOL), the value of R&D expenses divided by total assets (R&D)[16], and a dummy equal to one if a firm is not rated by S&P (UNRATED). Essentially, these controls aim to capture the role of bankruptcy costs, incentives to monitor and access to capital markets as potential determinants of the degree of debt specialization (Colla et al., 2013; Platikanova and Soonawalla, 2014).

We add to this set of controls a dummy equal to one if a firm is from a regulated industry (REG_DUM), and the firm age as the number of years since incorporation (FIRM_AGE). In particular, older firms are expected to show a wider access to capital markets with the consequence of exhibiting a lower degree of debt specialization. The vector of CEO control variables (Z) includes CEO ownership, defined as the percentage of a company´s shares owned by the CEO (OWN), and a pay slice variable that, as in Bebchuk et al. (2011), is defined as the percentage of the total compensation to the top five executives that goes to the CEO (PAYSLICE). As these variables might influence CEO behavior, their omission might bias the potential effect of compensation on our measure of debt specialization.

Table 3 presents the summary statistics for the explanatory variables employed in the debt specialization regression. LNVEGA presents a mean (median) value of 4.085 (4.375) and LNDELTA shows a mean (median) value of 5.546 (5.551). The summary statistics for our control variables are, in general, consistent with those reported in Colla et al. (2013), Billett et al. (2007), and Li et al. (2014) among others.

[16]Following Himmelberg et al. (1999) and Edmans et al. (2014) we replace missing R&D values by zero.

Table 3. Summary Statistics of Explanatory Variables

Variable	Definition	Mean	Std. Dev.	Min.	25th perc.	Median	75th perc.	Max.
LNVEGA	Natural log of one plus the change in the value of the CEO's option portfolio due to a 1% change in the annualized standard deviation of stock returns plus one. Ln (1+Vega)	5.546	1.371	2.048	4.656	5.551	6.448	9.184
LNDELTA	Natural log of one plus the change in the value of the CEO's stock and option portfolio due to a 1% increase in the value of the firm's common stock price plus one. Ln(1+Delta)	4.085	1.812	0.000	3.175	4.375	5.368	7.293
LEVERAGE	Total debt over total assets. Total debt is defined as debt in current liabilities plus long-term debt	0.260	0.156	0.001	0.15	0.25	0.353	0.722
SIZE	Logarithm of total assets measured in millions US$	8.030	1.485	4.912	6.936	7.913	9.019	11.835
MTOB	MV of equity plus total debt plus preferred stock liquidating value minus deferred taxes and investment tax credit over total assets	1.119	0.945	-0.106	0.491	0.901	1.468	5.054
PROF	Operating income before depreciation over total assets	0.139	0.076	-0.113	0.094	0.133	0.179	0.389
TANG	Net property, plant, and equipment over total assets	0.314	0.236	0.019	0.126	0.238	0.472	0.892
DIV_PAYER	Equals one if common stock dividends are positive	0.608	0.488	0.000	0.000	1.000	1.000	1.000
CF_VOL	Standard deviation of operating cash flows from operations calculated over the 3 year period before the observation year over total assets	0.032	0.029	0.002	0.013	0.023	0.041	0.159
R&D	Research and development expenses over total assets	0.021	0.038	0.000	0.000	0.000	0.025	0.199
UNRATED	Equals one if a firm has not a S&P rating on long-term debt, and zero otherwise	0.332	0.471	0.000	0.000	0.000	1.000	1.000
REG_DUM	Equals one if the firm's SIC code is between 4,900 and 4,939 (firms from regulated industries) and zero otherwise	0.078	0.269	0.000	0.000	0.000	0.000	1.000
FIRM_AGE	Natural log of one plus the number of years since the firm was added to the database Compustat.	3.320	0.638	1.792	2.773	3.434	3.932	4.143
OWN	Number of shares owned by the CEO scaled by total shares outstanding	0.014	0.038	0.000	0.001	0.003	0.008	0.250
PAYSLICE	The percentage of the total compensation to the top five executives that goes to the CEO	0.400	0.100	0.124	0.340	0.406	0.462	0.671

Notes: This table presents descriptive statistics for the variables used in the debt specialization model. The sample contains 6,300 observations and covers the 2001 to 2012 period.

4.4. Empirical results

4.4.1. The impact of executive compensation on debt specialization

In the first four columns of Table 4 we report the empirical results from the Tobit regression model where the degree of debt specialization, measured via HHI, is modeled as a function of executive pay incentives. Our empirical analysis starts with a parsimonious specification that includes only a limited number of control variables and progresses with additional models that differ in the number of controls.

In all specifications, the coefficients assigned to the two measures of executive incentives are in line with our first hypothesis. Specifically, the presence of higher risk-taking incentives in the forms of a higher sensitivity of CEO pay to stock return volatility, as indicated by higher values of LNVEGA, increases the degree of debt specialization in a firm's capital structure. LNDELTA enters all models with a negative coefficient, significant at customary levels, suggesting that an increase in the value incentives that should favor more prudent business choices by CEOs reduces the need for a more specialized debt structure. In essence, both results confirm the view that creditors seem to impose a higher degree of debt specialization when CEO incentives amplify the risk of asset substitution. In summary, when the potential conflicts between debtholders and shareholders are increased by the design of executive pay incentives, the enhanced monitoring incentives of creditors are reflected in a less dispersed debt structure.

In terms of economic impact, we observe that, using the results for the model reported in column 4, an increase from the 25th to the 75th percentile of the sample distribution in LNVEGA (LNDELTA) increases (reduces) the degree of debt specialization in the debt structure by 1.6% (2.7%).

Table 4. Debt Specialization and CEO Pay Incentives

	Dependent Variable: HHI					Excl90
	Tobit				OLS	Probit
	(1)	(2)	(3)	(4)	(5)	(6)
LNVEGA	0.00843***	0.00793***	0.00805***	0.00881***	0.00648**	0.0338**
	[0.00263]	[0.00266]	[0.00263]	[0.00291]	[0.00256]	[0.0148]
LNDELTA	-0.0139***	-0.0111***	-0.0109***	-0.0121**	-0.00893**	-0.0457*
	[0.00370]	[0.00369]	[0.00370]	[0.00480]	[0.00418]	[0.0248]
LEVERAGE	-0.556***	-0.557***	-0.565***	-0.570***	-0.466***	-2.259***
	[0.0274]	[0.0266]	[0.0274]	[0.0274]	[0.0233]	[0.137]
SIZE	-0.0254***	-0.0218***	-0.0247***	-0.0212***	-0.0160***	-0.0770***
	[0.00394]	[0.00397]	[0.00412]	[0.00432]	[0.00376]	[0.0223]
MTOB	0.0489***	0.0413***	0.0420***	0.0394***	0.0278***	0.126***
	[0.00605]	[0.00740]	[0.00742]	[0.00763]	[0.00544]	[0.0332]
PROF		-0.0364	-0.0459	-0.0437	-0.0191	0.0509
		[0.0605]	[0.0610]	[0.0612]	[0.0496]	[0.317]
TANG		0.0209	0.0263	0.0181	0.00702	-0.148
		[0.0285]	[0.0290]	[0.0293]	[0.0257]	[0.141]
DIV_PAYER		0.00378	0.00407	0.0158	0.0168**	0.0603
		[0.00961]	[0.00961]	[0.00973]	[0.00802]	[0.0459]
CF_VOL		0.662***	0.640***	0.663***	0.492***	2.867***
		[0.134]	[0.135]	[0.135]	[0.110]	[0.671]
R&D		1.362***	1.368***	1.359***	0.935***	4.787***
		[0.182]	[0.183]	[0.183]	[0.122]	[0.791]
UNRATED			-0.0119	-0.0149	-0.0209***	-0.106**
			[0.00911]	[0.00907]	[0.00770]	[0.0468]
REG_DUM			0.159***	0.164***	0.144***	1.216***
			[0.0502]	[0.0500]	[0.0493]	[0.466]
FIRM AGE				-0.0333***	-0.0238***	-0.131***
				[0.00679]	[0.00565]	[0.0348]
OWN				-0.0101	-0.0105	-0.223
				[0.129]	[0.107]	[0.650]
PAYSLICE				0.0153	0.0216	0.0521
				[0.0352]	[0.0291]	[0.178]
Constant	1.079***	1.019***	1.047***	1.115***	0.780***	1.493***
	[0.0342]	[0.0367]	[0.0396]	[0.0439]	[0.0376]	[0.224]
Industry dummies	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES
Obs.	6,300	6,300	6,300	6,300	6,300	6,294
Pseudo R2	0.395	0.430	0.432	0.438		0.136
R2 adj.					0.209	

Notes: This table presents regression results to examine the relation between the degree of debt specialization and the sensitivities of CEO´s wealth to stock return volatility (**LNVEGA**) and to changes (in percent) to stock prices (**LNDELTA**) controlling for firm, CEO characteristics, industry and time dummies. In the first five columns the dependent variable is an Herfindhal index of concentration of debt structure by type of debt ((**HHI**) while in the last columns is a dummy equal to one if more than 90% of the debt structure is concentrated in only one type of debt (**Excl90**). Columns from (1) to (4) present the regression results using the Tobit methodology. In column (1) we include leverage, size, and market to book as controls and in column (2) we add profitability, tangibility, dividend payer, cash flow volatility, and R&D expenses. In column (3) we add a dummy equal to one for unrated firms and a dummy equal to one for regulated firms and in column (4) we add firm age, CEO ownership and CEO payslice. Column (5) shows the results using Ordinary Least Squares as estimation method while Column (6) shows the results when we use as the dependent variable Excl90 and estimate the model by means of a Probit methodology. We include industry (Fama-French 49) dummies and year dummies in all specifications. Statistical significance is based on industry-year clustered standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

In columns (5) and (6) of Table 4 we assess whether our results depend on the estimation methods or the way we measure the degree of debt specialization. In column (5) we re-estimate the model reported in column (4) using OLS, while in column (6) we estimate a Probit model where Excl90 is the dependent variable that captures the degree of debt specialization at the firm level. Again, our results on the effects of Vega and Delta on the degree of debt specialization remain qualitatively unchanged. In unreported tests, we also repeat our analysis excluding utilities from our sample like Colla et al. (2013); our findings remain similar. Furthermore, we evaluate whether our results are driven by the financial crisis of 2007-2009 by interacting LNVEGA and LNDELTA with a dummy equal to one during the crisis period. Under this empirical setting, we do not find that the financial crisis explains our findings.

In terms of control variables, most of our results confirm the evidence provided by previous empirical studies on debt specialization (Colla et al., 2013, and Platikanova and Soonawalla, 2014). Specifically, the estimated coefficients on LEVERAGE and SIZE are negative and statistically significant at customary levels while increases in MTOB, CF_VOL, and R&D increase the degree of debt specialization. Furthermore, the degree of debt specialization is greater in more regulated industries as proved by the positive coefficient for REG_DUM, and in younger firms as shown by the negative and significant coefficient for FIRM_AGE.

To recap, the results discussed in this section validate our first hypothesis that creditors perceive debt specialization as a mechanism that favors monitoring and mitigates the incentives (generated by the compensation structure) for CEOs to engage in asset substitution.

4.4.2. Controlling for the endogeneity of executive incentives

One possible concern over the validity of the results reported in the previous section refers to the potential endogeneity of Vega and Delta. For instance, numerous studies have suggested that corporate policy might also affect the way the compensation packages offered to executives are designed (see for instance Coles et al., 2006; and Guay, 1999). One obvious source of endogeneity is, therefore, the potential reverse causality between debt specialization and pay incentives. In the context of our analysis, it might be the case that a higher concentration of creditors in the capital structure, and the related effect in terms of managerial discipline, might induce boards to increase incentives to CEOs so as to safeguard the interests of shareholders at the expense of debtholders.

We proceed in several ways to rule out the possibility that our results are biased due to the presence of reverse causality. The results of these tests are reported in Table 5.

Table 5. Debt Specialization and CEO Incentives: Endogeneity Analysis

	1 Lag		2 Lags		Tobit (IV)	Probit (IV)
	HHI	Excl90	HHI	Excl90	HHI	Excl90
	(1)	(2)	(3)	(4)	(5)	(6)
LNVEGA	0.0123***	0.0494***	0.00981**	0.0460**	0.0219**	0.103*
	[0.00364]	[0.0191]	[0.00394]	[0.0211]	[0.0106]	[0.0624]
LNDELTA	-0.0176***	-0.102***	-0.0226***	-0.131***	-0.108***	-0.541***
	[0.00596]	[0.0314]	[0.00628]	[0.0341]	[0.0235]	[0.139]
LEVERAGE	-0.490***	-2.024***	-0.410***	-1.689***	0.0326**	0.171**
	[0.0335]	[0.169]	[0.0358]	[0.179]	[0.0134]	[0.0792]
SIZE	-0.0144***	-0.0356	-0.00943*	0.00243	0.0780***	0.380***
	[0.00500]	[0.0256]	[0.00560]	[0.0288]	[0.0132]	[0.0786]
MTOB	0.0371***	0.119***	0.0451***	0.144***	0.0513	0.404
	[0.00980]	[0.0454]	[0.0102]	[0.0441]	[0.0570]	[0.339]
PROF	-0.0919	0.0454	-0.189**	-0.422	-0.516***	-2.517***
	[0.0862]	[0.411]	[0.0901]	[0.416]	[0.0261]	[0.159]
TANG	0.0335	-0.176	0.0637*	-0.0363	0.00806	0.0189
	[0.0334]	[0.165]	[0.0376]	[0.179]	[0.00805]	[0.0478]
DIV_PAYER	0.00574	0.0237	0.0126	0.0454	0.0248	-0.0655
	[0.0113]	[0.0537]	[0.0119]	[0.0606]	[0.0235]	[0.139]
CF_VOL	0.510***	2.339***	0.590***	2.867***	0.274**	1.741**
	[0.165]	[0.790]	[0.183]	[0.857]	[0.127]	[0.751]
R&D	1.539***	5.015***	1.705***	6.099***	0.872***	4.486***
	[0.216]	[0.936]	[0.227]	[0.943]	[0.120]	[0.733]
UNRATED	-0.0136	-0.100*	-0.0225*	-0.0806	-0.0183**	-0.0923*

	[0.0116]	[0.0561]	[0.0134]	[0.0589]	[0.00892]	[0.0527]
REG_DUM	0.156***	4.871***	0.239***	4.691***	0.129**	1.144**
	[0.0503]	[0.115]	[0.0491]	[0.137]	[0.0580]	[0.499]
FIRM_AGE	-0.0288***	-0.120***	-0.0251***	-0.127***	-0.0300***	-0.162***
	[0.00846]	[0.0419]	[0.00885]	[0.0437]	[0.00628]	[0.0371]
OWN	0.0655	0.364	0.261	1.809**	1.679***	8.233***
	[0.162]	[0.825]	[0.172]	[0.845]	[0.412]	[2.441]
PAYSLICE	-0.00925	0.0184	-0.000665	0.222	0.145***	0.696**
	[0.0423]	[0.201]	[0.0441]	[0.220]	[0.0478]	[0.284]
Constant	1.008***	1.086***	0.968***	0.850***	0.976***	1.393***
	[0.0494]	[0.262]	[0.0543]	[0.257]	[0.0486]	[0.288]
Industry dummies	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES
Obs.	4,524	4,519	3,814	3,810	6,300	6,294
Pseudo R2	0.418	0.123	0.402	0.115	.	.
Model Wald chi-squared					1614	949.3
Sig. Wald chi-squared					0	0
Wald chi-squared test of exogeneity					20.17	14.05
Sig. Wald chi-squared test of exogeneity					0.000	0.001
Hansen test					0.135	0.145

Notes: This table presents the regression results on the relation between the degree of debt specialization and the sensitivities of CEO´s wealth to stock return volatility (**LNVEGA**) and to changes (in percent) to stock prices (**LNDELTA**) controlling for firm, CEO characteristics, industry and time dummies and for the potential endogenetiy of equity-based incentives. We address endogeneity due to reverse causality by estimating the models with all right-hand side variables lagged one year (columns 1 and 2 for HHI and Excl90 respectively), all right-hand side variables lagged two years (columns 3 and 4 for HHI and Excl90 respectively)) and a single instrumental variable regression for HHI in column 5 based on the Tobit methodology and for Excl90 in column 6 based on the Probit methodology. The set of control variables include leverage, size, the market to book ratio, profitability, tangibility, dividend payer, cash flow volatility, R&D expenses, a dummy equal to one if firms are unrated, a dummy equal to one if firms belong to a regulated industry, firm age, CEO ownership and CEO payslice. We include industry (Fama-French 49) dummies and year dummies in all specifications. Statistical significance is based on industry-year clustered standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Initially, we follow Boone et al. (2007), Faleye et al. (2014) and Faleye (2015) among others that deal with reverse causality by regressing the dependent variable on lagged values of the potentially endogenous explanatory variables. This choice is based on the intuition that such historical values are largely predetermined (Faleye, 2015). Therefore, in the first four columns of Table 5 we re-estimate both the most comprehensive specification of the Tobit model reported in the previous section and the Probit specification for Excl90, with one and two period lags, respectively, of all explanatory variables. Our results remain qualitatively similar; we find again support for the idea that an increase (decrease) in Vega (Delta) increases the degree of debt specialization in a firm’s capital structure.

Next, we address reverse causality by estimating instrumental variable Tobit and Probit models (see, for instance, Purnanandam, 2008) that resemble the more conventional use of 2SLS in Coles et al., (2006) and Bhagat and Bolton (2008). To identify potential instruments for our measures of equity-pay incentives, we follow Kini and Williams (2012) that use industry benchmarks. Accordingly, we employ the mean values of Vega and Delta by industry and year as instruments for Vega and Delta at the firm level. Furthermore, similarly to Brockman et al. (2010) we employ the log transformation of (1 plus) the total cash compensation received by the CEO as an additional instrument, as CEOs that receive larger cash compensation are also more likely to benefit from larger Vega and Delta.

The results for the instrumental variable models are reported in the last two columns of Table 5 where we use the Wald test of exogeneity and the Hansen J-statistic of over-identifying restriction to test the validity of the selected instruments. In this respect, the statistical significance of the Wald test and the insignificant values of the Hansen test (under the null hypothesis that the instruments are valid) confirm the model is well identified and that our instruments satisfy the required conditions. More importantly, under this new empirical setting we generally confirm the results of the previous tests. In other words, we still find that an increase in LNVEGA (LNDELTA) increases (decreases) the degree of debt specialization.

Overall, the results reported in this section suggest that our key conclusion on the impact of pay incentives on debt specialization remains valid when we control for the potential presence of reverse causality.

4.4.3. Debt specialization and corporate risk

In this section we test the validity of our second hypothesis; namely, that, as debt specialization is motivated by asset substitution problems, its role as a tool to mitigate the agency costs of debt is stronger when firms become riskier. To test this hypothesis, we extend our baseline Tobit and Probit specifications with interaction terms between the two measures of executive pay-incentives (LNVEGA and LNDELTA) and three alternative proxies of firm distress risk: equity risk (computed yearly as the volatility on daily stock returns) and two measures of the distance to default based on market data.

More precisely, the first distance to default measure (DD) is based on Merton (1974) and is computed according to the formula reported below:

$$DD = \frac{\ln(V/F) + (\mu - 0.5\sigma^2_V)T}{\sigma_V \sqrt{T}} \tag{4}$$

where V is the total market value of the firm, F is the value of total liabilities, μ is an estimate of the expected annual return of the firm's assets, and σ_V is the annualized volatility of firm asset return. The derivation of DD requires the estimation of two unknowns, the market value of assets and the volatility of asset returns, that we obtain by employing the interactive numerical approach based on option pricing used, among others, in Hillegeist et al. (2004), Vallascas and Hagendorff (2013) and Vassalou and Xing (2004).

The second measure of the distance to default is the naïve distance to default (NAÏVE_DD) proposed by Bharath and Shumway (2008). Differently from DD, the calculation of NAÏVE_DD is less computationally intensive as it does not require an interactive numerical method. Specifically, following Bharath and Shumway (2008), we employ the formula reported below:

$$NA\ddot{I}VEDD = \frac{\ln\left[(\mathrm{E}+\mathrm{F}/F)\right] + (\mathrm{r}_{it-1} - 0.5 * na\ddot{i}ve\sigma^2_V)T}{na\ddot{i}ve\sigma_V \sqrt{T}} \tag{5}$$

where E is the market value of equity, r_{it-1} is the firm´s stock return over the previous year, and naïveσ_V is the approximation of asset volatility that is obtained by multiplying the volatility of equity returns by the equity to asset ratio.

As for both measures of distance to default, smaller values imply a higher likelihood that a default will occur; to conduct the empirical tests we multiply each measure by minus one. This allows us to ease the comparability with the findings obtained by using equity volatility. In other words, in all specifications, larger values of the selected risk variables will consistently signal higher firm risk.

Table 6. Debt Specialization and Corporate Risk

	Tobit			Probit		
	HHI	**HHI**	**HHI**	**Excl90**	**Excl90**	**Excl90**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Panel A: Regression analysis						
LNVEGA	0.00925***	0.00984***	0.00970***	0.0370**	0.0387***	0.0391***
	[0.00292]	[0.00289]	[0.00289]	[0.0149]	[0.0148]	[0.0149]
LNDELTA	-0.0134***	-0.0134***	-0.0143***	-0.0494**	-0.0489**	-0.0562**
	[0.00474]	[0.00474]	[0.00476]	[0.0247]	[0.0247]	[0.0247]
EQUITY_RISK	-0.166			-1.067		
	[0.327]			[1.657]		
EQUITY_RISK*LNVEGA	0.309**			1.668**		
	[0.156]			[0.774]		
EQUITY_RISK*LNDELTA	-0.101			-1.284		
	[0.169]			[0.828]		
DD		0.000931			0.00056	
		[0.00157]			[0.00786]	
DD*LNVEGA		0.00292***			0.0121***	
		[0.000642]			[0.00322]	
DD*LNDELTA		-0.000768			-0.00472	
		[0.000932]			[0.00448]	
NAÏVEDD			0.00121			0.00257
			[0.00162]			[0.00801]
NAÏVEDD*LNVEGA			0.00290***			0.0125***
			[0.000648]			[0.00314]
NAÏVEDD*LNDELTA			-0.000379			-0.00323
			[0.000927]			[0.00439]
LEVERAGE	-0.564***	-0.569***	-0.570***	-2.247***	-2.236***	-2.255***
	[0.0280]	[0.0287]	[0.0292]	[0.139]	[0.145]	[0.148]
SIZE	-0.0208***	-0.0198***	-0.0188***	-0.0775***	-0.0735***	-0.0674***
	[0.00431]	[0.00435]	[0.00432]	[0.0222]	[0.0226]	[0.0224]
CF_VOL	0.697***	0.665***	0.656***	0.127***	0.128***	0.135***
	[0.137]	[0.137]	[0.138]	[0.0330]	[0.0368]	[0.0380]
MTOB	0.0399***	0.0422***	0.0440***	0.00725	0.0775	0.117
	[0.00757]	[0.00836]	[0.00864]	[0.317]	[0.318]	[0.324]
PROF	-0.0545	-0.0374	-0.0338	-0.153	-0.155	-0.139
	[0.0613]	[0.0615]	[0.0623]	[0.141]	[0.143]	[0.144]
TANG	0.018	0.0202	0.026	2.983***	2.893***	2.802***
	[0.0291]	[0.0299]	[0.0303]	[0.691]	[0.683]	[0.686]
DIV_PAYER	0.013	0.0148	0.0133	0.0493	0.054	0.0544
	[0.00986]	[0.00981]	[0.00989]	[0.0466]	[0.0462]	[0.0464]
R&D	1.370***	1.358***	1.360***	4.816***	4.804***	4.840***
	[0.182]	[0.183]	[0.181]	[0.773]	[0.788]	[0.791]
UNRATED	-0.015	-0.0141	-0.0135	-0.108**	-0.102**	-0.103**
	[0.00916]	[0.00916]	[0.00922]	[0.0472]	[0.0473]	[0.0473]
REG_DUM	0.162***	0.158***	0.160***	1.204***	1.195***	1.205***
	[0.0492]	[0.0482]	[0.0485]	[0.463]	[0.460]	[0.462]
FIRM_AGE	-0.0330***	-0.0322***	-0.0309***	-0.132***	-0.128***	-0.134***
	[0.00681]	[0.00673]	[0.00682]	[0.0348]	[0.0348]	[0.0351]
OWN	0.0296	0.0235	0.0381	-0.0726	-0.139	-0.0748
	[0.130]	[0.129]	[0.130]	[0.653]	[0.654]	[0.664]
PAYSLICE	0.0119	0.0131	0.0211	0.0207	0.033	0.0858

	[0.0355]	[0.0356]	[0.0357]	[0.179]	[0.181]	[0.182]
Constant	1.078***	1.065***	1.042***	1.385***	1.340***	1.266***
	[0.0522]	[0.0518]	[0.0525]	[0.263]	[0.263]	[0.268]
Industry dummies	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES
Obs.	6,290	6,280	6,233	6,284	6,274	6,227
Pseudo R2	0.438	0.442	0.443	0.136	0.137	0.137
Panel B: Marginal effects of equity incentives by firm risk						
Vega (low risk firms)	0.005*	0.003	0.003	0.007	0.005	0.004
Vega (high risk firms)	0.008***	0.014***	0.014***	0.014***	0.024***	0.025***
Delta (low risk firms)	-0.010**	-0.010**	-0.011***	-0.012	-0.013	-0.017*
Delta (high risk firms)	-0.011***	-0.013***	-0.012***	-0.018**	-0.021**	-0.022**

Notes: Panel A of this table presents regression results to examine whether the relation between the degree of debt specialization and the sensitivities of CEO´s wealth to stock return volatility (**LNVEGA**) and to changes (in percent) to stock prices (**LNDELTA**) varies with firm risk. In all specifications we control for firm, CEO characteristics, industry and time dummies. In the first three columns the dependent variable is an Herfindhal index of concentration of debt structure by type of debt ((**HHI**) while in the last three columns is a dummy equal to one if more than 90% of the debt structure is concentrated in only one type of debt (**Excl90**). Accordingly, Columns from (1) to (3) present the regression results using the Tobit methodology while the remaining specifications are estimated via a Probit model. Firm risk is defined via three alternatives proxies: equity risk, distance to default and naïve distance to default. Firm controls include leverage, size, market to book, profitability, tangibility, dividend payer, cash flow volatility, R&D expenses, a dummy equal to one for unrated firm, a dummy equal to one for regulated firms and firms' age. CEO controls refer to CEO ownership and CEO payslice. Panel B reports the marginal effects of LNVEGA and LNDELTA for the Tobit and Probit models computed for low and high risk firms. We include industry (Fama-French 49) dummies and year dummies in all specifications. Statistical significance is based on industry-year clustered standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

The results of the extended Tobit regression models with interaction terms between LNVEGA, LNDELTA and firm risk are reported in the first three columns of Table 6 while the results for the extended Probit regression are reported from columns (4) to (6). Notably, to reduce multicollineary between the interaction terms and the constituent terms, we employ a de-mean approach as in Vallascas and Hagendorff (2013). This consists of subtracting for each variable involved in the computation of the interaction terms its sample mean before computing the interaction term. As a result, in Table 6 the coefficients of LNVEGA and LNDELTA have to be interpreted as referring to a company with average firm risk; namely, when the interaction term with one of the measures of firm risk is equal to zero.

Furthermore, as suggested by Norton et al. (2004) in non-linear models it is not possible to infer the role and the degree of significance of the interaction term simply through the estimated coefficient and the related standard error. Following Berger and Bouwman (2013), therefore, we report in Panel B the coefficients and standard errors of the marginal effects of equity-based incentives computed for low (corporate risk proxy equal to the 25th percentile of the sample distribution) and high risk firms (corporate risk proxy equal to the 75th percentile of the sample distribution)[17].

In general, the regression results of Table 6 show that a creditor perceives risk incentives linked to stock return volatility as being more dangerous in more risky firms: an increase in LNVEGA increases the degree of debt specialization especially in more risky firms. The result is not affected by the way we measure firm risk: in all specifications the interaction between LNVEGA and firm risk is positive and highly significant. More importantly, the marginal effects reported in Panel B tend to be significant only when firms are characterized by higher default risk.

Less consistent are the results when the focus is on LNDELTA. None of the interaction terms enter the models with a significant coefficient and, more importantly, the marginal effects tend to be significant in both low and high risky firms. This is especially the case when the analysis is based on HHI. Furthermore, in unreported tests we find that the magnitude of the marginal effects is not statistically different between low and high risky firms.

Overall, when firm risk increases it appears that creditors are more concerned because of the presence of risk-incentives linked to stock return volatility rather than because of the presence of risk-taking incentives linked to CEO Delta. This finding is not entirely surprising. Differently from Delta, it is likely that risk-incentives linked to stock return volatility have a more direct impact on firm default risk by favoring investments by managers in more volatile projects. As a result they are likely to be especially detrimental to the survival of firms that are characterized by a higher degree of riskiness.

In summary, while the findings reported in this section confirm the key conclusion of our analysis of debt specialization having a role in mitigating the

[17]More specifically, for the Tobit model we compute the marginal effects of the censored expected value. These marginal effects describe how the observed variable change with respect to the regressors.

agency costs of debt, they suggest that these costs are perceived as being higher in riskier firms, especially in the presence of an increase in our more direct proxy of risk-taking incentives linked to stock return volatility (Vega); the influence of Delta on debt specialization does not seem instead to vary with firm risk.

4.4.4. Debt specialization, managerial incentives and the percentage change in the market value of debt

Our analysis so far implies that debtholders perceive a higher degree of debt specialization as being beneficial in reducing the potential negative effects that might be generated by the presence of risk-taking incentives in CEO pay. Nevertheless, it says little as to the extent to which debt specialization is indeed beneficial for debtholders in reducing these agency costs produced by executive compensation.

In this section we assess the benefits for debtholders stemming from debt specialization by taking as a point of departure the view that the presence of the agency costs of debt could lead to a decrease in the market value of debt because of the propensity of managers to engage in asset substitution via riskier projects (Eisdorfer, 2008). In accordance with this view, we expect that the agency cost of debt related to risk-taking incentives in executive pay should materialize via a reduction in the percentage change in the market value of debt when Vega (Delta) increases (decreases). To be effective in curtailing the agency cost of debt, a higher degree of debt specialization should, therefore, mitigate the impact of risk-taking incentives on the percentage change in the market value of debt.

We design our empirical setting by initially estimating for the full sample the sensitivity of the percentage change in the market value of debt to risk-taking incentives in executive pay, via an OLS regression model specified as follows:

$$\%\Delta V_{Dit} = \beta_0 + \beta_1 LNVEGA_{it} + \beta_2 LNDELTA_{it} + \beta_3 INVESTMENT_{it} + \beta_4 X_{it} + \beta_5 Z_{it} + \sum_{k=1}^{49} S_k + \sum_{t=2001}^{2012} Y_t + \varepsilon_{it} \quad (6)$$

Similarly to Eisdorfer (2008) the dependent variable is the percentage change in the market value of debt (V_D), that we measure in continuous time ($Ln(V_{D_t}) - Ln(V_{D_{t-1}})$) to reduce skewness in the dependent variable. The market value of debt is the difference between the market value of firm assets derived as described in the previous section and the market value of equity.

Our key explanatory variables are LNVEGA and LNDELTA, while INVESTMENT is the investment intensity, calculated as in Eisdorfer (2008) as capital expenditures scaled by property, plant and equipment, and is expected to increase the market value of debt. In addition, we include the vector of firm characteristics (X) and the vector of CEO control variables (Z), both described in section 4.1.

Table 7. Effect of Managerial Risk-taking Incentives on the Percentage Change in the Market Value of Debt for Firms

	Percentage Change in Debt Value				
	Full sample	**HHI Below Median**	**HHI Above Median**	**Excl90=0**	**Excl90=1**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
LNVEGA	-0.00876***	-0.0117***	-0.00456	-0.0123***	-0.00314
	[0.00264]	[0.00390]	[0.00364]	[0.00373]	[0.00375]
LNDELTA	0.0193***	0.0274***	0.00952	0.0248***	0.00922
	[0.00517]	[0.00742]	[0.00704]	[0.00708]	[0.00720]
INVESTMENT	0.163***	0.204***	0.138**	0.233***	0.107*
	[0.0439]	[0.0645]	[0.0590]	[0.0625]	[0.0618]
LEVERAGE	0.179***	0.188***	0.164***	0.190***	0.145***
	[0.0304]	[0.0430]	[0.0443]	[0.0398]	[0.0483]
SIZE	0.00945**	0.00323	0.0118**	0.00627	0.0102
	[0.00404]	[0.00579]	[0.00576]	[0.00561]	[0.00618]
MTOB	0.0165**	0.00301	0.0261***	0.00517	0.0268***
	[0.00698]	[0.0118]	[0.00873]	[0.0114]	[0.00928]
PROF	-0.188**	-0.314**	-0.111	-0.299**	-0.107
	[0.0782]	[0.127]	[0.100]	[0.122]	[0.106]
TANG	-0.00405	-0.0375	0.0409	-0.0302	0.0396
	[0.0253]	[0.0329]	[0.0373]	[0.0313]	[0.0415]
DIV_PAYER	-0.00295	0.0127	-0.0176	0.0116	-0.0181
	[0.00948]	[0.0121]	[0.0143]	[0.0120]	[0.0149]

	(1)	(2)	(3)	(4)	(5)
CF_VOL	-0.966***	-0.914***	-0.991***	-0.895***	-1.016***
	[0.131]	[0.237]	[0.166]	[0.220]	[0.172]
R&D	-0.669***	-0.175	-0.836***	-0.305	-0.839***
	[0.179]	[0.323]	[0.208]	[0.307]	[0.221]
UNRATED	0.0487***	0.0341**	0.0564***	0.0396***	0.0543***
	[0.00947]	[0.0140]	[0.0145]	[0.0134]	[0.0154]
REG_DUM	0.00323	0.0189	-0.0292	0.00679	-0.134***
	[0.0153]	[0.0203]	[0.0324]	[0.0170]	[0.0335]
FIRM_AGE	-0.0200***	-0.0255***	-0.0131	-0.0264***	-0.0107
	[0.00675]	[0.00957]	[0.00960]	[0.00914]	[0.00999]
OWN	-0.218	-0.478**	0.0460	-0.426**	0.0458
	[0.141]	[0.216]	[0.201]	[0.207]	[0.206]
PAYSLICE	0.0138	0.0771	-0.0422	0.0729	-0.0476
	[0.0407]	[0.0611]	[0.0521]	[0.0580]	[0.0538]
Constant	-0.0383	-0.0734	0.00723	0.288	0.0697
	[0.135]	[0.0564]	[0.241]	[0.248]	[0.0713]
Industry dummies	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES
Obs.	4,517	2,330	2,187	2,592	1,925
R-squared	0.117	0.143	0.115	0.139	0.120
R2 adj.	0.103	0.117	0.0860	0.115	0.0881

Notes: This Table shows the regression results of the percentage change in debt value in a given year on managerial incentives (**LNVEGA** and **LNDELTA**) and a set of control variables. The model is estimated via OLS. The set of control variables include leverage, size, the market to book ratio, profitability, tangibility, dividend payer, cash flow volatility, R&D expenses, a dummy equal to one if firms are unrated, a dummy equal to one if firms belong to a regulated industry, firm age, CEO ownership and CEO pay slice. Column (1) reports the results for the full sample. Column (2) and Column (3) refer to subsamples of firms with values of **HHI** below and above the sample median, respectively. Column (4) and Column (5) refer to subsamples of firms with values of **Excl90**equal to zero and equal to one, respectively. All specifications include industry (Fama-French 49) dummies and year dummies. Statistical significance is based on industry-year clustered standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

The results for this model are reported in column (1) of Table 7 and confirm that the design of executive pay significantly impacts on debtholder wealth. In short, in line with our prediction an increase (decrease) in LNVEGA (LNDELTA) reduces the percentage change in the market value of debt. Next, to assess the role of debt specialization in safeguarding the interests of debtholders, we repeat the analysis by splitting our sample into firms with low and high degrees of debt specialization. Specifically, we group the firms in our sample by adopting two alternative criteria. First, we classify as having a highly specialized debt structure firms with a value of HHI above the sample median. Second, we employ the dummy variable Excl90 and define as highly specialized those firms with a value of Excl90 equal to one.

The results of the regression models for the sub-samples, reported from columns (2) to column (5) of Table 7 show the effects of Vega and Delta on the percentage change in debt value materializes only in firms with a low degree of debt specialization. In other words, when debt specialization is low, Vega has a negative effect on the value of debt with a coefficient of -0.0117 (-0.0123) for firms with a HHI index below the sample median (for firms with Excl90 equal to zero). In contrast, Vega and Delta do not have a significant impact on the percentage change in the market value of debt in firms with a higher degree of debt specialization. Overall, this analysis provides support to the view that debt specialization mitigates the agency costs of debt by showing that a decline in the market value of debt in the face of risk-taking incentives in executive pay is confined to firms with a less concentrated debt structure.

4.4.5. The interrelationship between debt specialization and debt maturity

While our results point to debt specialization facilitating monitoring by creditors, previous studies show that creditor incentives to monitor are also reflected in the maturity of debt contracts. Specifically, Brockman et al. (2010) show that when CEOs are rewarded with pay incentives that amplify the risk of asset substitution, the debt maturity in a firm's capital structure tends to decline. The intuition is that short-term debt can reduce discretionary funds and subject managers to the scrutiny of the financial market, effectively curbing self-serving behavior (Rajan and Winton, 1995; and Stulz, 2000) and the risk of asset substitution problems (Brockman et al., 2010; DeMarzo and Fishman, 2007; DeMarzo and Sannikov, 2006; Leland and Toft, 1996). In general, the shorter debt maturity mitigates the agency costs of debt (see for instance Grossman and Hart, 1982; Hart and Moore, 1995; Jensen, 1986; Stulz, 1990).

In the context of our analysis, therefore the use of shorter-term debt contracts might act as a potential substitute or as a possible complement to debt specialization. To examine the effects of managers' incentives on different aspects of a firm's financial policy and to control for a possible interrelationship between debt specialization and debt maturity, in this section we estimate a system of three equations. The three dependent variables are debt specialization, debt maturity and leverage with the inclusion of this latter equation being justified by the possible endogeneity between different aspects of financial policy and the degree of corporate leverage as suggested by Brockman et al. (2010). Furthermore, following Brockman et al. (2010), we measure debt maturity as the ratio between debt with a maturity lower than 3 years and total debt, and leverage as the ratio of long term debt over total assets.

The three variables are assumed to be jointly determined in a system of Tobit equations. The system is specified as follows:

$$HHI_{it} = \beta_0 + \beta_1 LNVEGA_{it} + \beta_2 LNDELTA_{it} + \beta_3 ST3_{it} + \beta_4 X_{it} + \beta_5 Z_{it} + \sum_{k=1}^{49} S_k + \sum_{t=2001}^{2012} Y_t + \varepsilon_{it} \quad (7)$$

$$ST3_{it} = \beta_0 + \beta_1 LNVEGA_{it} + \beta_2 LNDELTA_{it} + \beta_3 HHI_{it} + \beta_4 LEVERAGE_{it} + \beta_5 W_{it} + \beta_6 Z_{it} + \sum_{k=1}^{49} S_k + \sum_{t=2001}^{2012} Y_t + \varepsilon_{it} \quad (8)$$

$$LEVERAGE_{it} = \beta_0 + \beta_1 LNVEGA_{it} + \beta_2 LNDELTA_{it} + \beta_3 ST3_{it} + \beta_4 HHI_{it} + \beta_5 T_{it} + \beta_6 Z_{it} + \sum_{k=1}^{49} S_k + \sum_{t=2001}^{2012} Y_t + \varepsilon_{it} \quad (9)$$

In the equation where debt specialization is the dependent variable, we employ the same set of controls discussed in the previous section with the addition of debt maturity as a further explanatory factor to control for the interplay between these two characteristics of the debt structure.

In the selection of the explanatory variables for the other two equations we follow the previous literature and in particular the analysis of Brockman et al. (2010). Detailed definitions and summary statistics for the additional variables employed for this test are offered in the Appendix. In the maturity equation, in addition to LNVEGA and LNDELTA, debt specialization (HHI) and book leverage (LEVERAGE), the vector of firm characteristics (W) includes: size (SIZE), the square of firm size (SIZE2), the market to book ratio (MTOB), a dummy equal to one if a firm is not rated by S&P (UNRATED), a dummy equal to one if a firm is from a regulated industry (REG_DUM), asset maturity (ASSET_MAT), the term structure of interest rates (TERM), a measure of distress risk based on Altman´s (1977) Z-score (ZSCORE_DUM), a measure of abnormal earnings (ABNEARN) and the standard deviation of asset returns (STD_DEV). We also include the vector (Z) of control variables referring to CEO characteristics such as OWN and PAYSLICE.

As far as the leverage equation is concerned, in addition to debt specialization, debt maturity, LNDELTA and LNVEGA, the vector of control variables (T) includes: size (SIZE), the market to book ratio (MTOB), a dummy equal to one if a firm is from a regulated industry (REG_DUM), a measure of abnormal earnings (ABNEARN), the standard deviation of asset return (STD_DEV), the degree of asset tangibility (TANG), liquidity (LIQ), a dummy equal to one if a firm has an operating loss carried forward (NOL_DUM), and a dummy equal to one if the firm has an investment tax credit (ITC_DUM). Furthermore, as in the other two equations we control for CEO characteristics such as OWN and PAYSLICE. All equations include industry and time dummies.

Table 8. Debt Specialization, Debt Maturity and Leverage

Variables	**HHI**	**ST3**	**LEVERAGE**
	(1)	**(2)**	**(3)**
HHI		-1.083***	-0.411***
		[0.103]	[0.0682]
ST3	-0.445***		-0.510***
	[0.0465]		[0.0312]
LEVERAGE	-0.736***	-0.555**	
	[0.0640]	[0.240]	
LNVEGA	0.0106***	0.0182***	0.00753***
	[0.00258]	[0.00377]	[0.00185]
LNDELTA	-0.0227***	-0.0336***	-0.0253***
	[0.00481]	[0.00693]	[0.00329]
SIZE	-0.0147***	-0.288***	-0.0157***
	[0.00386]	[0.0398]	[0.00264]
MTOB	0.0447***	0.0761***	0.0502***
	[0.00606]	[0.00776]	[0.00429]
PROF	-0.0119		-0.290***
	[0.0598]		[0.0414]
TANG	0.00826		
	[0.00840]		
DIV_PAYER	-0.00314		0.0315*

	[0.0234]		[0.0167]
CF_VOL	0.604***		
	[0.124]		
R&D	0.929***		
	[0.121]		
UNRATED	0.0298**	0.123***	
	[0.0129]	[0.0221]	
REG_DUM	0.236***	0.351***	0.170***
	[0.0602]	[0.0902]	[0.0439]
FIRM AGE	-0.0249***		
	[0.00623]		
OWN	0.371***	0.755***	0.450***
	[0.126]	[0.177]	[0.0893]
PAYSLICE	-0.0111	-0.0271	-0.0216
	[0.0331]	[0.0484]	[0.0236]
SIZE2		0.0166***	
		[0.00244]	
ASSET_MAT		0.000251	
		[0.00118]	
TERM		-1.761	
		[2.102]	
ABNEARN		2.428	2.815***
		[1.563]	[0.718]
STD_DEV		0.830***	-0.249**
		[0.257]	[0.106]
ZSCORE_DUM		0.00857	
		[0.0373]	
LIQ			-0.0204***
			[0.00447]
NOL_DUM			0.00348
			[0.00513]
ITC_DUM			0.00211
			[0.0143]
Constant	1.258***	2.373***	1.054***
	[0.0582]	[0.195]	[0.0496]
Industry dummies	YES	YES	YES
Time dummies	YES	YES	YES
Obs.	6,115	6,115	6,115
Model Wald chi-squared	1259	1126	1946
Sig. Wald chi-squared	0.000	0.000	0.000
Wald chi-squared test of exogeneity	67.59	145.5	558.0
Sig. chi-squared test of exogeneity	0.000	0.000	0.000

Notes: This Table reports the empirical results on the relation between the degree of debt specialization, measured via HHI, and the sensitivities of CEO´s wealth to stock return volatility (**LNVEGA**) and to changes (in percent) to stock prices (**LNDELTA**) a system of three Tobit equations allowing joint determination of the debt specialization equation (1), debt maturity equation (2) and leverage equation (3). **ST3** is debt maturity measured by the ratio between debts with maturity lower than three years over total debts. **LEVERAGE** is the ratio between total debts and total liabilities. The set of control variables in the debt specialization equation include leverage, debt maturity, size, the market to book ratio, profitability, tangibility, dividend payer, cash flow volatility, R&D expenses, a dummy equal to one if firms are unrated, a dummy equal to one if firms belong to a regulated industry, firm age, CEO ownership and CEO payslice. The set of control variables in the debt maturity equation include leverage, debt specialization, size, the square of firm size, the market to book ratio, a dummy equal to one if firms are unrated, a dummy equal to one if a firm is from a regulated industry, asset maturity, the term structure of interest rates, a measure of distress risk based on the Altman´s (1977) Z-score, a measure of abnormal earnings, the standard deviation of asset returns, CEO ownership and CEO pay slice. The set of control variables in the leverage equation include debt specialization, debt maturity, size, the market to book ratio, a dummy equal to one if a firm is from a regulated industry, abnormal earnings, the standard deviation of asset return, asset tangibility, liquidity, a dummy equal to one if a firm has an operating loss carried forward, a dummy equal to one if the firm has an investment tax credit, CEO ownership and CEO pay slice. We include industry (Fama-French 49) dummies and year dummies in all specifications. Statistical significance is based on industry-year clustered standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Table 8 reports the empirical results of the system of equations. In the debt specialization we find that a decline in the maturity of debt reduces the need for a more specialized debt structure as shown by the negative coefficient on ST3. This result is in line with the view that maturity and specialization might act as substitute mechanisms in disciplining executives. Notably, LNVEGA and LNDELTA still enter the equation with a positive and negative coefficient, respectively, significant at customary levels, thus confirming the validity of our first hypothesis after controlling for debt maturity[18].

Moving to the analysis of the results for the two remaining equations, we observe that LNVEGA and LNDELTA influence debt maturity and leverage in a similar manner as to how they affect the degree of debt specialization. The results for debt maturity are in line with the findings offered by Brockman et al. (2010) and with the potential role of shorter-term debt acting as a mechanism to reduce the agency costs of debt. More importantly, our measure of debt specialization enters with a negative and highly significant coefficient in the maturity equation, confirming the initial conjecture that debt specialization can be seen as an alternative tool of debt policy to contain the risk of asset substitution generated by executive pay.

In summary, after controlling for the interplay between debt specialization and other attributes of financial policy, we still observe that an increase in CEO pay

[18]As a robustness check we also estimate this three-equation system using the GMM estimator. Our results remain unchanged.

incentives that have the potential to amplify the agency cost of debt leads to an increase in debt specialization. Furthermore, the analysis discussed in this section suggests that debt specialization acts as a potential substitute to a reduced maturity of debt to curtail the risk of asset substitution and the related agency costs of debt.

4.5. Conclusions to the fourth chapter

Previous studies identify the shortening of the maturity of debt as an efficient way for creditors to monitor managerial behavior and reduce the risk of asset substitution that arises from the design of executive compensation (Brockman et al., 2010). In this paper, we extend the existing literature on the impact of executive pay on debt structure by analyzing the role of another characteristic of firm debt policy, the degree of debt specialization, in moderating the agency costs of debt produced by executive pay.

We show that the specialization of the debt structure in fewer debt types is perceived by creditors as another way to attenuate the potential agency costs of debt produced by the way executive compensation is designed. Specifically, we find that when CEOs are expected to have greater incentives for asset substitution because of higher Vega or lower Delta, the degree of debt specialization increases. Our empirical results are robust to controls for numerous factors that have been shown to affect debt specialization, to changes in the econometric setting and in particular to the potential endogeneity of equity-based incentives. We also demonstrate that the sensitivity of debt specialization to equity-based incentives that favor investments in more volatile business lines is more pronounced in riskier firms. This finding is in line with the view that creditors aim to enhance monitoring when borrowing firms show higher incentives to engage in risk-shifting in the interest of shareholders and when this risk-shifting is more likely to lead to the default of the company.

Furthermore, we offer a direct test of the benefits of debt specialization in mitigating the agency costs of debt by quantifying how a more concentrated debt structure mitigates the impact of executive-pay incentives on the percentage change in the market value of debt. In essence, we show that after controlling for the level of investments, only in firms with a lower degree of debt specialization does an increase (decrease) in Vega (Delta) reduce the market value of debt. In contrast, the design of executive compensation has no effect on the market value of debt in firms characterized by a higher degree of debt specialization.

Finally, our results suggest that the degree of debt specialization acts as an alternative, and not as a complement, tool to a shortening in the maturity of debt to reduce the agency costs of debt. By estimating a simultaneous system of equations, we find that, holding constant the value of risk-taking incentives in CEO pay, an increase the maturity of debt reduces the degree of debt specialization while an increase in debt specialization reduces the need to shorten the maturity of debt to cope with the agency cost of debt.

Our analysis extends the literature on how creditors react to the design of executive pay and the evidence provided by Colla et al. (2013) on the possible drivers of debt specialization at the firm level by offering support for a strong causal relationship between the structure of debt types and executive compensation. Crucially, we also demonstrate that the creditors' assessment of the nexus between executive compensation and risk-seeking behavior by managers leads to the recognition that debt specialization is a similar but also an alternative mechanism to the use of debt with a shorter maturity.

FINAL CONCLUSIONS

At the end of each of the four chapters of this dissertation, we have included a section with the main conclusions to place the results in the theoretical framework of the previous literature and to highlight the contribution of our theoretical and empirical analysis to the research lines of capital structure and the business life cycle. Instead of repeating these explanations now, we start from the contributions made as well as their usefulness for potential groups of users to note several future possible extensions of this research.

We highlight the following ones as the main contributions of the first chapter.

- First, we include the incorporation of the life cycle factor to the capital structure explanation, studying the impact of the firm's stage on financial decisions. There is very little theory to explain differences in financing across the stages of firms' life cycles. Factors such as size, age, profitability, tangible assets, retained earnings (Bulan and Yan, 2010), or dividends (DeAngelo et al., 2006) show different leverage patterns when firms are mature. However, this chapter extends the literature of capital structure and the business life cycle, examining the most important drivers of leverage during the five stages of the life cycle (introduction, growth, maturity shake-out and decline) as well as explaining how and why firms choose their combination of capital structure in each stage.

- Furthermore, we identify what part of the theories explains debt in each life cycle stage, showing that the prevalence of the theories changes as the firms do. Frank and Goyal (2009) suggest that different theories of capital structure apply to firms under different circumstances and each factor could be dominant for some firms or in some circumstances. Specifically, Frank and Goyal (2003) and Lemmon and Zender (2010) point out that the greatest support for the pecking order is found among larger and mature firms. Our work extends the previous literature, finding support for both theories (pecking order and trade-off) across the life cycle of the firm.

- Moreover, we use an innovative measure (Dickinson, 2011) to distinguish the stages of the life cycle of the firm. This approach considers the ability of generating cash flows at the different business levels of the firm (operating, investing, and financing), and this dissertation is the first work that employs that model to study the firm's capital structure, thus approximating the research on the financing decisions and the research on the life cycle of the firm, contributing to both research streams, i.e., capital structure and the business life cycle. Although age is a common criterion to distinguish the life cycle, we propose that some operating, investing and financing events induce the change from one stage to another independently of the age of the firm, which gives a higher discriminant potential to the variable we use. In this chapter, the Dickinson model is shown to be consistent with the life cycle theory by applying it to a new theoretical framework as the capital structure.

Our results have important implications for researchers concerning the analysis of the capital structure along the stages of the life cycle. Business managers could be interested in the interpretation of our results as capital structure is the prime financial decision to be taken by firms, and our findings show that the life cycle stage is a discriminant element when taking this decision. Additionally, our work may help business assessors, financial analysts or investors to better understand different behavior patterns regarding firms' financing policies.

The study of the second chapter contributes to the empirical literature in several ways.

- First, we explain the capital structure of tech versus non-tech firms along the life cycle stages and observe the differences by stage.

- Furthermore, we use the differences in growth opportunities to discriminate between high-tech firms to further analyze their capital structures.

- As in the first chapter, our work confirms that Dickinson's (2011) model provides the research community with a new proxy for the life cycle that allows us to apply capital structure models within a new dynamic framework, giving rise to much more detailed analyses on either general or specific sector samples.

- Our work contributes to a very small group of works comparing tech firms to non-tech firms concerning capital structure. Unlike the two most comparable studies (Hogan and Hutson, 2005; Hyytinen and Pajarinen, 2005), employing a one-country SME sample, we study an international sample of listed companies. In addition, the two works referenced adopt a static standpoint without considering life cycle stages.

- The same type of implications could be adduced with respect to the identified smaller groups of high tech firms after demonstrating that growth opportunities address significant differences concerning the evolution of capital structure. In sum, more homogeneous samples allow the researcher to better explain the effects of the capital structure theories on the group under study.

Our results have relevant implications for researchers both in the selection of the sample to be analyzed as well as in the interpretation of results depending on the distribution of the sample over the life cycle stages. Due to the evolution of the capital structure patterns along the life cycle, a sample consisting of firms in different stages of their life cycles would produce some non-significant or spurious results, whereas different samples could produce opposite results, depending on the life cycle stage in which most firms are included. Employing by-stage samples allows the researcher to form homogenous groups in respect to the life cycle. Thus, the offsetting effect of some drivers that evolve along the life cycle is avoided, and some mixed effects found in the literature can be disentangled.

In the third chapter, we observe that since the seminal work of Fischer et al. (1989), the cost of transactions relative to the changes toward the new capital structure and the speed of adjustment have been considered to vary across companies and over time (Hovakimian et al., 2001). Recent papers have studied the target leverage as a function of firm-level (Byoun, 2008; Chang and Dasgupta, 2009; Hovakimian and Li, 2011; Aybar-Arias et al., 2012; Faulkender et al., 2012) or country-level variables (Cook and Tang, 2010; Rubio and Sogorb, 2011) as well as in relation to firms´ legal and institutional environment (González and González, 2008; Öztekin and Flannery, 2012). Several contributions to the extant literature on target leverage are provided in this third chapter.

- First, we demonstrate that the main factors of target leverage as well as the speed of adjustment vary along the stages of the life cycle, as the capital structure theories play different roles along the life cycle stages of firms. Our findings suggest that firms adjust to the target ratio faster during the introduction or maturity stage than during the growth stage.

- Moreover, we observe differential effects of some determinants and a lower speed of adjustment in firms that have changed stage. We attribute this result to the increase of asymmetric information resulting in an intensification of transaction costs.

- Finally, we contribute to the target leverage literature by adding a new explanatory factor: the next-year target debt. Our results provide evidence that next-stage target leverage is a relevant factor to induce the level of the current leverage, consistent with firms involved in the process of leverage adjustment previously (in advance) to conduct their planned investments.

Our last empirical analysis, collected in the fourth chapter, offers an additional number of contributions.

- First, our study extends the existing evidence on the role of executive compensation in influencing a firm's capital structure. Several studies have commonly linked managerial incentives to firm leverage (Berger et al., 1997; Coles et al., 2006) to the types of debt (straight debt versus convertible debt) (Ortiz-Molina, 2007) and to the maturity of the debt contracts (Brockman et al., 2010). This work is the first that finds evidence of a strong relationship between the degree of concentration of corporate debt structure and executive compensation as motivated by the agency costs of debt.

- Second, we show the empirical evidence on the drivers of debt specialization in Colla et al. (2013), specifically, on the importance of monitoring encouragements of creditors. This work indicates how debt specialization might be used as a tool to limit the agency costs of debt produced by the way that the managerial incentives are designed and how this use of debt concentration is even stronger in the case of riskier firms.

- Finally, we contribute to the literature on the creditor perception of pay incentives in managerial compensation. Billett et al. (2010) indicate that there is a positive (negative) bond price reaction in the presence of an increase in Delta (Vega). Moreover, Brockman et al. (2010) and Daniel et al. (2004), among others find a higher cost of debt when the compensation risk is higher. This chapter extends the evidence in Brockman et al. (2010) by showing that the creditors' assessment of the relationship between managerial incentives and risk-seeking behavior by managers leads to debt specialization having an alternative role to the use of short-term debt.

The main results of this chapter have important implications for managers, debtholders and bondholders. Debt concentration might be a widespread phenomenon for debtholders because they can employ a higher degree of debt specialization as an effective tool to curtail asset substitution problems. In addition, the design of pay incentives to executives might determine the degree of debt structure; therefore, the compensation of managers could be altered by creditors' strategies.

Future research extensions could take a step forward in the following ways.

- The model to distinguish among life cycle stages. Dickinson's (2011) model offers a clear advantage over the most commonly employed approximations: the classification of the company is based on operating, investing and financing cash flows, which gathers several main aspects of the firm's functioning instead of considering only one relevant variable. However, the model has shown higher instability than expected because the flows of the firm are changing every day and, for example, a firm that is considered mature (generally looking to its age and stable business in time) may go through phases of higher investment and growth when starting new projects, but disinvestment and low growth when a line of business is less profitable and is planned to be closed. Alternative methods also considering several main aspects of the firm's business and strategy could be developed in the near future, and a horse race would be desirable.

- The sample. In this dissertation, we have used data from different groups of countries. However, the distribution of the firm-year observations among life cycle stages as well as further classifications, such as tech/non-tech, high-tech/low-tech or high-tech with high-growth/low-growth opportunities, has hampered the comparison between results by country or by industry due to the small number of data in some of the countries and industries. A comparison could be done between large countries or trying homogeneous groups of countries. As for the comparison by industry in a country, an extension of the study could be done using US data and selecting those industries with a higher number of firms.

- The methodology. In spite of the diverse methodologies applied in this study (Fama-MacBeth, panel data-GMM, Ordinary Least Squares, Tobit or Probit), we could test other methodologies appropriate for this study to check the robustness of our results, such as fixed or random effects estimations. Additionally, it would be interesting to consider the cluster standard errors based on industry, year or firm effects to obtain more robust results. Because of the use of different groups of firms (by stage or by industry) across the dissertation chapters, we could try other tests to prove the significance of the differences between the groups. Finally, due to the potential endogeneity of capital structure concerns, it would also be interesting to control for these possible endogeneity issues through different methodologies (using instrumental variables and equations systems for the endogeneity and the Granger test for the causality).

- Debt specialization measure. The analysis of the last chapter might be extended by employing a different measure of debt concentration. There are more classifications of debt structure that could be considered to calculate a debt specialization measure. Another possible analysis could focus not only on the intensity of debt concentration but on the types of debt with a higher proportion in the firms' financing because certain peculiarities of different debt types could condition their use.

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APPENDIX

Appendix A. Chapter 2

Table I. Description of Variables

Variable	**Definition**
Firm Characteristics. Data Source: Worldscope	
LDEBT	Long-term debt to the book value of assets (Shyam-Sunder and Myers, 1999).
PROF	Earnings before interest and taxes to total assets (Rajan and Zingales, 1995).
GROWTH	Market value of equity plus debt in current liabilities plus long-term debt plus preferred stocks minus deferred taxes and investment tax credit, all scaled by total assets (Frank and Goyal, 2009).
LIQ	Current assets to current liabilities (Ozkan, 2001).
SIZE	Logarithm of total assets (La Rocca et al., 2011).
NDTS	Depreciation, depletion, and amortization to total assets (Titman and Wessels, 1988).
TANG	Net property, plant, and equipment to total assets (González and González, 2008).
AGE	The logarithm of years after the firm's foundation (La Rocca et al., 2011).
AMINTAN	Amortization of intangibles to total depreciation.
HGO	Equals one if a firm has high technology with higher growth opportunities and zero otherwise.
LGO	Equals one if a firm has high technology with lower growth opportunities and zero otherwise.
DEF	Cash dividends plus net investment plus the change in working capital plus cash flow after interest and taxes plus the current portion of the long-term debt plus net debt issued plus net equity issued (Frank and Goyal, 2003).
LEV	Total liabilities to total assets (Welch, 2011).
CRISIS	Equals one if a firm is in systemic banking crisis period and zero otherwise (Laeven and Valencia, 2013).
CR	Country creditors' rights (Djankov et al., 2007).

RDA	Research and development expenses to total assets (Fama and French, 2002).
Legal Origin	Five dummies that equal one if the firm has Anglo-Saxon, French, German, Scandinavian or Socialist legal origin and zero otherwise (Djankov et al., 2007).

Table II. By-Stage Determinants of Leverage. Alternative Measure of Intangible Assets

Panel A. Determinants in Non-Tech Firms.GMM

Variables	**Introduction**	**Growth**	**Maturity**	**Shake-Out**	**Decline**
$LDEBT_{t-1}$	0.356***	0.377***	0.518***	0.525***	0.675***
	[0.00825]	[0.00252]	[0.000414]	[0.00331]	[0.00451]
$PROF_t$	-0.0944***	-0.120***	-0.117***	-0.0413***	-0.0448***
	[0.00506]	[0.00191]	[0.000302]	[0.00150]	[0.00226]
$GROWTH_t$	-0.000688	0.000857***	0.00285***	0.00817***	-0.000298
	[0.000607]	[0.000277]	[3.94e-05]	[0.000293]	[0.000314]
LIQ_t	-0.00323***	-0.00210***	-0.00930***	-0.00112***	-0.000459***
	[0.000356]	[0.000140]	[4.58e-05]	[9.44e-05]	[0.000145]
$SIZE_t$	0.0169***	0.0241***	0.0201***	0.0119***	0.00263***
	[0.00137]	[0.000420]	[6.63e-05]	[0.000345]	[0.000266]
$NDTS_t$	-0.167***	-0.517***	-0.611***	0.0403**	-0.147***
	[0.0370]	[0.0144]	[0.00289]	[0.0158]	[0.0129]
$TANG_t$	0.0633***	0.0618***	0.102***	0.0788***	0.0629***
	[0.00801]	[0.00301]	[0.000625]	[0.00236]	[0.00227]
AGE_t	0.000669	0.00200***	-0.00526***	-0.00637***	0.00463***
	[0.00128]	[0.000459]	[5.57e-05]	[0.000552]	[0.000532]
RDA_t	0.0987*	-0.934***	0.0984***	0.403***	0.0629***
	[0.0565]	[0.0235]	[0.00489]	[0.0223]	[0.0198]
Constant	0.0103	-0.165***	-0.187***	-0.101***	-0.0158
	[0.0371]	[0.0171]	[0.00234]	[0.00769]	[0.0107]
Country Dummies	YES	YES	YES	YES	YES
Time Dummies	YES	YES	YES	YES	YES
Obs.	1,769	2,607	4,895	1,032	428
#Firms	658	987	1,047	592	288
F Test	200.5	2261	1.050e+10	8207	243727

Sig. F Test	0	0	0	0	0
Hansen Test	334.4	810.5	1015	463.9	210.3
Sig. Hansen	0.606	0.489	1	0.427	0.736
m2	-0.0211	1.640	1.955	1.099	0.970
Sig. m2	0.983	0.101	0.0506	0.272	0.332

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Panel B. Determinants in Tech Firms. GMM

Variables	Introduction	Growth	Maturity	Shake-Out	Decline
$LDEBT_{t-1}$	0.476***	0.476***	0.568***	0.473***	0.853***
	[0.00151]	[0.00529]	[0.00591]	[0.00126]	[0.00654]
$PROF_t$	-0.0280***	-0.0907***	-0.0478***	-0.0391***	-0.0183***
	[0.000810]	[0.00390]	[0.00439]	[0.000892]	[0.00447]
$GROWTH_t$	0.000880***	0.000140	0.000970**	0.00772***	0.00395***
	[0.000117]	[0.000432]	[0.000466]	[0.000278]	[0.000862]
LIQ_t	-0.00522***	0.00225***	-0.000996**	-0.00823***	-0.00230***
	[5.67e-05]	[0.000301]	[0.000420]	[0.000161]	[0.000398]
$SIZE_t$	0.00500***	0.0132***	0.0116***	0.00937***	0.00561***
	[0.000316]	[0.000570]	[0.000565]	[0.000232]	[0.000927]
$NDTS_t$	0.628***	-0.383***	-0.0428	0.181***	0.108*
	[0.00657]	[0.0378]	[0.0372]	[0.00611]	[0.0595]
$TANG_t$	0.0397***	0.124***	0.0697***	0.191***	0.0146
	[0.00132]	[0.00693]	[0.00702]	[0.00231]	[0.0116]
AGE_t	0.0113***	0.00683***	-0.00786***	-0.00433***	0.00675***
	[0.000479]	[0.000733]	[0.000678]	[0.000270]	[0.00184]
RDA_t	-0.211***	-0.746***	-0.219***	-0.260***	-0.0876*
	[0.00991]	[0.0345]	[0.0309]	[0.00592]	[0.0497]
Constant	0.0661***	-0.110***	-0.0969***	0.225***	-0.0708***
	[0.00511]	[0.0117]	[0.0129]	[0.00429]	[0.0186]
Country Dummies	YES	YES	YES	YES	YES
Time Dummies	YES	YES	YES	YES	YES
Obs.	1,372	1,656	2,899	585	364
# Firms	454	602	647	339	212
F Test	3.583e+06	1145	898.5	398074	31912
Sig. F Test	0	0	0	0	0
Hansen Test	385.3	471.1	476.2	302.9	135
Sig. Hansen	1	0.338	0.280	0.915	1
m2	-0.622	-0.864	1.612	1.131	1.919

Sig. m2	0.534	0.388	0.107	0.258	0.0550

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table III. By-Stage Determinants of Leverage. With Institutional and Legal Controls

Panel A. Determinants in Non-Tech Firms. GMM

Variables	**Introduction**	**Growth**	**Maturity**	**Shake-Out**	**Decline**
$LDEBT_{t-1}$	0.383***	0.398***	0.851***	0.498***	0.634***
	[0.000406]	[0.000641]	[0.0202]	[0.00424]	[0.00301]
$PROF_t$	-0.0477***	-0.115***	-0.0623***	-0.0403***	-0.0559***
	[0.000140]	[0.000277]	[0.0229]	[0.00214]	[0.00212]
$GROWTH_t$	0.00190***	0.000356***	0.00715**	0.00588***	0.00178***
	[1.44e-05]	[5.61e-05]	[0.00293]	[0.000525]	[0.000336]
LIQ_t	-0.00186***	0.00449***	0.00260	0.00259***	-0.000860***
	[1.33e-05]	[2.37e-05]	[0.00202]	[0.000154]	[0.000148]
$SIZE_t$	0.0114***	0.0273***	0.00892***	0.00979***	0.00703***
	[6.34e-05]	[9.01e-05]	[0.00125]	[0.000421]	[0.000276]
$NDTS_t$	0.00635***	-0.528***	-0.311***	0.154***	-0.250***
	[0.00134]	[0.00325]	[0.118]	[0.0224]	[0.0180]
$TANG_t$	0.0741***	0.125***	0.0697***	0.151***	0.0769***
	[0.000312]	[0.000374]	[0.0156]	[0.00356]	[0.00287]
AGE_t	0.00514***	0.00255***	-0.00203	-0.00263***	9.82e-05
	[6.72e-05]	[0.000120]	[0.00206]	[0.000528]	[0.000536]
$AMINTAN_t$	0.0355***	0.0600***	0.0446***	0.00625***	0.0573***
	[0.000129]	[0.000242]	[0.0145]	[0.00182]	[0.00140]
$CRISIS_t$	0.0229***	-1.94e-05	-0.000464	-0.0278***	-0.0314***
	[0.00142]	[0.000329]	[0.00382]	[0.00210]	[0.00866]
CR_t	-0.0123***	-0.00135***	0.000656	-0.00538***	-0.00870***
	[0.000148]	[0.000172]	[0.000823]	[0.000568]	[0.00106]
Constant	-0.0675***	-0.283***	-0.102***	-0.0950***	-0.0320***
	[0.000849]	[0.00113]	[0.0190]	[0.00552]	[0.00589]
Legal Origin Dummies	YES	YES	YES	YES	YES
Country Dummies	YES	YES	YES	YES	YES
Time Dummies	YES	YES	YES	YES	YES
Obs.	1,769	2,607	4,895	1,032	428
# Firms	658	987	1,047	592	288
F Test	4.730e+07	534245	125.7	3402	2.256e+06
Sig. F Test	0	0	0	0	0

Hansen Test	567.9	929.2	249.5	468.2	211.8
Sig. Hansen	0.587	0.474	0.126	0.374	0.727
m2	0.0627	1.375	1.501	1.210	0.782
Sig. m2	0.950	0.169	0.133	0.226	0.434

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Panel B. Determinants in Tech Firms. GMM

Variables	**Introduction**	**Growth**	**Maturity**	**Shake-Out**	**Decline**
$LDEBT_{t-1}$	0.550***	0.496***	0.569***	0.502***	0.900***
	[0.00313]	[0.0113]	[0.00504]	[0.00197]	[0.0123]
$PROF_t$	-0.0329***	-0.0768***	-0.0501***	-0.0310***	-0.0322***
	[0.00214]	[0.00701]	[0.00495]	[0.000944]	[0.00974]
$GROWTH_t$	0.00264***	0.000280	-0.00133**	0.00721***	0.00224
	[0.000328]	[0.000927]	[0.000529]	[0.000173]	[0.00205]
LIQ_t	-0.00382***	0.00179***	-0.00265***	-0.00860***	-0.00120
	[0.000216]	[0.000604]	[0.000540]	[0.000146]	[0.000929]
$SIZE_t$	-0.00499***	0.0157***	0.0131***	0.00920***	-0.00287
	[0.000756]	[0.00110]	[0.000608]	[0.000156]	[0.00244]
$NDTS_t$	0.357***	-0.454***	-0.200***	0.275***	-0.493***
	[0.0268]	[0.0691]	[0.0395]	[0.0134]	[0.148]
$TANG_t$	0.0982***	0.104***	0.0552***	0.149***	0.0730***
	[0.00721]	[0.0138]	[0.00720]	[0.00270]	[0.0247]
AGE_t	0.0122***	0.00205*	-0.00761***	-0.00258***	0.00840
	[0.000595]	[0.00117]	[0.000742]	[0.000321]	[0.00595]
$AMINTAN_t$	0.0241***	-0.00287	-0.0113***	-0.00704***	-0.0273**
	[0.00227]	[0.00612]	[0.00261]	[0.000815]	[0.0131]
$CRISIS_t$	0.0187***	0.00209	0.000481	-0.00771***	-0.00321
	[0.00265]	[0.00410]	[0.00139]	[0.00119]	[0.00458]
CR_t	-0.00787***	0.000987	0.00249***	-0.00113***	-0.00787**
	[0.000864]	[0.000993]	[0.000452]	[0.000251]	[0.00304]
Constant	0.0679***	-0.149***	-0.0985***	-0.115***	0.0677
	[0.00907]	[0.0156]	[0.00817]	[0.00284]	[0.0540]
Legal Origin Dummies	YES	YES	YES	YES	YES
Country Dummies	YES	YES	YES	YES	YES
Time Dummies	YES	YES	YES	YES	YES
Obs.	1,372	1,656	2,899	585	364
Firms	454	602	647	339	212
F Test	1840	188.8	1204	84565	73014
Sig. F Test	0	0	0	0	0

Hansen Test	351.7	358.6	490.7	301.7	66.50
Sig. Hansen	0.347	0.258	0.148	0.923	1
m2	-0.592	-0.657	1.467	1.218	1.615
Sig. m2	0.554	0.511	0.142	0.223	0.106

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table IV. Chow Test

PANEL A. Comparison between Life Stages within each Sector (No Tech-Low Tech-High Tech)

Notes: Chow Test between life stages in each sector (5 groups by sector)

	Non Tech Firms		**Low Tech Firms**		**High Tech Firms**	
Variable	***F***	***Sig.***	***F***	***Sig.***	***F***	***Sig.***
L.LDEBT	35.65	0.00	9.91	0.00	53.06	0.00
PROF	8.63	0.00	6.66	0.00	7.88	0.00
GROWTH	8.12	0.00	0.64	0.59	7.86	0.00
LIQ	16.96	0.00	3.87	0.01	10.06	0.00
SIZE	6.77	0.00	4.38	0.01	7.43	0.00
NDTS	7.86	0.00	1.93	0.13	2.73	0.04
TANG	5.27	0.00	3.82	0.01	12.46	0.00
AGE	25.42	0.00	3.67	0.01	11.9	0.00
AMINTAN	8.85	0.00	6.99	0.00	10.66	0.00
Overall	27.31	0	6.61	0	17.42	0

PANEL B. Comparison between Life Stages and Sectors (Tech vs. Non Tech)

Notes: Chow Test between life stages and between tech and non tech firms (5 life stages x 2 sectors = 10 groups)

Variable	*F*	*Sig.*
L.LDEBT	25.23	0
PROF	10.54	0
GROWTH	7.32	0
LIQ	2.51	0.0102
SIZE	10.86	0
NDTS	4.11	0.0001
TANG	13.94	0
AGE	29.01	0
AMINTAN	6.04	0
Overall	15.81	0

PANEL C. Comparison between Life Stages and Sectors (High Tech vs. Low Tech)

Notes: Chow Test between life stages and between high tech and low tech firms (5 life stages x 2 sectors = 10 groups)

Variable	*F*	*Sig.*
L.LDEBT	18.86	0.00
PROF	8.81	0.00
GROWTH	2.69	0.01
LIQ	5.48	0.00
SIZE	6.8	0.00
NDTS	6.17	0.00

TANG	13.67	0.00
AGE	6.07	0.00
AMINTAN	4.81	0.00
Overall	14.24	0.00

PANEL D. Chow Test in Pecking Order Framework. Comparison between Life Stages within each Sector

	No Tech Firms		Low Tech Firms		High Tech Firms	
Variable	***F***	***Sig.***	***F***	***Sig.***	***F***	***Sig.***
DEF	589.46	0.00	95.45	0.00	148.7	0.00

PANEL E. Chow Test in Pecking Order Framework. Comparison between Life Stages and Sectors (Tech vs. Non Tech)

Notes: Chow Test between life stages and between tech and non tech firms (5 life stages x 2 sectors = 10 groups)

Variable	***F***	***Sig.***
DEF	370.12	0.00

PANEL F. Chow Test in Pecking Order Framework. Comparison between Life Stages and Sectors (High Tech vs. Low Tech)

Notes: Chow Test between life stages and between high tech and low tech firms (5 life stages x 2 sectors = 10 groups)

Variable	***F***	***Sig.***
DEF	112.31	0.00

Table V. VIF Factors

	All Sample		Non Tech		Tech	
Variables	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
TANG	1.65	0.61	1.53	0.65	2.07	0.48
NDTS	1.49	0.67	1.49	0.67	1.78	0.56
AMINTAN	1.39	0.72	1.33	0.75	1.53	0.65
SIZE	1.38	0.73	1.32	0.76	1.44	0.69
PROF	1.29	0.77	1.28	0.78	1.35	0.74
LIQ	1.27	0.79	1.27	0.79	1.26	0.80
GROWTH	1.17	0.85	1.16	0.87	1.22	0.82
AGE	1.16	0.86	1.13	0.88	1.15	0.87
Mean VIF	1.35		1.31		1.47	

Appendix B. Chapter 3

Table I. Correlation Analysis

	TDEBT	PROF	GROWTH	TANG	SIZE
TDEBT	1				
PROF	0.0011	1			
GROWTH	-0.0938	-0.1618	1		
TANG	0.2928	0.1835	-0.1402	1	
SIZE	0.2768	0.371	-0.2569	0.2314	1

Table II. VIF Factors

All Sample		
Variable	VIF	**1/VIF**
SIZE	1.25	0.80
PROF	1.18	0.85
GROWTH	1.08	0.92
TANG	1.08	0.93
Mean VIF	1.15	

Table III. Controlling by Institutional Factors

Panel A. By-Stage Determinants of Debt

Variables	All Firms	Introduction	Growth	Maturity
$TDEBT_{t-1}$	0.587***	0.527***	0.706***	0.680***
	[0.0166]	[0.00305]	[0.0198]	[0.00757]
$PROF_t$	-0.148***	-0.0333***	-0.173***	-0.168***
	[0.0153]	[0.00145]	[0.0274]	[0.00616]
$GROWTH_t$	0.000544	-0.00287***	-0.00730***	0.00952***
	[0.00181]	[0.000230]	[0.00241]	[0.000438]
$TANG_t$	0.160***	0.228***	0.0978***	0.0713***
	[0.0205]	[0.00464]	[0.0220]	[0.00459]
$SIZE_t$	0.0162***	-0.0127***	0.00965***	0.0118***
	[0.00158]	[0.000597]	[0.00269]	[0.000794]
CR_t	-0.00970***	0.0128**	-0.00873***	-0.00520**
	[0.00248]	[0.00615]	[0.00272]	[0.00221]
$Debt\_efficiency_t$	0.000318*	0.000317	0.000454**	7.58e-05
	[0.000166]	[0.000415]	[0.000181]	[0.000155]

$CRISIS_t$	0.00914**	0.0268***	0.00732	0.00705**
	[0.00414]	[0.00341]	[0.00606]	[0.00345]
Constant	-0.0406	-0.884	-0.130**	-0.0755***
	[0.0271]	[0.601]	[0.0584]	[0.0183]
Industry Eff.	YES	YES	YES	YES
Country Eff.	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES
Legal Origin Eff.	YES	YES	YES	YES
Obs.	11,553	2,189	5,541	3,823
# Firms	2,681	1,013	2,007	1,532
F Test	158.8	29591	93.63	445.5
Sig. F Test	0	0	0	0
Hansen Test	359.1	510.5	218.1	590.6
Sig. Hansen	0.714	1	0.123	0.229
m2	1.351	0.325	1.213	-0.349
Sig. m2	0.177	0.745	0.225	0.727

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Panel B. Determinants Debt according to the Stage Change

Variables	Introduction: Unchange	Change: Intro to Growth	Growth: Unchange	Change: Growth-Mat	Maturity: Unchange
$TDEBT_{t-1}$	0.589***	0.743***	0.564***	0.772***	0.687***
	[0.00808]	[0.0306]	[0.00756]	[0.0178]	[0.000980]
$PROF_t$	-0.0323***	-0.158***	-0.160***	-0.305***	-0.185***
	[0.00437]	[0.0225]	[0.0104]	[0.0226]	[0.00140]
$GROWTH_t$	0.00177***	0.00608**	-0.00455***	0.00926***	0.0163***
	[0.000464]	[0.00269]	[0.000760]	[0.00213]	[0.000233]
$TANG_t$	0.200***	0.164***	0.105***	0.0826***	0.101***
	[0.0110]	[0.0254]	[0.0106]	[0.0141]	[0.00152]
$SIZE_t$	-0.0117***	0.0102***	0.0166***	0.00895***	0.00959***
	[0.00111]	[0.00356]	[0.00117]	[0.00148]	[0.000267]
CR_t	-0.0332	-0.00522	-0.00770***	-0.000372	-0.000973
	[0.0294]	[0.00921]	[0.00288]	[0.00300]	[0.00116]
$Debt\_efficiency_t$	-7.35e-05	-0.000488	0.000302	2.64e-06	-0.000182***
	[0.000856]	[0.00100]	[0.000195]	[0.000217]	[7.00e-05]
$CRISIS_t$	0.0459***	-0.00445	-0.00278	0.0131**	-0.000237
	[0.00957]	[0.0201]	[0.00445]	[0.00618]	[0.000929]
Constant	0.158**	-0.689	-0.0533**	-0.0622**	0

	[0.0671]	[0.437]	[0.0245]	[0.0267]	[0]
Industry Eff.	YES	YES	YES	YES	YES
Country Eff.	YES	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES	YES
Legal Origin Eff.	YES	YES	YES	YES	YES
Obs.	837	453	2,700	1,363	1,683
# Firms	437	395	1,230	977	821
F Test	13181	11243	646.7	271.5	1.600e+08
Sig. F Test	0	0	0	0	0
Hansen Test	297.3	119.7	485.6	280	599.6
Sig. Hansen	0.756	0.963	0.155	0.239	0.999
m2	-0.945	-0.382	2.210	1.563	0.197
Sig. m2	0.345	0.702	0.0271	0.118	0.844

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Panel C. Influence of the Next Target on Firm Debt

Variables	**Change: Introduction to Growth**	**Change: Growth to Maturity**
$TDEBT_{t-1}$	0.782***	0.744***
	[0.0170]	[0.0224]
$PROF_{t+1}$	0.116***	0.0345
	[0.0137]	[0.0220]
$GROWTH_{t+1}$	0.0284***	0.0120***
	[0.00387]	[0.00308]
$TANG_{t+1}$	0.163***	0.0972***
	[0.0285]	[0.0186]
$SIZE_{t+1}$	-0.00567**	0.0123***
	[0.00242]	[0.00217]
CR_t	-0.0518***	-0.00909**
	[0.0160]	[0.00366]
$Debt\_efficiency_t$	-0.00205*	0.000172
	[0.00108]	[0.000262]
$CRISIS_t$	0.0312*	-0.00538
	[0.0174]	[0.00673]
Constant	0.0510	-0.118***
	[0.0760]	[0.0367]
Industry Eff.	YES	YES
Country Eff.	YES	YES
Time Eff.	YES	YES

Legal Origin Eff.	YES	YES
Obs.	395	1,296
# Firms	345	947
F Test	19166	103.6
Sig. F Test	0	0
Hansen Test	122.8	195.8
Sig. Hansen	0.996	0.490
m2	-1.074	1.553
Sig. m2	0.283	0.120

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table IV. Controlling by Age

Panel A. By-Stage Determinants of Debt

Variables	**All Firms**	**Introduction**	**Growth**	**Maturity**
$TDEBT_{t-1}$	0.602***	0.598***	0.705***	0.611***
	[0.0119]	[0.00835]	[0.0185]	[0.000523]
$PROF_t$	-0.126***	-0.0526***	-0.165***	-0.132***
	[0.0105]	[0.00540]	[0.0242]	[0.000280]
$GROWTH_t$	-0.00441***	-0.00880***	-0.00271	0.00974***
	[0.00135]	[0.00100]	[0.00213]	[2.75e-05]
$TANG_t$	0.182***	0.0890***	0.137***	0.119***
	[0.0129]	[0.0120]	[0.0197]	[0.000256]
$SIZE_t$	0.00993***	-0.00418***	0.0110***	0.00848***
	[0.00126]	[0.00155]	[0.00247]	[0.000146]
AGE_t	-0.00121	0.00994***	-8.36e-05	-0.00322***
	[0.00241]	[0.00234]	[0.00175]	[0.000191]
Constant	0.0547	0.597	-0.101**	0.00652
	[0.490]	[0.389]	[0.0508]	[0.00776]
Industry Eff.	YES	YES	YES	YES
Country Eff.	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES
Obs.	9,247	1,810	4,484	2,953
# Firms	2,051	789	1,541	1,154
F Test	184	871762	107.6	3.360e+08
Sig. F Test	0	0	0	0
Hansen Test	469.4	264.7	233.2	931.6
Sig. Hansen	0.311	0.950	0.356	1
m2	0.848	0.493	0.737	-0.659

Sig. m2	0.396	0.622	0.461	0.510

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Panel B. Determinants Debt according to the Stage Change

Variables	Introduction: Unchange	Change: Intro to Growth	Growth: Unchange	Change Growth-Mat	Maturity: Unchange
$TDEBT_{t-1}$	0.579***	0.712***	0.590***	0.772***	0.676***
	[0.00594]	[0.0238]	[0.00353]	[0.0166]	[0.00333]
$PROF_t$	-0.0397***	-0.132***	-0.224***	-0.192***	-0.196***
	[0.00447]	[0.0208]	[0.00467]	[0.0175]	[0.00294]
$GROWTH_t$	0.00220***	-0.00114	0.00185***	0.00864***	0.0215***
	[0.000390]	[0.00216]	[0.000402]	[0.00187]	[0.000512]
$TANG_t$	0.168***	0.208***	0.156***	0.136***	0.142***
	[0.00955]	[0.0219]	[0.00386]	[0.0164]	[0.00401]
$SIZE_t$	-0.00873***	0.00386	0.0208***	0.00559***	0.00419***
	[0.00115]	[0.00379]	[0.000825]	[0.00172]	[0.000343]
AGE_t	0.0180***	7.28e-05	-0.00512***	-0.00225	-0.00346***
	[0.00158]	[0.00413]	[0.000753]	[0.00143]	[0.000480]
Constant	0	-0.232*	-0.209***	-0.0314	0.150***
	[0]	[0.118]	[0.0448]	[0.0328]	[0.0180]
Industry Eff.	YES	YES	YES	YES	YES
Country Eff.	YES	YES	YES	YES	YES
Time Eff.	YES	YES	YES	YES	YES
Obs.	716	374	2,221	1,059	1,292
# Firms	359	323	975	740	625
F Test	3.790e+08	10561	1.712e+06	232.4	5.170e+07
Sig. F Test	0	0	0	0	0
Hansen Test	294.3	144.8	541.6	202.6	405.3
Sig. Hansen	0.998	0.978	0.473	0.630	0.768
m2	-0.750	-0.450	1.439	1.400	-0.413
Sig. m2	0.453	0.652	0.150	0.161	0.680

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Panel C. Influence of the Next Target on Firm Debt

Variables	Change: Introduction to Growth	Change: Growth to Maturity
$TDEBT_{t-1}$	0.742***	0.680***
	[0.0149]	[0.00321]
$PROF_{t+1}$	0.0501***	0.0684***
	[0.0116]	[0.00113]
$GROWTH_{t+1}$	0.0180***	-0.00407***
	[0.00210]	[0.000492]
$TANG_{t+1}$	0.105***	0.0784***
	[0.0188]	[0.00306]
$SIZE_{t+1}$	0.00225	0.00993***
	[0.00261]	[0.000396]
AGE_{t+1}	0.00440	0.00385***
	[0.00427]	[0.000718]
Constant	0.114	-0.120***
	[0.199]	[0.0365]
Industry Eff.	YES	YES
Country Eff.	YES	YES
Time Eff.	YES	YES
Obs.	324	1,019
# Firms	280	725
F Test	19264	1.291e+06
Sig. F Test	0	0
Hansen Test	156.1	451.5
Sig. Hansen	1	0.794
m2	-1.096	1.511
Sig. m2	0.273	0.131

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table V. Chow Test in the Main Tables

	Table 3		Table 4		Table 5	
Variables	**F (Chow Test)**	**Sig.**	**F (Chow Test)**	**Sig.**	**F (Chow Test)**	**Sig.**
Categorical groups	7.58	0.006	12.77	0.000	58.82	0.000
TDEBTt-1	16.04	0.000	9.58	0.000	10.62	0.000
PROF	9.66	0.002	6.36	0.000	31.38	0.000
GROWTH	40.89	0.000	5.77	0.001	15.85	0.000
TANG	16.09	0.000	6.43	0.000	10.38	0.000
SIZE	16	0.000	16	0.000	97.65	0.000
Overall	22.12	0.000	6.64	0.000	43.52	0.000

Appendix C. Chapter 4

A. Estimation of Vega and Delta

We define the volatility sensitivity or Vega as the change in the value of the CEO's option portfolio due to a 1% increase in the standard deviation of the stock return. The CEO's portfolio price sensitivity or Delta is similarly defined as the change in the value of the CEO's stock and option portfolio in response to a 1% increase in the price of the firm's common stock. The sensitivity of an option (Υ and Δ) might be observed as partial derivatives that are based on the Black and Scholes (1973) option pricing model adjusted for dividends by Merton (1973). We follow the same procedure as Core and Guay (2002) and Coles et al. (2006).

$$\Delta = e^{-dT} N(Z)$$

$$\Upsilon = e^{-dT} N'(Z) S\sqrt{T}$$

$$Z = \frac{\ln\left[\frac{S}{X}\right] + T\left[r - d + \frac{\sigma^2}{2}\right]}{\sigma\sqrt{T}}$$

where *d* is the natural logarithm of the expected dividend yield over the life of the option, *T* is the time to maturity of the option in years, *N* is the cumulative normal probability function, and *N´* is the density function for the normal distribution; *S* is the price of the underlying stock; X is the exercise price of the option; *r* is the natural logarithm of the risk-free interest rate and σ is the expected stock return volatility over the life of the option.

The six variables necessary to compute the Vega and Delta of an option are the exercise price, time to maturity, volatility, the risk-free rate, the dividend yield, and the stock price. All of these input variables are either directly observable or can be accurately estimated; however, because of the FAS 123R issued by the FASB in 2004 specifies a change in format for accounting for equity-based compensation, following Coles et al. (2013) we use different calculations for the fiscal years 2001–2006 and for the fiscal years 2007 and later in some variables.

Variable	Pre 2006	Post 2006
Volatility	BS_VOLATILITY in Execucomp	We use the annualized standard deviation of stock returns estimated over the 60 months prior to the beginning of the fiscal period, winsorized at the 5th and 95th levels.
Dividend yield	BS_YIELD	We use the average of DIVYIELD provided by Execucomp over the current year and the two prior years and winsorize the values at the 5th and 95th levels.
Risk free rate	Risk-free rate corresponding to the (rounded) maturity of the options as of the fiscal year end. The risk-free rate is obtained from historical data provided by the Federal Reserve.	
Exercise price	Exercise price in Execucomp.	
Time to maturity	Expiration date of option - needed to compute the maturity of the options as of the fiscal year end.	
Stock price	Stock price at fiscal year end.	

- Pre 2006

For the pre-2006 data, we use the approximation method detailed in Core and Guay (2002) to calculate the Vega and Delta of the option portfolio.

We consider three option portfolios: current year's option grants, portfolio of unvested options from previously granted awards, and the portfolio of vested options. The executive's incentives are given by the summation of the incentives from these three portfolios.

For the current year's option grants, we obtain the number of options granted during that year, the stated exercise price, and maturity.

For the portfolio of previously granted unvested options, we estimate the exercise price in three steps. First, we estimate the total number of options in the portfolio and the average exercise price of each option in the portfolio. Later, we estimate the intrinsic value of the portfolio of previously granted unvested options by subtracting the intrinsic value of the current year's grants from the reported intrinsic value of all unvested options. Lastly, the average exercise price of each previously granted unvested option is obtained by subtracting the average intrinsic value of each option in the portfolio from the stock price.

For vested options, we calculate the average exercise price based on the realizable value and the number of vested options.

Finally, we estimate Vega and Delta options. Vega is the sum of the Vega of the current year options as well as previously-granted options (both vested and unvested). The Delta is the sum of the Delta of current year options, the Delta of the portfolio of previously granted options (both vested and unvested), and the Delta from the shares owned by manager.

- Post 2006

For the period post 2006, in calculating Vega and Delta, we utilize only the vested and unvested shares and options, using a separate record for each outstanding option tranche. We underestimate the true Vega and Delta ignoring the unearned awards. These unearned shares or options will be classified as either shares or options when they are earned, and, if these grants are still held by the executive as of the end of the year, they will be included in the Vega and Delta calculation at that point.

We use the values of the variables defined in the previous table and formulate Vega and Delta values according to the methodology provided in Core and Guay (2002) and Coles et al., (2006), which in turn is the Black and Scholes (1973) option valuation model as modified by Merton (1973) to account for dividends.

The Vega and Delta of all vested and unvested tranches of options are summed up for each executive-year to give the Vega and Delta of the option portfolio.

Finally, we obtain the Vega and Delta of the equity portfolio. For Vega of the equity portfolio, we use only the Vega of the option portfolio calculated previously. We assume, as in Guay (1999) and Coles et al. (2006), that Vega of the share portfolio is zero. To compute the overall Delta, we add the Delta of the portfolio of options and the Delta of the portfolio of shares.

B. Tables

Table B.I. Debt Specialization by Industry.

Industries	Fama-French 49 sectors	Obs.	HHI	Excl90
Agriculture	1	23	0.692	0.478
Food Products	2	162	0.660	0.321
Candy & Soda	3	23	0.646	0.435
Beer & Liquor	4	15	0.778	0.600
Tobacco Products	5	22	0.867	0.682
Toys Recreation	6	35	0.875	0.800
Fun Entertainment	7	68	0.507	0.191
Books Printing and Publishing	8	60	0.535	0.167
Consumer Goods	9	139	0.672	0.388
Clothes Apparel	10	79	0.793	0.595
Healthcare	11	116	0.665	0.397
Medical Equipment	12	183	0.751	0.541
Drugs Pharmaceutical Products	13	206	0.773	0.553
Chemicals	14	273	0.657	0.348
Rubber and Plastic Products	15	44	0.602	0.364
Textiles	16	34	0.518	0.235
Construction Materials	17	167	0.719	0.509
Construction	18	116	0.785	0.578
Steel Works	19	146	0.777	0.575

etc.				
Fabricated Products	20	6	0.439	0.000
Machinery	21	363	0.665	0.421
Electrical Equipment	22	104	0.703	0.423
Automobiles and Trucks	23	128	0.560	0.219
Aircraft	24	72	0.695	0.458
Ships, Shipbuilding, Railroad Equipment	25	16	0.373	0.063
Guns Defence	26	26	0.723	0.385
Precious Metals	27	14	0.749	0.429
Mines, Non-Metallic and Industrial Metal Mining	28	43	0.750	0.488
Coal	29	33	0.599	0.273
Oil, Petroleum and Natural Gas	30	354	0.710	0.449
Utilities	31	512	0.663	0.311
Communication	32	168	0.692	0.458
Personal Service	33	96	0.674	0.302
Business Service	34	292	0.716	0.497
Computer Hardware	35	119	0.823	0.697
Computer Software	36	233	0.867	0.764
Electronic Equipment	37	368	0.811	0.649
Measuring and Control Equipment	38	159	0.697	0.447
Paper, Business Supplies	39	172	0.661	0.384
Shipping Containers	40	78	0.516	0.128
Transportation	41	252	0.623	0.317
Wholesale	42	249	0.656	0.349
Retail	43	304	0.708	0.454
Meals, Restaurants, Hotels, Motels	44	129	0.666	0.426
Others	49	99	0.589	0.313
Total		6300	0.697	0.440

Notes: Table B.I reports the industrial distribution of the degree of debt specialization (HHI and Excl90). The final sample contains 6,300 observations from the 2001 to 2012 period.

Table B.II. Summary Statistics of Additional Explanatory Variables in the Maturity and Leverage Models

Variable	Definition	Mean	Std. Dev.	Min.	25th perc.	Median	75th perc.	Max.
Additional Variables in the Maturity equation								
ST3	Debt in current liabilities plus debt maturing in the second year plus debt maturing in the third year, scaled by total debt	0,373	0,314	0,000	0,12	0,298	0,541	1,000
SIZE2	Square of SIZE	66,69	24,664	24,125	48,108	62,611	81,348	140,07
ASSET_MAT	Book value-weighted average of the maturities of property plant and equipment and current assets, computed as (gross property, plant, and equipment over total assets) multiplied by (gross property, plant, and equipment over depreciation expense) plus (current assets over total assets) multiplied by (current assets over cost of goods sold)	3,091	5,409	0,027	0,366	0,899	3,039	31,925
TERM	Yield on 10-year government bonds subtracted from the yield on 6-month government bonds at the fiscal year end. Data source: Federal Research Economic Data (FRED) at the Federal Reserve Bank of St. Louis	0,020	0,012	-0,002	0,01	0,02	0,032	0,036
ZSCORE_DUM[1]	Equals one if Altman's Z-score is greater than 1.81, and zero otherwise	0,830	0,376	0,000	1,000	1,000	1,000	1,000
ABNEARN	Earnings in year t+1 minus earnings in year t over the share price multiplied by outstanding shares in year t	0,000	0,003	-0,010	0,000	0,000	0,000	0,022
STD_DEV	Monthly stock return standard deviation during the fiscal year multiplied by the ratio of the market value of equity to the market value of assets	0,059	0,035	0,010	0,034	0,051	0,073	0,192
Additional Variables in the Leverage equation								
LIQ	Current assets scaled by current liabilities	1,971	1,206	0,440	1,163	1,684	2,387	7,348
NOL_DUM	Equals one if the firm has operating loss carryforward, and zero otherwise	0,625	0,484	0,000	0,000	1,000	1,000	1,000
ITC_DUM	Equals one if the firm has an investment tax credit, and zero otherwise	0,965	0,184	0,000	1,000	1,000	1,000	1,000

[1] According to Altman (1977): Z-score = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + X5; where: X1 = Working capital/total assets; X2 = Retained earnings/total assets; X3 = Earnings before interest and taxes/total assets; X4 = Market value of equity/book value of total liabilities; X5 = Sales/total assets

Notes: This table presents descriptive statistics for the additional variables used in the debt maturity and leverage regressions.

Normativa Mención "Doctor Internacional"

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DEPARTAMENTO DE DIRECCIÓN Y ECONOMÍA DE LA EMPRESA

Tesis Doctoral

"Investigaciones sobre estructura de capital: ciclo de vida y especialización de deuda"

Paula Castro Castro

De acuerdo con el artículo 15 del Real Decreto 99/2011 y con la Normativa de la Universidad de León, la mención "Doctor Internacional" en el título de doctor, podrá adquirirse cuando se cumplan los requistos establecidos. Uno de ellos es que una parte de la Teis Doctoral que debe incluirse, al menos el resumen y las conclusiones, se haya redactado y presentado en español. En este apartado se muestra el índice, un resumen completo de la Tesis anteriormente presentada y unas conclusiones generales.

1. Índice

2. Resumen

Esta Tesis Doctoral tiene como principal objetivo analizar la estructura de capital de la empresa en un entorno dinámico, para obtener un conocimiento más profundo de cómo y por qué las empresas adoptan su estructura de capital a lo largo de su ciclo de vida, es decir, en un contexto en el que las condiciones y circunstancias de la empresa son cambiantes. Además, como objetivo más específico dentro de la estructura de capital, se estudia en detalle la concentración de deuda y la utilización de esta estrategia para ejercer un mayor control sobre los directivos por parte de los acreedores.

Nuestro principal objetivo se puede desglosar en tres: 1) el análisis de la importancia del ciclo de vida como factor explicativo del apalancamiento y la identificación de qué parte de las diferentes teorías de estructura de capital, teoría de la jerarquía (*pecking order theory*) y teoría del equilibrio (*trade-off theory*) predominan en cada etapa de vida de la empresa; 2) el análisis de la estructura de capital de las empresas tecnológicas frente a las no tecnológicas en un marco dinámico, para identificar las diferencias en cuanto a los factores que explican el apalancamiento de las empresas, aplicando además el test de *"pecking order";* y 3) el estudio del apalancamiento objetivo y la velocidad de ajuste hacia una estructura de capital óptima a lo largo de las diferentes etapas del ciclo de vida de la empresa. En cuanto a nuestro objetivo más específico, estudiamos la estructura de deuda, concretamente la especialización de la deuda, y la utilización por parte de los acreedores de la especialización como una herramienta para mitigar determinados costes de agencia a través de los incentivos de los directivos de la empresa.

En el capítulo 1 se explica por qué las empresas eligen distintos niveles de deuda en diferentes etapas de su ciclo de vida, de manera que nuestro principal objetivo es situar el estudio sobre la estructura de capital en el contexto de condiciones y circunstancias cambiantes de la empresa. Como apoyo a este problema de investigación contamos con el elevado grado de coincidencia entre las variables que han resultado significativas en trabajos empíricos anteriores que se ocupan de las dos líneas de investigación (estructura de capital y ciclo de vida). Examinamos el diferente comportamiento de los factores más comunes que explican el apalancamiento financiero de la empresa a través de las etapas de vida de ésta. Una dificultad importante en el desarrollo de este trabajo es la identificación empírica de las etapas del ciclo de vida de la empresa. La literatura previa no ha llegado a un acuerdo sobre cuántas etapas debe tener la empresa, su denominación y condiciones. Por ello, hemos seguido el novedoso trabajo de Dickinson (2011), donde el criterio para distinguir la etapa de vida en la que se encuentra la empresa considera la capacidad de cada empresa para generar diferentes tipos de flujos de caja: operativo, de inversión y financiero. Este criterio nos permite identificar 5 etapas diferentes: introducción, crecimiento, madurez, reestructuración y declive. Los resultados obtenidos para una muestra internacional compuesta por empresas cotizadas de Alemania, España, Francia y el Reino Unido en el periodo 1980 – 2011, tras aplicar la metodología de Fama-MacBeth, así como GMM, indican que la etapa de vida en la que se encuentre la empresa afecta a la estructura de capital de la misma. Así, nuestra principal contribución en este capítulo es la identificación de factores que afectan con mayor intensidad en cada etapa, lo que permite explicar las causas de los niveles de deuda por etapa del ciclo de vida. Además, nuestros resultados son consistentes con las teorías fundamentales sobre estructura de capital, equilibrio y jerarquía, y nos permiten identificar también qué parte de las teorías explica el apalancamiento en cada etapa de ciclo de vida, para concluir que la prevalencia de las diferentes teorías varía a medida que las empresas cambian de etapa. Por tanto, este capítulo contribuye al desarrollo de dos líneas de investigación: estructura de capital y ciclo de vida de la empresa. Se añade un factor explicativo dinámico a la literatura sobre estructura de capital, el ciclo de vida de la empresa, que aporta un conocimiento más preciso acerca de la elección del apalancamiento, contribuyendo a desentrañar una parte de las relaciones no lineales identificadas entre el endeudamiento y las características de la empresa. Asimismo, nuestro estudio proporciona apoyo a las ideas tanto de la teoría del equilibrio como de la teoría de la jerarquía. En la línea de investigación sobre el ciclo de vida, el capítulo aporta evidencia empírica internacional de un modelo muy reciente, diseñado para distinguir entre las etapas del ciclo de vida. Nuestros resultados confirman que el modelo de

Dickinson (2011) es consistente con la teoría del ciclo de vida aplicado a un nuevo marco teórico, la evolución de la deuda según las teorías estáticas ampliamente estudiadas sobre estructura de capital.

Por otro lado, en el capítulo 2 se analiza la estructura de capital de las empresas tecnológicas frente a las no tecnológicas en un marco dinámico, examinando la sensibilidad del apalancamiento de las empresas a determinados factores, así como la tendencia de la deuda mediante la aplicación del test de "*pecking order"*. Nuestras hipótesis se apoyan en las características peculiares del sector tecnológico. La evidencia empírica indica que el rápido desarrollo del sector tecnológico, la complejidad de la tecnología, la importancia del componente intangible del negocio y la presencia del efecto red en estas empresas podrían tener implicaciones en sus patrones de financiación. Además, las oportunidades de crecimiento se analizan como factor discriminante en las empresas de alta tecnología, ya que esas oportunidades constituyen un elemento importante para las decisiones estratégicas financieras de la empresa. Por tanto, teniendo en cuenta que las empresas tecnológicas disponen, en general, de elevadas oportunidades de crecimiento, que pueden proporcionar a las empresas elevados rendimientos más rápido, se considera que las oportunidades de crecimiento podrían ser un factor clave para distinguir empresas tecnológicas con el fin de observar detalladamente su estructura de capital a lo largo de sus vidas. En este capítulo, se proporciona evidencia empírica internacional para una muestra de empresas cotizadas de los siguientes países europeos: Alemania, Austria, Bélgica, España, Francia, Holanda, Italia, y el Reino Unido, en el periodo 2000-2012, aplicando el estimador GMM en dos etapas en datos de panel, así como efectos fijos para la estimación del test de *"pecking order*". Usando el modelo de Dickinson (2011) para distinguir entre las etapas del ciclo de vida de las empresas, se muestra que las estructuras de capital de las empresas tecnológicas y no tecnológicas son diferentes a lo largo de sus etapas de vida. Nuestros resultados confirman el papel de la información asimétrica para diferenciar los patrones de la estructura de capital en ambos sectores. Además, el test de *"pecking order"* confirma un menor uso de deuda de empresas tecnológicas en comparación con el resto de empresas a lo largo de sus etapas de vida. Finalmente, tomando como referencia la mediana del proxy utilizado como indicador de las oportunidades de crecimiento por año y ciclo de vida, se distingue entre empresas de alta tecnología que tengan las mayores oportunidades de crecimiento y empresas de alta tecnología con las menores oportunidades de crecimiento. En este caso, mostramos que las oportunidades de crecimiento son un factor clave para distinguir las empresas de alta tecnología, así como para explicar mejor sus estructuras de capital. Nuestros resultados indican que la teoría de la jerarquía predominará más en empresas con bajas oportunidades de crecimiento, lo que podría indicar que estas empresas se asemejan más a las empresas no tecnológicas. Este capítulo contribuye a la literatura previa en varios aspectos. En primer lugar, este trabajo se añade al todavía escaso grupo de estudios que comparan las empresas tecnológicas con las no tecnológicas en lo referente a la estructura de capital, estudiando una muestra internacional de empresas cotizadas. En segundo lugar, se utilizan las diferencias en las oportunidades de crecimiento para diferenciar mejor entre empresas de alta tecnología, con el fin de analizar más a fondo sus estructuras de capital.

En el capítulo 3 se analizan las diferencias en cuanto al endeudamiento objetivo y a la velocidad de ajuste entre tres fases del ciclo de vida de la empresa: introducción, crecimiento y madurez. Según la teoría del equilibrio, los costes y los beneficios de la deuda financiera podrían cambiar a lo largo de la vida de la empresa, lo que permitiría o forzaría a éstas a modificar sus estrategias financieras. Por otro lado, de acuerdo con la teoría de la jerarquía, las asimetrías de información entre los directivos o personas pertenecientes a la empresa y las personas ajenas a la empresa tienden a ser mayores durante las primeras etapas de vida, mientras que la capacidad de deuda es menor. Usando la misma clasificación de ciclo de vida de Dickinson (2011), pero utilizando las tres primeras etapas en lugar de las cinco descritas anteriormente, analizamos el apalancamiento objetivo y la velocidad de ajuste a través de las diferentes etapas de vida de la empresa (introducción, crecimiento y madurez). Sobre una muestra de 11.553 observaciones de empresas cotizadas pertenecientes a 14 países europeos (Alemania, Austria, Bélgica, Dinamarca, España, Finlandia, Francia, Grecia, Holanda, Italia, Noruega, Portugal, Suecia y Reino Unido) durante el periodo 2001-2012, y aplicando datos de panel, concretamente la metodología GMM, mostramos que tanto el apalancamiento objetivo como la velocidad de ajuste varían a lo largo de las etapas del ciclo de vida. Específicamente, los resultados indican que las empresas ajustan su ratio objetivo más rápido durante la introducción o madurez que durante el crecimiento. Las empresas que cambian de etapa ajustan su endeudamiento objetivo más despacio y éste depende en mayor medida de la rentabilidad, especialmente cuando la empresa cambia de crecimiento a madurez. Además, se muestra un efecto diferente de determinados factores explicativos del apalancamiento. Específicamente, encontramos que rentabilidad y tangibilidad son los determinantes más estables, mientras que los efectos de las oportunidades de crecimiento y el tamaño cambian de una a otra etapa. Nuestros resultados también muestran una menor velocidad de ajuste en empresas que han cambiado de etapa de vida respecto a aquellas que han permanecido en la misma. Este resultado puede deberse al incremento de la información asimétrica, consecuencia de una intensificación de los costes de transacción. Finalmente, nuestros resultados confirman la existencia de objetivos de deuda a largo plazo, ya que el objetivo del próximo año resulta ser un factor relevante para explicar la deuda actual cuando las empresas cambian de una fase a otra del ciclo de vida.

El último estudio empírico de esta Tesis se recoge en el capítulo 4. En este caso, se examina cómo la compensación de los directivos influye en la estructura de capital de la empresa. De acuerdo con la literatura previa, el diseño de la compensación de ejecutivos contribuye a alinear los intereses de los directivos con los intereses de los accionistas (Coles et al., 2006 y Brockman et al., 2010). Estos incentivos tienen como objetivo reducir los costes de agencia en los posibles conflictos entre directivos y accionistas, alineando el interés de los directivos por invertir en proyectos más arriesgados con el objetivo de los accionistas de maximizar su riqueza. Otro efecto producido por los incentivos de los directivos es el incremento de los costes de agencia relacionados con el problema de sustitución de activos. Es decir, los directivos reemplazan los activos más seguros con otros más arriesgados, transfiriendo la riqueza de los acreedores a los accionistas. Sin embargo, los acreedores entienden los incentivos de riesgo ofrecidos a los directivos a través de los posibles efectos negativos para los acreedores (Brockman et al., 2010). Por lo tanto, los acreedores esperan tomar decisiones para reducir el impacto de estos incentivos en su riqueza. En este capítulo mostramos la importancia del aumento de la concentración de la deuda de la empresa ya que esto facilita el seguimiento de los acreedores. Fundamentalmente, la estructura de la deuda se caracteriza por un aumento cada vez mayor de deudas, proporcionando a los acreedores una potente herramienta de monitorización, que ofrece mayor flexibilidad para controlar a los directivos o gerentes con el mínimo esfuerzo. El marco teórico de este capítulo muestra que los efectos negativos que el diseño de los incentivos a los ejecutivos puede producir en términos del problema de sustitución de activos afecta al grado de concentración de la deuda. Para ello, contamos con dos medidas ampliamente conocidas de remuneración de directivos basadas en los fondos propios, la sensibilidad de los incentivos a la volatilidad de las acciones (Vega) y la sensibilidad de los incentivos al precio de las acciones (Delta). Sobre una muestra de empresas cotizadas estadounidenses durante el periodo 2001-2012 (6.300 observaciones), mostramos cómo un incremento de los incentivos a los directivos que eligen inversiones más arriesgadas para la empresa conlleva una mayor concentración de deuda, de manera que la empresa usa uno o muy pocos tipos de deuda para financiarse. Además, esta tendencia a elegir una mayor concentración de deuda se acentúa cuando nos encontramos en empresas con riesgo más elevado. Asimismo, el análisis empírico demuestra que la especialización y la madurez de la deuda son herramientas alternativas utilizadas por los acreedores para facilitar su control sobre los directivos y para reducir así los costes de sustitución de activos

Por otro lado, indicamos cuáles son los beneficios de la especialización de la deuda en cuanto a la reducción de los costes de agencia y su uso como herramienta por parte de los acreedores para mitigar el problema de sustitución de activos. Se muestra también que sólo en empresas con un bajo nivel de especialización de deuda, un incremento (reducción) en Vega (Delta) reduce el valor de mercado de la deuda. En este último estudio empírico se han usado varias metodologías para contrastar todas las hipótesis: Tobit, Probit, y Mínimos Cuadrados para las principales hipótesis; y la estimación de un sistema de ecuaciones con utilización de retardos para el estudio y control de la posible endogeneidad.

Las contribuciones más importantes de esta Tesis Doctoral para directivos de empresas, académicos y demás grupos de interés son: la demostración de la importancia del ciclo de vida dentro de las políticas financieras de la empresa, y la comprensión de la estructura de deuda como un elemento eficaz para la reducción de determinados costes de agencia.

Como extensión a lo estudiado en esta Tesis Doctoral, futuras investigaciones pueden analizar otros aspectos determinantes de las políticas financieras y de inversión de la empresa que pueden verse afectadas por el ciclo de vida de la empresa. Además, se podría realizar una comparación entre las empresas estadounidenses y las europeas para observar si se presentan diferencias significativas en su comportamiento a lo largo de las etapas de vida de la empresa. Por otro lado, se podría analizar la concentración de deuda, calculada con diferentes tipos de deuda, así como estudiar determinadas peculiaridades de esos tipos de financiación, que podrían condicionar su uso por parte de las empresas. Asimismo, se podría considerar un horizonte temporal más amplio para los análisis y observar si en determinados periodos la concentración de deuda varía respecto al periodo que se ha estudiado en este trabajo.

3. Conclusiones

Al final de cada una de las cuatro partes en que se ha dividido esta Tesis Doctoral, hemos incluido un apartado con las principales conclusiones con el fin de situar los resultados en el contexto de la literatura previa y destacar las principales contribuciones de nuestros análisis tanto teóricos como empíricos a las líneas de investigación de estructura de capital y ciclo de vida. En lugar de repetir cada una de esas explicaciones, en esta sección vamos a recoger el conjunto de resultados de forma esquemática, relacionando las contribuciones con las posibles extensiones futuras de este trabajo de investigación.

En esta sección comenzamos señalando cada una de las principales contribuciones del primer capítulo de esta Tesis.

- En primer lugar, destacamos la incorporación del factor de ciclo de vida a la explicación de la estructura de capital, estudiando el impacto de la etapa de vida en la que se encuentre la empresa en las decisiones financieras. Por otro lado, apenas existe literatura que explique las diferencias de financiación entre las etapas del ciclo de vida de las empresas. Factores como tamaño, edad, rentabilidad, activos tangibles, beneficios retenidos (Bulan y Yan, 2010) o dividendos (DeAngelo et al., 2006), muestran diferente comportamiento en los patrones de apalancamiento cuando las empresas están en la etapa de madurez. Este capítulo extiende la literatura de estructura de capital y ciclo de vida analizando los factores más importantes del apalancamiento a lo largo de las cinco etapas de vida de la empresa (introducción, crecimiento, madurez, reestructuración y declive), además explica cómo y por qué las empresas eligen su combinación de estructura de capital en cada etapa de vida.

- Identificamos qué parte de las teorías de estructura de capital explica la deuda en cada etapa de vida de la empresa, mostrando que la influencia de las teorías cambia a medida que las empresas lo hacen. Frank y Goyal (2009) sugieren que las diferentes teorías de estructura de capital son aplicadas a las empresas en diferentes contextos, siendo cada factor determinante para algunas empresas o en determinadas circunstancias. Concretamente, Frank y Goyal (2003) y Lemmon y Zender (2010) señalan que la teoría de la jerarquía financiera se cumple principalmente en empresas grandes y maduras. Nuestro trabajo extiende la literatura previa, encontrando apoyo para ambas teorías (teoría de la jerarquía y del equilibrio) a lo largo de las etapas de ciclo de vida de la empresa.

- Usamos un modelo innovador (Dickinson, 2011) para distinguir las etapas del ciclo de vida de la empresa. Este modelo considera la capacidad para generar los flujos de caja en diferentes niveles de negocio de la empresa (operativo, de inversión y financiero). Esta Tesis Doctoral es el primer trabajo que usa este modelo para estudiar la estructura de capital de la empresa, aproximando la investigación sobre las decisiones financieras y la investigación sobre el ciclo de vida de la empresa y contribuyendo a ambas líneas de investigación.

- A pesar de que la edad es un criterio habitual para distinguir las fases del ciclo de vida de la empresa, en este trabajo proponemos que algunos elementos de la actividad operativa, de inversión y financiero inducen el cambio de una etapa hacia otra, independientemente de la edad de la empresa, lo que le da un mayor potencial discriminante al modelo que utilizamos. En este capítulo se muestra que el modelo de Dickinson es consistente con la teoría del ciclo de vida aplicándolo a un nuevo marco teórico como es la estructura de capital.

Nuestros resultados tienen importantes implicaciones para los investigadores en cuanto al análisis de la estructura de capital a lo largo de las etapas de vida de la empresa. Los gestores de la empresa podrían estar interesados en la interpretación de nuestros resultados en cuanto a que la estructura de capital es la primera decisión financiera tomada por las empresas, y nuestros resultados muestran que el ciclo de vida de la empresa es un elemento determinante cuando se toma esta decisión. Además, nuestro trabajo podría ayudar a asesores, analistas financieros o inversores a entender mejor los diferentes patrones de comportamiento de la política financiera de la empresa.

El segundo capítulo de esta Tesis Doctoral contribuye a la literatura empírica sobre estructura de capital de diversas formas.

- En primer lugar, explicamos la estructura de capital de las empresas tecnológicas frente a las no tecnológicas a lo largo de las etapas de vida de la empresa, además de observar las diferencias existentes por etapa.

- Por otro lado, usamos las diferencias de oportunidades de crecimiento para discriminar mejor entre las empresas con alta tecnológica y así analizar más exhaustivamente sus estructuras de capital.

- Tal como se hizo en el primer capítulo, nuestro trabajo confirma que el modelo de Dickinson (2011) proporciona a la investigación una nueva aproximación para estimar el ciclo de vida, permitiendo aplicar modelos de estructura de capital dentro de un nuevo marco dinámico, y proporcionando así un análisis mucho más detallado tanto en general como en muestras específicas por sector.

- Este capítulo se añade al pequeño número de trabajos que comparan las estructuras de capital de empresas tecnológicas con las de no tecnológicas. A diferencia de los dos estudios previos más comparables (Hogan y Hutson, 2005; Hyytinen y Pajarinen, 2005), que usan una muestra de pequeñas y medianas empresas, nosotros estudiamos una muestra internacional de empresas cotizadas. Además, los dos trabajos de referencia antes mencionados adoptan un punto de vista estático, sin considerar las fases del ciclo de vida de la empresa.

- El mismo tipo de implicaciones se pueden aducir respecto a los grupos más pequeños identificados de empresas de alta tecnología, después de demostrar que las oportunidades de crecimiento conducen a diferencias significativas en relación con la evolución de la estructura de capital. En resumen, las muestras más homogéneas permiten al investigador explicar mejor los efectos de las teorías de estructura de capital dentro del grupo objeto de estudio.

Nuestros resultados tienen implicaciones relevantes para los investigadores, tanto en la selección de la muestra analizada como en la interpretación de los resultados, ya que éstos dependen de la distribución de la muestra a lo largo las etapas del ciclo de vida. Debido a la evolución en los patrones de comportamiento de la estructura de capital a lo largo del ciclo de vida, una muestra compuesta por empresas en diferentes etapas de su ciclo de vida podría producir resultados no significativos o espúreos, mientras que diferentes muestras podrían producir resultados opuestos, dependiendo de la etapa del ciclo de vida en la que se encuentren la mayoría de las empresas. Usar las muestras por etapa permite al investigador formar grupos homogéneos con respecto al ciclo de vida. De este modo, se evita el efecto compensación de algunos factores determinantes del apalancamiento que evolucionan a lo largo del ciclo de vida y, además, de esta manera se explican algunos efectos opuestos encontrados en la literatura.

En el tercer capítulo, observamos que desde el trascendental trabajo de Fischer et al. (1989), se ha considerado el efecto que el coste de las transacciones tiene sobre los cambios hacia una nueva estructura de capital y sobre la velocidad de ajuste y cómo varía de unas empresas a otras y a lo largo del tiempo (Hovakimian et al., 2001). Los trabajos más recientes han estudiado el apalancamiento objetivo como una función de variables a nivel de empresa (Byoun, 2008; Chang y Dasgupta, 2009; Hovakimian y Li, 2011; Aybar-Arias et al., 2012; Faulkender et al., 2012) o variables a nivel país (Cook y Tang, 2010;

Rubio y Sogorb, 2011), así como en relación con el entorno institucional y legal de las empresas (González y González, 2008; Öztekin y Flannery, 2012). En este capítulo se aportan algunas contribuciones a la literatura existente sobre el apalancamiento objetivo.

- Primero, mostramos que los principales factores determinantes del apalancamiento objetivo, así como la velocidad de ajuste hacia ese apalancamiento objetivo varían a lo largo de las etapas del ciclo de vida, ya que las teorías de estructura de capital desempeñan un papel diferente a lo largo de las etapas de vida de las empresas. Nuestros resultados sugieren que las empresas ajustan su apalancamiento al ratio objetivo más rápido durante la introducción o la madurez que durante el crecimiento.

- Además, observamos efectos diferentes en algunos factores determinantes del endeudamiento objetivo así como una baja velocidad de ajuste en aquellas empresas que han cambiado de etapa. Atribuimos este resultado al incremento de información asimétrica, consecuencia de una intensificación de los costes de transacción en los periodos de cambio.

- Finalmente, contribuimos a la literatura sobre apalancamiento objetivo añadiendo un nuevo factor explicativo: la deuda objetivo del periodo siguiente. Nuestros resultados muestran que el apalancamiento objetivo de la etapa siguiente es un factor relevante para determinar el nivel actual de apalancamiento. Este resultado es consistente con la idea de que las empresas se implican en el ajuste de su endeudamiento cuando están planificando las inversiones con anterioridad a su realización.

Nuestro último análisis empírico, recogido en el cuarto capítulo, aporta algunas contribuciones adicionales a la literatura previa.

- Primero, nuestro estudio extiende la evidencia previa sobre el papel de la compensación de los ejecutivos y su influencia sobre la estructura de capital de la empresa. Varios estudios previos han vinculado los incentivos de los gestores al apalancamiento de las empresas (Berger et al., 1997; Coles et al., 2006), a los tipos de deuda (deuda ordinaria frente a deuda convertible) (Ortiz-Molina, 2007) y a la madurez de los contratos de deuda (Brockman et al., 2010). Este trabajo es el primero en encontrar evidencia de una fuerte relación entre el grado de concentración de la estructura de deuda y la compensación de los directivos, motivada por los costes de agencia de la deuda.

- Además, mostramos evidencia empírica sobre las causas de la especialización de la deuda (Colla et al. (2013)), en concreto, sobre la importancia del control de los acreedores sobre los directivos. Este trabajo indica como la especialización de deuda se podría usar como herramienta para limitar los costes de agencia de la deuda producidos por la forma en que se diseñan los incentivos de los directivos. Además, se concluye que este uso de concentración de deuda es incluso mayor en las empresas más arriesgadas.

- Finalmente, contribuimos a la literatura explicando la percepción que tienen los acreedores sobre el pago de incentivos a los directivos de la empresa. Billet et al. (2010) indican que hay una reacción positiva (negativa) en el precio de los bonos en presencia de un incremento en Delta (Vega). Además, Brockman et al. (2010) y Daniel et al. (2004), entre otros, encuentran un coste de deuda mayor cuando el riesgo de incentivos es mayor. Este capítulo extiende la evidencia proporcionada por el trabajo de Brockman et al. (2010) mostrando que la valoración que hacen los acreedores sobre la relación existente entre los directivos a los gestores y su comportamiento de búsqueda de riesgo conduce a la especialización de deuda como mecanismo alternativo al uso de deuda a corto plazo.

Los principales resultados de este capítulo tienen importantes implicaciones para los gestores, los teneduores de deuda y los tenedores de bonos. La concentración de deuda podría ser una herramienta de uso generalizado para los tenedores de deuda ya que resulta efectivo para limitar los problemas de sustitución de activos.

Por otra parte, el diseño de incentivos de pago a los ejecutivos podría ser determinante en la estructura de la deuda; de ahí que la compensación de los gestores se pueda ver alterada por las estrategias de los acreedores.

En cuanto a las extensiones futuras del trabajo, se podrían señalar las siguientes:

- Sobre el modelo para distinguir las etapas de vida de la empresa. El modelo de Dickinson (2011) ofrece una clara ventaja sobre la mayoría de las aproximaciones generalmente usadas en la literatura previa: la clasificación de la empresa por etapas está basada en los flujos de caja operativos, de inversión y financieros, lo que reúne varios aspectos principales del funcionamiento de la empresa en lugar de tener en cuenta sólo una variable relevante. Sin embargo, el modelo ha mostrado una inestabilidad más alta de la esperada ya que los flujos de caja de la empresa cambian cada día y, por ejemplo, una empresa considerada madura (teniendo en cuenta criterios habituales como su edad y si su negocio es estable en el tiempo) podría pasar por fases de aumento de inversión y elevado crecimiento, al iniciar nuevos proyectos, pero por fases de desinversión y bajo crecimiento, cuando una línea de negocio es menos rentable y está previsto que se cierre. Puede que en el futuro próximo se desarrollen métodos alternativos que también consideren varios aspectos principales del negocio y estrategias de la empresa y en ese caso sería interesante la realización de una comparación entre las diferentes aproximaciones.

- Sobre la muestra. En esta Tesis Doctoral hemos usado datos de diferentes grupos de países. Sin embargo, la distribución de las observaciones empresa-año entre las diferentes etapas, así como otras clasificaciones como tecnológicas/no tecnológicas, alta tecnología/baja tecnología o alta tecnología con altas y bajas oportunidades de crecimiento, ha dificultado la comparación entre los resultados por país o por sector debido al escaso número de observaciones en algunos países o sectores. Como posible extensión podría realizarse una comparación entre países grandes o entre grupos homogéneos de países. En cuanto a la comparación por sector en un determinado país, podríamos considerar como extensión del estudio, un análisis utilizando datos de Estados Unidos y tomar los sectores con mayor número de empresas.

- Sobre la metodología. A pesar de las diversas metodologías aplicadas en este estudio (Fama - MacBeth, datos de panel - GMM, mínimos cuadrados ordinarios, Tobit o Probit), se podrían probar otras metodologías apropiadas para este estudio para comprobar la solidez de los resultados, tales como estimaciones por efectos fijos o aleatorios. Además, podría ser interesante considerar los errores estándar de clúster basados en los efectos de la industria, del año o de la empresa, para obtener resultados más robustos. Debido al uso de diferentes grupos de empresas (por etapa o por sector) a lo largo de los diferentes capítulos de la Tesis Doctoral, se podrían realizar otros análisis para probar la significatividad de las diferencias entre los grupos. Finalmente, debido a la posible aparición de endogeneidad en los estudios sobre estructura de capital, podría ser interesante establecer controles adicionales con otras metodologías como variables instrumentales y sistemas de ecuaciones, para la endogeneidad, y el test de Granger, para la causalidad.

- Sobre la medida de especialización de deuda. El análisis del último capítulo de esta Tesis Doctoral puede ser extendido usando una medida diferente de concentración de deuda. Existen más clasificaciones de la estructura de deuda que se pueden emplear para calcular la medida de especialización de deuda. Por ejemplo, podría enfocarse no sólo en la intensidad de la concentración de deuda sino en los tipos de deuda que constituyen una elevada proporción en la financiación externa de las empresas, ya que ciertas características de los tipos de deuda podrían condicionar su uso por parte de las empresas.