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Instituto Universitário de Lisboa

ESSAYS ON DEBT MATURITY

Luis Miguel da Silva Laureano

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Supervisor:

Prof. Doutor Miguel Luís Sousa Almeida Ferreira, Universidade Nova de Lisboa

Faculdade de Economia

Co-Supervisor:

Prof. Doutor José Dias Curto, ISCTE-IUL Business School

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Abstract

This dissertation consists of three major empirical studies about debt maturity following two introductory chapters describing the data used and also the most relevant theoretical and empirical work in the existent literature.

In the first empirical study we examine the debt maturity trend from 1980 to 2004 for US firms and identify if the changes in the debt maturity determinants over time help to explain that same trend. We find evidence of a statistically significant downtrend. Unconstrained firms have significantly higher average debt maturity than constrained ones. We model the average debt maturity using the major determinants found in the most relevant literature. The results give mixed support to most of the existing theories. Opposite to the agency costs theory, we find that firms with higher growth options have higher average debt maturity ratios. Being a regulated firm yields more long term debt and larger firms have higher debt maturity in their capital structures. The signaling hypothesis finds weak support in the results. We provide evidence that our model significantly overestimates the average debt maturity and that the changes occurred over time in the firm characteristics used in the model do not explain the overall trend observed in the debt maturity ratio.

In the second empirical study we investigate the relation between debt maturity and macroeconomic conditions for US industrial firms from 1974 to 2004. We find some evidence that firms hold more short-term debt during economic recessions. However, the results obtained in the financially constrained and unconstrained subsamples are statistically weakly significant. At the firm specific level we find no support for the agency costs hypothesis. In contrast, our results show a positive relation between long-term debt and growth options with a stronger economic impact in unconstrained firms. We find a statistically significant positive relation between size and debt maturity and no evidence that being a regulated firm has any influence on debt maturity choice. We also find no evidence that supports the signaling mechanism in which firms use their debt maturity choice to signal their quality to the market. The matching principle receives good support in our study, particularly from constrained firms. We find that firms with higher effective tax rates borrow more long-term.

The third empirical study focuses on using different approaches to provide support to previous results and to find additional evidence in explaining the choice of the debt maturity level. Through logistic regression we find that larger firms with more growing opportunities and asset maturity and that are subject to higher tax rates are more likely to have higher average debt maturity in their capital structure. Using cluster analysis we are able to clearly identify two distinct groups. We examine the debt maturity in each group and find good support to the previous findings. Using classification trees we find similar results to those obtained using logistic regression while using regression trees yields the indication that the largest firms and those with highest asset maturity are expected to have, on average, the highest debt maturity ratios.

JEL Classification: G30, G32

Keywords: Debt maturity, capital structure, financial constraints, macroeconomic conditions

Resumo

Esta dissertação é constituída por três estudos empíricos sobre a maturidade da dívida antecedidos por dois capítulos introdutórios onde são descritas as bases de dados e as variáveis utilizadas, assim como as principais teorias e estudos empíricos já existentes na literatura.

No primeiro estudo analisa-se a tendência na maturidade da dívida, desde 1980 até 2004, para empresas norte-americanas e identifica-se se as alterações nos determinantes da maturidade da dívida ao longo do tempo permitem explicar essa tendência. Observa-se que a tendência de descida é estatisticamente significativa e que as empresas sem constrangimento financeiro possuem, em média, maturidade da dívida mais elevada que as empresas com constrangimento financeiro. Cria-se um modelo para explicar a maturidade da dívida utilizando os principais determinantes encontrados na literatura mais relevante. Os resultados são mistos quanto ao suporte das teorias existentes. Ao contrário da teoria dos custos de agência, verifica-se que empresas com maiores oportunidades de crescimento possuem, em média, rácios superiores de maturidade da dívida. Empresas regulamentadas têm mais dívida de longo prazo e empresas de maior dimensão possuem dívida de maior maturidade na sua estrutura de capital. Empresas sujeitas a taxas de imposto superiores possuem dívida de maior maturidade, assim como empresas com maior maturidade nos seus activos. Os resultados não suportam a teoria de sinalização ao mercado. Apresenta-se também evidência empírica que o modelo utilizado sobrestima significativamente a média da maturidade da dívida e que as alterações ocorridas ao longo do tempo nas características das empresas utilizadas no modelo não são suficientes para explicar a tendência observada no rácio de maturidade da dívida.

No segundo estudo empírico investiga-se a relação entre a maturidade da dívida e as condições macroeconómicas para empresas industriais norte-americanas desde 1974 a 2004. Apresenta-se evidência empírica que as empresas utilizam mais dívida de curto-prazo durante recessões económicas. No entanto, os resultados obtidos para empresas com constrangimento financeiro são fracos. Ao nível da empresa não se encontra suporte para a hipótese dos custos de agência. Por outro lado, os resultados identificam uma relação positiva entre dívida de longo-prazo e oportunidades de crescimento, existindo maior impacte económico nas empresas sem constrangimento financeiro. Observa-se uma relação positiva entre a dimensão da empresa e a maturidade da dívida mas não detecta-se nenhuma evidência empírica de que uma empresa regulamentada tenha alguma influência significativa na escolha da maturidade da dívida. Também não se encontra suporte para a teoria de sinalização em que as empresas utilizam a escolha da maturidade da dívida para dar indicações ao mercado sobre a sua qualidade. O princípio de que as empresas tentam acompanhar a maturidade dos seus activos com semelhante maturidade no financiamento dos mesmos é fortemente suportada pelos resultados. Verifica-se ainda que empresas sujeitas a maiores taxas de imposto financiam-se mais no longo-prazo.

No terceiro estudo empírico utilizam-se diferentes técnicas estatísticas e de *data mining* de forma a dar suporte aos resultados obtidos anteriormente e ainda a procurar novas evidências que permitam compreender melhor a escolha do nível da maturidade da dívida. Através da regressão logística foi possível detectar que empresas de maior dimensão, com maiores oportunidades de crescimento e maior maturidade dos activos e sujeitas a taxas de imposto superiores, têm maior probabilidade de possuírem maturidade da dívida superior à média. Recorrendo à análise de clusters identifica-se de forma distinta dois grupos homogéneos de empresas. Examina-se a maturidade da dívida em ambos e encontra-se um bom suporte nos resultados obtidos previamente. Através de árvores de classificação obtém-se resultados similares aos obtidos através da regressão logística, enquanto através de árvores de regressão verifica-se que as empresas de maior dimensão e com maior maturidade dos seus activos tenderão a ter, em média, rácios de maturidade da dívida mais elevados.

Classificação JEL: G30, G32

Palavras-chave: Maturidade da dívida, estrutura de capital, constrangimento financeiro, condições macroeconómicas

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Chapter 1 Introduction

In order to finance their activities or future investments, firms need to decide where to obtain the necessary funds. When borrowing debt, whether bank or market debt, the maturity choice is a must. Priority has been given to the study of capital structure and to the factors that influence managements' decisions in having more or less debt in their firm's capital structure. The choice between equity and debt in financing new projects and in maximizing the company's value has been studied since the early work of Modigliani and Miller (1958, 1963). Some of the most relevant studies were mainly presented during the seventies: (Donaldson, 1961), (Kraus and Litzenberger, 1973), (Stiglitz, 1974), (Jensen and Meckling, 1976), (Miller, 1977), (Ross, 1977) and (Myers, 1977). More recently, the contributions of Titman and Wessels (1988), Fischer *et al.* (1989), Shyam-Sunder and Myers (1999) and Hovakimian *et al.* (2001) have significantly improved the knowledge about capital structure choice.

The first theoretical work with references to the debt maturity choice appeared in the late fifties, early sixties and seventies (Modigliani and Miller, 1958, 1963) and (Stiglitz, 1974)). In the late eighties and during the nineties, academics presented the first empirical studies regarding debt maturity ((Titman and Wessels, 1988), (Mitchell, 1991), (Barclay and Smith, 1995), (Stohs and Mauer, 1996) and (Guedes and Opler, 1996)). However, most of the existing work focus only on firm-specific variables in trying to explain the debt maturity choice. There are few studies on the impact of macroeconomic conditions on the choice of debt maturity as the main subject. Some research work focus on the relation between debt maturity and specific time events or specific country development stages, but to the best of our knowledge, none in the US: accessing the 1997 Asian crisis ((Wiwattanakantang *et al.,* 2003), (Charumilind *et al.,* 2006), (Guerrero and Parker, 2006) and (Deesomsak *et al.,* 2009)); focusing on developing or emerging countries and on the financial globalization ((Bussiere *et al.,* 2006), (Guerrero, 2007) and (Schmukler and Vesperoni, 2001)).

Several theories have been presented through the years to help determine the choice of debt maturity: the irrelevant hypothesis, the "matching" between debt maturity and asset maturity proposition, the agency costs model, the credit and liquidity risk model, the asymmetric information and signaling model and the tax based model. Next we succinctly describe these theories and present the results from some relevant empirical studies.

The irrelevant hypothesis was first introduced by Modigliani and Miller (1958) and later developed by Stiglitz (1974). The authors argue that in the presence of perfect capital markets, both the capital structure and the maturity of debt are irrelevant to the firm's value. Stiglitz, however, recognized that market imperfections would interfere with his theorem.

The "matching" between debt maturity and assets maturity was first studied by Grove (1974), Morris (1976) and Myers (1977). The authors argue that firms try to match their assets maturity with their debt maturity in order to minimize the risk of owning assets which generate return in different periods than those from the debt obligations. Stohs and Mauer (1996) also defend this idea. Other authors also suggest that firms synchronize their assets and debt maturities, although for different reasons: to reduce agency costs ((Myers, 1977), (Stove *et al.,* 1980) and (Van Auken and Holman, 1995)) or to reduce liquidity risk (Diamond, 1991a). This theory has been strongly supported throughout several empirical work (i.e. (Guedes and Opler, 1996), (Stohs and Mauer, 1996), (Ozkan, 2000)[1] and (Danisevská, 2002)).

Myers (1977) argues that the underinvestment problem and the agency costs associated may be mitigated by shortening the debt maturity. Increasing growing options in a firm's investment opportunities set increases the agency costs (Myers and Majluf, 1984) and (Mauer and Ott, 2000)). Several other solutions to this problem have been presented by Myers (1977), Barnea *et al.* (1980), Ho and Singer (1982), Stulz and Johnson (1985). The conflict between stockholders and creditors have higher probability of occurring in small firms (Smith and Warner, 1979) and are also more relevant in this riskier firms ((Petit and Singer, 1985) and Whited, 1992)). Empirical research has found mix results. Barclay and Smith (1995) find that, in average, firms with more growth options have more short-term debt. Guedes and Opler (1996) and Ozkan (2000) show consistent results with the theory. However, Stohs and Mauer (1996) and Danisevská (2002) find no support for the prediction that more growth options in the firm's investment opportunity set leads to a relative increase in short-term debt. Johnson (2003) finds strong support for Myers (1977) prediction and suggests that firms trade-off the costs of the

[1] The sample uses only UK firms.

underinvestment problems against the costs of illiquidity risk when choosing short-term debt. Antoniou *et al.* (2006) find no support for the theory and even find contradictory results[2].

In the credit and liquidity risk model firms face the risk of not being able to refinance their debt. Diamond (1991a) presents a model relating liquidity risk with debt maturity. In this model, high quality firms choose to issue short-term debt while low quality firms also borrow short-term because they have no other choice. Only medium-risk firms tend to issue long-term debt. Sharpe (1991) and Titman (1992) follow the ideas presented by Diamond. Rizzi (1994) also suggests that firms with inferior ratings are often kept away from issuing long-term debt. Houston and Venkatarman (1994) argue that firms use multiple debt issues with different maturities and not simply short or long-term debt. They show that the debt financing costs can be mitigated by issuing the proper mix of short and long-term debt. Stohs and Mauer (1996) and Scherr and Hulburt (2001)[3] find strong support for Diamond's (1991a) prediction of a nonmonotonic relation between debt maturity and bond rating. To a lesser degree a similar result is presented by Barclay and Smith (1995). Guedes and Opler (1996) find that large firms with investment grade credit rating typically issue debt on the short or long end of the maturity spectrum while firms with speculative grade credit ratings borrow on the middle of the spectrum. Elyasiani *et al.* (2002) find inconsistent results for the expected effect of liquidation risk and debt maturity while Berger *et al.* (2005)[4] find consistent results for low-risk firms but conflicting results for high-risk firms.

In the asymmetric information and signaling framework, the first relevant paper was presented by Flannery (1986). The author concludes that firms with favorable private information signal their projects quality issuing short-term debt. This idea is reinforced in O'Hara (1992). Firms with unfavorable information issue long-term debt while firms facing the absence of information asymmetries are likely to be indifferent in choosing debt maturity. Kale and Noe (1990) and Titman (1992) extend Flannery's work. The former validating Flannery's model in the absence of transaction costs and the latter adding interest rate uncertainty. Goswani *et al.*

[2] Their cross-country study comprises French, German and UK firms.

[3] Their sample focus only on small US firms taken from the National Survey of Small Business Finances (NSSBF) database.

[4] Their study relies on bank loans to small businesses.

(1995) study the maturity structure as a function of the temporal distribution of asymmetric information. They conclude that firms issue long term debt when the asymmetry is related to long-term cash-flows uncertainty. When the distribution of informational asymmetry is randomly spread between the short and long-term, firms issue short-term debt. Barclay and Smith (1995) find evidence that firms with larger information asymmetries issue more short-term debt. Little evidence is found for the prediction that firms use their debt structure for signaling purposes. Wittenberg-Moerman (2007)[5] finds similar results to Barclay and Smith (1995). Cuñat (1999)[6] finds no evidence for the signaling usage of debt maturity structure. Berger *et al.* (2005) find that a reduction in informational asymmetries in low-risk firms increases their average maturity. Danisevská's (2002) work on asymmetric information finds no support to Goswani *et al.* (1995) model. The author finds no relation between long-term asymmetric information and debt maturity. However, firms with both high short-term asymmetric information and good news use significantly more short-term debt.

When studying the relation between taxes and debt maturity, Kane *et al.* (1985) develop a continuous time model and conclude that debt maturity increases as the effective tax rate decreases. In the same year, Brick and Ravid (1985) argue that firms employ more long-term debt in order to maximize firm value, when the term structure of interest rates has a positive slope. However, Lewis (1990) contradicts this argument stating that taxes have no impact in the firm's value when optimal leverage and debt maturity structure are determined simultaneously. Brick and Ravid (1991) extend their previous work and demonstrate that firms tend to issue long-term debt when interest rates are uncertain, despite having a positive, flat or a negative slope. Barclay and Smith (1995) find no support for Brick and Ravid's (1985) tax hypothesis, however they argue that the results are broadly consistent with Lewis's (1990). Stohs and Mauer (1996) find an inverse relation between the effective tax rate and debt maturity, thus supporting Kane *et al.*

[5] The author observes syndicated loans and uses the bid-ask spread in the secondary market as a measure for informational asymmetries.

[6] The study uses a sample of Spanish firms.

(1985) model. Guedes and Opler (1996) and Cai *et al.* (2008)[7] find no significant impact of taxes on debt maturity.

This dissertation is devoted to the analysis of the debt maturity choice. We contribute to the existing literature in three major ways: we analyze the existence of a time trend in the debt maturity held by firms and identify the factors that generate that trend; we introduce macroeconomic determinants to explain the debt maturity choice and analyze its behavior during expansions and recessions periods; we apply econometric techniques different from those usually applied in the recent empirical studies to generate new information and to provide robustness to the existing results.

In the first empirical study, presented in Chapter 4, our main motivation is to investigate how the debt maturity structure of US firms has evolved from 1980 to 2004. After identifying the existent trend in the debt maturity ratio for the full sample, we proceed with the same analysis for several subsamples of financially constrained and unconstrained firms. Next, using the most relevant determinants found in the literature, we build a model to explain the debt maturity of firms during the sample period. Finally, using the 1980s as a reference period, we investigate if the firm-specific determinants of the debt maturity have changed over time and if they are responsible for the observed trend. Some of the methodologies used follow the work of Bates *et al.* (2009).

In the second study (Chapter 5) we use a sample of 10,159 non-financial US firms over the period from 1974 to 2004. We focus on how macroeconomic conditions impact on debt maturity decisions. The main contribution of this work relies in the fact that we focus not only at the firm-specific level but also at the macroeconomic level in determining the maturity structure of debt held by firms. Furthermore, we test whether there are differences in the debt maturity structure of financially constrained and unconstrained firms with emphasis on the macroeconomic conditions. We expect that during economic recessions firms shorten their debt maturity structure, particularly financially constrained firms. We also expect strong support to the maturity matching hypothesis between debt and assets, with a stronger economic impact on financially constrained firms. We classify firms as financially constrained and unconstrained

[7] The sample included in the study are all Chinese listed firms.

according to five criteria: growth potential, size, a constrain dummy variable, bond rating and commercial paper rating. To proxy for macroeconomic cycles and business conditions we use proven variables, namely, the two year equity market return, the two year corporate growth and the commercial paper spread. The work by Korajczyk and Levy (2003) constituted an additional motivation to our analysis.

Chapter 6 documents the last empirical study. Our main motivation is to give robustness to our previous findings and to the existing literature using different econometric techniques than those previously applied. We also aim at obtaining additional information regarding the debt maturity choice by firms. We use the same data sample as in Chapter 5. Using firm-specific and macroeconomic determinants and applying logistic regression and classification trees, we classify firms into high or low debt maturity firms, according to the debt maturity level being above or below average. Using cluster analysis and the debt maturity firm-specific determinants as discriminating factors, we identify homogeneous groups in our data. We identify the type of firms and analyze the debt maturity in each group. Finally, we perform a regression tree and identify the most relevant determinants that influence the debt maturity level held by firms. The results obtained from the cluster analysis and from the regression tree are then compared with those obtained in the previous two studies and also with the existing literature.

The remaining chapters of this dissertation are organized as follows. Chapter 2 succinctly describes the most relevant theoretical studies and empirical work. In Chapter 3 we offer a description of the main data samples and variables used throughout our empirical studies. Chapter 4 analyses the debt maturity trend in the last decades and investigates if the changes occurred in the debt maturity determinants during that period are responsible for the observed trend. In Chapter 5 we study the impact of macroeconomic conditions on the debt maturity choice with emphasis on financially constrained and unconstrained firms. In Chapter 6 we take a different approach in the study of the debt maturity of firms using logistic regression, cluster analysis and decision trees techniques. The final Chapter summarizes the conclusions.

Chapter 2 Reference theoretical and empirical work

In this chapter we provide some of the most relevant theoretical and empirical work on debt maturity. We present a synthetic description of each theory followed by several empirical studies and the major results reported. Overall, this chapter serves the purpose of identifying the background on debt maturity studies and help us define the framework of our investigation.

2.1 Reference theoretical studies

2.1.1 The irrelevance hypothesis

The irrelevance in financing decisions, where the debt maturity choice is included, had its origins in the work of Modigliani and Miller (1958). The authors implicit demonstrate that, in the presence of perfect markets, the maturity of debt is irrelevant to the companies' value. The perfect markets hypothesis assume absence of taxes, absence of transaction costs, absence of agency costs, individuals have homogeneous expectancies relative to future investments and information is freely accessible and it is equally available to all market intervenients.

In one of the propositions presented, the authors argue that the market value of a company is independent of its capital structure and that the decision concerning the maturity of debt never leads to changes in the company's value, becoming irrelevant.

The initial work of Modigliani and Miller was later developed by Stiglitz (1974). Stiglitz explicitly demonstrates the irrelevance of debt maturity. Once again, some of markets' imperfections are eliminated. In his first theorem, he makes four assumptions: there are no bankruptcies; existence of a perfect market for bonds with all maturities; all real decisions have been made by companies and the existence of a general equilibrium.

Under these assumptions, Stiglitz proves the existence of another general equilibrium in which a company may change one or several financing policies but the firm value and the value of all bonds with different maturities remain the same. In this new equilibrium investors change their bond and stock portfolio in order to balance the changes made by firms of which they own securities. If, for example, a firm decides to issue more five year bonds than three year bonds, then investors have the ability to adjust their portfolios to counterbalance that decision.

Theoretical studies about the determinants of debt maturity structure evolved with the introduction of market imperfections. The theories developed embrace different issues like adverse selection, market signaling, taxes, moral hazard and others. These theories are explained next.

2.1.2 "Matching" between debt maturity and asset maturity

Grove (1974), Morris (1976) and Myers (1977) were the first to study the impact of assets maturity on debt maturity. Morris argues that firms try to match their assets maturity with their debt maturity. This way they can reduce the risk of upcoming cash-flows fall short to pay interests and the debt itself. This idea is also defended by Stohs and Mauer (1996). Owning debt with maturity inferior to assets maturity may be risky because the latter may not generate enough return to face debt obligations. On the other hand, owning debt with maturity greater than the maturity of assets may also be risky, because debt obligations must be fulfilled when the assets in place no longer generate return, leading to the need of new investments. To reduce the risk mentioned, firms try to match both maturities.

Myers (1977) argues that firms synchronize their debt payments with the declining value of their assets, reducing agency costs. This way, firms with medium and long term assets can have more long-term debt in their capital structure. Maturity matching allows firms to lengthen their debt maturity without increasing agency costs. This idea can also be found in Stowe *et al.* (1980) and in Van Auken and Holman (1995).

Diamond (1991a) argues that liquidity risk can be reduced by financing long-term assets with long-term capital. Other explanations for matching the maturity of assets and debt can be found in the work of Goswami *et al.* (1995) and in Hart and Moore (1994).

2.1.3 Agency costs

Agency costs result from any costs deriving from conflict of interest between two parties (Jensen and Meckling, 1976). The agency costs of debt may influence its maturity. According to Myers (1977), agency costs may occur in what the author named the under-investment problem. When projects are financed with debt, it is possible that managers will not take on projects with positive NPV. When firms have large debt, the residual claims may be low and the investment return may benefit almost exclusively the creditors. Stockholders, knowing they may not get a fair return are reluctant to embrace in future investments which reduce the firms' growing opportunities.

The value of a company comes from the value of assets and from the present value of its growing opportunities, which can be looked at like options to follow future investments. If these options are not exercised, they expire, and the value of the firm diminishes. In an attempt to solve this problem the author suggests that the maturity of debt should be reduced in order to end before the maturity of investment options. Long-term debt can then be obtained through the continuous renewing of short-term debt. The growing options of a firm affect the choice of debt maturity due to this underinvestment problem ((Myers and Majluf, 1984), (Mauer and Ott, 2000) and (Childs *et al.,* 2005)).

Other solutions to this problem can arise from using call and sinking funds provisions ((Barnea *et al.*, 1980) and (Ho and Singer, 1982)), by reducing the level of debt in the capital structure or by including covenants in debt contracts (Myers, 1977). Stulz and Johnson (1985) suggest that by issuing high priority fixed claims, firms can limit the transfer of value from stockholders to bondholders.

Barnea *et al.* (1980) point out the agency costs that result from the replacement of assets where mangers invest in riskier assets than those that were initially agreed. Short-term debt can reduce the costs because it is less sensitive to variations in projects' cash-flows when compared to long-term debt. To Smith and Warner (1979) the probability of conflict between stockholders and creditors in small firms is higher. Petit and Singer (1985) argue that agency issues are directly related to debt financing and are more relevant in smaller firms. Whited (1992) shows that small firms are usually set aside from long-term debt markets because the proportion of their assets as collateral to future investment opportunities are low.

Hart and Moore (1995) show that is possible that firms choose an optimal amount of debt, senior and junior, in a way that counterbalances managers incentive to invest in less profitable projects. The authors agree that the choice of debt maturity can reduce the agency conflict between managers and stockholders. Berlin and Loeys (1988) on the other hand conclude that banks do better monitoring firms than other creditors, thus reducing agency problems and the need for shorter debt maturity.

Leland and Toft (1996) examine the optimum level of capital structure when it is possible to determine the amount of debt and its maturity. In their model the optimal amount of debt depends on the maturity of debt and it is lower when firms finance in the short-term. The maturity of debt suggests a trade-off between tax benefits and financing costs, including agency costs. In the presence of agency costs, riskier firms should issue more short-term debt and additionally reduce the amount of debt.

2.1.4 Credit and liquidity risk

Every firm with debt faces the risk of not being able to refinance that debt. The risk of bankruptcy may influence the debt maturity choice (Sarkar, 1999). This way, financing with debt of longer maturities may prove beneficial under this reality. Stiglitz and Weiss (1981), like Diamond (1991a), argue that although liquidity risk may influence firms to give priority to long-term debt, some may be unable to get it because the return demanded by investors for the long-term risk may lead to the acceptance of riskier and low quality projects.

Diamond (1991a) presents a model relating liquidity risk with short-term financing. Like Diamond, Sharpe (1991) and Titman (1992) agree that bad news may occur prior to the refinancing date regarding the debt holder, which could lead to the deterioration of financing conditions or even to the end of the contract. Diamond defines liquidity risk as the risk of the debt holder having to inefficiently liquidate his assets, once access to new debt has been denied.

Firms with favorable inside information about their future earnings will prefer short-term debt because this will lead to better refinancing conditions. Short-term financing means higher liquidity risk. According to Diamond, firms with higher ratings prefer short-term debt for the liquidity risk is low. Firms with inferior ratings prefer long-term debt reducing the refinancing risk. Firms with very low ratings use short-term debt because the chances of generating sufficient cash-flows to face long-term debt are weak.

According to Rizzi (1994), firms with inferior ratings are often incapable of issuing long-term debt. Those who can, usually face unfavorable credit conditions and access it trough financial intermediaries.

2.1.5 Asymmetric information and signaling

Every time both parties in a contract have different information we are under asymmetric information. Managers often have more information about future financial conditions then future or current creditors. Flannery (1986), after analyzing asymmetric information relation with projects quality suggests that a firm with favorable private information signals its quality issuing short-term debt. According to the author, this happens because high quality projects are less undervalued in the short-term than in the long-term.

There is a separating equilibrium when firms with low quality projects cannot mimic the behavior of firms with good projects, because the short-term refinancing costs may exceed the overvaluation of short-term debt of the lesser firm. Firms with unfavorable private information issue long-term debt. Firms with no asymmetric information problems are likely to be indifferent in the choice of debt maturity. O'Hara (1992) reinforces the idea that in the presence of asymmetric information about the quality of assets in place, a firm may signal the assets quality by issuing short-term debt.

Kale and Noe (1990) show that the separating equilibrium presented by Flannery (1986) remains valid with the inexistence of transaction costs. Similar results are obtained if the nature of the released information is correlated through time. Titman (1992) verifies that it is possible to obtain a long-term pooling equilibrium if we consider financial distress costs and if the interest rates are uncertain.

Goswani *et al.* (1995) introduce the temporal distribution of asymmetric information. Their model suggests that differences in the degree of asymmetric information in the short or long-term cash-flows influence the choice of debt maturity. When we have a high degree of uncertainty in the long-term cash-flows firms issue long-term debt with limited coupons and dividend payouts. In the presence of more asymmetric information in the short-term cash-flows and of refinancing risk, firms then issue long-term debt without limited coupons and payout dividends. When there is asymmetric information in the short and long-term cash-flows then firms issue short-term debt.

Other studies about asymmetric information and debt maturity can also be found in (Diamond, 1991b, 1993), (Robbins and Schatzberg, 1986), (Goswami, 2000), (Kanatas and Qi, 2001) and (Lensink and Pham, 2006).

2.1.6 Taxes

Since the early work of Modigliani and Miller (1963) that the influence of taxes in the capital structure choice has been taken into account. In fact, financing through debt and not with capital has a clear advantage: the financial costs of debt are tax deductible while dividend payouts are not. Despite this advantage in the usage of debt, authors like Baxter (1967), Kraus and Litzenberger (1973) and Scott (1976) show that a higher degree of debt financing may lead to a higher probability of bankruptcy, while the costs of bankruptcy may exceed the tax advantage of debt.

Miller (1977) introduced personal taxes in the study of debt but Kane *et al.* (1985) were the first to develop a model in continuous time that allowed the endogenous determination of optimal debt maturity including taxes, corporate and personal. They conclude that the optimal debt maturity rises as the debt fiscal advantages decline. This inverse relation exists as a way to assure that the remaining debt fiscal benefit deducting the bankruptcy costs is not lower than the amortization of the flotation costs.

Brick and Ravid (1985) establish a generic platform relating taxes and debt maturity. Since firms may enter into default on debt payments, the expected value of the tax benefits depends on the debt maturity structure when the interest rates are not flat. The authors demonstrate that the firm market value rises with long-term debt when the interest rate curve is upward sloping.

Long-term debt is also ideal in stochastic interest rate environment (Brick and Ravid, 1991). The reason for this relation comes from the fact that the debt fiscal benefits are higher with a higher proportion of debt payments allocated to the long-term. When the interest rate is downward sloping the conclusion is symmetric and the higher the marginal tax rate the more relevant are the impacts mentioned.

Brick and Ravid (1985) make the assumption that the debt level is established before the debt maturity. Meanwhile, Lewis (1990) argues that taxes have no relevance in the choice of debt maturity if we are to assume that the optimal level of leverage and its maturity are simultaneously defined. Lewis points out that the choice of debt maturity is irrelevant when the presence of taxes is the only market imperfection.

The choice of debt maturity may also be influenced by taxes because the choice of long-term debt instead of short-term debt represents a tax-timing option, resulting from the possibility of the firm to re-acquire and issue new debt ((Mauer and Lewellen, 1987), (Emery *et al.,* 1988) and Brick and Palmon, 1992)).

2.1.7 Other theories

Kane *et al.* (1985) argue that the optimal debt maturity is negatively related with volatility in the firm value. The maturity rises as the volatility declines. Wiggins (1990) shows that higher volatility in the firm value may lead to longer debt maturities. Leland (1994) and Ravid (1996) confront these two different perspectives. Ravid states that the opposite implications derive from different tax related assumptions. Ju and Ou-Yang (2006) develop a model to jointly determine the optimal capital structure and debt maturity under stochastic interest rates. They find that the long run mean of the interest rate is key in determining the optimal capital structure and debt maturity. They also find that the interest rate volatility and the correlation between the interest rate and a firm assets' value are important factors in the debt maturity determination.

Harford *et al.* (2007) examine the impact of weaker or stronger boards in the debt maturity choice. They find that stronger boards force the firm to hold more short-term debt and that the impact of the board in the short-term debt usage is likely to be stronger in low-growth firms. Datta *et al.* (2005) find that managerial stock ownership plays an important role in determining debt maturity. They find a significant and robust inverse relation between the two. They also argue that managerial stock ownership influences the relation between credit quality and debt maturity and between growth opportunities and debt maturity. Emery (2001) develops a model in which debt maturity depends on the demand for a firm's product. The author finds that firms use short-term debt to match their assets' and liabilities' maturities and to increase the amplitudes of the firms' investment, production, and sales cycles. Aarstol (2000) finds an inverse relation between private debt maturity and inflation.

2.2 Empirical Studies

The first studies with results regarding debt maturity came as a byproduct of studies about capital structure. Titman and Wessels (1988) focus their study in the usage of short-term or long-term debt in capital structure decisions. The study uses data from US companies, from 1974 to 1982. The authors conclude that smaller firms have a higher proportion of short-term debt in their capital structures. The reason presented is that firms could minimize the costs associated with the issuing of long-term debt.

Mitchell (1987) tries to explain why the short-term debt over long-term debt ratio had an increase in the economy between 1952 and 1982. Mitchell finds out the existence of a positive correlation between the increase in the ratio and the increase in interest rates uncertainty.

Mitchell (1991) analyses the time to maturity of public corporate bonds. The author finds that a firm has more probability to became indebted in the short-term (less than 20 years) if it is not part of the NYSE or the S&P400 index. According to the author, this conclusion is consistent with the theory that when firms have a high degree of asymmetric information they tend to choose short-term debt in order to minimize the costs of adverse selection. Firms of lesser size and with convertible debt have more probability of issuing short-term debt (less than 10 years). Mitchell finds no support for the matching theory.

Despite the fact that the three empirical works presented already give some pointers about debt maturity choosing, the main subject of these studies was never the debt maturity. Next we present the most relevant empirical work with debt maturity as the main theme.

Barclay and Smith (1995) use a sample of US firms taken from COMPUSTAT and CRSP. They have a total of 39,949 firm-year observations, between 1974 and 1992. The authors conclude that smaller firms have most of their debt with maturities less than three years. This conclusion supports the theory that firms with higher growing opportunities issue short-term debt. The result is consistent with Myers (1977), where firms use debt maturity as a way to control the conflicts of interest between bondholders and stockholders. Other results give strong support to the contracting costs hypotheses: firms with little growing opportunities, large or regulated, have more long term capital in their capital structure. Little evidence is found about the usage of debt maturity as a signaling tool. No support is found for the influence of taxes in debt maturity.

Stohs and Mauer (1996) use information from 328 large firms, from several industries and publicly traded. The sample period is from 1980 to 1989. The results show that large firms with lesser risk and long duration assets use long-term debt. The authors also conclude that the maturity of debt is inversely related to unexpected news about firms' results and with the effective tax rate. As to the inverse relation between growing opportunities and debt maturity they find mixed evidence. The authors find a strong support to the relation between debt maturity and the bond rating level. Firms with bond ratings very high or very low, use short-term debt.

Guedes and Opler (1996) examine the determinants of the term to maturity for new debt issues and not for existing debt, like the two previous studies. The bond and notes issues occurred between 1983 and 1992, with a total of 7,369 observations. The main finding of the study is that large firms with investment grade credit ratings borrow at the extremes of the maturity spectrum, either short-term (less than 10 years) or long-term (more than 30 years). Firms with speculative grade credit ratings issue debt in the middle of the maturity spectrum. The authors find that firms with above average growing expectations tend to issue short-term debt. They also find support for Myers (1977) matching theory where firms have a tendency to match the maturity of assets with debt maturity. The results obtained also give support for the theory in Diamond (1991a), where firms with higher ratings are mostly present in the short-term debt market and that riskier firms try to avoid issuing short-term debt due to the non refinancing risk.

As reference, the empirical work of Elyasiani *et al.* (2002) and Jun and Jen (2003) also study the main determinants of the debt maturity structure of US firms.

Ozkan (2000) studies 429 non financial British firms. The sample period goes from 1983 to 1996. The results support the theory that firms with higher growing opportunities have more short-term debt and that there is a negative impact between firm size and debt maturity structure. The matching theory is also supported by the results. In the study little support is found for the signaling theory and the inverse relation between taxes and debt maturity is not confirmed. The author points out that the results indicate that firms have long-term debt target ratios and that the adjustment to those values is made relatively quickly, what may suggest that the default costs are significant. Similar results are found in Ozkan (2002).

Like Ozkan (2000, 2002), some recent studies have focused on explaining the debt maturity choice in other European countries and in the Asian region. European countries include Spain ((Cuñat, 1999) and (García-Teruel and Martínez-Solano, 2009)), Italy (Magri, 2006), Turkey (Arslan and Karan, 2006) and Ukraine ((Antonenko *et al.,* 2006) and (Stephan *et al.,* 2007)). Asian countries include Thailand (Guerrero and Parker, 2006), South-Korea (Guerrero, 2007)), China (Cai *et al.,* 2008) and Japan (Cai *et al.,* 1999).

Demirgüç-Kunt and Maksimovic (1999) argue that the debt maturity choice is not only determined by firm-specific factors but also by country-specific factors such as economic conditions and institutional environment. They examine the debt maturity in 30 countries from 1980-1991. They find significant differences between developed and developing countries and also between firms of different sizes. They conclude that inflation is negatively related to the use of long-term debt. Several other cross-country studies have been conducted in recent years. Some focus on emerging economies, in particular in the Asian/Pacific region and in South America, such as (Schmukler and Vesperoni, 2001), (Schmukler and Vesperoni, 2006) and (Deesomsak *et al.,* 2009); Others on the confrontation between developed and developing countries, like (Sorge and Zhang, 2007) and (Fan *et al.,* 2006), or on SME European firms (Hernández-Cánovas and Koëter-Kant, 2006). Antoniou *et al.* (2006) examine the determinants of debt maturity structure in French, German and British firms. Their results suggest that the debt maturity structure of firms is determined not only by firm-specific factors but also by the countries' financial and institutional system. Their results support the major debt maturity theories for the British firms. However, they find mixed results for the German and French firms.

Scherr and Hulburt (2001), unlike the previous studies, focused their study in small firms. The sample was taken from the National Survey of Small Business Finances (NSSBF) for the years 1987 and 1993. The total number of observations was 3,404 and 4,637 respectively for each year. Each firm could not have more than 500 employees. Despite the differences between small and large firms, the authors found that some of the determinants of debt maturity were the same. Strong evidence was reported that the default risk, asset maturity and capital structure influence the debt maturity choice. Firms with high or low default risk have more short-term debt than firms with intermediate risk. The authors did not find the influence of fiscal regimes or the firm's level of asymmetric information on the determination of debt maturity. Although theoretical smaller companies have more growing opportunities, in this study no evidence was found on the relation between the firms growing potential and debt maturity. According to the authors, the reason for this relation may be in the sample itself. Heyman *et al.* (2003) study debt maturity in small Belgium firms while Pindado *et al.* (2006) focus their study on small Portuguese firms. Ortiz-Molina and Penas (2008) investigate the determinants of the maturity of lines of credit to US small businesses.

In addition to the previous presented work, some recent research has focused on specific factors that contribute to determine the debt maturity structure of firms. Danisevská (2002) analyses the effect of asymmetric information between managers and investors in debt maturity while Berger *et al.* (2005) test the implications of Flannery's (1986) and Diamond's (1991a) models concerning the effects of risk and asymmetric information in determining debt maturity. Lately, new directions have been taken by researchers: the study of the debt maturity from the lender's perspective has been followed in the recent work of Sorge and Zhang (2007), Magri (2006) and Trà and Lensink (2006); Harford *et al.* (2007) focus their attention on the role of the boards in making financing decisions that discipline managers and find that stronger boards will force the firm to hold more debt and more short-term debt, and that the effect of the board on the use of short-term debt is likely to be stronger among low-growth firms than among high-growth firms; Datta *et al.* (2005) study the role of managerial stock ownership in determining corporate debt maturity and find a significant inverse relation between the two, also suggesting that the relation between credit quality and debt maturity and growth opportunities and debt maturity are influenced by managerial stock ownership.

The development of empirical studies on the impact of macroeconomic conditions in corporate decisions has been small. In recent years though, some studies were developed. The most relevant for our work is Korajczyk and Levy (2003). The authors study the impact of macroeconomic conditions and financial constraints in the choice of capital structure. The model defines the capital structure target as a function of macroeconomic conditions and firm-specific variables. The main results lead to the conclusion that target leverage is counter-cyclical for the financially unconstrained firms but pro-cyclical for the constrained ones. The authors also conclude that macroeconomic conditions have a negative significant impact on the choice of debt issuing in financially unconstrained firms but less in constrained firms. The conclusions about macroeconomic conditions are consistent with the pecking order theory, in particular in the financially unconstrained group of firms. The firm-specific variables are consistent not only with the pecking order theory but also with the tradeoff theory.

Chapter 3 Data samples and variables description

In this chapter we provide a full description of the most relevant samples and variables used throughout our empirical studies (presented in the next three chapters). A synthetic description is also given in each empirical work for reference.

3.1 Sample and subsamples

For our empirical work we use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. Like Opler *et al.* (1999) or Korajczyk and Levy (2003), we exclude from the sample financial firms (SIC[8] one digit code 6) and utilities (SIC two digits code 49). Financial and utilities firms are excluded because they tend to have significant different capital structures, due to regulation factors, than the other firms included in the sample. American Depositary Receipts (ADRs) and firms designated as pre-FASB[9] are also excluded. Firms may enter or leave the panel during the sample period. Our dependent and independent variables were cleaned by eliminating all outliers at the top and bottom 5% level.

We use two main sample periods: from 1980-2004 in our first empirical study and from 1974-2004 in the other two. From 1980-2004 we have 9,367 different firms with a total of 45,943 firms-year observations while from 1974-2004 we find 10,159 firms with a total of 56,768 firm-year observations.

In Chapter 4 and in Chapter 5 we split our sample in six subsamples. The subsamples are divided in financially constrained and unconstrained firms according to three criteria:

- In the first criterion, a firm is considered to be financially constrained (unconstrained) if it has a Tobin's Q ratio higher (lower) than one (Korajczyk and Levy, 2003). *Tobins_Q* is defined as the sum of the market value of equity ($Data\#25 \times Data\#199$ [10]) and the book value of debt ($Data\#9 + Data\#34$), divided by the book value of assets ($Data\#6$). The

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[8] SIC stands for Standard Industrial Classification. A complete codes list can be consulted at http://www.sec.gov/info/edgar/siccodes.htm.

[9] FASB stands for Financial Accounting Standards Board. Their website link is http://www.fasb.org/home.

[10] Data item number in COMPUSTAT database.

authors argument for using this criterion is that firms with more investment opportunities are usually riskier and younger, leading to greater exposure to market conditions;

- In the second criterion a financially constrained (unconstrained) firm is the one which has an assets' book value ($Data\#6$) in the first quartile (last quartile), by year. The argument presented is that small firms are usually more vulnerable to market imperfections due to being typically younger and less known (Almeida et al, 2004);
- In the third criterion we use a constrain dummy (*Cdummy*) that is set to one if: (1) the firm does not have a net repurchase of debt ($Data\#9_t - Data\#9_{t-1} \geq 0$) or equity ($Data\#115 \leq 0$) and does not pay dividends within the year ($Data\#21 \leq 0$), and (2) the firm's Tobin's Q is greater than one. The constrain dummy is set to zero and the firm is labeled as financially unconstrained if it does not meet these two conditions (Korajczyk and Levy, 2003).

In Chapter 5 we introduce two new criteria to split our sample in four additional subsamples of financially constrained and unconstrained firms:

- In the first criterion a firm is considered to be financially constrained (unconstrained) if it has leverage and no (has) bond rating associated with it (Almeida *et al.*, 2004). Using this criterion, the firm's credit quality is in line with the market's opinion;
- The last criterion is similar to the fourth, but now we use the commercial paper rating instead of the bond rating (Almeida *et al.*, 2004).

3.2 Dependent variable

The dependent variable is the debt maturity. Previous empirical studies consider different approaches to measure debt maturity. The incremental approach, which uses the maturity of the issued bonds as a proxy for debt maturity, has been followed, for example, by Guedes and Opler (1986). The balance sheet approach uses the debt percentage that matures after a certain period ((Barclay and Smith, 1995) and (Titman and Wessels, 1988)) or the weighted averaged of all debt obligations ((Stohs and Mauer, 1996) and (Scherr and Hulburt, 2001)) as proxy for debt maturity. Our approach is similar to the one followed by Barclay and Smith (1995). We measure debt maturity (*Debt_maturity*) as the proportion of the firm's total debt ($Data\#9 + Data\#34$) that has a maturity of more than three years ($Data\#9 - Data\#91 - Data\#92$).

3.3 Independent firm-specific variables

At the firm-specific level we use proven variables applied in relevant empirical work: the market-to-book ratio, the firm size, a regulation dummy, abnormal earnings, the asset maturity and the effective tax rate.

As suggested by Smith and Watts (1992) and Gaver and Gaver (1993), we use the market-to-book ratio (*Market_to_book*) as a measure of growth options. Firms with market values greater than their book values are expected to have profitable investment opportunities. The ratio is computed as market value of assets, divided by the book value of assets ($Data\#6$). The market value of assets is determined by the book value of assets, less the book value of equity, plus the market value of equity ($Data\#6 - Data\#60 + Data\#25 \times Data\#199$). We use the market value of equity at the end of each calendar year.

The firm size (*Real_size*) is calculated as the natural logarithm of the book value of assets ($Data\#6$) inflated into 2004 dollars using the Consumer Price Index (CPI)[11].

We use a dummy variable for industries that have been subject to entry and price regulation during a given period (*Regulation_dummy*). This variable is similar to that employed by Barclay and Smith (1995) and Opler *et al.* (1999). Regulated industries include railroads (SIC code 4011) through 1980, trucking (SIC codes 4210, 4213) through 1980, airlines (SIC code 4512) through 1978 and telecommunications (SIC codes 4812, 4813) through 1982.

Similar to previous empirical studies ((Barclay and Smith, 1995) and (Stohs and Mauer, 1996) among others) we use future abnormal earnings (*Abnormal_earnings*) as a proxy for firm quality. Abnormal earnings in time *t* is measured as the difference in earnings per share ($Data\#58$) between time *t* and *t-1*, divided by time *t-1* share price ($Data\#199$).

[11] Data obtained from the United States Department of Labor – Bureau of Labor Statistics website: http://stats.bls.gov/cpi/home.htm.

As proxies for asset maturity (*Asset_maturity*), and following Stohs and Mauer (1996), we use the property, plant and equipment (*Data* #7) to depreciation and amortization expense (*Data* #14) ratio.

We calculate the effective tax rate (*Taxes*) as the ratio between income taxes (*Data* #16) and pretax income (*Data* #170).

3.4 Independent macroeconomic variables

To proxy for macroeconomic and business conditions we use three variables: the two-year equity market return (*2_year_equity_market_return*), the two-year aggregate domestic nonfarm and nonfinancial corporate growth (*2_year_corporate_growth*) and the commercial paper spread (*Commercial_paper_spread*). We use these variables following the empirical work by Korajczyk and Levy (2003).

The *2_year_equity_market_return* is calculated from the CRSP (Center for Research in Security Prices[12]) value-weighted index of stocks traded on NYSE, AMEX and NASDAQ. The *2_year_corporate_growth* is computed using quarterly data from the Flow of Funds. The *Commercial_paper_spread* is obtained from the difference between the annualized rate on the three-month commercial paper and the three-month Treasury Bill[13].

All macroeconomic variables are lagged six months and matched to the end of the year of the firm-specific variables.

3.5 Summary descriptive statistics

Table 3-1 shows the main descriptive statistics for the variables from 1974 to 2004. Firms have, in average, 45.15%[14] of their debt maturing in more than three years. The median value is

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[12] The website link is http://www.crsp.com/.

[13] The Flow of Funds, the commercial paper spread rate and the Treasury Bill rate were obtained from the Board of Governors of the Federal Reserve System's web page at http://www.federalreserve.gov/releases. From 1974 to August 1997 the commercial paper rate is a rate on short-term negotiable promissory notes issued by financial an nonfinancial firms with AA bond ratings. After August 1997 the rate is on commercial paper issued by nonfinancial firms only.

[14] Although most values in the several outputs are presented as proportions, in the text sometimes is used the percentage value instead for better understanding.

slightly higher with a value of 49.31%. When we compare these results with those reported in Table 3-2 for the 1980-2004 period we find a decrease of almost 2.5 percentage points (pp henceforth) in the average value and of more than 4 pp in the median. This implies that during the seventies the average debt maturity was higher than for the remaining sample period, thus providing some indication of a downward trend. The standard deviation practically remains the same, with a value of 0.31, despite the decrease in the mean.

Turning our focus to the independent variables, and comparing both sample periods, we find slight changes in the average and median values. In the last 25 years firms have, in average, higher market-to-book ratios than for the full sample period (0.9348 and 0.9123 respectively). We also find an average increase in the equity market return, from 28.34% for the full sample period to 32.61% from 1980 to 2004. For the remaining variables we observe a drop in all values when we compare the full sample period and only the last 25 years. In average, in the most recent years firms are subject to inferior tax rates (less 2.35 pp), have lower assets maturity (half a percentage point), generate less abnormal earnings (0.8% compared to 1.18%) and are smaller with almost less 15 million dollars in book value of assets[15]. The commercial paper spread remains practically unchanged while the two year corporate growth decreases about 4 pp, in average, from the 1974-2004 to the 1980-2004 period.

In Table 3-3 and Table 3-4 we present the Pearson linear correlation coefficients for all our continuous variables for both sample periods. With some few exceptions, particularly in the *Commercial_paper_spread* variable, the correlations are statistically significant at the 0.01 level or at the 0.05 level. Overall, we do not find any correlations near ± 1. The strongest correlation is -0.577 between the *Real_size* variable and the *Market_to_book* variable for the 1974-2004 sample period, which represents a tendency to decrease the market-to-book value given an increase in the firm value.

Considering the relation between the dependent variable and all the firm-specific variables we find a negative weak correlation to the *Market_to_book* variable and also to the *Abnormal_earnings* variable (although the last is not statistically significant at the 0.1 level). All other three variables have a positive correlation to the debt maturity ratio with emphasis on the

[15] Recall that the *Real_size* variable is equal to the natural logarithm of the book value of assets in 2004 dollars.

firm size. The correlation between the *Debt_maturity* variable and all macroeconomic variables is quite low (less than 0.05). The direction of these relations is not clear with changes on all three variables from the 1974-2004 period to the last 25 years.

The correlation coefficients between the firm-specific and macroeconomic variables are quite low, with values inferior to 0.08 in all cases. Among the macroeconomic variables the correlation is also low with a top value of 0.133 between the *2_year_corporate_growth* and the *Commercial_paper_spread*.

Table 3-1 – Descriptive statistics of firm-specific variables and macroeconomic variables for the sample period of 1974-2004.

The table presents the main descriptive statistics of firm-specific variables and macroeconomic variables for the 1974-2004 sample of US-based publicity traded firms. *Debt_maturity* is defined as the proportion of debt that matures in more than three years. The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets inflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. The *2_year_equity_market_return* is the return on CRSP value weighted index of stocks traded on NYSE, AMEX, and Nasdaq. The *2_year_corporate_growth* is computed using the annual data from the Flow of Funds. The *Commercial_paper_spread* is the difference between the annualized rate on the three-month commercial paper and the three-month Treasury bill. N is the number of non missing observations in the sample for each variable.

	1974-2004 Period					
Variables	**Mean**	**Median**	**Std. Dev.**	**Min.**	**Max.**	**n**
Debt_maturity	0.4515	0.4931	0.3053	0.0000	0.9493	56,768
Market_to_book	0.9123	0.7741	0.4826	0.4559	4.2690	56,768
Taxes	0.3164	0.3750	0.1631	-0.0549	0.5332	56,768
Asset_maturity	12.9388	12.7247	4.9793	3.5020	26.4203	56,768
Abnormal_earnings	0.0118	0.0067	0.1124	-0.3537	0.5095	56,768
Real_size	5.0697	5.0145	1.6791	1.4472	8.7249	56,768
2_year_equity_market_return	0.2834	0.2637	0.2508	-0.4237	0.8113	56,768
2_year_corporate_growth	0.1566	0.1505	0.2828	-0.5370	1.5573	56,768
Commercial_paper_spread	0.0039	0.0036	0.0031	0.0074	0.0173	56,768

Table 3-2 – Descriptive statistics of firm-specific variables and macroeconomic variables for the sample period of 1980-2004.

The table presents the main descriptive statistics of firm-specific variables and macroeconomic variables for the 1980-2004 sample of US-based publicity traded firms. *Debt_maturity* is defined as the proportion of debt that matures in more than three years. The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets inflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. The *2_year_equity_market_return* is the return on CRSP value weighted index of stocks traded on NYSE, AMEX, and Nasdaq. The *2_year_corporate_growth* is computed using the annual data from the Flow of Funds. The *Commercial_paper_spread* is the difference between the annualized rate on the three-month commercial paper and the three-month Treasury bill. N is the number of non missing observations in the sample for each variable.

	1980-2004 Period					
Variables	**Mean**	**Median**	**Std. Dev.**	**Min.**	**Max.**	**n**
Debt_maturity	0.4273	0.4517	0.3103	0.0000	0.9493	45,943
Market_to_book	0.9348	0.7806	0.5134	0.4559	4.2690	45,943
Taxes	0.2929	0.3601	0.1646	-0.0549	0.5332	45,943
Asset_maturity	12.4396	12.1250	4.9707	3.5020	26.4203	45,943
Abnormal_earnings	0.0080	0.0042	0.1124	-0.3537	0.5095	45,943
Real_size	4.9741	4.8946	1.7252	1.4472	8.7249	45,943
2_year_equity_market_return	0.3261	0.3192	0.2359	-0.4191	0.7819	45,943
2_year_corporate_growth	0.1182	0.0833	0.2893	-0.5370	1.5573	45,943
Commercial_paper_spread	0.0036	0.0031	0.0030	-0.0074	0.0173	45,943

Table 3-3 - Correlation matrix of firm-specific variables and macroeconomic variables for the full sample: 1974-2004 COMPUSTAT firms.

The table presents Pearson correlation coefficients of firm-specific variables and macroeconomic variables for the 1974-2004 sample of US-based publicity traded firms. *Debt_maturity* is defined as the proportion of debt that matures in more than three years. The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets inflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. The *2_year_equity_market_return* is the return on CRSP value weighted index of stocks traded on NYSE, AMEX, and Nasdaq. The *2_year_corporate_growth* is computed using the annual data from the Flow of Funds. The *Commercial_paper_spread* is the difference between the annualized rate on the three-month commercial paper and the three-month Treasury bill.

	1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**
1. Debt_maturity	1								
2. *Market_to_book*	-.228**	1							
3. *Taxes*	.240**	-.358**	1						
4. *Asset_maturity*	.292**	-.165**	.172**	1					
5. *Abnormal_earnings*	-.001	.037**	.046**	.020**	1				
6. *Real_size*	.431**	-.577**	.307**	.225**	-.030**	1			
7. *2_year_equity_market_return*	-.016**	.048**	-.064**	-.073**	-.027**	-.064**	1		
8. *Commercial_paper_spread*	.006	-.002	.023**	-.002	-.003	.005	-.098**	1	
9. *2_year_corporate_growth*	.018**	-.028**	.027**	.031**	.049**	.023**	-.121**	.133**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3-4 - Correlation matrix of firm-specific variables and macroeconomic variables for the full sample: 1980-2004 COMPUSTAT firms.

The table presents Pearson correlation coefficients of firm-specific variables and macroeconomic variables for the 1980-2004 sample of US-based publicity traded firms. *Debt_maturity* is defined as the proportion of debt that matures in more than three years. The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets inflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. The *2_year_equity_market_return* is the return on CRSP value weighted index of stocks traded on NYSE, AMEX, and Nasdaq. The *2_year_corporate_growth* is computed using the annual data from the Flow of Funds. The *Commercial_paper_spread* is the difference between the annualized rate on the three-month commercial paper and the three-month Treasury bill.

	1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**
1. *Debt_maturity*	1								
2. *Market_to_book*	$-.221^{**}$	1							
3. *Taxes*	$.223^{**}$	$-.368^{**}$	1						
4. *Asset_maturity*	$.276^{**}$	$-.144^{**}$	$.140^{**}$	1					
5. *Abnormal_earnings*	$-.016^{**}$	$.043^{**}$	$.014^{**}$	.008	1				
6. *Real_size*	$.432^{**}$	$-.573^{**}$	$.318^{**}$	$.199^{**}$	$-.039^{**}$	1			
7. *2_year_equity_market_return*	$.042^{**}$	$.013^{**}$	$.057^{**}$	.000	$-.011^{*}$	$-.027^{**}$	1		
8. *Commercial_paper_spread*	$-.016^{**}$	$.016^{**}$	$-.032^{**}$	$-.047^{**}$	$-.016^{**}$	$-.021^{**}$	$.100^{**}$	1	
9. *2_year_corporate_growth*	$-.032^{**}$	-.001	$-.068^{**}$	$-.031^{**}$	$.037^{**}$	$-.012^{*}$	$-.036^{**}$	$.083^{**}$	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Chapter 4 Debt maturity trend analysis

4.1 Introduction

Considerable attention has been given to the study of the debt maturity and its importance in the capital structure of firms. As presented in Chapter 2, in the last decades substantial empirical work has been developed. Most of these studies are devoted to determine the factors that influence the debt maturity choice.

With the several studies performed in this chapter we aim at improving the overall knowledge about the debt maturity of firms, not only seeking support for the existent theories but also exploring different approaches. Our first motivation is to investigate how the debt maturity structure of US firms has evolved from 1980 to 2004. After documenting a significant downward trend in the debt maturity ratio for the full sample, we proceed with the same analysis for several subsamples of financially constrained and unconstrained firms. Statistical evidence of a negative trend is found in all subsamples. We also find that financially unconstrained firms have more long term debt on their capital structures than constrained ones.

Next, using the most relevant determinants found in the literature, we build a model to explain the debt maturity of firms during the same sample period. Our results give mix support to the existing theories. Consistent with Diamond (1991a), firms with more growth options in their investment opportunity sets have more long-term debt. This result is contradictory to Myers (1977) agency cost hypothesis. We find no evidence that firms use their debt maturity to signal information to the market. We find strong support that firms match their asset maturity with their debt maturity and also that larger firms have more long-term debt in their capital structures. Contradictory to Kane *et al.* (1985), we find that firms subject to higher tax rates have higher debt maturity ratios. Finally, we find some support that being a regulated firm increases the proportion of long-term debt.

Our next motivation is to see if the firm-specific determinants of the debt maturity have changed over time and if they are responsible for the observed trend. Using the 1980s as reference period we find substantial differences in the determinants in the next decade and also in the 2000-2004 period. Important conclusions are drawn as we find that the debt maturity model for the 1980s significantly overestimates the out of the sample for the 1990-2004 period, denoting a poor predictive power. Also, though we find significant changes in the debt maturity determinants over time, these changes are not sufficient in explaining the significant downward trend in the average debt maturity.

The chapter proceeds as follows. In Section 4.2 we briefly describe the data and samples used. Section 4.3 presents the adopted methodology. In Section 4.4 we report the empirical results and finally we offer a brief summary of the chapter including the main conclusions in Section 4.5.

4.2 Data and samples[16]

In our study we use a large sample of US firms. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digits code 49), ADRs and firms designated as pre-FASB are also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period. Our dependent and independent variables were cleaned by eliminating all outliers at the top and bottom 5% level.

In order to better understand the debt maturity trend, we split our sample in six subsamples. The subsamples are divided in financially constrained and unconstrained firms according to three criteria:

- The first criterion is size. A financially constrained (unconstrained) firm is the one which has an assets' book value in the first quartile (last quartile), by year;
- In the second criterion we use a constrain dummy (*Cdummy*) that is set to one if: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one. The constrain dummy is set to zero and the firm is labeled as financially unconstrained if it does not meet these two conditions;
- In the third criterion, a firm is considered to be financially constrained (unconstrained) if it has a Tobin's Q ratio (*Tobins_Q*) higher (lower) than one. *Tobins_Q* is defined as the

[16] For a thorough description see Chapter 3.

sum of the market value of equity and the book value of debt, divided by the book value of assets.

The dependent variable is the debt maturity ratio (*Debt_maturity*). We measure *Debt_maturity* as the proportion of the firm's total debt that has a maturity of more than three years. As independent variables we only use the firm-specific ones:

- We use the market-to-book ratio (*Market_to_book*) as a measure of growth options. Firms with market values greater than their book values are expected to have profitable investment opportunities. The ratio is computed as market value of assets, divided by the book value of assets. The market value of assets is determined by the book value of assets, less the book value of equity, plus the market value of equity. We use the market value of equity at the end of each calendar year;
- The firm size (*Real_size*) is calculated as the natural logarithm of the book value of assets inflated into 2004 dollars using the CPI;
- We use a dummy variable for industries that have been subject to entry and price regulation during a given period (*Regulation_dummy*). Regulated industries include railroads (SIC code 4011) through 1980, trucking (SIC codes 4210, 4213) through 1980, airlines (SIC code 4512) through 1978 and telecommunications (SIC codes 4812, 4813) through 1982;
- Future abnormal earnings (*Abnormal_earnings*) are used as a proxy for firm quality. *Abnormal_earnings* in time t is measured as the difference in earnings per share between time t and $t-1$, divided by time $t-1$ share price;
- As proxies for asset maturity (*Asset_maturity*) we use the property, plant and equipment to depreciation and amortization expense ratio;
- We calculate the effective tax rate (*Taxes*) as the ratio between income taxes and pretax income.

4.3 Methodology

Our first step is to show the existence of a time trend in the average debt maturity ratio. We do this in three ways: in Table 4-2 through Table 4-5 we show the evolution of some descriptive statistics for the whole sample and subsamples through the 25 years span; in Figure 4-1 through

Figure 4-4 we graphically depict the average and median evolution during our sample period, helping to visualize the trend in our dependent variable for the sample and subsamples; finally in Table 4-6 we show the regressions models of average and median debt maturity ratios on a constant and time from 1980-2004, again for the whole sample and subsamples. For financially constrained and unconstrained subsamples we perform average and median comparison by criteria (Table 4-7). To do so we run t tests to analyze the difference in means and use the Wilcoxon rank-sum (Mann-Whitney) test to analyze the differences in the distributions of the medians.

Next we investigate if the decrease in the average debt maturity ratio can be explained by firm characteristics and whether these firm characteristics impact changes over time. We use four different multiple linear regression models as shown in Table 4-8. To properly identify the best model to estimate we first look for the existence of firms individual effects. We use the Breusch and Pagan (1980) test to choose between the pooled regression and the random effects regression. The pooled regression hypothesis was rejected [$\chi^2(1) = 20{,}008.65$; $p<0.001$]. We then use the Hausman (1978) test to choose between the random effects regression and the fixed effects regression. The random effects hypothesis was rejected [$\chi^2(6) = 387.27$; $p<0.001$]. In Models 1-3 we run fixed effects regressions while in Model 4 we run random effects regression in order to introduce industry dummies. In all models the independent variables are observed in the same fiscal year as the dependent variable. All regressions include robust standard errors adjusted for clusters by firm.

In Model 1 we include all the independent variables as determinants of the firms' debt maturity. In Models 2, 3 and 4 we introduce two dummy variables: the *1990s_dummy* takes a value of one for years 1990 through 1999 and the *2000s_dummy* takes a value of one from the year 2000 and thereafter. These two indicators will allow to better determine if the decrease in the debt maturity ratio is influenced by exogenous factors unrelated to the firm characteristics used. In Models 3 and 4 we determine if the impact of firm characteristics on the debt maturity ratio changes over time. Using the 80s as the comparison base we then allow the independent variables slopes to change for the 90s decade and for the years 2000 through 2004.

The next step aims at attributing the decrease in debt maturity to specific firm characteristics. As a starting point, we first estimate fixed effects regression using all the independent variables for the years 1980 through 1989. The estimates obtained are reported in Table 4-9. We then calculate the differences between the actual debt maturity values and the values predicted by the fixed effects model for the years 1990 through 2004 for the sample and all subsamples. The results are showed in Table 4-10, Table 4-11 and Table 4-12. The t-statistics on the differences in the averages of the actual *versus* predicted debt maturity ratios are also reported. As a robustness test we follow the same methodology using the Fama and MacBeth (1973) (FM henceforth) two steps regression. The results are reported in Table 4-13 through Table 4-16. Finally, using fixed effects regression, we observe the changes in the determinants of the debt maturity from the 1980-1989 period to the 1990-2004 period and their different impact on the dependent variable. We then analyze the differences between the two sample periods and associate them to the existing trend of the debt maturity ratio. The results are obtained for the whole sample and subsamples and are reported in Table 4-17 through Table 4-20. As a robustness test we follow the same procedure using the FM regression. The results are shown in **Table 4-21** through Table 4-24.

4.4 Empirical Results

4.4.1 Debt maturity trend Analysis

From 1980 to 2004 we observe a substantial decrease in the average debt maturity ratio for the whole sample. The descriptive statistics reported in Table 4-2 are very clear, the average debt maturity has fallen from 54.33% in 1980 to 38.62% in 2004. A decrease of almost 16 pp corresponding to an approximately 29% drop. The number of firms has also been decreasing, in particular after the year 1997. While the average debt maturity has been falling through the years, the yearly dispersion of values, reported by the standard deviation, has been progressively increasing. The number of firms in 2004 is almost 41% lower than in 1980 but the standard deviation has increased approximately 7 pp. The minimum debt maturity ratio value for all the years, though not reported, is always zero while the maximum value lies between 94% and 95%.

In Figure 4-1 we can observe the downtrend in the average debt maturity, with the exception of the latest years where the trend inverses after the year 2000. This inversion follows a severe drop from 1999 to 2000. The median trend follows the average trend. However, while in the earlier years the median value is higher than the average (in 1980 is more than 6 pp higher), denoting the possible existence of downward extreme values, in the latter years the opposite occurs though the difference tends to diminish (less than 2 pp in 2004).

In Table 4-3 we find the average and median debt maturity ratio for financially constrained and unconstrained subsamples by size, over the sample period. In the financially constrained group (small firms) the downward trend is very significant. In 2004 the average debt maturity ratio is almost half of the 1980's value. For the financially unconstrained firms (large firms) the decrease in the debt maturity ratio, although existent, is quite small (less than 10% in the 25 year period). Observing the median for the two groups we find two completely distinct behaviors. The downward trend found in the average debt maturity of the financially constrained firms is more significant when using the median. From an initial value of 42.54% in 1980 we find a median value in 2004 of only 5.3%, a substantial drop of 86%. The difference between the average and median values in the latter years strongly suggests the existence of firms with debt maturity ratios substantially higher than the firms pattern.

In the financially unconstrained firms (large firms) the median follows a similar behavior as the average, with values slightly higher. Figure 4-2 graphically shows the average and median evolution over the sample period. It is important to notice the discrepancy in debt maturity values between the two groups: financially unconstrained firms have much higher debt maturity than the constrained firms. In 1980, for the large firms, the debt maturing in more than three years was in average 65.53%, while for the small firms was 40.35% (38% less). In 2004 the average debt maturity of the financially constrained group is roughly one third of the unconstrained group (66% less).

The information in Table 4-4 is similar to Table 4-3, but now the criterion used to separate financially constrained from financially unconstrained firms is the constrain dummy (*Cdummy*). One of the biggest differences between the two groups derives from the number of observations. According to the criterion used there were only identified 5,413 financially constrained firms against a total of 40,530 unconstrained firms. The trend evolution is similar in both groups with a drop of about 15 pp in the average debt maturity value. However, though to a lesser degree, the financially constrained group, like in the previous criterion, has less debt maturity than the unconstrained one. The difference between the two is less than 9 pp in 2004. Once again, the median trend is negative and more significant than the average trend, in particular in the financially constrained group where the drop surpassed 55% while in the unconstrained firms the median fell by 36%.

In Figure 4-3 we visually follow the average and median trend for both groups, from 1980 to 2004. The median for the financially constrained firms has an irregular behavior with some sharp ups and downs, in particular in the latest years. The median for the financially unconstrained firms has a smooth evolution closely following the average. The difference between the average and median is higher in the constrained firms: in 2004 the median is about 9 pp lower than the average, once again suggesting the existence of untypical firms with high debt maturity ratios.

Table 4-5 shows the average and median values for the financially constrained and unconstrained subsamples firms according to the Tobin's Q criterion. Again, we find a negative trend in the debt maturity ratio, independent of the subsample. Both subsamples are quite similar, even in the number of firms. Despite the fact that financially unconstrained firms usually have slightly higher debt maturity ratios, the difference for the constrained group is small. In 1980 the difference between the two is 4 pp and this value is cut in half when we reach 2004. The decrease in the debt maturity ratios is also very similar: 14 pp in the financially constrained firms and about 16 pp in the unconstrained ones. The downward trend is also observable in the median for both groups (see Figure 4-4). With one or two exceptions, the medians run smoothly along with the averages.

In Table 4-6 we model the average and median debt maturity ratio against a time (year) variable to statistically test the existence of a time trend. This is done to the whole sample and to all subsamples. The results obtained are quite expressive. For the whole sample, and for the average maturity, we report a coefficient on the time trend of -0.0073 with strong statistical significance (a t-value of -10.98). The regression's adjusted R^2 is 0.83, suggesting that time alone explains 83% of the debt maturity ratio's variance.

For the subsamples we also find strong results on the existence of a time trend. According to size, the financially constrained firm's regression presents more robust values than the unconstrained one: the time trend coefficient is more negative and more significant, while the R^2 is almost the double. In the opposite direction, the regressions of financially constrained and unconstrained firms according to the constrain dummy criterion show a stronger time trend in the unconstrained group. The time trend coefficient is -0.0076 with a corresponding t-value of -11.34. The R^2 is higher than 0.84. Conversely, the R^2 for the constrained group is only 0.45, and the time coefficient, though negative (-0.0042), is less statistically significant (t-value of -4.57). According to the Tobin's Q criterion, both subsamples show strong regressions results with negative and statistically significant coefficients. Both R^2 are near the 0.8 value.

Using the median maturity instead of the average maturity yields quite similar results with one relevant exception: the unconstrained subsample according to size (large firms). In fact, the time trend coefficient, though slightly negative, losses statistically significance at the 0.01 and 0.05 levels and the adjusted R^2 is just 0.08. Thus, the downward trend is not clear in this case.

4.4.2 Financially constrained and unconstrained debt maturity trend comparison

From the previous data analyzed we can easily observe that the three criteria used to distinguish firms with and without financial constrains lead to different results. The difference in the number of observations that can be found in each group is quite significant: for the financially constrained group we have a total of 11,495 firms (by size), 5,413 (by constrain dummy) and 23,808 (for the Tobin's Q); for the unconstrained group we find 11,495 firms (by size), 40,530 (by constrain dummy) and 22,135 (by Tobin's Q). As we can see, the different criteria applied identify different groups of firms.

Despite the differences found we can safely say that the average debt maturity is higher for the financially unconstrained firms (see Figure 4-2 through Figure 4-4). We can also state that the major difference in the average debt maturity occurs in the size criterion and that the difference using the Tobin's Q criterion is very small. To statistically test the difference in the average debt ratios between the financially constrained and unconstrained firms we perform t-tests and report the results in Table 4-7. The results give support to our findings, the difference between the two groups is statistically much more significant in the size criterion than in the constrain dummy criterion and is not statistically significant (even at the 0.1 level) in the Tobin's Q criterion. Since from previous analysis we sometimes found substantial differences between the average and the median debt maturity, we also perform the Wilcoxon rank-sum (Mann-Whitney) test to analyze differences in the distributions of the medians of financially constrained and unconstrained firms. The results, also reported in Table 4-7, provide the same conclusions previously drawn from the average analysis.

From Table 4-6 we can conclude that the trend existent in the debt maturity ratio is negative and statistically significant in the constrained and unconstrained groups whatever the criteria used. In the constrained group the impact of a new year in the debt maturity ratio is stronger in the size criterion where each year decreases the debt maturity by 0.78%, in average, while in the constrain dummy criterion, where the impact is the lowest, the yearly drop is only 0.42%. Observing the statistical significance of the time coefficient, the Tobin's Q presents the highest (in absolute terms) t-statistic value of -9.67 for a yearly influence in debt maturity ratio of -0.67%, in average.

In the financially unconstrained group the impact in the debt maturity for each year is almost the same, in average, when using the constrain dummy criterion (-0.76%) or the Tobin's Q criterion (-0.75%). Using the size criterion, the negative influence in the debt maturity for the time variable is less than one third of the others criteria: only 0.23%, in average. All time coefficients are statistically significant at the 0.01 level though the value of the t-statistic for the size criterion (-4.11) is much lower than for the constrain dummy criterion and the Tobin's Q criterion (-11.34 and -10.36 respectively).

The main conclusions drawn from the trend analysis of the average debt maturity, among the same type of firms using different criteria, can also be obtained from the observation of the trend analysis of the median of the debt maturity. However, one exception must be pointed out, we find a weak result for the existence of a negative time trend in the median debt maturity ratio for the unconstrained sample according to the size criterion. The time coefficient, though negative, is statistically significant only at the 0.05 level (a t-statistic value of -1.75).

4.4.3 Debt maturity determinants

In Table 4-8 we first investigate if the main theories behind the debt maturity structure of firms receive support from our panel data. In Model 1 we run a fixed effects regression of several firm characteristics, our independent variables, against the debt maturity ratio (*Debt_maturity*), the dependent variable. We use the whole sample and our time span ranges from 1980 through 2004:

$$\widehat{Debt\_maturity_{it}} = 0.0077 + 0.0448\,Market\_to\_book_{it} + 0.0507\ Regulation\_dummy_{it} + \\ + 0.0571\,Real\_size_{it} - 0.0146\ Abnormal\_earnings_{it} + 0.0046\ Asset\_maturity_{it} + 0.1263\,Taxes_{it}$$

When observing the regression estimated coefficients we notice that, with the exception of the *Abnormal_earnings*, all are positive. In terms of economic relevance we find that the tax rate (*Taxes*) and the firm size (*Real_size*) are the two most important firm characteristics (by unit change), followed by the existence of growth opportunities (*Market_to_book*) and being a regulated firm (*Regulation_dummy*). In this model, all coefficients are statistically significant at the 0.01 level with the exception of the *Abnormal_earnings* coefficient, which is not statistically significant, and the *Regulation_dummy* coefficient which is statistically significant at the 0.05 level. According to the most relevant existent debt maturity theory portfolio, we would expect the following relations to happen:

Table 4-1 - Expected determinants' impact on debt maturity

An increase in the independent variable	Expected impact in the debt maturity ratio
Market_to_book	+ / -
Regulation_dummy	+
Real_size	+
Abnormal_earnings	-
Asset_maturity	+
Taxes	+ / -

The coefficient on the *Market_to_book* is positive and highly significant (with a t-statistic of 7.63). We find that in average, other things equal, an increase in the firms' growth options of 1 pp leads to an increase in the debt maturity structure of 0.0448 pp. This result proves inconsistent with the agency costs theory where larger opportunities sets should yield shorter debt maturity ratios. However, our results give support to Diamond's liquidity risk argument (Diamond, 1991a) where firms issuing long-term debt can mitigate the inefficient liquidation of riskier growth options.

Being a regulated firm we expect a higher debt maturity structure. This holds true with our results where being a regulated firm increases the proportion of long-term debt by 0.0507 pp, in average. The coefficient is statistically significant only at the 0.05 level. In our sample we only find regulated firms during the 1980s.

The coefficient for the log of the firm value is statistically significantly positive with a t-statistic of 14.34. The economic relevance of this variable is very important, in average, an increase of 1% results in an increase of 0.0571 pp in the debt maturity ratio. Larger firms tend to have more long-term debt in their capital structure.

According to the signaling hypothesis firms with higher future earnings tend to have more short term debt. Our results give weak support to this theory. The coefficient for the *Abnormal_earnings*, though negative as expected (-0.0146), is not statistically significant at the 10% level (with a t-statistic value of -1.47). Furthermore, the economic relevance of this characteristic is quite low.

The matching theory between asset maturity and debt maturity finds good support in our model. The *Asset_maturity* coefficient is positive and statistically significant at the 0.01 level. However, this variable's the economic relevance is the weakest in our model, an increase in 1 pp in the asset maturity ratio has an impact of less than a half of percentage point (0.0046) in the debt maturity ratio, in average, other things equal.

The effective tax rate plays, in our model, an important role in determining the debt maturity structure of firms. Our variable's coefficient is positive and statistically significant at the 0.01 level. Higher effective tax rates produce higher debt maturity ratios. This result is contradictory to Kane *et al.* (1985) assessment that firms increase their debt maturity structure as the debt tax advantages decrease. The economic relevance of this variable is quite significant in our model, an increase of 1 pp in the effective tax rate leads to an increase of 0.1263 pp in the debt maturity ratio, in average. We find no evidence of the limited impact on debt maturity by taxes as pointed out by Lewis (1990).

In Model 2 of Table 4-8 we introduce two dummy variables allowing for changes in the intercepts for the 1990s decade and for the 2000-2004 period. The *1990s_dummy* takes a value of one for firm-year observations from 1990 to 1999, while the *2000s_dummy* takes a value of one for firm-year observations from 2000 to 2004. The results obtained in Model 2 for the variables used in Model 1 are quite similar. With the exception of the intercept, all variables have the same sign as in Model 1. At the economic relevance level we find a significant decrease in the *Regulation_dummy* coefficient (about 35%) and in the *Taxes* coefficient (almost 47%) and a dramatic decrease in the *Abnormal_earnings* coefficient of roughly 92.5%. The only variable with a significant increase in economic relevance is *Real_size* with an increase of almost 46.5%. The statistical significance of the coefficients is in the same level as in the previous model.

The two dummies introduced have negative coefficients and are statistically significant at the 0.01 level. Relating to the 1980s decade we find that a firm in the 1990s has, in average, a decrease in the debt maturity ratio of 0.0793 pp, while in the years 2000-2004 the drop in the debt maturity is higher, about 0.13 pp. From these results we can conclude that the debt maturity ratio has been decreasing, presenting a negative trend from the years 1980s to the 1990s and from the 1990s to the 2000s. We also find that the firms' characteristics included in the model are not sufficient to explain this negative trend, other endogenous and exogenous factors are also responsible for the existing trend. The adjusted R^2 is slightly higher than in Model 1.

In Model 3 we allow the variables' slopes to change over time. We include the interaction between each firm characteristic and the 1990s decade and the years 2000-2004. Using this regression we intend to observe the influence of the firm characteristics on the debt maturity ratio over time. In the first column of Model 3 we find the coefficients values for our base decade, the 1980s. The coefficient signs are all positive. The *Abnormal_earnings*, the *Asset_maturity* and *Taxes* all have higher coefficients than in Model 2, while the *Real_size* and in particular the *Market_to_book* have lower values. Thus, we find that the coefficients of the *Market_to_book* and *Real_size* are much higher in the 1990s and in the 2000s, all being statistically significant at the 0.01 level with the exception of the *Market_to_book* coefficient in the 2000s, which is only significant at the 0.1 level. On the other hand, the coefficients of *Abnormal_earnings* (in particular in the 1990s interaction), *Asset_maturity* and *Taxes* (most relevant in the 2000s interaction) are much lower than in the 1980s. The statistical significance of these coefficients is very weak for the *Abnormal_earnings*. The *Asset_maturity* and *Taxes* coefficients are statistically significant at the 0.01 level and at the 0.05 level, respectively.

The main conclusions from Model 3 are that the model's power in determining the debt maturity ratio is basically the same as Model 2 and that the economic relevance of the firm characteristics changes substantially over time.

In Model 4 we control for the existence of industry effects. We run random effects regression adding dummy variables for firms' two-digits industry SIC code. With these variables addition the adjusted R^2 increases almost 3 pp, however, we find no meaningful impact on the other variables used in the model.

4.4.4 Predicted versus actual debt maturity

In this section we first estimate Model 1 of Table 4-8 using the fixed effects regression. Our sample strictly uses 1980s firm-year observations. The model is as follows (see Table 4-9):

$$\widehat{Debt\_maturity}_{it} = 0.0233 + 0.0231\,Market\_to\_book_{it} + 0.0177\,Regulation\_dummy_{it} + \\ + 0.0633\,Real\_size_{it} + 0.0253\,Abnormal\_earnings_{it} + 0.0079\,Asset\_maturity_{it} + 0.0761\,Taxes_{it}$$

We find that all coefficients have a positive impact on the debt maturity ratio. These results give some support to the main theories existent, with the exception of the agency costs theory (expects a negative coefficient for the *Market_to_book*) and the signaling hypothesis (expects a negative coefficient for the *Abnormal_earnings*). However, we find that the latter coefficient is not statistically significant at the 0.1 level. The *Regulation_dummy* coefficient is also not statistically significant, even at the 0.1 level, while all others coefficients are significant at the 0.01 level.

In Table 4-10 we use the model obtained by the fixed effects regression for the 1980s to derive the predicted debt maturity ratio for the whole sample period from 1990 to 2004. We then compare the predicted values with the actual values and test for differences between the two. The results show that our model always predicts substantial higher debt maturity ratios than the observed values. The difference shows a tendency to increase through the years from a 6.1 pp difference in 1990 to a difference of over 12 pp in the years 2000s. These results were expected to happen since we have already identified a negative time trend in the debt maturity ratio and that the variables used in the model alone are not sufficient to model this trend. Thus, the model does a better job in predicting the debt maturity ratio in the early years of the 1990s than in the late 1990s and 2000s. The t-statistics have values between -9.39 and -18.49 which show the statistical significance in the differences in means between the predicted and actual debt maturity ratios.

In Table 4-11 we follow the same methodology used in Table 4-10 but apply it to the financially constrained subsamples. Once again, the results show that our model over predicts the debt maturity ratio in all subsamples. However, while in the size criterion and in the Tobin's Q criterion the main conclusions are the same as for the whole sample, using the constrain dummy we find relevant differences: the difference between actual and predicted debt maturity are smaller than in the other subsamples, we do not find a clear tendency in the differences to increase over time and the t-statistics values are quite low and sometimes indicating that the differences between the predicted and actual debt maturity ratios are not statistically significant.

We now turn our focus to the financially unconstrained subsamples. The results are presented in Table 4-12. Using the constrain dummy and Tobin's Q criteria give us similar results as those obtained for the whole sample: the predicted values are always larger than the actual values, they follow an increasing pattern and all t-statistics are substantially high. Conversely, when observing the results for the large firms we find that our model predicts quite well the debt maturity ratio. With the exception of the year 2000, the model's debt maturity over prediction ranges from 1.51% to 9.33% of the actual values. The t-statistics show that the differences between predicted and actual debt maturity ratios are not statistically significant for several years in our time span.

Overall, our model over estimates the debt maturity ratios for the whole sample and subsamples. The best fit appears to be in the financially unconstrained group of large firms and on the constrained group, according to the constrain dummy criterion. From Table 4-6 we have already established that the negative time trend occurs in all samples. However, we can also identify that the two groups where this trend is less prevalent are the same groups where our model better predicts the debt maturity ratios.

As a robustness test we follow the same methodology using the two-steps approach of FM. In Table 4-13 we report the FM coefficients for the 1980-1989 sample period. All coefficients remain positive. The *Market_to_book* loses some statistical significance while the *Regulation_dummy* is now statistically significant at the 0.1 level. The impact on *Debt_maturity* from each variable varies slightly: the *Market_to_book* loses some economic significance while *Taxes*'s and *Asset_maturity*'s economic significance increases. When we compare the predicted *versus* the actual debt maturity ratio for the whole sample (see Table 4-14) we find strong support to the results previously reported. The model still over predicts the maturity ratio with a similar trend. The t-statistics values are also quite close to previous results.

When we focus on the financially constrained and unconstrained subsamples (Table 4-15 and Table 4-16, respectively) we find strong support from the FM approach to the results obtained using fixed effects. The model keeps overestimating (though slightly less) the debt maturity ratio with similar time trend. Like before, our model best fit is in the financially constrained subsample, according to the constrained dummy criterion and the in financially unconstrained subsample, according to the size criterion. Overall, the FM approach strongly supports previous results.

4.4.5 Changes in firm characteristics and their impact on the debt maturity ratio over time

We have already established the existence of a significant downward time trend in the debt maturity ratio which covers the whole sample and almost all subsamples. We now try to investigate how firm characteristics used in our model have changed over time and if this evolution can account for the existent downward trend in the debt maturity ratios. To achieve this task we first calculate the contribution of each debt maturity determinant in the debt maturity ratio. To do so we use the variables averages from the 1980-1989 sample period. We then follow the same procedure for the 1990-2004 sample period. First, we run the fixed effects regression using the 1990-2004 sample period and compare the coefficients values and the overall impact of each determinant in the debt maturity ratio. We then calculate the difference on the impact on the debt maturity ratio from the 1980-1989 sample period to the 1990-2004 sample period.

In Table 4-17 we first model the debt maturity for the 1990-2004 period using the fixed effects regression. We can find some differences in the determinants coefficients when comparing to the 1980-1989 sample period, however, the main conclusions remain the same. The *Market_to_book* coefficient almost doubles its value and is statistically more significant. In the latter period there are no regulated firms thus the dropped variable. The *Real_size* coefficient, although statistically more significant, slightly differs from the previous period value. The coefficient for the *Abnormal_earnings* changes sign and is now supportive of the signaling hypothesis where firms with higher future earnings are expected to hold more short-term debt. However, the coefficient remains statistically insignificant at the 0.1 level. Although remaining with the same sign and still significant at the 0.01 level, the *Assets_maturity* coefficient and the *Taxes* coefficient reduce their values, as well as their significance from the values reported in the 1980-1989 model. Globally, the impact on the debt maturity ratio from unitary changes in its determinants is lower in the 1990-2004 period than in the 1980-1989 period, with the exceptions of the *Market_to_book* and *Real_size* variables.

When analyzing the overall impact of each determinant on the change of debt maturity ratio for the whole sample and the differences from the 1980-1989 and 1990-2004 periods (see Table 4-18) we find that four variables decrease their impact on our dependent variable, thus supporting the negative change in the latter. However, from these four variables only *Taxes* and *Asset_maturity* are relevant since the other two (*Abnormal_earnings* and *Regulation_dummy*) have residual differences. The *Real_size* and the *Market_to_book* show an increase in their impact on the *Debt_maturity* through time. The positive differences in these variables are contrary in explaining the negative change in the dependent variable and completely eliminate the negative impact of all other determinants in the model.

In Table 4-19 we report the results for the financially constrained subsamples. We find similar results as to the whole sample analysis: the variables with negative and positive changes are the same as are their order of importance. Between the constrained subsamples we find that only for the small firms the change in the impact of all the determinants is negative, thus supporting the negative change in the debt maturity ratio. When using the constrain dummy and the Tobin’s Q we find an overall positive change in the impact of the independent variables on the dependent variable from de 1980-1989 period to the 1990-2004 period.

For the financially unconstrained subsamples the results are reported in Table 4-20. When observing the impact of each determinant and the sign of the differences from one sample period to the other the conclusions are the same as those previously stated for the whole sample and for the financially constrained subsamples. However, when combining all the determinants we find that according to the size criterion the overall change in the impact on the debt maturity ratio is positive while according to the other two criteria the change is negative. These results are contrary to those observed in the constrained subsamples.

In Table 4-25 we present a summary of the positive or negative movements in the observed differences in firm characteristics between our two sample periods and their impact on the firms' debt maturity ratios. All samples are included in this table. With the exception of large firms, we find that firms present a decrease in their investment opportunities according to a decrease in their market-to-book value. However, the impact on the dependent variable increases over time in all samples, due to an increase in this determinant's coefficient.

Over time we find that firms are subject to inferior tax rates, which associated with a decrease in this variable's coefficient results in a decrease of the impact on the debt maturity ratio. The maturity of assets follows the same pattern as the tax rate. Through all samples we can observe a decrease in the assets maturity values and a corresponding decrease of the impact on the firms' debt maturity ratio, since this determinant's coefficient also decreases. The firm quality, proxied by the *Abnormal_earnings* variable, suffers an increase in all samples. However, this movement in firm quality is not sufficient to generate an increase on the impact on the debt maturity ratio because the proxy's coefficient decreases through time. Regulated firms only exist in our initial sample period, thus the obvious decrease in all dimensions of Table 4-25.

With the exception of the financially unconstrained subsample according to the Tobin's Q criterion, firms have grown over time. Their assets value has increased over time such as the determinant's coefficient which results in a higher impact on the firms' debt maturity ratios.

Overall, we find that the firms' characteristics used in our debt maturity model do change over time. The inferior tax rates applied, the decrease in the maturity of assets in place, the decrease in abnormal earnings and the inexistence of regulated companies help explaining the downward trend previously identified. However, we find contradictory results from an increase in the size of firms and also from a decrease in firms' growing opportunities, which associated with a higher sensitivity of the debt maturity values from unitary changes in each of these determinants result in a higher impact on the dependent variable.

As a robustness test we performed the same analysis using the FM two-steps regression for the whole sample and subsamples. From **Table 4-21** we find similar results as those obtained using the fixed effects regression. From the 1980-1989 sample period to the 1990-2004 sample period we find an increase in the *Real_size* coefficient and a strong increase in the *Market_to_book* coefficient. As before, all other determinants' coefficients decrease, in particular *Taxes*. The overall impact on the debt maturity ratio from each determinant follows the same pattern as before, however the size of the impact differs (see Table 4-22).

When using the fixed effects regression, the sum of the differences reported in the last column of Table 4-18 is almost zero while using the FM the sum of the last column of Table 4-22 exceeds 10 positive pp. Once again we can conclude that the changes in firm characteristics are not sufficient in explaining the downward trend in the debt maturity ratio. From Table 4-22 we can even see that the determinants used in our model would suggest, per se, an upward trend of the dependent variable.

When comparing the results from both methods for the financially constrained and unconstrained subsamples (Table 4-19 and Table 4-20 with Table 4-23 and Table 4-24, respectively) we find similar results as those described for the whole sample. The determinants impact on the debt maturity ratio has the same sign in both methods though when using FM we consistently get higher values for the differences between the two sample periods. Overall, the sum of the differences reported in the last column of Table 4-23 and Table 4-24 (using FM) yield about 10 pp higher than those reported in the last column of Table 4-19 and Table 4-20 (using fixed effects).

4.5 Summary

We report a substantial downtrend in the average debt maturity ratio from 1980 to 2004 for the whole sample. This drop is quite severe in the small (financially constrained) firms. Conversely, large (financially unconstrained) firms do not present the same behavior with a slight decrease in the debt maturity values over time. The average debt maturity is much higher for large firms than for small firms, from about 25 pp higher in 1980 to almost 40 pp in 2004.

According to the constrain dummy criterion we find a similar behavior in the financially constrained and unconstrained subsamples. Both present a downward trend in the average debt maturity of about 15 pp. Again, though to a lesser extent, unconstrained firms show higher debt maturity than the constrained group. According to Tobin's Q criterion we find that both subsamples follow almost the same pattern. Both have similar values for the debt maturity with a drop of about 15 pp through the sample period.

When testing the existence of a time trend in the whole sample and subsamples we conclude that, overall, that trend exists and is statistically significant. The existing trend is statistically less evident in the financially unconstrained group of large firms.

The criteria used to identify financially constrained and unconstrained firms yield substantial different groups for the same type of firm. However, independently of the criterion used, financially unconstrained firms have higher average debt maturity than constrained firms. This is most evident when using the size criterion and less evident when using the Tobin's Q criterion. The differences between financially constrained and unconstrained firms are statistically significant for the size and constrain dummy criteria but not when using the Tobin's Q criterion.

We model the debt maturity using the major determinants found in the most relevant literature. The results give mixed support to most of the existing theories. Opposite to the agency costs theory, we find that firms with higher growth options have higher debt maturity ratios, thus supporting Diamond's liquidity risk argument. Being a regulated firm yields more long-term debt. Larger firms have higher debt maturity in their capital structures. The signaling hypothesis finds weak support in our results due to a statistically insignificant coefficient at the 0.1 level.

When we model the average debt maturity for 1980s and then apply it to the out of the sample 1990-2004 period firms we find that the model significantly overestimates it. The differences increase through time and are most relevant in the latter years. Following the same method with the financially constrained subsamples we reach similar conclusions with the exception of using the constrained dummy criterion where the differences are less expressive and do not show a clear tendency over time. In the financially unconstrained subsamples we find that our model fits quite well in the large firms group where some differences are even statistically insignificant. Using the other two criteria the overestimation is again clear.

We observe that firm characteristics change over time, from our initial period of 1980s to the 1990-2004 period. In average, firms have slightly less growth options, when measured by the market-to-book ratio, are subject to lower tax rates (about 6 pp less) and have about 10% less asset maturity. Opposite to the 1980s we find no regulated firms in the 1990-2004 period. Firms are larger and have more abnormal earnings. The economic relevance of the debt maturity determinants also change between the two sample periods. The firm size and the existence of investment opportunities have more economic impact on the debt maturity ratio, while all other factors decline in importance.

When combining the changes in the averages of firm characteristics with the changes of their impact on the average debt maturity ratio we conclude that these changes are not sufficient in explaining the significant downward trend in the dependent variable. The contribution to this negative trend observed in four of the debt determinants is counterbalanced by the increase in the average debt maturity ratio derived from the *Real_size* and *Market_to_book* determinants.

Concluding, we find a significant downward trend in the average debt maturity ratio from 1980 to 2004. The main debt maturity determinants used in the most relevant literature are applied in our model for the 1980s and yield an overestimation of the debt maturity ratio for the 1990-2004 period, which is in accordance with the previous conclusion. The exception comes from the financially unconstrained group of large firms where the negative average debt maturity trend is not significant and thus, our model fits quite well. Changes in the firm characteristics used in our model do not explain the overall observed trend in the dependent variable. We must seek other relevant endogenous or exogenous factors to help us explain and predict this behavior in the firms' capital structure.

Table 4-2 - Descriptive statistics for *Debt_maturity* for the 1980-2004 sample period.

We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digit scode 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent and firm-specific independent variables were cleaned by eliminating all outliers at the top and bottom 5% level. We measure *Debt_maturity* as the proportion of the firm's total debt that has a maturity of more than three years.

Year	Observations	Average	Standard Deviation	Median	Maximum
1980	1,952	0.5433	0.2635	0.6074	0.9462
1981	1,955	0.5368	0.2635	0.5957	0.9488
1982	1,971	0.5210	0.2698	0.5799	0.9481
1983	2,014	0.5067	0.2759	0.5668	0.9489
1984	2,184	0.4803	0.2789	0.5259	0.9484
1985	2,014	0.4776	0.2839	0.5231	0.9490
1986	1,923	0.4708	0.2940	0.5110	0.9493
1987	1,961	0.4574	0.2982	0.4965	0.9489
1988	1,990	0.4403	0.3027	0.4631	0.9480
1989	1,825	0.4232	0.3065	0.4370	0.9477
1990	1,746	0.4071	0.3038	0.4160	0.9485
1991	1,684	0.4005	0.3043	0.4066	0.9489
1992	1,761	0.3891	0.3057	0.3904	0.9493
1993	1,872	0.3876	0.3111	0.3776	0.9489
1994	2,073	0.3781	0.3120	0.3470	0.9491
1995	2,043	0.3804	0.3172	0.3520	0.9492
1996	2,139	0.3894	0.3247	0.3603	0.9493
1997	2,158	0.3855	0.3298	0.3370	0.9491
1998	2,077	0.3962	0.3341	0.3644	0.9491
1999	1,859	0.3801	0.3249	0.3627	0.9487
2000	1,679	0.3492	0.3237	0.2830	0.9490
2001	1,331	0.3593	0.3207	0.3124	0.9486
2002	1,320	0.3590	0.3261	0.3196	0.9491
2003	1,254	0.3769	0.3327	0.3538	0.9485
2004	1,158	0.3862	0.3311	0.3711	0.9478
Standard Deviation	289.6014	0.0589		0.0973	

Figure 4-1 - Average and median debt maturity ratio for the whole sample from 1980 to 2004.

We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digits code 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent and firm-specific independent variables were cleaned by eliminating all outliers at the top and bottom 5% level. We measure *Debt_maturity* as the proportion of the firm's total debt that has a maturity of more than three years.

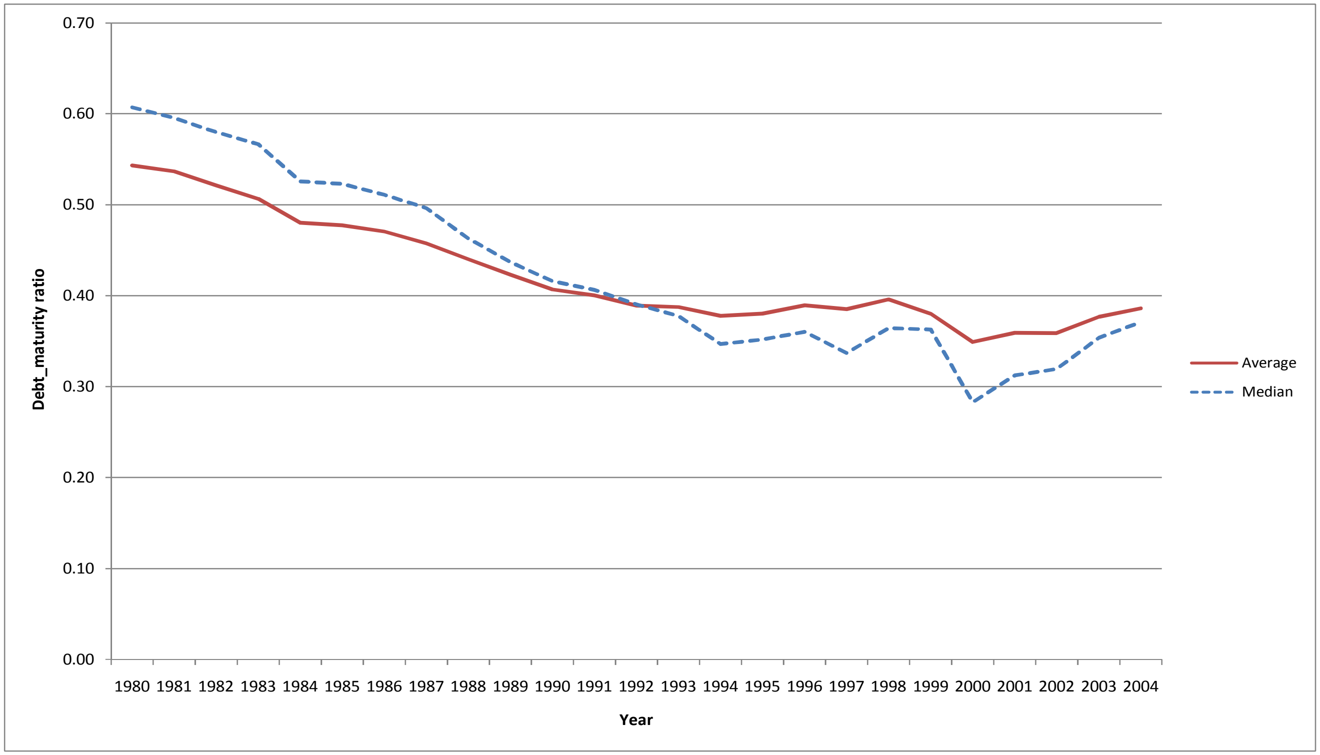

Table 4-3 - Average and median debt maturity for constrained and unconstrained firms by size for the 1980-2004 sample period.

We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digits code 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent and firm-specific independent variables were cleaned by eliminating all outliers at the top and bottom 5% level. We measure *Debt_maturity* as the proportion of the firm's total debt that has a maturity of more than three years. The subsamples are divided in constrained and unconstrained firms according to size: a constrained (unconstrained) firm is the one which has an assets' value in the first quartile (last quartile), by year.

	Constrained (small firms)			Unconstrained (large firms)		
Year	**Observations**	**Average**	**Median**	**Observations**	**Average**	**Median**
1980	488	0.4035	0.4254	488	0.6553	0.7043
1981	489	0.4022	0.3987	489	0.6522	0.6948
1982	493	0.3660	0.3386	493	0.6484	0.6946
1983	504	0.3391	0.2972	504	0.6402	0.6940
1984	546	0.3059	0.2509	546	0.6336	0.6839
1985	504	0.3250	0.2728	504	0.6283	0.6768
1986	481	0.2828	0.1931	481	0.6376	0.6971
1987	491	0.2751	0.1805	491	0.6304	0.6970
1988	498	0.2704	0.1728	498	0.6040	0.6546
1989	457	0.2335	0.1198	457	0.5953	0.6480
1990	437	0.2209	0.0991	437	0.5756	0.6294
1991	421	0.2121	0.0951	421	0.5895	0.6565
1992	441	0.2191	0.0952	441	0.5974	0.6582
1993	468	0.2303	0.1119	468	0.5979	0.6594
1994	519	0.2056	0.0920	519	0.5809	0.6320
1995	511	0.2133	0.0909	511	0.6011	0.6771
1996	535	0.2301	0.0964	535	0.6187	0.6973
1997	540	0.2221	0.0819	540	0.6176	0.7169
1998	520	0.2247	0.0775	520	0.6176	0.6897
1999	465	0.2149	0.0565	465	0.5846	0.6463
2000	420	0.1942	0.0340	420	0.5513	0.6140
2001	333	0.1929	0.0474	333	0.5919	0.6699
2002	330	0.1912	0.0363	330	0.6082	0.6789
2003	314	0.2004	0.0347	314	0.6095	0.6793
2004	290	0.2082	0.0530	290	0.6047	0.6559
Standard Deviation	72.4247	0.0654	0.1159	72.4247	0.0258	0.0260

Figure 4-2 - Average and median debt maturity for constrained and unconstrained firms by size from 1980 to 2004.

We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digits code 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent and firm-specific independent variables were cleaned by eliminating all outliers at the top and bottom 5% level. We measure *Debt_maturity* as the proportion of the firm's total debt that has a maturity of more than three years. The subsamples are divided in constrained and unconstrained firms according to size: a constrained (unconstrained) firm is the one which has an assets' value in the first quartile (last quartile), by year.

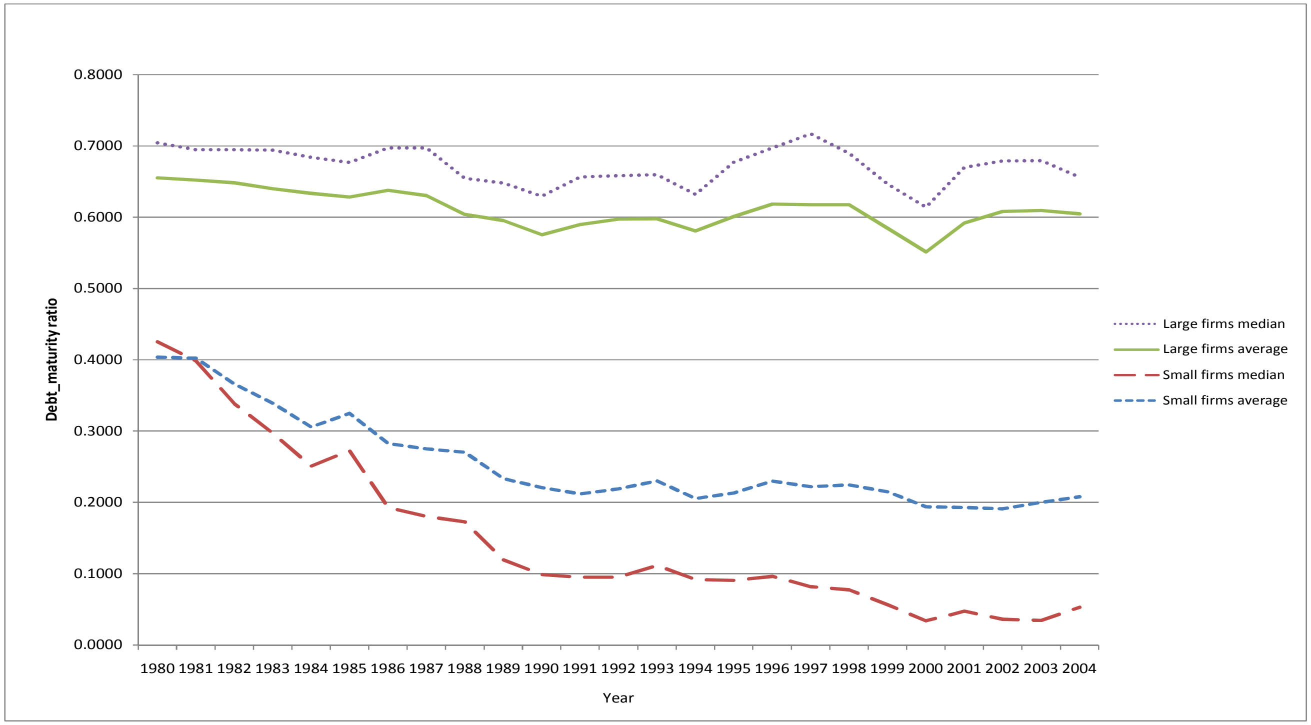

Table 4-4 - Average and median debt maturity for constrained and unconstrained firms by constrain dummy for the 1980-2004 sample period.

We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digits code 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent and firm-specific independent variables were cleaned by eliminating all outliers at the top and bottom 5% level. We measure *Debt_maturity* as the proportion of the firm's total debt that has a maturity of more than three years. In the subsamples we use a constrain dummy (*Cdummy*) that is set to one if: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one. *Cdummy* is set to zero and the firm is labeled as unconstrained if it does not meet these two conditions.

	Constrained (*Cdummy*=1)			**Unconstrained (*Cdummy*=0)**		
Year	**Observations**	**Mean**	**Median**	**Observations**	**Mean**	**Median**
1980	137	0.4714	0.5035	1815	0.5488	0.6131
1981	145	0.4576	0.5057	1810	0.5431	0.6053
1982	150	0.4221	0.3884	1821	0.5292	0.5893
1983	192	0.4092	0.4291	1822	0.5170	0.5800
1984	237	0.3996	0.4089	1947	0.4901	0.5376
1985	252	0.3946	0.3528	1762	0.4895	0.5414
1986	222	0.4413	0.4402	1701	0.4746	0.5166
1987	201	0.4181	0.4015	1760	0.4619	0.5042
1988	215	0.3702	0.3266	1775	0.4488	0.4770
1989	186	0.3727	0.3100	1639	0.4289	0.4478
1990	149	0.3260	0.2480	1597	0.4147	0.4321
1991	170	0.2961	0.2241	1514	0.4122	0.4335
1992	242	0.3168	0.2279	1519	0.4006	0.4125
1993	312	0.3602	0.2909	1560	0.3931	0.3962
1994	362	0.3405	0.2555	1711	0.3860	0.3678
1995	353	0.3449	0.2456	1690	0.3878	0.3692
1996	338	0.3599	0.2807	1801	0.3950	0.3780
1997	385	0.3711	0.2866	1773	0.3886	0.3443
1998	252	0.3631	0.2945	1825	0.4008	0.3750
1999	222	0.3840	0.3534	1637	0.3796	0.3629
2000	166	0.3296	0.2227	1513	0.3514	0.2954
2001	112	0.3612	0.2601	1219	0.3591	0.3165
2002	104	0.3640	0.3573	1216	0.3586	0.3148
2003	128	0.3483	0.2201	1126	0.3802	0.3648
2004	181	0.3152	0.2256	977	0.3993	0.3916
Standard Deviation	80.44	0.0448	0.0880	246.9072	0.0603	0.0971

Figure 4-3 - Average and median debt maturity for constrained and unconstrained firms by constrain dummy from 1980 to 2004.

We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digits code 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent and firm-specific independent variables were cleaned by eliminating all outliers at the top and bottom 5% level. We measure *Debt_maturity* as the proportion of the firm's total debt that has a maturity of more than three years. In the subsamples we use a constrain dummy (*Cdummy*) that is set to one if: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one. *Cdummy* is set to zero and the firm is labeled as unconstrained if it does not meet these two conditions.

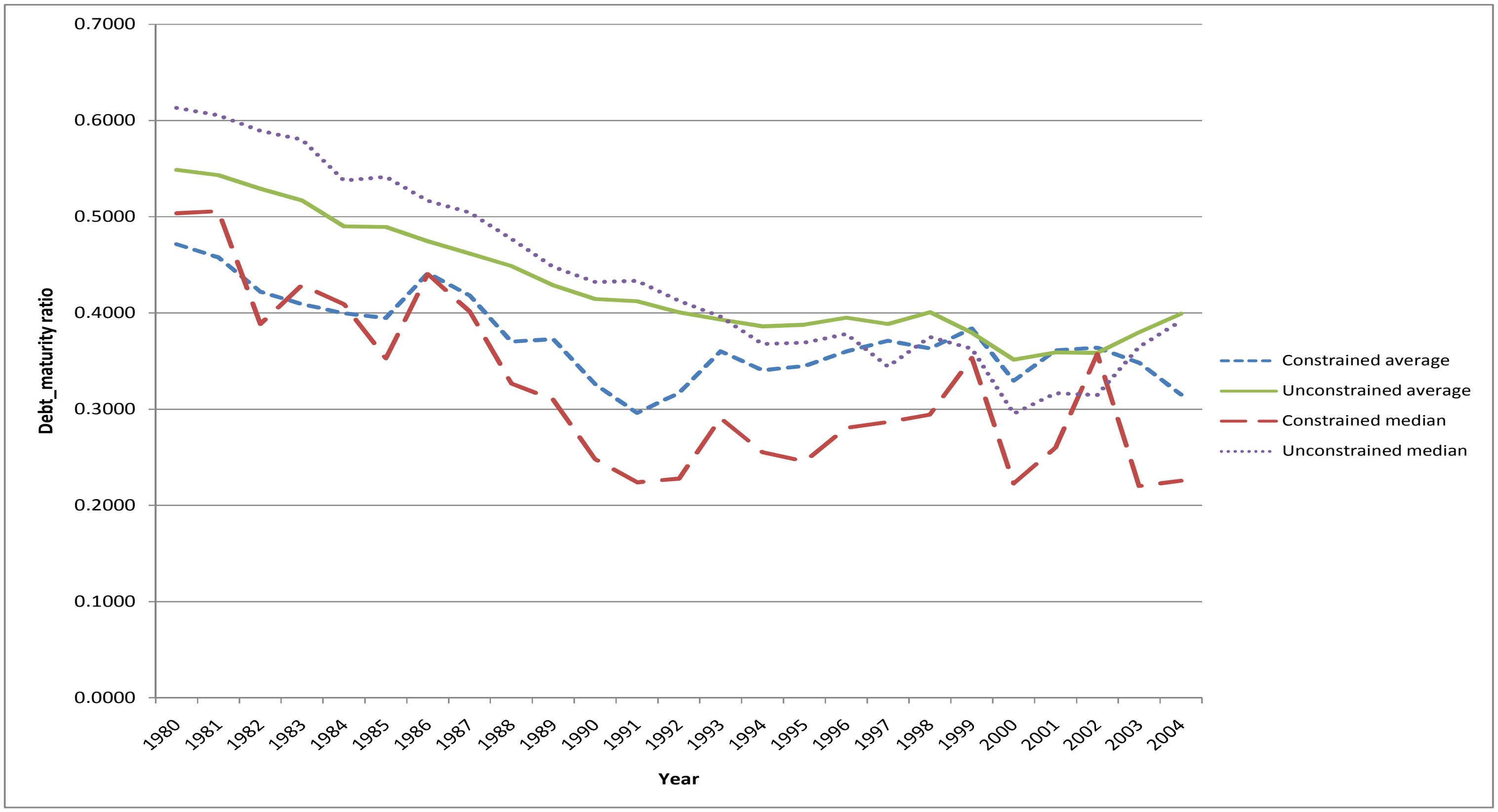

Table 4-5 - Average and median debt maturity for constrained and unconstrained firms by Tobin's Q for the 1980-2004 sample period.

We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digits code 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent and firm-specific independent variables were cleaned by eliminating all outliers at the top and bottom 5% level. We measure *Debt_maturity* as the proportion of the firm's total debt that has a maturity of more than three years. A firm is considered to be constrained (unconstrained) if it has a Tobin's Q ratio (*Tobins_Q*) higher (lower) than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets.

	Constrained (*Tobins_Q*>1)			Unconstrained (*Tobins_Q*<1)		
Year	**Observations**	**Mean**	**Median**	**Observations**	**Mean**	**Median**
1980	692	0.5197	0.5801	1,260	0.5563	0.6201
1981	639	0.5186	0.5863	1,316	0.5456	0.6057
1982	800	0.4956	0.5491	1,171	0.5384	0.5991
1983	1,000	0.5020	0.5628	1,014	0.5113	0.5740
1984	933	0.4736	0.5244	1,251	0.4852	0.5266
1985	1,063	0.4708	0.4983	951	0.4853	0.5397
1986	1,044	0.4643	0.4943	879	0.4785	0.5309
1987	909	0.4430	0.4661	1,052	0.4699	0.5071
1988	962	0.4372	0.4591	1,028	0.4432	0.4659
1989	910	0.4262	0.4544	915	0.4202	0.4302
1990	705	0.3985	0.3987	1,041	0.4130	0.4232
1991	833	0.3902	0.3614	851	0.4106	0.4306
1992	990	0.3735	0.3498	771	0.4093	0.4241
1993	1,190	0.3831	0.3730	682	0.3954	0.3809
1994	1,177	0.3532	0.2784	896	0.4108	0.4050
1995	1,255	0.3682	0.3278	788	0.3999	0.3784
1996	1,386	0.3816	0.3285	753	0.4040	0.4083
1997	1,515	0.3814	0.3305	643	0.3952	0.3595
1998	1,126	0.3839	0.3424	951	0.4108	0.3890
1999	979	0.3655	0.3216	880	0.3963	0.3775
2000	783	0.3523	0.2822	896	0.3465	0.2869
2001	695	0.3662	0.3250	636	0.3518	0.3063
2002	587	0.3809	0.3777	733	0.3415	0.2853
2003	807	0.3684	0.3222	447	0.3923	0.3961
2004	828	0.3803	0.3579	330	0.4009	0.3964
Standard Deviation	232.0283	0.0549	0.0979	238.6678	0.0606	0.0971

Figure 4-4 - Average and median debt maturity for constrained and unconstrained firms by Tobin's Q from 1980 to 2004.

We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digits code 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent and firm-specific independent variables were cleaned by eliminating all outliers at the top and bottom 5% level. We measure *Debt_maturity* as the proportion of the firm's total debt that has a maturity of more than three years. A firm is considered to be constrained (unconstrained) if it has a Tobin's Q ratio (*Tobins_Q*) higher (lower) than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets.

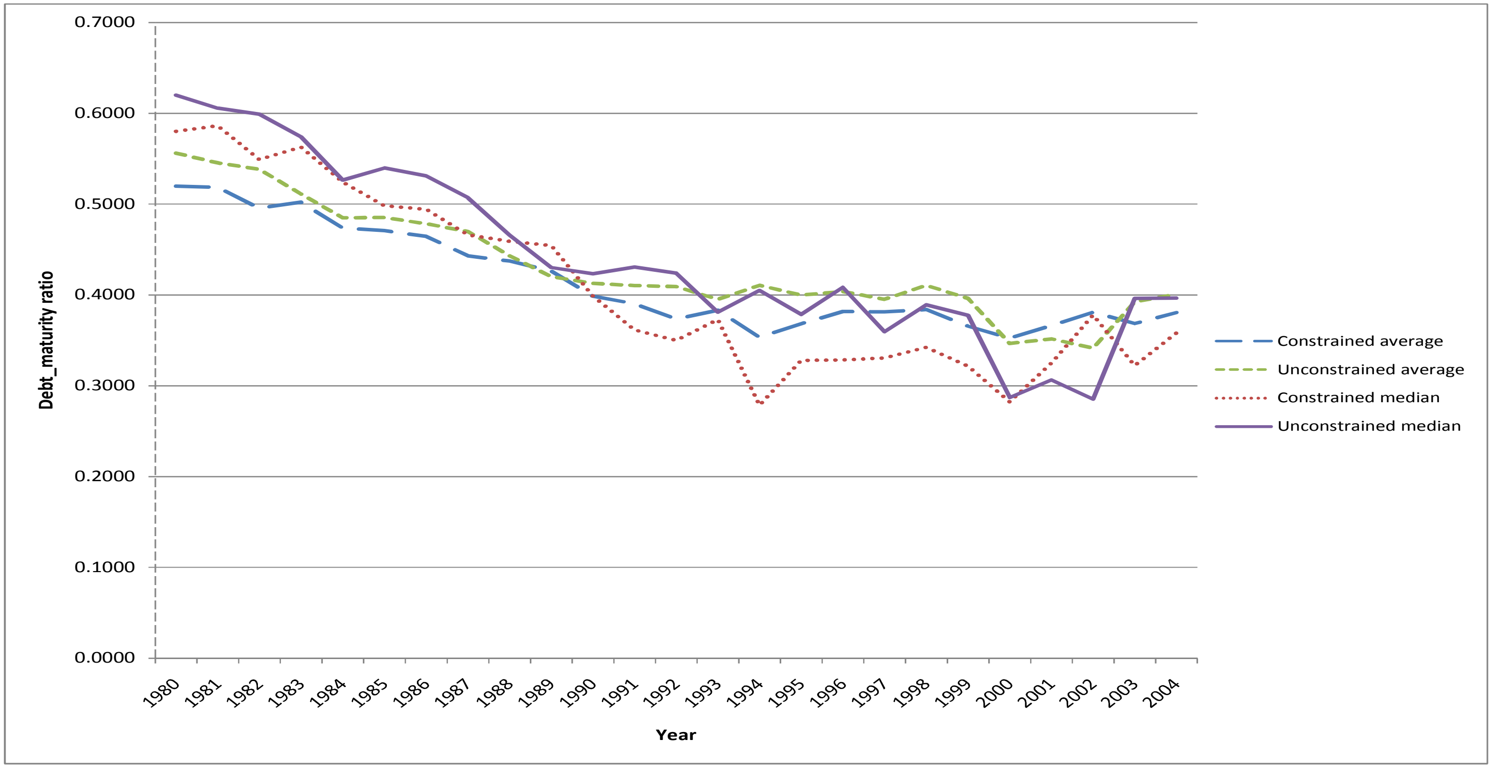

Table 4-6 - Trend analysis for the average and median debt maturity ratio for the whole sample and subsamples from 1980 to 2004.

We modeled the average and median debt maturity ratio against a time (year) variable to test for the existence of trend. We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digits code 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent variable was cleaned by eliminating all outliers at the top and bottom 5% level. We measure *Debt_maturity* as the proportion of the firm's total debt that has a maturity of more than three years. We split the sample in six subsamples according to three criteria: In the first criterion a constrained (unconstrained) firm is the one which has an assets' value in the first quartile (last quartile), by year; In the second criterion we use a constrain dummy that is set to one if: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one. *Cdummy* is set to zero and the firm is labeled as unconstrained if it does not meet these two conditions; In the third criterion a firm is considered to be constrained (unconstrained) if it has a Tobin's Q ratio higher (lower) than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets. T-test values are reported in parentheses.

	Whole sample	**Constrained (small firms)**	**Unconstrained (large firms)**	**Constrained (*Cdummy*=1)**	**Unconstrained (*Cdummy*=0)**	**Constrained (*Tobins_Q*>1)**	**Unconstrained (*Tobin's Q*<1)**
Average maturity							
Constant	15.0289 (11.30)	15.7933 (8.94)	5.1565 (4.66)	8.7399 (4.78)	15.4702 (11.67)	13.7249 (9.97)	15.3048 (10.66)
Year	-0.0073 (-10.98)	-0.0078 (-8.80)	-0.0023 (-4.11)	-0.0042 (-4.57)	-0.0076 (-11.34)	-0.0067 (-9.67)	-0.0075 (-10.36)
Adjusted R^2	0.8328	0.7609	0.3981	0.4533	0.8418	0.7941	0.8158
Median maturity							
Constant	24.8952 (12.28)	28.6033 (10.38)	3.0889 (2.24)	17.9994 (5.40)	25.0397 (12.96)	23.8849 (9.31)	24.4257 (10.91)
Year	-0.0123 (-12.07)	-0.0143 (-10.33)	-0.0012 (-1.75)	-0.0089 (-5.31)	-0.0123 (-12.74)	-0.0118 (-9.15)	-0.012 (-10.71)
Adjusted R^2	0.8577	0.8149	0.0794	0.5309	0.8704	0.7751	0.8257

Table 4-7 - Average and median comparison between constrained and unconstrained subsamples by criteria.

We performed t tests to analyze the difference in means and the Wilcoxon rank-sum (Mann-Whitney) test to analyze differences in the distributions (in the medians) between constrained and unconstrained subsamples. We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digits code 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent variable was cleaned by eliminating all outliers at the top and bottom 5% level. We measure *Debt_maturity* as the proportion of the firm's total debt that has a maturity of more than three years. We split the sample in six subsamples according to three criteria: In the first criterion a constrained (unconstrained) firm is the one which has an assets' value in the first quartile (last quartile), by year; In the second criterion we use a constrain dummy that is set to one if: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one. *Cdummy* is set to zero and the firm is labeled as unconstrained if it does not meet these two conditions; In the third criterion a firm is considered to be constrained (unconstrained) if it has a Tobin's Q ratio higher (lower) than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets.

	Constrained/Unconstrained (Size)		**Constrained/Unconstrained (*Cdummy*)**		**Constrained/Unconstrained (*Tobins_Q*)**	
	Average	**Median**	**Average**	**Median**	**Average**	**Median**
Average Constrained	0.2553		0.3735		0. 4151	
Average Unconstrained	0.6109		0.4296		0.4325	
t	-25.2888		-3.7299		-1.0626	
Rank-sum Constrained		325		438		562
Rank-sum Unconstrained		950		837		713
z		-6.063		-3.871		-1.465

Table 4-8 - Regressions estimating the debt maturity determinants for the whole sample from 1980 to 2004.

We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digits code 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent and independent variables were cleaned by eliminating all outliers at the top and bottom 5% level. The dependent variable in the regressions is the ratio of debt maturing in more than three years over total debt. The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. Models 1, 2 and 3 are fixed effects regressions while Model 4 is a random effects regression using two-digit SIC codes for industry dummies. All regressions include robust standard errors adjusted for clusters by firm. Models 2, 3 and 4 include separate intercepts for firm year observations from 1990 to 1999 and from 2000 to 2004. All regressions are statistically significant according to the F-Test. T-test values are reported in parentheses.

	Model 1	**Model 2**	**Model 3**			**Model 4**		
Variable	**Estimate**	**Estimate**	**Estimate**	**Interaction 1990s**	**Interaction 2000s**	**Estimate**	**Interaction 1990s**	**Interaction 2000s**
Constant	0.0077 (0.33)	-0.0593 (-2.53)	-0.0128 (-0.46)					
Market_to_book	0.0448 (7.63)	0.044 (7.63)	0.0191 (2.47)	0.0374 (3.75)	0.0256 (1.78)	0.01399 (2.36)	0.0367 (4.57)	0.0324 (3.02)
Regulation_dummy	0.0507 (2.39)	0.0329 (1.64)	0.0329 (1.64)	Dropped	Dropped	0.0357 (1.78)	Dropped	Dropped
Real_size	0.0571 (14.34)	0.0836 (20.74)	0.0709 (15.43)	0.0168 (5.59)	0.0174 (4.1)	0.067 (29.83)	0.0199 (7.7)	0.02 (5.65)
Abnormal_earnings	-0.0146 (-1.47)	-0.0011 (-0.12)	0.0173 (1.2)	-0.0426 (-1.99)	-0.0065 (-0.22)	0.0163 (1.18)	-0.0329 (-1.61)	-0.0173 (-0.64)
Asset_maturity	0.0046 (7.88)	0.005 (8.98)	0.0072 (9.83)	-0.0033 (-3.91)	-0.0038 (-3.15)	0.009 (15.3)	-0.0023 (-3.21)	-0.0028 (-2.75)
Taxes	0.1263 (9.62)	0.0672 (5.3)	0.0977 (5.93)	-0.0568 (-2.38)	-0.0833 (-2.26)	0.123 (8.45)	-0.0766 (-3.64)	-0.0725 (-2.36)
1990s_dummy		-0.0793 (-16.72)	-0.1368 (-5.74)			-0.1594 (-8.01)		
2000s_dummy		-0.1302 (-18.03)	-0.1689 (-4.86)			-0.2041 (-7.41)		
Industry_dummy	no	no	no			yes		
Adjusted R^2	0.2257	0.2455	0.2482			0.2757		

Table 4-9 – Fixed effects coefficients (1980 a 1989).

We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digits code 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent and independent variables were cleaned by eliminating all outliers at the top and bottom 5% level. The dependent variable in the regressions is the ratio of debt maturing in more than three years over total debt. The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. T-test values are reported in parentheses.

constant	***Market_to_book***	***Regulation_dummy***	***Real_size***	***Abnormal_earnings***	***Asset_maturity***	***Taxes***
0.0233 (0.57)	0.0231 (2.64)	0.0177 (0.92)	0.0633 (8.63)	0.0253 (1.78)	0.0079 (9.31)	0.0761 (4.71)

Table 4-10 - Predicted debt maturity ratio *versus* actual debt maturity for the whole sample, from 1990 to 2004, using fixed effects coefficients.

Year	**Actual**	**Predicted**	**Difference**	**t-statistic**
1990	0.4071	0.4679	-0.0607	-9.39
1991	0.4005	0.4704	-0.0699	-10.79
1992	0.3891	0.4741	-0.0850	-13.45
1993	0.3876	0.4719	-0.0842	-13.45
1994	0.3781	0.4712	-0.0931	-15.62
1995	0.3804	0.4720	-0.0916	-14.96
1996	0.3894	0.4718	-0.0823	-13.46
1997	0.3855	0.4698	-0.0843	-13.60
1998	0.3962	0.4740	-0.0778	-12.06
1999	0.3801	0.4789	-0.0988	-14.75
2000	0.3492	0.4797	-0.1304	-18.49
2001	0.3593	0.4837	-0.1244	-16.06
2002	0.3590	0.4911	-0.1321	-17.06
2003	0.3769	0.5027	-0.1258	-15.31
2004	0.3862	0.5075	-0.1213	-14.11

Table 4-11 - Predicted debt maturity versus actual debt maturity for the constrained subsamples, from 1990 to 2004, using fixed effects coefficients.

We split the sample in three subsamples for constrained firms according to three criteria: In the first criterion a constrained firm is the one which has an assets' value in the first quartile, by year; In the second criterion we use a constrain dummy (*Cdummy*) that is set to one if: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one; In the third criterion a firm is considered to be constrained if it has a Tobin's Q ratio higher than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets.

	Constrained (small firms)				**Constrained (*Cdummy=1*)**				**Constrained (*Tobins_Q*>1)**			
Year	**Actual**	**Predicted**	**Difference**	**t-statistic**	**Actual**	**Predicted**	**Difference**	**t-statistic**	**Actual**	**Predicted**	**Difference**	**t-statistic**
1990	0.2209	0.3242	-0.1033	-8.55	0.3260	0.3900	-0.0640	-2.72	0.3985	0.4646	-0.0661	-6.18
1991	0.2121	0.3340	-0.1219	-10.08	0.2961	0.3927	-0.0966	-4.63	0.3902	0.4667	-0.0765	-8.00
1992	0.2191	0.3377	-0.1186	-9.97	0.3168	0.3991	-0.0823	-4.79	0.3735	0.4672	-0.0937	-10.95
1993	0.2303	0.3362	-0.1059	-8.98	0.3602	0.4127	-0.0524	-3.32	0.3831	0.4665	-0.0834	-10.55
1994	0.2056	0.3291	-0.1235	-11.61	0.3405	0.4221	-0.0816	-5.71	0.3532	0.4583	-0.1051	-13.03
1995	0.2133	0.3305	-0.1172	-10.81	0.3449	0.4251	-0.0803	-5.25	0.3682	0.4627	-0.0946	-12.05
1996	0.2301	0.3288	-0.0987	-8.55	0.3599	0.4224	-0.0624	-4.01	0.3816	0.4662	-0.0846	-10.92
1997	0.2221	0.3289	-0.1068	-9.30	0.3711	0.4269	-0.0557	-3.73	0.3814	0.4692	-0.0878	-11.73
1998	0.2247	0.3294	-0.1046	-8.78	0.3631	0.4275	-0.0644	-3.48	0.3839	0.4698	-0.0859	-9.70
1999	0.2149	0.3344	-0.1195	-9.43	0.3840	0.4241	-0.0401	-1.98	0.3655	0.4665	-0.1010	-10.73
2000	0.1942	0.3314	-0.1372	-10.83	0.3296	0.4261	-0.0965	-4.32	0.3523	0.4775	-0.1252	-11.89
2001	0.1929	0.3349	-0.1419	-10.19	0.3612	0.4541	-0.0930	-3.44	0.3662	0.4876	-0.1214	-11.17
2002	0.1912	0.3383	-0.1471	-10.97	0.3640	0.4469	-0.0830	-2.97	0.3809	0.4963	-0.1153	-9.34
2003	0.2004	0.3541	-0.1537	-10.42	0.3483	0.4545	-0.1062	-3.91	0.3684	0.4948	-0.1264	-12.10
2004	0.2082	0.3596	-0.1515	-9.78	0.3152	0.4434	-0.1282	-5.97	0.3803	0.5019	-0.1216	-11.91

Table 4-12 - Predicted debt maturity versus actual debt maturity for the unconstrained subsamples, from 1990 to 2004, using fixed effects coefficients.

We split the sample in three subsamples for unconstrained firms according to three criteria: In the first criterion a unconstrained firm is the one which has an assets' value in the last quartile, by year; In the second criterion we use a constrain dummy (*Cdummy*) that is set to zero if it doesn't meet the following two conditions: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one; In the third criterion a firm is considered to be unconstrained if it has a Tobin's Q ratio lower than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets.

	Unconstrained (large firms)				**Unconstrained (*Cdummy*=0)**				**Unconstrained (*Tobins_Q*<1)**			
Year	**Actual**	**Predicted**	**Difference**	**t-statistic**	**Actual**	**Predicted**	**Difference**	**t-statistic**	**Actual**	**Predicted**	**Difference**	**t-statistic**
1990	0.5756	0.6293	-0.0537	-4.50	0.4147	0.4751	-0.0604	-8.99	0.4130	0.4701	-0.0571	-7.07
1991	0.5895	0.6292	-0.0396	-3.27	0.4122	0.4791	-0.0669	-9.83	0.4106	0.4741	-0.0635	-7.25
1992	0.5974	0.6305	-0.0331	-2.69	0.4006	0.4860	-0.0854	-12.57	0.4093	0.4830	-0.0737	-7.89
1993	0.5979	0.6249	-0.0270	-2.32	0.3931	0.4837	-0.0906	-13.30	0.3954	0.4812	-0.0857	-8.35
1994	0.5809	0.6237	-0.0428	-3.70	0.3860	0.4816	-0.0955	-14.56	0.4108	0.4882	-0.0773	-8.77
1995	0.6011	0.6256	-0.0245	-2.07	0.3878	0.4818	-0.0940	-14.07	0.3999	0.4868	-0.0869	-8.87
1996	0.6187	0.6281	-0.0094	-0.82	0.3950	0.4811	-0.0861	-12.94	0.4040	0.4821	-0.0782	-7.87
1997	0.6176	0.6274	-0.0098	-0.81	0.3886	0.4792	-0.0905	-13.30	0.3952	0.4714	-0.0762	-6.90
1998	0.6176	0.6322	-0.0146	-1.22	0.4008	0.4805	-0.0797	-11.58	0.4108	0.4790	-0.0683	-7.25
1999	0.5846	0.6368	-0.0522	-4.30	0.3796	0.4863	-0.1067	-15.09	0.3963	0.4926	-0.0963	-10.13
2000	0.5513	0.6375	-0.0861	-6.24	0.3514	0.4855	-0.1342	-18.05	0.3465	0.4815	-0.1350	-14.23
2001	0.5919	0.6382	-0.0463	-3.16	0.3591	0.4864	-0.1272	-15.75	0.3518	0.4793	-0.1275	-11.57
2002	0.6082	0.6479	-0.0397	-2.71	0.3586	0.4949	-0.1363	-16.93	0.3415	0.4870	-0.1455	-14.82
2003	0.6095	0.6560	-0.0465	-3.03	0.3802	0.5082	-0.1280	-14.86	0.3923	0.5170	-0.1247	-9.39
2004	0.6047	0.6571	-0.0524	-3.29	0.3993	0.5194	-0.1201	-12.79	0.4009	0.5217	-0.1208	-7.57

Table 4-13 - Fama-MacBeth Coefficients (from 1980 to 1989)

We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digits code 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent and independent variables were cleaned by eliminating all outliers at the top and bottom 5% level. The dependent variable in the regressions is the ratio of debt maturing in more than three years over total debt. The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. T-test values are reported in parentheses.

Constant	***Market_to_book***	***Regulation_dummy***	***Real_size***	***Abnormal_earnings***	***Asset_maturity***	***Taxes***
-0.0127	0.0065	0.0302	0.0614	0.0201	0.0112	0.1325
(-0.64)	(1.78)	(1.85)	(26.68)	(1.59)	(19.41)	(6.65)

Table 4-14 - Predicted debt maturity ratio *versus* actual debt maturity for the whole sample, from 1990 to 2004, using Fama-Macbeth coefficients.

Year	**Actual**	**Predicted**	**Difference**	**t-statistic**
1990	0.4071	0.4622	-0.0551	-8.52
1991	0.4005	0.4649	-0.0644	-9.95
1992	0.3891	0.4687	-0.0796	-12.60
1993	0.3876	0.4660	-0.0783	-12.51
1994	0.3781	0.4648	-0.0867	-14.57
1995	0.3804	0.4649	-0.0845	-13.82
1996	0.3894	0.4639	-0.0744	-12.21
1997	0.3855	0.4611	-0.0756	-12.22
1998	0.3962	0.4656	-0.0694	-10.76
1999	0.3801	0.4694	-0.0893	-13.30
2000	0.3492	0.4694	-0.1202	-17.02
2001	0.3593	0.4747	-0.1154	-14.88
2002	0.3590	0.4838	-0.1248	-16.14
2003	0.3769	0.4957	-0.1187	-14.47
2004	0.3862	0.4997	-0.1135	-13.21

Table 4-15 - Predicted debt maturity versus actual debt maturity for the constrained subsamples, from 1990 to 2004, using Fama-Macbeth coefficients.

We split the sample in three subsamples for constrained firms according to three criteria: In the first criterion a constrained firm is the one which has an assets' value in the first quartile, by year; In the second criterion we use a constrain dummy (*Cdummy*) that is set to one if: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one; In the third criterion a firm is considered to be constrained if it has a Tobin's Q ratio higher than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets.

	Constrained (small firms)				**Constrained (*Cdummy*=1)**				**Constrained (*Tobins_Q*>1)**			
Year	**Actual**	**Predicted**	**Difference**	**t-statistic**	**Actual**	**Predicted**	**Difference**	**t-statistic**	**Actual**	**Predicted**	**Difference**	**t-statistic**
1990	0.2209	0.3048	-0.0839	-6.94	0.3260	0.3701	-0.0441	-1.87	0.3985	0.4550	-0.0565	-5.29
1991	0.2121	0.3157	-0.1035	-8.54	0.2961	0.3729	-0.0768	-3.65	0.3902	0.4571	-0.0669	-7.02
1992	0.2191	0.3201	-0.1010	-8.45	0.3168	0.3802	-0.0634	-3.67	0.3735	0.4579	-0.0844	-9.85
1993	0.2303	0.3171	-0.0868	-7.39	0.3602	0.3971	-0.0369	-2.36	0.3831	0.4576	-0.0744	-9.44
1994	0.2056	0.3074	-0.1019	-9.63	0.3405	0.4076	-0.0670	-4.75	0.3532	0.4480	-0.0948	-11.78
1995	0.2133	0.3084	-0.0951	-8.84	0.3449	0.4088	-0.0639	-4.18	0.3682	0.4521	-0.0840	-10.71
1996	0.2301	0.3062	-0.0761	-6.66	0.3599	0.4058	-0.0458	-2.96	0.3816	0.4548	-0.0733	-9.50
1997	0.2221	0.3069	-0.0848	-7.40	0.3711	0.4104	-0.0392	-2.64	0.3814	0.4588	-0.0774	-10.37
1998	0.2247	0.3069	-0.0822	-6.90	0.3631	0.4090	-0.0459	-2.46	0.3839	0.4576	-0.0737	-8.33
1999	0.2149	0.3127	-0.0978	-7.68	0.3840	0.4024	-0.0185	-0.91	0.3655	0.4501	-0.0846	-8.96
2000	0.1942	0.3094	-0.1153	-9.19	0.3296	0.4061	-0.0765	-3.44	0.3523	0.4629	-0.1106	-10.50
2001	0.1929	0.3143	-0.1213	-8.79	0.3612	0.4359	-0.0747	-2.77	0.3662	0.4745	-0.1083	-9.97
2002	0.1912	0.3185	-0.1273	-9.61	0.3640	0.4300	-0.0661	-2.36	0.3809	0.4865	-0.1056	-8.55
2003	0.2004	0.3353	-0.1350	-9.22	0.3483	0.4371	-0.0888	-3.27	0.3684	0.4831	-0.1147	-10.99
2004	0.2082	0.3407	-0.1325	-8.65	0.3152	0.4266	-0.1114	-5.24	0.3803	0.4914	-0.1111	-10.92

Table 4-16 - Predicted debt maturity versus actual debt maturity for the unconstrained subsamples, from 1990 to 2004, using Fama-Macbeth coefficients.

We split the sample in three subsamples for unconstrained firms according to three criteria: In the first criterion a unconstrained firm is the one which has an assets' value in the last quartile, by year; In the second criterion we use a constrain dummy (*Cdummy*) that is set to zero if it doesn't meet the following two conditions: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one; In the third criterion a firm is considered to be unconstrained if it has a Tobin's Q ratio lower than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets.

	Unconstrained (large firms)				**Unconstrained (*Cdummy*=0)**				**Unconstrained (*Tobins_Q*<1)**			
Year	**Actual**	**Predicted**	**Difference**	**t-statistic**	**Actual**	**Predicted**	**Difference**	**t-statistic**	**Actual**	**Predicted**	**Difference**	**t-statistic**
1990	0.5756	0.6318	-0.0562	-4.69	0.4147	0.4708	-0.0561	-8.35	0.4130	0.4671	-0.0541	-6.70
1991	0.5895	0.6311	-0.0416	-3.43	0.4122	0.4752	-0.0630	-9.27	0.4106	0.4725	-0.0619	-7.06
1992	0.5974	0.6323	-0.0349	-2.83	0.4006	0.4828	-0.0822	-12.11	0.4093	0.4826	-0.0734	-7.87
1993	0.5979	0.6267	-0.0288	-2.46	0.3931	0.4797	-0.0866	-12.71	0.3954	0.4806	-0.0851	-8.27
1994	0.5809	0.6249	-0.0440	-3.80	0.3860	0.4769	-0.0908	-13.86	0.4108	0.4868	-0.0760	-8.64
1995	0.6011	0.6264	-0.0252	-2.11	0.3878	0.4766	-0.0888	-13.33	0.3999	0.4853	-0.0854	-8.74
1996	0.6187	0.6272	-0.0085	-0.74	0.3950	0.4748	-0.0798	-12.04	0.4040	0.4805	-0.0766	-7.72
1997	0.6176	0.6260	-0.0083	-0.69	0.3886	0.4721	-0.0835	-12.30	0.3952	0.4666	-0.0713	-6.47
1998	0.6176	0.6308	-0.0132	-1.10	0.4008	0.4734	-0.0726	-10.57	0.4108	0.4750	-0.0642	-6.83
1999	0.5846	0.6337	-0.0491	-4.02	0.3796	0.4784	-0.0989	-13.96	0.3963	0.4908	-0.0945	-9.92
2000	0.5513	0.6328	-0.0815	-5.87	0.3514	0.4764	-0.1250	-16.81	0.3465	0.4752	-0.1286	-13.53
2001	0.5919	0.6348	-0.0429	-2.90	0.3591	0.4783	-0.1191	-14.73	0.3518	0.4750	-0.1231	-11.14
2002	0.6082	0.6468	-0.0385	-2.61	0.3586	0.4884	-0.1298	-16.16	0.3415	0.4817	-0.1402	-14.34
2003	0.6095	0.6544	-0.0450	-2.93	0.3802	0.5023	-0.1221	-14.21	0.3923	0.5184	-0.1261	-9.53
2004	0.6047	0.6550	-0.0503	-3.14	0.3993	0.5132	-0.1139	-12.12	0.4009	0.5204	-0.1195	-7.44

Table 4-17 - Fixed Effects Coefficients (from 1990 to 2004)

We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digits code 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent and independent variables were cleaned by eliminating all outliers at the top and bottom 5% level. The dependent variable in the regressions is the ratio of debt maturing in more than three years over total debt. The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price.

constant	***Market_to_book***	***Taxes***	***Asset_maturity***	***Abnormal_earnings***	***Regulation_dummy***	***Real_size***
-0.0804	0.0430	0.0430	0.0030	-0.0126	dropped	0.0750
(-2.51)	(5.27)	(2.17)	(3.94)	(-0.94)	n.a.	(13.61)

Table 4-18 - Changes in the determinants of debt maturity from the 1980-1989 period to the 1990-2004 period for the whole sample, using fixed effects coefficients.

Whole Sample

Variable	**1980-1989 Average**	**Impact on *Debt_maturity***	**1990-2004 Average**	**Impact on *Debt_maturity***	**Difference**
Market_to_book	0.9601	0.0222	0.9156	0.0394	0.0171
Taxes	0.3298	0.0251	0.2650	0.0114	-0.0137
Asset_maturity	13.1237	0.1041	11.9220	0.0361	-0.0680
Abnormal_earnings	0.0043	0.0001	0.0108	-0.0001	-0.0002
Regulation_dummy	0.0042	0.0001	0.0000	0.0000	-0.0001
Real_size	4.9152	0.3112	5.0186	0.3764	0.0652

Table 4-19 - Changes in the determinants of debt maturity from the 1980-1989 period to the 1990-2004 period for the constrained firms' subsamples, using fixed effects coefficients.

We split the sample in three subsamples for constrained firms according to three criteria: In the first criterion a constrained firm is the one which has an assets' value in the first quartile, by year; In the second criterion we use a constrain dummy (*Cdummy*) that is set to one if: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one; In the third criterion a firm is considered to be constrained if it has a Tobin's Q ratio higher than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets. The dependent variable in the regressions is the ratio of debt maturing in more than three years over total debt (*Debt_maturity*). The *Market_to_book* ratio is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. Taxes is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price.

Constrained (small firms)

Variable	1980-1989 Average	Impact on *Debt-Maturity*	1990-2004 Average	Impact on *Debt-Maturity*	Difference
Market_to_book	1.5061	0.0349	1.4250	0.0613	0.0264
Taxes	0.2538	0.0193	0.1653	0.0071	-0.0122
Asset_maturity	11.7926	0.0935	10.9196	0.0331	-0.0605
Abnormal_earnings	0.0085	0.0002	0.0202	-0.0003	-0.0005
Regulation_dummy	0.0018	0.0000	0.0000	0.0000	0.0000
Real_size	2.8112	0.1780	2.8133	0.2110	0.0330

Constrained (*cdummy=1*)

Variable	1980-1989 Average	Impact on *Debt-Maturity*	1990-2004 Average	Impact on *Debt-Maturity*	Difference
Market_to_book	1.3728	0.0318	1.1736	0.0505	0.0187
Taxes	0.2505	0.0191	0.2079	0.0089	-0.0101
Asset_maturity	11.5022	0.0912	10.7211	0.0325	-0.0588
Abnormal_earnings	0.0071	0.0002	0.0109	-0.0001	-0.0003
Regulation_dummy	0.0031	0.0001	0.0000	0.0000	-0.0001
Real_size	3.8041	0.2409	4.2785	0.3209	0.0800

Constrained (*Tobins_Q*>1)

Variable	1980-1989 Average	Impact on *Debt-Maturity*	1990-2004 Average	Impact on *Debt-Maturity*	Difference
Market_to_book	1.0988	0.0254	0.9853	0.0424	0.0169
Taxes	0.3224	0.0245	0.2550	0.0110	-0.0136
Asset_maturity	12.3761	0.0981	11.3097	0.0342	-0.0639
Abnormal_earnings	0.0070	0.0002	0.0161	-0.0002	-0.0004
Regulation_dummy	0.0019	0.0000	0.0000	0.0000	0.0000
Real_size	4.7201	0.2989	5.0008	0.3751	0.0762

Table 4-20 - Changes in the determinants of debt maturity from the 1980-1989 period to the 1990-2004 period for the unconstrained firms' subsamples, using fixed effects coefficients.

We split the sample in three subsamples for unconstrained firms according to three criteria: In the first criterion a unconstrained firm is the one which has an assets' value in the last quartile, by year; In the second criterion we use a constrain dummy (*Cdummy*) that is set to zero if it doesn't meet the following two conditions: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one; In the third criterion a firm is considered to be unconstrained if it has a Tobin's Q ratio lower than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets. The dependent variable in the regressions is the ratio of debt maturing in more than three years over total debt (*Debt_maturity*). The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. .

Unconstrained (large firms)

Variable	1980-1989 Average	Impact on *Debt-Maturity*	1990-2004 Average	Impact on *Debt-Maturity*	Difference
Market_to_book	0.6665	0.0154	0.7010	0.0301	0.0147
Taxes	0.3668	0.0279	0.3270	0.0141	-0.0138
Asset_maturity	14.5550	0.1154	13.2361	0.0401	-0.0753
Abnormal_earnings	0.0003	0.0000	0.0036	0.0000	-0.0001
Regulation_dummy	0.0065	0.0001	0.0000	0.0000	-0.0001
Real_size	7.1616	0.4534	7.3251	0.5494	0.0959

Unconstrained (*cdummy=0*)

Variable	1980-1989 Average	Impact on *Debt-Maturity*	1990-2004 Average	Impact on *Debt-Maturity*	Difference
Market_to_book	0.9153	0.0212	0.8760	0.0377	0.0165
Taxes	0.3384	0.0257	0.2738	0.0118	-0.0140
Asset_maturity	13.2996	0.1055	12.1061	0.0367	-0.0688
Abnormal_earnings	0.0040	0.0001	0.0108	-0.0001	-0.0002
Regulation_dummy	0.0043	0.0001	0.0000	0.0000	-0.0001
Real_size	5.0357	0.3188	5.1320	0.3849	0.0661

Unconstrained (*Tobins_Q<1*)

Variable	1980-1989 Average	Impact on *Debt-Maturity*	1990-2004 Average	Impact on *Debt-Maturity*	Difference
Market_to_book	0.8456	0.0196	0.8239	0.0354	0.0159
Taxes	0.3359	0.0256	0.2782	0.0120	-0.0136
Asset_maturity	13.7412	0.1090	12.7272	0.0385	-0.0704
Abnormal_earnings	0.0021	0.0001	0.0039	0.0000	-0.0001
Regulation_dummy	0.0061	0.0001	0.0000	0.0000	-0.0001
Real_size	5.0763	0.3214	5.0419	0.3782	0.0567

Table 4-21 - Fama-Macbeth Coefficients (from 1990 to 2004)

We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1980 to 2004. We exclude from the sample financial firms (SIC one digit code 6) and utilities (SIC two digit code 49). ADRs and firms designated as pre-FASB were also excluded. Our sample has 9,367 firms with a total of 45,943 firm-year observations. Firms may enter or leave the panel during the sample period 1980-2004. Our dependent and independent variables were cleaned by eliminating all outliers at the top and bottom 5% level. The dependent variable in the regressions is the ratio of debt maturing in more than three years over total debt (*Debt_maturity*). The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price.

constant	***Market_to_book***	***Taxes***	***Asset_maturity***	***Abnormal_earnings***	***Regulation_dummy***	***Real_size***
-0.2272	0.0470	0.0552	0.0104	-0.0123	dropped	0.0848
(-12.78)	(8.37)	(5.54)	(34.7)	(-0.59)	n.a.	(54.13)

Table 4-22 - Changes in the determinants of debt maturity from the 1980-1989 period to the 1990-2004 period for the whole sample, using Fama-Macbeth coefficients.

Whole Sample

Variable	1980-1989 Average	Impact on *Debt-Maturity*	1990-2004 Average	Impact on *Debt-Maturity*	Difference
Market_to_book	0.9601	0.0062	0.9156	0.0430	0.0368
Taxes	0.3298	0.0437	0.2650	0.0146	-0.0291
Asset_maturity	13.1237	0.1465	11.9220	0.1237	-0.0227
Abnormal_earnings	0.0043	0.0001	0.0108	-0.0001	-0.0002
Regulation_dummy	0.0042	0.0001	0.0000	0.0000	-0.0001
Real_size	4.9152	0.3018	5.0186	0.4254	0.1236

Table 4-23 - Changes in the determinants of debt maturity from the 1980-1989 period to the 1990-2004 period for the constrained firms' subsamples, using Fama-Macbeth coefficients.

We split the sample in three subsamples for constrained firms according to three criteria: In the first criterion a constrained firm is the one which has an assets' value in the first quartile, by year; In the second criterion we use a constrain dummy (*Cdummy*) that is set to one if: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one; In the third criterion a firm is considered to be constrained if it has a Tobin's Q ratio higher than one. *Tobins_Q* ratio is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets. The dependent variable in the regressions is the ratio of debt maturing in more than three years over total debt (*Debt_maturity*). The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price.

Constrained (small firms)

Variable	1980-1989 Average	Impact on *Debt-Maturity*	1990-2004 Average	Impact on *Debt-Maturity*	Difference
Market_to_book	1.5061	0.0098	1.4250	0.0669	0.0572
Taxes	0.2538	0.0336	0.1653	0.0091	-0.0245
Asset_maturity	11.7926	0.1316	10.9196	0.1133	-0.0183
Abnormal_earnings	0.0085	0.0002	0.0202	-0.0002	-0.0004
Regulation_dummy	0.0018	0.0001	0.0000	0.0000	-0.0001
Real_size	2.8112	0.1726	2.8133	0.2385	0.0658

Constrained (*Cdummy*=1)

Variable	1980-1989 Average	Impact on *Debt-Maturity*	1990-2004 Average	Impact on *Debt-Maturity*	Difference
Market_to_book	1.3728	0.0089	1.1736	0.0551	0.0462
Taxes	0.2505	0.0332	0.2079	0.0115	-0.0217
Asset_maturity	11.5022	0.1284	10.7211	0.1113	-0.0171
Abnormal_earnings	0.0071	0.0001	0.0109	-0.0001	-0.0003
Regulation_dummy	0.0031	0.0001	0.0000	0.0000	-0.0001
Real_size	3.8041	0.2336	4.2785	0.3627	0.1291

Constrained (*Tobins_Q*>1)

Variable	1980-1989 Average	Impact on *Debt-Maturity*	1990-2004 Average	Impact on *Debt-Maturity*	Difference
Market_to_book	1.0988	0.0071	0.9853	0.0463	0.0392
Taxes	0.3224	0.0427	0.2550	0.0141	-0.0286
Asset_maturity	12.3761	0.1381	11.3097	0.1174	-0.0207
Abnormal_earnings	0.0070	0.0001	0.0161	-0.0002	-0.0003
Regulation_dummy	0.0019	0.0001	0.0000	0.0000	-0.0001
Real_size	4.7201	0.2899	5.0008	0.4239	0.1341

Table 4-24 - Changes in the determinants of debt maturity from the 1980-1989 period to the 1990-2004 period for the unconstrained firms' subsamples, using FM coefficients.

We split the sample in three subsamples for unconstrained firms according to three criteria: In the first criterion a unconstrained firm is the one which has an assets' value in the last quartile, by year; In the second criterion we use a constrain dummy (*Cdummy*) that is set to zero if it doesn't meet the following two conditions: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one; In the third criterion a firm is considered to be unconstrained if it has a Tobin's Q ratio lower than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets. The dependent variable in the regressions is the ratio of debt maturing in more than three years over total debt (*Debt_maturity*). The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price.

Unconstrained (large firms)

Variable	1980-1989 Average	Impact on *Debt-Maturity*	1990-2004 Average	Impact on *Debt-Maturity*	Difference
Market_to_book	0.6665	0.0043	0.7010	0.0329	0.0286
Taxes	0.3668	0.0486	0.3270	0.0181	-0.0306
Asset_maturity	14.5550	0.1624	13.2361	0.1374	-0.0251
Abnormal_earnings	0.0003	0.0000	0.0036	0.0000	-0.0001
Regulation_dummy	0.0065	0.0002	0.0000	0.0000	-0.0002
Real_size	7.1616	0.4398	7.3251	0.6209	0.1812

Unconstrained (*Cdummy*=0)

Variable	1980-1989 Average	Impact on *Debt-Maturity*	1990-2004 Average	Impact on *Debt-Maturity*	Difference
Market_to_book	0.9153	0.0059	0.8760	0.0411	0.0352
Taxes	0.3384	0.0449	0.2738	0.0151	-0.0297
Asset_maturity	13.2996	0.1484	12.1061	0.1256	-0.0228
Abnormal_earnings	0.0040	0.0001	0.0108	-0.0001	-0.0002
Regulation_dummy	0.0043	0.0001	0.0000	0.0000	-0.0001
Real_size	5.0357	0.3092	5.1320	0.4350	0.1258

Unconstrained (*Tobins_Q*<1)

Variable	1980-1989 Average	Impact on *Debt-Maturity*	1990-2004 Average	Impact on *Debt-Maturity*	Difference
Market_to_book	0.8456	0.0055	0.8239	0.0387	0.0332
Taxes	0.3359	0.0445	0.2782	0.0154	-0.0292
Asset_maturity	13.7412	0.1534	12.7272	0.1321	-0.0213
Abnormal_earnings	0.0021	0.0000	0.0039	0.0000	-0.0001
Regulation_dummy	0.0061	0.0002	0.0000	0.0000	-0.0002
Real_size	5.0763	0.3117	5.0419	0.4274	0.1157

Table 4-25 - Summary table of the changes in the determinants of debt maturity from the 1980-1989 period to the 1990-2004 period for the whole sample and subsamples, using fixed effects coefficients.

We split the sample in six subsamples for constrained and unconstrained firms according to three criteria: In the first criterion a constrained (unconstrained) firm is the one which has an assets' value in the first (last) quartile, by year; In the second criterion we use a constrain dummy (*Cdummy*) that is set to one (zero) if it meets (doesn't meet) the following two conditions: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one; In the third criterion a firm is considered to be constrained (unconstrained) if it has a Tobin's Q ratio higher (lower) than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets. The dependent variable in the regressions is the ratio of debt maturing in more than three years over total debt (*Debt_maturity*). The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price.

	Whole Sample			**Constrained Subsamples**						**Unconstrained Subsamples**					
				Small Firms		***Cdummy***		***Tobins_Q***		**Large Firms**		***Cdummy***		***Tobins_Q***	
	Variables Coefficients	**Average**	**Impact**	**Average**	**Impact**	**Average**	**Impact**	**Average**	**Impact**	**Average**	**Impact**	**Average**	**Impact**	**Average**	**Impact**
Market_to_book	+	-	+	-	+	-	+	-	+	+	+	-	+		+
Taxes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asset_maturity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Abnormal_earnings	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
Regulation_dummy	-	-	-	-	-	-	=	-	-	-	-	-	-	-	-
Real_size	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+

Chapter 5 Corporate debt maturity and macroeconomic conditions

5.1 Introduction

This chapter evolves from the previous one. We have regarded that the firm-specific debt maturity determinants, by themselves, are not sufficient in explaining the debt maturity level in a satisfactory manner. The models obtained in the last chapter have poor predictive power, though in line with some of the existent empirical work. Our motivation is supported not only from the previous results but also from the work of Korajczyk and Levy (2003).

Our main research focus is to find how macroeconomic conditions impact on debt maturity decisions. The main contribution of this work relies in the fact that we focus not only at the firm-specific level but also at the macroeconomic level in determining the maturity structure of debt held by firms. To proxy for macroeconomic cycles and business conditions we use proven variables, namely, the two year equity market return, the two year corporate growth and the commercial paper spread.

Several other contributions are included in this chapter. We use a sample of 10,159 non-financial US firms over the period from 1974 to 2004, adding six years to the previous sample. Furthermore, we test whether there are differences in the debt maturity structure of financially constrained and unconstrained firms with emphasis on the macroeconomic conditions. We expect that during economic recessions firms shorten their debt maturity structure, particularly financially constrained firms. We also expect strong support to the maturity matching hypothesis between debt and assets, with a stronger economic impact on financially constrained firms. We classify firms as financially constrained and unconstrained according to five criteria, adding two new criteria: bond rating and commercial paper rating.

We perform several specification checks in order to give robustness to our findings. These specification checks are in line with some of the methodologies followed in recent empirical work. The conditions on these additional regression models include firms with a minimum change in the debt level from the previous year of 5%, firms which have at least three consecutive observations, firms split in sub-periods, re-estimation of the main regressions using the Tobit estimator and also the inclusion of a new proxy variable for macroeconomic conditions.

At the firm-specific level we find mixed results. We find no support for the agency costs hypothesis. These results are in line with Stohs and Mauer (1996) and Danisevská (2002), but contradictory to Barclay and Smith (1995) and Guedes and Opler (1996) . We find a positive relation between long-term debt and growth options, giving support to Diamond's (1991a) prediction. This relation is stronger in financially unconstrained firms. As expected, we find a significant positive relation between size and debt maturity in all our studied samples. Opposed to Barclay and Smith (1995), we find no evidence that being a regulated firm has any influence on the debt maturity choice. Also we find no evidence that supports the signaling mechanism in which firms use their debt maturity choice to signal their quality to the market. Myers (1977) matching principle receives good support in our study, in particularly from financially constrained firms. Contradicting Kane *et al.* (1985) we find that firms with higher effective tax rates borrow more long-term. This result is also supported in our financially constrained and unconstrained subsamples, though to a lesser extent.

At the macroeconomic level we find some support for our main hypothesis that firms hold more short-term debt during economic recessions. In the financially constrained and unconstrained subsamples we find that the results are far from being conclusive. Our hypothesis confirmation is closely dependent to the criteria used to split our sample what may suggest some inconsistency in our results.

The chapter proceeds as follows. In Section 5.2 we briefly describe the data and samples used. Section 5.3 presents our working hypothesis. In Section 5.4 we briefly discuss the adopted methodology. In Section 5.5 we report the main descriptive statistics and empirical results and finally we offer a brief summary of the chapter including the main conclusions in Section 5.6.

5.2 Data and samples[17]

As in the previous chapter, we use a large sample of US firms. The sample period is extended and now lies from 1974 to 2004. As before we exclude from the sample financial (SIC one digit code 6) and utilities (SIC two-digit code 49) firms and also ADRs and firms designated as pre-FASB. Our sample has 10,159 firms with a total of 56,768 firm-year observations. Firms may enter or leave the panel during the sample period. Our dependent and independent variables were cleaned by eliminating all outliers at the top and bottom 5% level.

We split our sample in financially constrained and unconstrained firms. To label each firm as constrained/unconstrained we apply the same three criteria used in the previous chapter and an additional two. The five criteria are:

- The first criterion is size. A financially constrained (unconstrained) firm is the one which has an assets' book value in the first quartile (last quartile), by year;
- In the second criterion we use a constrain dummy (*Cdummy*) that is set to one if: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one. The constrain dummy is set to zero and the firm is labeled as financially unconstrained if it does not meet these two conditions;
- In the third criterion, a firm is considered to be financially constrained (unconstrained) if it has a Tobin's Q ratio (*Tobins_Q*) higher (lower) than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets;
- In the first additional criterion a firm is considered to be financially constrained (unconstrained) if it has leverage and no (has) bond rating associated with it;
- The second additional criterion is similar to the first, but now we use the commercial paper rating instead of the bond rating.

[17] For a thorough description see Chapter 3.

Our dependent variable remains the debt maturity ratio (*Debt_maturity*). We measure *Debt_maturity* as the proportion of the firm's total debt that has a maturity of more than three years. As determinants of the debt maturity ratio we use the same firm-specific variables as in the previous chapter:

- We use the market-to-book ratio (*Market_to_book*) as a measure of growth options. Firms with market values greater than their book values are expected to have profitable investment opportunities. The ratio is computed as market value of assets, divided by the book value of assets. The market value of assets is determined by the book value of assets, less the book value of equity, plus the market value of equity. We use the market value of equity at the end of each calendar year;
- The firm size (*Real_size*) is calculated as the natural logarithm of the book value of assets inflated into 2004 dollars using the CPI;
- We use a dummy variable for industries that have been subject to entry and price regulation during a given period (*Regulation_dummy*). Regulated industries include railroads (SIC code 4011) through 1980, trucking (SIC codes 4210, 4213) through 1980, airlines (SIC code 4512) through 1978 and telecommunications (SIC codes 4812, 4813) through 1982;
- Future abnormal earnings (*Abnormal_earnings*) are used as a proxy for firm quality. *Abnormal_earnings* in time *t* is measured as the difference in earnings per share between time *t* and *t-1*, divided by time *t-1* share price;
- As proxies for asset maturity (*Asset_maturity*) we use the property, plant and equipment to depreciation and amortization expense ratio;
- We calculate the effective tax rate (*Taxes*) as the ratio between income taxes and pretax income.

We introduce three macroeconomic variables as additional determinants of the debt maturity. These new variables are used as proxies for macroeconomic conditions:

- The two-year equity market return (*2_year_equity_market_return*), which is calculated from the CRSP value-weighted index of stocks traded on NYSE, AMEX and NASDAQ;

- The two-year aggregate domestic nonfarm and nonfinancial corporate growth (*2_year_corporate_growth*), computed using quarterly data from the Flow of Funds;
- The commercial paper spread (*Commercial_paper_spread*). is obtained from the difference between the annualized rate on the three-month commercial paper and the three-month Treasury Bill.

5.3 Hypotheses

Next we present our working hypotheses. We will consider the presented theories in face of economic expansion or recession cycles.

During economic recessions companies' earnings are expected to be inferior than during economic expansions. The probability of the results being insufficient to cope with the financial costs of the short-term debt increases. Owning debt with maturity inferior to the assets maturity becomes riskier. According to theory, the matching of assets and debt maturity should be stronger during economic recessions. On the other hand, having debt with maturity superior to the assets maturity does not carry such high risk because in the long-term, firms will find themselves in an expansion cycle and it will be easier to invest in new assets that assure the payment of debt obligations.

Under de sub-investment problem, if the firm needs leverage to finance investment opportunities, we expect agency costs to be higher during economic recessions. This happens because an increase in leverage associated with a higher default risk will lead to a value loss for stockholders and debt holders. Debt holders will demand higher spreads and guarantees, leading to higher agency costs. During economic recessions, when growing opportunities decrease, the probability of managers' interests and stockholders' interests being in sync diminishes, increasing the agency costs. Managers may endure in more aggressive policies in order to get personnel benefits. During economic recessions, agency costs are expected to increase. To face increasing agency costs, firms should hold more short-term debt on their capital structure.

During economic slowdown firms face more financial difficulties. Earnings decrease and growing opportunities are reduced. In this sense, firm value tends to diminish. The default risk is higher and credit ratings deteriorate. This credit rating deterioration is more pronounced in less quality firms. During economic recessions the refinancing risk is higher. We expect high rating firms (little refinancing risk) or very low rating firms (where the access to long-term debt is difficult) to borrow short-term. Firms with intermediate rating should borrow more long-term.

During economic retraction, where market sentiment is usually negative, and in the presence of asymmetric information, quality projects may be undervalued by investors. Firms may signal their projects quality issuing short-term debt. In economic recessions, lesser quality firms will face more difficulties to mimic the behaviour of firms with good growing opportunities because the costs associated with the debt and the risk of non refinancing are higher. On the other hand, during recessions the uncertainty of short-term and long-term cash flow generation increases. Assuming the asymmetric information associated with those cash flows, Goswani *et al.* (1995) suggest that firms should issue short-term debt. During recessions, under the presence of asymmetric information, firms with higher quality projects should have more short-term debt, reducing the undervaluation of the latter (this is also true during expansion phases although to a lesser degree).

According to Kane *et al.* (1985) debt maturity has an inverse relation with the fiscal benefits of debt usage. Thus being, during economic recession, we would expect decreasing fiscal benefits. The higher bankruptcy costs and financial distress associated with decreasing taxable results may diminish the firm's ability to take advantage of all the fiscal benefits of debt. During economic recession we would then expect firms to have more long-term debt. However, Brick and Ravid (1985) argue that the firm's value increases with the usage of short-term debt, when in the presence of negative sloped interest rate curves. This is the case during economic recessions.

According to the previous analysis, we were able to identify the following working hypotheses:

H1: We expect that during economic recessions firms shorten their debt maturity structure, particularly financially constrained firms;

H2: We also expect strong support to the maturity matching hypothesis between debt and assets, with a stronger economic impact on financially constrained firms;

H3: We have no prior as to the relation of taxes and debt maturity during economic expansions or recessions.

5.4 Methodology

Our first step is to provide an overview of the variables used for the entire sample period, in particular for the dependent variable. We do this in three ways: in Table 5-1 we briefly report the main descriptive statistics for all the variables used, for the full sample; Table 5-2 shows the main descriptive statistics for the debt maturity ratio for the full sample and all subsamples of financially constrained and unconstrained firms; finally in Figure 5-1 we graphically depict the average debt maturity ratio for the full sample and identify the recession periods according to the NBER[18].

Next we estimate panel data regressions of *Debt_maturity* on firm-specific variables and macroeconomic variables. The firm-specific variables are observed in the same fiscal year as the dependent variable while macroeconomic variables are considered with a six month lag. We use year dummies and robust standard errors in all regressions. Firms may enter or leave the panel during the sample period 1974-2004. Our dependent and firm-specific independent variables were cleaned by eliminating all outliers at the top and bottom 5% level.

To properly identify which type of regression – pooled, fixed effects or random effects – is more appropriate for describing the relationship between the changes in debt maturity and the explanatory variables, we use the following statistical tests. The Breusch-Pagan Lagrange Multiplier test (Breusch and Pagan, 1980) is used to test the

[18] NBER stands for National Bureau of Economic Research. The data was obtained from their website: www.nber.org.

pooled regression against the random effects regression. If the null hypothesis is rejected, the random effects regression is more appropriate than the pooled regression[19]. The Hausman test (Hausman, 1978) is used to test the random effects regression against the fixed effects regression. If the null hypothesis is rejected, the fixed effects regression is more appropriate than the random effects regression. Since we reject the null hypothesis in the Breusch-Pagan test [$\chi^2(1) = 27{,}168.07$; $p<0.001$], and also in the Hausman test [$\chi^2(9) = 429.05$; $p<0.001$], the pooled and random effects models are discarded in favor of the fixed effects model. Table 5-3 shows the regression results for the full sample.

In the following stage we estimate fixed effects regressions predicting the debt maturity level against all independent variables for financially constrained and unconstrained firms, according to the five criteria described in Section 5.2. The results for the ten subsamples are reported in Table 5-4.

To give robustness to our finding we next perform several specification checks. First, we restrict our sample to include only those firms where changes in the debt level over net assets are greater than 5% of the book value of assets of the previous year. The idea behind this measure is to introduce a dynamic feature to the debt level instead of the static one previously used. Another restriction is made to include only those firms which have at least three consecutive observations during the sample period. Through this measure we look for improved consistency in the data. The regressions results can be found in Panel A and Panel B (respectively) of Table 5-5. We find similar approaches in Korajczyk and Levy (2003).

Next we split our time span in three sub-periods, with approximately a decade each (1974-1983, 1984-1993 and 1994-2004). Here we try to find timely differences in the determinants of the debt maturity choice, in particular the importance of macroeconomic conditions (see results in Panel C of Table 5-5). Since our dependent variable has values restricted between zero and one (both inclusive), we reestimate the full sample regression using the Tobit estimator[20]. The log or a log transformation of the dependent variable

[19] For details see Baltagi (2001).

[20] For details see Wooldridge (2001).

could not be used because several observations have a zero value. We run two Tobit regressions: with and without dummy variables for each industry defined by two-digits SIC code. Panel D of Table 5-5 shows the results.

As a last specification check we use a new variable to proxy for macroeconomic conditions – the Gross Domestic Product annual growth rate. This variable is used in several empirical work as a control variable for macroeconomic environment ((Guerrero, 2007), (Sorge and Zhang, 2007) and (Hernández-Cánovas and Koëter-Kant, 2006). A decrease in the growth rate, though positive, represents an economic slowdown, while negative growth rates usually stand for a recession period. Results can be found in Table 5-6.

5.5 Descriptive statistics and empirical results

5.5.1 Descriptive statistics

Table 5-1 presents some descriptive statistics for the variables used in our study for the full sample. Debt maturity equal or greater than three years represents, in average, 45% of total debt. The variation across the sample is high. Among the macroeconomic variables there are large differences between percentiles, in particular, as expected, in the *2_year_equity_market_return* and in the *2_year_corporate_growth*).

Table 5-2 presents descriptive statistics for the debt maturity ratio for the full sample and for the financially constrained and unconstrained group of firms. According to the five criteria used, financial unconstrained firms have, in average, more debt with larger maturity (from more than 5 pp difference in the Tobin's Q criterion to more than 33 pp in the size criterion). The exception comes from the last criterion – commercial paper rating - where the opposite occurs (the unconstrained group has about 15 pp less average debt maturity than the constrained one). We can also see that the number of firms included in each group is clearly different from one criterion to another. For the constrained group we have minimum total of 2,325 cases according to the commercial paper rating criterion and a maximum value of 48,309 cases according to the bond rating criterion. For the unconstrained group the opposite occurs, with a minimum value of

8,459 cases according to the bond rating criterion and a maximum value of 54,443 cases in the commercial paper rating criterion.

Figure 5-1 presents the average debt maturity ratio over the 1974-2004 period for the full sample. Recession periods, as defined by the NBER, are identified by shaded vertical bars. The average debt maturity ratio has its high peak in 1976 and 1977 with a value of 57% and a low point in 2000 with a 35% value. From the end of the 70's the ratio drops constantly until the year 2000 when this trend reverts and suffers a slight increase. During the recession periods of 1974 and 1975 we can observe a strong increase in the average debt maturity ratio. In the following recession periods the ratio follows a downward trend. The last recession period was very short and the ratio's value does not present a relevant variation.

5.5.2 Debt maturity determinants for the full sample

Table 5-3 reports the fixed effects panel regression for the full sample of the proportion of a firm's debt payable in more than three years on the firm specific variables and macroeconomic variables described earlier. The model is as follows:

$$\widehat{Debt\_maturity_{it}} = -0.112 + 0.0435\, Market\_to\_book_{it} + 0.0041\, Regulation\_dummy_{it} + \\ + 0.0883\, Real\_size_{it} + 0.0072\, Abnormal\_earnings_{it} + 0.0047\, Asset\_maturity_{it} + 0.0519\, Taxes_{it} + \\ + 0.02\, 2\_year\_equity\_market\_return_{it} + 0.0154\, 2\_year\_corporate\_growth_{it} + \\ + 0.2068\, Commercial\_paper\_spread_{it}$$

Inconsistent with the agency costs hypothesis, the coefficient on *Market_to_book* is positive and highly statistically significant. Thus, we find no support for the prediction that debt maturity structure decreases as the proportion of growth options in the firm's investment opportunity set increases. However, a positive relation between long-term debt and growth options is expected in the liquidity risk argument (Diamond, 1991a) where the inefficient liquidation of the firm's risky growth opportunities can be avoided issuing long-term debt. Our results give support to the latter.

Being a regulated firm represents an increase (other things equal) in the proportion of long-term debt. However, the dummy variable used for firms in regulated industries (*Regulation_dummy*), despite being slightly positive, is statistically insignificant.

We find, has expected, a positive relation between firm size and debt maturity. The coefficient for the logarithm of the firm value (*Real_size*) is positive and highly statistically significant, with a t-statistic of 33.31.

The coefficient of *Abnormal_earnings* has the wrong sign, according to the signaling hypothesis. This implies that firms with higher future earnings have more long-term debt. However, the coefficient is statistically insignificant.

The hypothesis of maturity matching between assets and debt is well supported. The coefficient of the proxy used (*Asset_maturity*) has a positive sign and is highly statistically significant. The economic impact is quite low with an increase in the debt maturity ratio, in average, of less than half a pp when the independent variable increases one pp (other things equal).

The coefficient of the effective tax rate (*Taxes*) is positive and highly statistically significant. We find that firms with higher effective tax rates tend to borrow more long-term debt. This result contradicts the argument by Kane *et al.* (1985) that firms increase their debt maturity structure as the tax advantage of debt decreases.

The results provided by the macroeconomic variables are broadly consistent with our hypotheses. In general, during periods of economic recession, firms tend to hold more short-term debt. The macroeconomic variables are positive and statistically significant, with the exception of the *Commercial_paper_spread*. Other things equal, in average, an increase of 1 pp in the *2_year_equity_market_return* tends to lead to an increase of 0.02 pp in the debt maturity ratio of firms, while the same increase in the *2_year_corporate_growth* tends to produce an increase of 0.0154 pp in the dependent variable.

5.5.3 Financially constrained and unconstrained debt maturity determinants

Table 5-4 reports the regressions results for the ten subsamples used in our study divided by the five criteria defined earlier. The results on the Tobin's Q criterion show that on the firm specific variables level the differences between financially constrained and unconstrained firms are mainly two: constrained regulated firms tend to shorten their debt maturity while no statistically significance evidence can be found for unconstrained firms and on the tax hypothesis we find that unconstrained firms have higher debt maturities when faced with higher effective tax rates, with no such evidence for the constrained firms.

On the other variables the sign of the coefficients are the same, but the economic impact on debt maturity is slightly higher for the high growth potential (financially constrained) group of firms. The coefficient for *Abnormal_earnings* is not statistically significant for both groups of firms. At the macroeconomic level we find evidence that both financially constrained and unconstrained firms shorten, in average, their debt maturity structure during recessions. The *Commercial_paper_spread* coefficient is not statistically significant, at the 0.1 level, for both groups of firms.

According to the size criterion we find little differences between small (financially constrained) and large (financially unconstrained) firms. At the firm-specific level all the supported hypotheses for the full sample are also valid for the two subsamples. The only exception comes from the *Market_to_book* where the coefficient is not statistically significant at the 0.1 level, for the constrained group. The macroeconomic variables, despite the fact of having all the right signs, are also not statistically significant at the 0.1 level, thus giving no support for our hypotheses.

Using the constrain dummy variable (*Cdummy*) criterion the conclusions withdrawn from the regressions for the firm-specific variables are very similar to those made for the Tobin's Q criterion. The main differences come from the fact that the *Regulation_dummy* coefficient is not statistically significant for both subsamples and that the coefficient for the *Abnormal_earnings* is statistically significant at the 0.1 level for the financially constrained group of firms. The negative sign of the latter coefficient is expected and in line with the empirical results of Barclay and Smith (1995), thus indicating that firms with higher future earnings have more short-term debt. At the macroeconomic level we find support for our hypotheses in the unconstrained group of firms. Financially unconstrained firms have more short-term debt during economic slowdowns. The results for the constrained firms give no such evidence, for all the economic variables' coefficients are statistically insignificant at the 0.1 level.

In the bond rating and in the commercial paper rating criteria the results for the firm-specific variables are quite similar. The *Regulation_dummy* and the *Abnormal_earnings* coefficient are in all cases not statistically significant at the 0.1 level, as happens with the full sample. All other hypotheses are supported for the financially constrained group of firms in both criteria. In the unconstrained group the tax rate (*Taxes*) coefficient is not statistically significant, at the 0.1 level, for both criteria, thus giving no support for the tax hypothesis underlined by the full sample results. The matching between assets maturity and debt maturity is also not supported for the unconstrained firms under the commercial paper rating criterion, despite the fact of the coefficient (*Asset_maturity*) showing the right sign.

The macroeconomic variables in the bond rating criterion give some support, though weak, for the hypothesis that firms increase their debt maturity during expansion cycles. This support is given by different proxy variables for both subsamples. In the financially constrained group the *2_year_equity_market_return* is the only macro variable which coefficient is statistically significant at the 0.1 level, while in the unconstrained group this is true for the *2_year_corporate_growth*. In the commercial paper rating criterion the conclusions withdrawn from the macroeconomic variables are different from the latter criterion. We now find strong support for out hypotheses in the financially constrained group of firms. Conversely, for the unconstrained group of firms we find no support at all, as all coefficients are not statistically significant at the 0.1 level. The *Commercial_paper_spread* coefficient is never statistically significant in both criteria.

5.6 Robustness checks

In order to check the robustness of our main results, we estimate additional regression models. Table 5-5 presents full sample regressions for different restrictions or conditions. Panel A includes only those firms where changes in the debt level over net assets are greater than 5% of the book value of assets of the previous year. A similar measure is used by Korajczyk and Levy (2003). The results for the firm-specific variables give good support to our main findings. However, at the macroeconomic level we find no such support, for all the coefficients are not statistically significant at the 0.1 level. The number of observations in the panel fell sharply to less than a third of the original sample, although the adjusted R^2 remains statistically significant.

In Panel B we only include in the subsample firms which have at least three consecutive observations during our sample period. This measure aims at giving some consistency to our sample. Once again, at the firm-specific level our main results receive good support. This is also the case at the macroeconomic level where the *2_year_equity_market_return* and the *2_year_corporate_growth* coefficients are both positive, as expected, and statistically significant at the 0.05 and 0.01 level, respectively.

Panel C splits the sample period in three different time spans. In the first sub-period, which ranges from 1974 to 1983, we find good support, at the firm-specific level, to our main results. The exception comes from the *Market_to_book* which coefficient is not statistically significant. At the macroeconomic level the *2_year_equity_market_return* is the only proxy having a statistically significant coefficient. In this decade, we then find some evidence that firms increase their debt maturity structure during economic expansion cycles. The second time span ranges from 1984 to 1993. The results are quite similar to the previous period. However, the coefficient for the *Market_to_book* is now statistically significant at the 0.01 level, giving an overall better support to the debt maturity structure theory proxied by the firm-specific variables.

Our hypotheses that firms decrease their debt maturity structure during economic recessions get a somehow weak support from our macroeconomic variables. Only the

2_year_corporate_growth coefficient is statistically significant. The last sub-period, from 1994 to 2004 is the one showing less robustness to our results. In the firm-specific variables group, the coefficient measuring the relation between the effective tax rate and debt maturity structure (*Taxes*) is not statistically significant, while in the macroeconomic environment none of the proxies for economic cycles have a statistically significant coefficient, thus giving no support to our previous results. The number of observations in all three sub-periods varies slightly.

Since our dependent variable has values restricted between zero and one (both inclusive), in Panel D we re-estimate our main regression using the Tobit estimator. We could not use the log or a log transformation of the dependent variable because several observations have a zero value. We run two Tobit regressions: with and without dummy variables for each industry defined by two-digits SIC code. Both regressions present similar results and have no material changes to our main regression. At the firm level all coefficients have the same sign as our previous results though presenting larger t-statistics for most variables. At the macro-economic level we find good support to our results. Despite the fact that the *2_year_market_return* is not statistically significant at the 0.1 level, the other two variables have the right sign and are statistically significant at the 0.05 level (the *2_year_corporate_growth* is statistically significant at the 0.01 level in the regression without industry dummy).

Our last specification check is presented in Table 5-6. We run our main regression using a new proxy variable for macroeconomic conditions, the Gross Domestic Product annual growth rate[21](*GDP_rate*). The results give emphasis to our hypothesis that firms shorten their debt maturity structure during periods of economic slowdowns. The *GDP_rate* coefficient is positive and statistically significant at the 0.05 level. As these results show, the elasticity of debt maturity with respect to the annual GDP growth rate is about 0.39, suggesting that if the GDP growth rate goes up by 1 pp, in average, the debt maturity ratio goes up by about 0.39 pp.

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[21] GDP data was obtained from the BEA (Bureau of Economic Analysis) web site - http://www.bea.gov/. Real GDP is expressed in 2000 chained dollars.

5.7 Summary

We examine the impact of macroeconomic conditions on the corporate debt maturity choice, using a sample of 10,159 non-financial US firms over the period from 1974 to 2004. We then split our sample in financially constrained and unconstrained firms according to five criteria and look for differences in the influence of business conditions on their debt maturity structure. The main contribution of this work relies in the fact that we focus not only at the firm-specific level but also at the macroeconomic level in determining the maturity structure of debt held by firms.

At the firm-specific level our results show mixed results. Some of the existing theories find strong support in our study while others find no support at all, or even contradictory results. We find a positive relation between long-term debt and growth options (in line with (Diamond, 1991a)), with a stronger economic impact in the financially unconstrained group of firms. A positive relation between size and debt maturity is found in all our studied samples. Myers (1977) matching principle receives good support in our study, in particularly from financially constrained firms. The agency costs hypothesis finds no support in the results. This is in line with Stohs and Mauer (1996) and Danisevská (2002), but contradictory to Barclay and Smith (1995) and Guedes and Opler (1996) .

Opposed to Barclay and Smith (1995), we find no evidence that being a regulated firm has any significant influence on debt maturity choice. We also find no evidence that supports the signaling mechanism in which firms use their debt maturity choice to signal their quality to the market. Our results show that firms with higher effective tax rates borrow more long-term, contradicting Kane *et al.* (1985). This result is also supported in our financially constrained and unconstrained subsamples, though to a lesser extent. The main results obtained at the firm-specific level are quite robust.

At the macroeconomic level we find some support for our main hypothesis that firms hold more short-term debt during economic recessions. However, the robustness tests conducted let us realize that our results lack definite confirmation. Though we never find statistically significant contradictory results to our main hypothesis, we also do not find the desired robustness. In our financially constrained and unconstrained subsamples we get somewhat weak results. In the latter, our hypothesis confirmation is closely dependent to the criteria used to split our sample.

As a final conclusion, our results give strength to the importance of firm-specific factors in the determination of the debt maturity structure of firms and to some of the existing theories. At the macroeconomic level and despite the fact of our results giving some indication on the influence of business conditions in the debt maturity choice framework, further studies must be conducted in order to achieve robust conclusions.

Table 5-1 - Description of firm-specific variables and macroeconomic variables for the full sample: 1974-2004 COMPUSTAT firms.

The table presents the descriptive statistics for our sample of firm years from the 1974-2004 sample of US-based publicity traded firms. *Debt_maturity* is defined as the proportion of debt that matures in more than three years. The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. The *2_year_equity_market_return* is the return on CRSP value weighted index of stocks traded on NYSE, AMEX, and Nasdaq. The *2_year_corporate_growth* is computed using the annual data from the Flow of Funds. The *Commercial_paper_spread* is the difference between the annualized rate on the three-month commercial paper and the three-month Treasury bill. N is the number of non missing observations in the sample for each variable.

Variable	Mean	25th Percentile	Median	75th Percentile	n
Debt_maturity	0.4515	0.1539	0.4931	0.7206	56,768
Market_to_book	0.9123	0.6408	0.7741	0.9840	56,768
Real_size	5.0697	3.8364	5.0145	6.2538	56,768
Taxes	0.3164	0.2444	0.3750	0.4339	56,768
Asset_maturity	12.9388	9.1811	12.7247	16.1918	56,768
Abnormal_earnings	0.0118	-0.0293	0.0067	0.0418	56,768
2_year_equity_market_return	0.2793	0.1378	0.2731	0.4811	56,768
2_year_corporate_growth	0.1668	-0.0420	0.1631	0.3813	56,768
Commercial_paper_spread	0.3218	0.1500	0.2800	0.4400	56,768

Table 5-2 - Descriptive statistics for debt maturity by groups of firms.

The table presents the debt maturity ratio's average and quartiles by groups of firms. We use five measures to group firms as financially constrained or unconstrained. In the first criterion, a firm is considered to be constrained (unconstrained) if it has a Tobin's Q ratio higher (lower) than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets. In the second criterion a constrained (unconstrained) firm is the one which has an assets' value in the first quartile (last quartile), by year. In the third criterion we use a constrain dummy (*Cdummy*) that is set to one if: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one. *Cdummy* is set to zero and the firm is labeled as unconstrained if it does not meet these two conditions. In the fourth criterion a firm is considered to be constrained (unconstrained) if it has leverage and no (has) bond rating associated with it. The last criterion is similar to the fourth, but now we use the commercial paper rating instead of the bond rating. N is the number of observations in each sample.

Groups	Mean	25th Percentile	Median	75th Percentile	n
Full sample	0.4515	0.1539	0.4931	0.7206	56,768
Constrained (*Tobins_Q*)	0.4206	0.0845	0.4393	0.7091	25,921
Unconstrained (*Tobins_Q*)	0.4775	0.2220	0.5286	0.7275	30,847
Constrained (size)	0.2918	0.0044	0.2136	0.5250	14,203
Unconstrained (size)	0.6224	0.4928	0.6846	0.8103	14,203
Constrained (*Cdummy*)	0.3750	0.0535	0.3344	0.6609	5,743
Unconstrained (*Cdummy*)	0.4601	0.1712	0.5068	0.7246	51,025
Constrained (bond rating)	0.4251	0.1160	0.4498	0.6972	48,309
Unconstrained (bond rating)	0.6026	0.4550	0.6656	0.8061	8,459
Constrained (commercial paper rating)	0.6027	0.4523	0.6706	0.8027	2,325
Unconstrained (commercial paper rating)	0.4451	0.1437	0.4825	0.7148	54,443

Figure 5-1 - Average of the debt maturity ratio from 1974-2004.

This figure presents the average debt maturity ratio (*Debt_maturity*) over the 1974-2004 period for the full sample. *Debt_maturity* is defined as the proportion of debt that matures in more than three years. Recessions, as defined by the NBER, are identified by shaded bars.

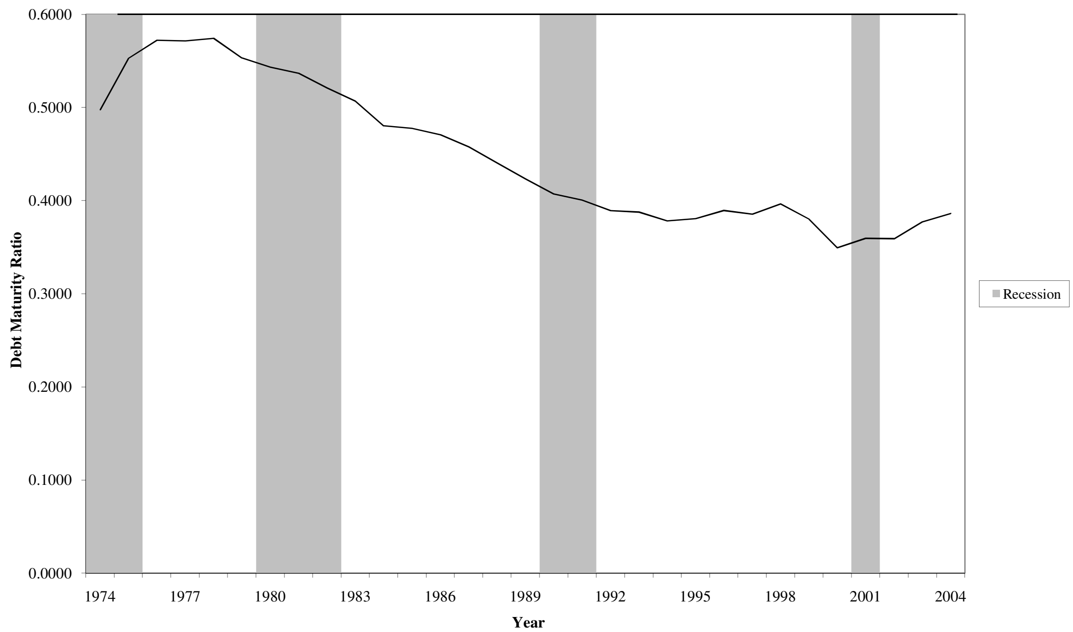

Table 5-3 - Fixed effects regressions predicting debt maturity levels for the full sample from 1974 to 2004.

The dependent variable (*Debt_maturity*) in the regression is the ratio of debt maturing in more than three years over total debt. The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. The *Regulation_dummy* has the value 1 for regulated firms and 0 otherwise. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. The *2_year_equity_market_return* is the return on CRSP value weighted index of stocks traded on NYSE, AMEX, and Nasdaq. The *2_year_corporate_growth* is computed using the annual data from the Flow of Funds. The *Commercial_paper_spread* is the difference between the annualized rate on the three-month commercial paper and the three-month Treasury bill. N is the number of non missing observations in the sample for each variable. The regression includes year dummies and robust standard errors. The regression is statistically significant according to the F-Test. T-test values are reported in parentheses.

	Fixed Effects
Constant	-0.1120
	(-6.46)
Market_to_book	0.0435
	(10.04)
Regulation_dummy	0.0041
	(0.29)
Real_size	0.0883
	(33.31)
Abnormal_earnings	0.0072
	(0.8)
Asset_maturity	0.0047
	(12)
Taxes	0.0519
	(5.12)
2_year_equity_market_return	0.0200
	(2.32)
2_year_corporate_growth	0.0154
	(2.07)
Commercial_paper_spread	0.2068
	(0.45)
n	56,768
Adjusted R^2	0.2518

Table 5-4 - Fixed effects regressions predicting debt maturity levels for constrained and unconstrained firms from 1974 to 2004.

Ten subsamples are used for these regressions. The subsamples are divided in constrained and unconstrained firms according to five criteria: In the first criterion, a firm is considered to be constrained (unconstrained) if it has a Tobin's Q ratio higher (lower) than one. *Tobins_Q* is defined as the sum of the market value of equity and the book value of debt, divided by the book value of assets. In the second criterion a constrained (unconstrained) firm is the one which has an assets' value in the first quartile (last quartile), by year. In the third criterion we use a constrain dummy (*Cdummy*) that is set to one if: (1) the firm does not have a net repurchase of debt or equity and does not pay dividends within the year, and (2) the firm's Tobin's Q is greater than one. *Cdummy* is set to zero and the firm is labeled as unconstrained if it does not meet these two conditions. In the fourth criterion a firm is considered to be constrained (unconstrained) if it has leverage and no (has) bond rating associated with it. The last criterion is similar to the fourth, but now we use the commercial paper rating instead of the bond rating. The dependent variable (*Debt_maturity*) in the regressions is the ratio of debt maturing in more than three years over total debt. The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. The *Regulation_dummy* has the value 1 for regulated firms and 0 otherwise. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. The *2_year_equity_market_return* is the return on CRSP value weighted index of stocks traded on NYSE, AMEX, and Nasdaq. The *2_year_corporate_growth* is computed using the annual data from the Flow of Funds. The *Commercial_paper_spread* is the difference between the annualized rate on the three-month commercial paper and the three-month Treasury bill. N is the number of non missing observations in the subsample. All regressions include year dummies and robust standard errors. They are all statistically significant according to the F-Test. T-test values are reported in parentheses.

	Tobin's Q		Size		Constrain dummy		Bond rating		Commercial paper rating	
	Constrainded	Unconstrained	Constrainded	Unconstrained	Constrainded	Unconstrained	Constrainded	Unconstrained	Constrainded	Unconstrained
Constant	-0.1491	-0.0997	0.0345	0.1451	-0.1167	-0.1096	-0.0886	-0.1310	-0.1132	-0.1497
	(-4.36)	(-3.74)	(0.93)	(2.85)	(-1.11)	(-5.82)	(-4.66)	(-2.57)	(-6.44)	(-1.22)
Market_to_book	0.0476	0.0337	0.0089	0.1200	0.0320	0.0493	0.0351	0.1054	0.0420	0.2105
	(7.99)	(3.3)	(1.41)	(5.31)	(1.86)	(9.77)	(7.78)	(4.7)	(9.61)	(4.39)
Regulation_dummy	-0.1281	0.0120	-0.1017	-0.0163	-0.1970	0.0083	-0.0058	0.0300	0.0069	-0.0278
	(-1.82)	(0.88)	(-1.02)	(-0.95)	(-0.75)	(0.59)	(-0.33)	(1.22)	(0.45)	(-0.92)
Real_size	0.0979	0.0873	0.0567	0.0442	0.1071	0.0858	0.0842	0.0905	0.0886	0.0853
	(20.7)	(21.77)	(6.66)	(7.09)	(7.7)	(29.94)	(27.33)	(16.66)	(32.63)	(6.24)
Abnormal_earnings	0.0138	0.0078	-0.0080	0.0184	-0.0984	0.0067	0.0053	0.0333	0.0073	0.0120
	(0.67)	(0.73)	(-0.51)	(0.86)	(-1.75)	(0.7)	(0.55)	(1.1)	(0.81)	(0.14)
Asset_maturity	0.0060	0.0036	0.0061	0.0024	0.0047	0.0045	0.0052	0.0027	0.0049	0.0002
	(8.75)	(6.48)	(7.52)	(3.07)	(2.39)	(10.72)	(12.04)	(2.81)	(12.1)	(0.09)
Taxes	-0.0166	0.0877	0.0471	0.0560	-0.0460	0.0640	0.0543	0.0160	0.0514	0.0362
	(-0.86)	(6.72)	(2.51)	(2.56)	(-0.88)	(5.92)	(5.01)	(0.54)	(5.01)	(0.55)
2_year_equity_market_return	0.0260	0.0134	0.0079	0.0192	0.0233	0.0202	0.0173	0.0338	0.0203	0.0110
	(1.68)	(1.23)	(0.43)	(1.23)	(0.44)	(2.23)	(1.85)	(1.48)	(2.29)	(0.27)
2_year_corporate_growth	0.0107	0.0187	0.0080	0.0206	-0.0613	0.0220	0.0119	0.0362	0.0136	0.0545
	(0.84)	(1.94)	(0.5)	(1.56)	(-1.46)	(2.83)	(1.49)	(1.87)	(1.79)	(1.64)
Commercial_paper_spread	1.4389	-0.4572	0.1821	0.1727	1.4390	0.0799	0.1367	0.7721	0.3007	-2.0071
	(1.58)	(-0.82)	(0.18)	(0.2)	(0.48)	(0.17)	(0.27)	(0.62)	(0.63)	(-1)
n	25,921	30,847	14,203	14,203	5,743	51,025	48,309	8,459	54,443	2,325
Adjusted R^2	0.2326	0.2576	0.1498	0.0567	0.2133	0.2515	0.2445	0.0748	0.2528	0.0357

Table 5-5 - Modified fixed effects regressions predicting debt maturity levels.

The dependent variable (*Debt_maturity*) in the regressions is the ratio of debt maturing in more than three years over total debt. The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. The *Regulation_dummy* has the value 1 for regulated firms and 0 otherwise. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. The *2_year_equity_market_return* is the return on CRSP value weighted index of stocks traded on NYSE, AMEX, and Nasdaq. The *2_year_corporate_growth* is computed using the annual data from the Flow of Funds. The *Commercial_paper_spread* is the difference between the annualized rate on the three-month commercial paper and the three-month Treasury bill. N is the number of non missing observations in the subsample. All regressions include year dummies and robust standard errors. They are all statistically significant according to the F-Test. Panel A includes only firms with changes in leverage over net assets greater than 5% of the book value of assets. In Panel B we consider only firms that have at least three consecutive observations. In Panel C we split the sample in three mutually exclusive time spans and in Panel D we estimate the Tobit model with and without dummy variables for each industry defined by 2-digit SIC code. T-test values are reported in parentheses.

	Panel A Var.>5% assets	**Panel B** Consecutive observations	**Panel C** - Period splits			**Panel D** - Tobit	
			1974-1983	1984-1993	1994-2004	Without industry dummies	With industry dummies
Constant	-0.2193	-0.1134	-0.0186	-0.0465	-0.3075	-0.2027	-0.2518
	(-4.9)	(-6.24)	(-0.48)	(-1.22)	(-6.42)	(-16.76)	(-10.09)
Market_to_book	0.0664	0.0495	0.0078	0.0373	0.0589	0.0289	0.0281
	(6.23)	(10.36)	(0.84)	(4.37)	(6.43)	(8.89)	(8.68)
Regulation_dummy	-0.0008	0.0021	0.0091	(dropped)	(dropped)	0.0470	-0.0111
	(-0.03)	(0.15)	(0.57)	n.a.	n.a.	(3.15)	(-0.69)
Real_size	0.0871	0.0886	0.0747	0.0860	0.1082	0.0793	0.0776
	(16.41)	(32.57)	(11.44)	(12.84)	(15.95)	(87.3)	(83.76)
Abnormal_earnings	0.0122	0.0002	0.0183	0.0187	0.0045	0.0077	0.0084
	(0.67)	(0.02)	(1.39)	(1.19)	(0.26)	(0.71)	(0.78)
Asset_maturity	0.0053	0.0046	0.0053	0.0045	0.0035	0.0114	0.0095
	(6.78)	(11.14)	(7.35)	(5.74)	(4.17)	(44.21)	(34.25)
Taxes	0.0625	0.0626	0.0536	0.0355	0.0102	0.1248	0.1303
	(2.94)	(5.92)	(3.13)	(2.09)	(0.44)	(14.38)	(14.83)
2_year_equity_market_return	0.0084	0.0197	0.0222	0.0147	0.0147	0.0050	0.0058
	(0.49)	(2.24)	(1.9)	(1.12)	(0.61)	(0.45)	(0.53)
2_year_corporate_growth	0.0178	0.0187	0.0160	0.0185	0.0024	0.0250	0.0218
	(1.27)	(2.48)	(1.4)	(1.92)	(0.09)	(2.62)	(2.32)
Commercial_paper_spread	0.5585	0.1454	0.0264	-0.1788	-2.1190	-1.2989	-1.1504
	(0.57)	(0.31)	(0.05)	(-0.19)	(-1.14)	(-2.21)	(-1.98)
n	17,711	47,547	18,717	18,960	19,091	56,768	56,768
Adjusted R^2	0.2401	0.2251	0.1627	0.2314	0.2303	0.3765	0.4107

Table 5-6 - Fixed effects regression predicting debt maturity levels with new macro variables, for the full sample from 1794 to 2004.

The dependent variable (*Debt_maturity*) in the regressions is the ratio of debt maturing in more than three years over total debt. The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets. The *Regulation_dummy* has the value 1 for regulated firms and 0 otherwise. *Real_size* is defined as the natural logarithm of total assets deflated using the CPI into 2004 dollars. *Taxes* is obtained from the ratio of income taxes over pretax income. Other firm variables displayed include measures of asset maturity from the property, plant and equipment over amortization and depreciation expenses ratio (*Asset_maturity*) and *Abnormal_earnings* measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. In this model we introduce a new macro variable: the Gross Domestic Product (*GDP*). The *GDP* stands for the annual growth rate. N is the number of non missing observations in the subsample. The regression includes year dummies and robust standard errors. The regression is statistically significant according to the F-Test. T-test values are reported in parentheses.

	Other Macro Variable
Constant	0.0032
	(0.22)
Market_to_book	0.0433
	(10.01)
Regulation_dummy	0.0039
	(0.27)
Real_size	0.0882
	(33.29)
Abnormal_earnings	0.0075
	(0.83)
Asset_maturity	0.0047
	(12.01)
Taxes	0.0519
	(5.12)
GDP	0.3864
	(2.12)
n	56,768
Adjusted R^2	0.2518

Chapter 6 Debt maturity estimation and classification using logistic regression, cluster analysis and decision trees

6.1 Introduction

In the previous two chapters we focus our study on the debt maturity on non-financial US firms over the last three decades. We analyze the existing trend and discuss if this trend can be explained by firm characteristics and whether these firms' characteristics impact changes over time. We then focus on how macroeconomic conditions influence debt maturity decisions. Using some of the most relevant debt maturity determinants found in the literature at the firm-specific level we add macroeconomic determinants and investigate the maturity structure held by firms during economic expansions and recessions. In most previous studies we analyze the differences on the debt maturity structure between financially constrained and unconstrained firms.

In this chapter we approach the debt maturity analysis from a different perspective. Using the same database sample and most of the debt maturity determinants of the previous studies, we apply different statistical multivariate techniques in order to reach two main objectives:

- Give support and robustness to the main findings of our previous studies;
- Acquire additional knowledge about the debt maturity structure of firms and the factors that influence the decision of having more short-term or long-term debt.

First, we apply logistic regression to estimate the probabilities and the odds ratio of a firm having a certain level of debt maturity. This allows us to find the importance of each determinant in predicting the probability of a firm having a certain level of the debt maturity ratio and if the estimated model is well suited in classifying firms in the right category.

Second, through cluster analysis, we aim at splitting our sample in homogeneous groups, according to the firms' specific characteristics previously identified, then analyze the debt maturity of each group and identify the main factors that differentiate and characterize them.

Finally, we use decision trees analysis with a double purpose:

- As a regression tool we find which determinants are more relevant in predicting the debt maturity ratio of firms. We then compare the results to those obtained in previous chapters using multiple linear regression analysis;

- As a classification tool in order to label firms and give each one a determined debt maturity class. We then compare some of the results with those obtained when using logistic regression.

The remainder of the present chapter is structured as follows. In Section 6.2 a concise description of the data and sample is provided. In Section 6.3 we present the adopted methodology. In Section 6.4 we present our main empirical results and in Section 6.5 we offer a brief summary of the chapter.

6.2 Data and sample[22]

We use a large sample of US firms, taken from COMPUSTAT Industrial Annual database. The sample period lies from 1974 to 2004. Financial firms (SIC one digit code 6) and utilities (SIC two digits code 49) are excluded from the sample. ADRs and firms designated as pre-FASB are also excluded. Our sample has 10,159 firms with a total of 56,768 firm-year observations.

The variables we use are the same as in the previous chapters. The variable that will support the dependent one is the debt maturity ratio and it is measured as the percentage of the firm's total debt that has a maturity of more than three years. As independent variables (covariates or predictors) we use:

- The market-to-book ratio (*Market_to_book*). The ratio is computed as market value of assets divided by the book value of assets;
- The firm size (*Real_size*) is calculated as the natural logarithm of the book value of assets inflated into 2004 dollars;
- The regulation dummy (*Regulation_dummy*) has a value of one for firms operating in industries that have been subject to entry and price regulation during a given period;
- The future abnormal earnings (*Abnormal_earnings*) in time t is measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price;
- The asset maturity (*Asset_maturity*) is the ratio between the property, plant and equipment to depreciation and amortization expense;
- The effective tax rate (*Taxes*) is the ratio between income taxes and pretax income;

[22] See Chapter 3 for further remarks on the sample and variables used.

- The two-year equity market return (*2_year_equity_market_return*) is calculated from the CRSP value-weighted index of stocks traded on NYSE, AMEX and NASDAQ;
- The two-year aggregate domestic nonfarm and nonfinancial corporate profit growth (*2_year_corporate_growth*) is computed using quarterly data from the Flow of Funds;
- The commercial paper spread (*Commercial_paper_spread*) is obtained from the difference between the annualized rate on the three-month commercial paper and the three-month Treasury Bill.

Firms may enter or leave the panel during the sample period 1974-2004. Our variables were cleaned from influential observations (outliers and extreme points) by eliminating all observations at the top and bottom 5% level and by eliminating all observations with missing data.

6.3 Methodology

6.3.1 High debt maturity probability estimation

We first address the question of predicting the probability of a firm having high debt maturity given some firm characteristics and economic conditions. Discriminant analysis should not be appropriate because the independent variables are a mixture of categorical and continuous variables and the multivariate normality assumption does not hold. In these cases logistic regression is usually recommended (Sharma,1996). Logistic regression is more flexible than discriminant analysis or than using regression analysis with a dichotomous dependent variable, since has no assumptions about the distributions of the independent variables and does not produce negative predicted probabilities (Barbara and Fidell, 2006). Logistic regression is also much more robust than discriminant analysis when the mentioned assumptions are not met (Hair *et al.*, 2005).

Our dichotomous dependent variable (*Debt_maturity_d*) is coded as 1 for high debt maturity and as 0 otherwise. A firm is considered having high debt maturity if the debt maturity ratio is higher than the average value for the whole sample (mean value of 0.4515). The covariates are the independent variables defined in the previous section.

At an initial stage we use SPSS Binary Logistic Regression command and the "Enter" method where all covariates enter the model at the same time. Then we run the regression using the "Forward LR" method in order to propose a more parsimonious estimated model. In the "Forward LR" method, at each step, the covariate not yet used that has a significance test associated p-value sufficiently small (we use a significance level of alfa=0.05), enters the model. Variables already in the regression equation are removed based on the probability of a likelihood-ratio statistic based on the maximum partial likelihood estimates, if the associated probability becomes sufficiently large (we use a significance level of alfa=0.10). The method ends when no more variables are eligible for inclusion.

To access the overall fit of the logistic regression models we rely on three different criteria:

- Statistical measures: one of these measures is the chi-square test for the changes in the Log Likelihood value from the base model (with only the constant) to the final model (with all covariates). Higher values of the test denote better model fit; the other is the Hosmer and Lemeshow test which measures the difference between the actual and predicted values of the dependent variable, indicating a better model fit when this difference is smaller (Hosmer and Lemeshow, 2000);
- Pseudo R^2 measures: these measures give indication of the estimated model goodness-of-fit and can be compared to the R^2 in linear regression models. We use the Cox and Snell R^2, the Nagelkerke R^2 and the McFadden R^2 [23]. Higher values indicate an increase in model fit;
- Classification accuracy: the hit ratio is used as a predictive accuracy measure and gives the percentage of cases correctly classified. The ratio is calculated for the overall sample and also by groups. We can compare the values obtained between the in sample analysis and holdout samples and also between the predictive accuracy achieved by the model and by chance. We also depict the ROC [24] curve which measures the model's ability to discriminate between cases with the success outcome and others.

We test the statistical significance of the estimated coefficients for the covariates using the Wald statistic in a similar manner to the *t* test in multiple linear regressions. We can identify next the significant independent variables that affect the predicted probabilities and group membership.

[23] The first two are given in the SPSS output while the latter can be easily computed with the following expression: $\text{McFadden } R^2 = \frac{-2\,\text{LLnull} - (-2\,\text{LLmodel})}{-2\,\text{LLnull}}$. This indicator shows the proportion in the reduction of the maximum value of the Log Likelihood function from the base model (null) to the final model.

[24] ROC stands for Receiver Operating Characteristic (Hosmer and Lemeshow, 2000).

6.3.2 Debt maturity in homogeneous groups

Our objective is to analyze the debt maturity in homogeneous groups and identify the main differences between them and relate those differences to the existing debt maturity theory. The first step is to find homogeneous groups according to specific firm characteristics. We use the full sample from 1974 to 2004 and all the firm specific variables presented in Section 6.2. The macroeconomic variables are not included since they do not discriminate between subjects.

To identify the homogeneous groups we use cluster analysis. This widely used technique aims at building groups where the similarities between subjects in the same group are as high as possible and between subjects of different groups are as low as possible, according to some similarity/distance measure used. To achieve this we use the Two-Step Cluster approach (see Chiu *et al.*, 2001). This approach has several characteristics that are more adequate to our study than the hierarchical or relocation (ie: k-means) methods[25]:

- It can handle well very large datasets;
- It is capable of handling both continuous and categorical variables;
- It can determine automatically the number of cluster;
- It is computationally more efficient.

The algorithm is based on the BIRCH – Balanced Iterative Reducing and Clustering using Hierarchies algorithm (Zhang *et al.*, 1997) and works in two steps: The first step pre-clusters the records into many small sub-clusters in order to reduce the size of the matrix containing the differences between all pairs of cases; In the second step, using the standard hierarchical algorithm, clusters the sub-clusters created in the previous step into the desired number of clusters (if the number of clusters is unknown the algorithm automatically finds the proper number).

Some of the considerations needed when using cluster analysis, like handling outliers and standardizing the variables are also included in this method. Since we have a mixture of categorical and continuous variables, the distance measure is defined by the log-likelihood decrease. All other main options are left in the default values.

The results obtained from the Two-Step Cluster approach are influenced by the data structure and observation order SPSS (2006). Since our data is ordered by firm and then by

[25] For a full description of the Two-Step Cluster method see SPSS (2001).

year, we must change it to guarantee that the sample is in random order. To do so we create five random variables and order the sample by each one and run the cluster analysis on the sample randomly ordered five times to show that the results obtained lead to similar conclusions. After choosing one of the previous five samples we find if the differences in the means of the firm-specific characteristics (only the continuous) and on the debt maturity ratio are statistically significant between the identified groups.

In the next step we analyze the descriptive statistics of each cluster and trace its profile identifying the main firms' characteristics associated with each one. To better understand the subjects included in each cluster we perform a crosstabulation of each cluster with each of the firm characteristics considered and also with the debt maturity ratio. Finally we relate the obtained results with the existent theoretical work.

6.3.3 Debt maturity estimation and classification using decision trees

In this section we have two main goals:

- Use CRT (Classification and Regression Trees) as a regression tool to estimate the debt maturity ratio, and then compare the results with those previously obtained using other techniques, namely statistical multiple linear regression;
- Use CRT as a classification tool in order to find which firm characteristics lead to high or low debt maturity ratios and compare the results with those obtained in section 6.4.1, using logistic regression.

The CRT algorithm can be found in the supervised learning domain and is used to analyze quantitative data (regression) or qualitative data (classification). The tree growing method starts from a root node with all cases. The algorithm then finds which independent (predictor) variable, and at which value or category, is the best in splitting the parent node in two child nodes (it is a binary tree where each parent node has always two child nodes). The variable selected in each node aims at maximizing the purity of the two child nodes so that each group is the most homogeneous possible, that is, it reduces the variability of the target variable (dependent variable) intra-nodes and maximizes the variability inter-nodes. The terminal nodes determine the prediction or classification performed by the model through the average value of the dependent variable of all cases included in the node or through the proportion of cases correctly classified in each category[26]. Each case follows a unique path throughout the tree branches from the parent node to the leaf nodes.

As quality improvement measures (impurity measures) we use the Gini(G)[27] index for the classification tree and the least-squared deviation (LSD)[28] for the regression tree. To access the quality of the models we use the risk estimate (the error) obtained from the terminal nodes (leaf nodes). In the regression, the risk estimate is equal to the squared errors means intra terminal nodes. We then divide the risk estimate by the total variance (the variance in the root node) to obtain the proportion of the total variance not explained by the model. Finally we obtain the proportion of total variance explained by subtracting the latter value from one. In the classification tree the quality of the model is given by the proportion of cases correctly classified. This value is obtained by subtracting the risk estimate (represents the proportion of misclassified cases) from one.

We use the default values of 0.001 for the minimum change in improvement, a maximum number of levels of 5, a minimum number of cases in the parent node of 100 and in the child nodes of 50. Since we establish the previous growth limits we choose not to perform the pruning of the tree. To validate our models we perform a cross validation with a 10 sample fold and also use a training sample and a test sample, with an 80%-20% and 50%-50% splits.

For both trees, regression and classification, we use the full sample from 1974 to 2004. As independent variables we use all firm and macroeconomic variables described in section 6.2. For the regression tree the target (dependent variable) is the debt maturity ratio as the proportion of debt with maturity over three years. The results are compared with those previously obtained using different techniques and are addressed according to the existent theory. For the classification tree our target variable is the same we use in the logistic regression in section 6.3.1, a binary variable (*Debt_maturity_d*) with two categories (1 for

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[26] For further description of the CRT algorithm and its advantages see Berry and Linof (1997), Breiman et al. (1984) or Han and Kamber (2006).

[27] $G = 1 - \left[\left(\text{Proportion}_{Category1} \right)^2 + ... + \left(\text{Proportion}_{Categoryn} \right)^2 \right]$, and an improvement in node splitting of: $\text{Improvemet} = G_{parent} - (\text{Proportion}_{child1} \times G_{child1} + \text{Proportion}_{child2} \times G_{child2})$

[28] $\text{Improvemet} = LSD_{parent} - (\text{Proportion}_{child1} \times LSD_{child1} + \text{Proportion}_{child2} \times LSD_{child2})$

high debt maturity and 0 for low). A firm is considered having high debt maturity if the debt maturity ratio is higher than the average value for the whole sample (mean value of 0.4515). Finally we compare the results to those obtained from the logistic regression performed in section 6.4.1.

6.4 Empirical Results

6.4.1 High debt maturity probability estimation

Output 1 describes the results obtained for the direct logistic regression on our debt maturity dichotomous dependent variable and all covariates. The analysis uses the full sample[29], from 1974 to 2004 and the "enter" method was applied. We have a total of 56,768 selected cases and no missing observations (Table 6-5). Our dependent variable (*Debt_maturity_d*) is encoded with 1 for cases with a debt maturity ratio higher than 0.4515 (the mean value of the all sample) and with 0 otherwise.

The beginning block (Bock 0) is relative to the null model (with only the intercept). Using this simplest model all observations have an estimated probability of 0.5362[30] which is the dependent variable mean. Since we are using a cut off value of 0.5, all observations are predicted has having high debt maturity and the percentage of correct cases is 53.6% (see Table 6-6).

In Block 1 we find the results for our final model with all covariates, since we use the enter method. To access the overall model fit we first look at the Omnibus tests of model coefficients (Table 6-8), which gives us the test for the difference in the maximum LL value between the null and the final models. For a $G^2(9) = 11{,}697.929$; $p<0.001$, we can conclude that at least one of the covariates has a predictive power over our dependent variable, thus the full model represents an improvement over the null model.

[29] Although not reported, we also ran the regression with an in sample analysis and a holdout sample (splits of 50/50 and 80/20). The results are very similar to those reported for the full sample.

[30] $\hat{\pi}_j = \frac{e^{0.145}}{1 + e^{0.145}} = 0.5362 \quad (j = 1, \ldots, 56{,}768)$

In Table 6-9 we find the Cox & Snell $R^2 = 0.186$ and the Nagelkerke $R^2 = 0.249$. The McFadden R^2 has a value of 0.1492[31]. These values, though in line we those obtained in previous chapters using multiple linear regression, are somewhat low for purposes of practical significance. The full model has a mediocre quality, accounting with low values in the variation in the dependent variable. The Hosmer and Lemeshow test (Table 4-10) presents a $\chi^2_{HL}(8) = 54.479$; $p<0.001$, indicating that significant differences still remain between the predicted and actual values.

The classification table (Table 6-11) shows the observed and predicted group membership by the model. The model sensitivity is 74.0% (the model correctly classifies 74.0% of the subjects with high debt maturity/successful) and the specificity is 63.5% (the model correctly classifies 63.5% of the subjects that do not have high debt maturity/unsuccessful). The total percentage of cases well classified is 69.1%, which represents an increase of 15.5 pp over the null model and is 18.84 pp higher than the proportional percentage number of correct cases classified by chance of 50.26%[32].

Analyzing the ROC curve (see Figure 6-3) we find that the probability of occurrence of the success group (those who have high debt maturity) is higher than the occurrence of the non success group (those who have low debt maturity). The area under the curve has a 0.752 value. Hosmer and Lemeshow (2000) provide us with a reference table (Table 6-1) for this discrimination value:

Table 6-1- ROC Discriminating Power

ROC Area	Discriminating power
0.5	No discrimination
]0.5; 0.7[	Weak
[0.7;0.8[	Acceptable
[0.8;0.9[	Excellent
≥ 0.9	Outstanding

According to the reference table, our model shows an acceptable discriminating power.

31 Knowing that $G^2 = -2LL_{null} - (-2LL_{model}) \Leftrightarrow -2LL_{null} = 11{,}697.929 + 66{,}700.534 \Leftrightarrow -2LL_{null} = 78{,}398.463$, then

$$\text{McFadden } R^2 = \frac{78{,}398.463 - 66{,}700.534}{78{,}398.463} = 0.1492$$

32 $$\left[\left(\frac{26{,}326}{56{,}768}\right)^2 + \left(\frac{30{,}442}{56{,}768}\right)^2\right] \times 100 = 50.26\%$$

Table 6-12 shows us all the variables in the final model with the coefficients value, their standard error, the Wald statistic and significance level and in the last column (Exp(B)) which reflect the magnitude of the expected change in the dependent variable (the odds ratio) per each unit change in the independent variable. Since we use the "enter" method, all covariates are part of the final model and enter it at the same time. Our estimated model can be written through the following equation:

$$Ln\left(\frac{\hat{\pi}}{1-\hat{\pi}}\right) = -4.339 + 0.349\,Market\_to\_book + 1.349\,Taxes + 0.088\,Asset\_maturity +$$
$$+ 0.037\,Abnormal\_earnings + 0.844\,Regulation\_dummy + 0.506\,Real\_size +$$
$$+ 0.229\,2\_year\_equity\_market\_return + 0.733\,Commercial\_paper\_spread +$$
$$+ 0.014\,2\_year\_corporate\_growth$$

Note: The $\hat{\pi}$ represents the estimated probability that the dependent variable will be 1.

According to the Wald test we find that three estimated coefficients are not statistically significant even at the 0.1 level: the ones associated to the variables *Abnormal_earnings* [$\chi^2_{Wald}(1)=0.192$; p=0.661], *Commercial_paper_spread* [$\chi^2_{Wald}(1)=0.059$; p=0.807] and the *2_year_corporate_growth* [$\chi^2_{Wald}(1)=0.170$; p=0.680]. All other estimated coefficients are statistically significant at the 0.01 level. Analyzing the directionality of the relationships between the independent variables and the dependent one, we find that all covariates coefficients are positive, which translates into a positive relationship where in average an increase in the independent variable is associated with an increase in the predicted probability. The same conclusion can be gathered from the last column of the exponentiated logistic coefficients, although the reading is different: a coefficient (B) value of 0 (no effect) equates to an odd value of 1 and an associated probability of 0.5. Values higher than 1 (B>0) in the Exp(B) column indicate a positive relationship and values lower than 1 (B<0) indicate a negative relationship. As expected, our results show all covariates with values higher than 1.

To access the magnitude of the relationship between our independent variables and our dependent one we look at the exponentiated coefficients in the last column of the table. The most relevant magnitudes, for the statistically significant coefficients, are found in the *Taxes*, *Regulation_dummy*, *Real_size* and *Market_to_book* variables. The following table shows the expected percentage change in odds ratio per a unit change in the mentioned variables (ceteris paribus):

Table 6-2 - Independent variables' impact on odds ratio

Variable	Exp(B)	% Change in odds ratio for each unit[33]
Taxes	3.853	285.30%
Real_size	1.659	65.90%
Market_to_book	1.418	41.80%

From the previous table we can state that on average the odds ratio increases 285.30% for each unit increase in the tax rate, increases 65.90% for each unit increase in the *Real_size*[34] variable and increases 41.80% for each unit increase in the market-to-book ratio, supposing that all the rest remains constant. For practical purposes the previous relations can be stated as follows: in average, for each percentage point increase in the tax rate the odds ratio increases 1.36%, for each 10 pp increase in the market-to-book ratio the odds ratio increases 3.55% and for each 1% increase in the assets value the odds ratio increases roughly 0.51%. Since the Regulation_dummy is a categorical variable, the magnitude interpretation is different. With an Exp(B) = 2.325, regulated firms have on average 132.50% higher odds ratio than non regulated firms. Overall, we can conclude that an increase in all covariates and being a regulated firm has a positive impact in the odds ratio and consequently increases the probabilities of firms having high debt maturity.

Since the marginal effects of the logit model are not exactly the estimated coefficients, we follow the procedure suggested by Greene (2007) in which the marginal effect of each independent variable is the product of the logistic cumulative density function by the associated estimated coefficient. On average, for each unit change in *Taxes* the probability of a firm having high debt maturity changes in the same direction by 0.7233, while for each unit change in the *Logsize* the probability changes 0.2714. The probability of a firm having high debt maturity increases/decreases on average 0.1872 for each unit increase/decrease, respectively, in the *Market_to_book* variable. For the dummy variable *Regdum* we find the marginal effect through the difference in the estimated probabilities for *Regdum*=1 and *Regdum*=0, using the mean values for all other independent variables. In average, the

[33] % Change in odds ratio = (Exponentiated coefficient$_i$ – 1.0) x 100.

[34] Remember that this variable is the natural logarithm of the firm assets value in 2004 dollars.

probability of a regulated firm having debt maturity above average is 0.191 superior to the same probability for a not regulated firm, other things equal.

As a specification test we perform the LM test proposed by Davidson and MacKinnon (1993) in order to check for heteroscedasticity problems in the model. We perform the test for all independent variables and find values between 30 and 38. Since the critical value for the test is 3.84 (corresponding to a χ^2 distribution with 1 degree of freedom) we reject the null hypothesis and conclude that the errors are heteroscedastic. Therefore, the estimated coefficients in the logistic regression are no longer the most efficient. To obtain consistent estimators for the estimators' variance we run the same logistic regression with the Huber-White procedure. This procedure only corrects the estimators' variance while the estimated coefficients remain the same. The results (not reported) for all variables' standard errors and significance levels are almost the same as those previously obtained and the conclusions involving the explanatory variables remain valid.

In Output 2 we show the results of running the previous logistic regression, which results were presented in Output 1, but this time using the "forward LR" method instead of the "enter" method[35]. The results for the null model are omitted (Block 0) since are the same as those presented in Output 1.

From the Omnibus tests of model coefficients table (Table 6-15) we find that the final model was obtained in six steps and that each step introduced a new variable with predictive power over our dependent variable. The $G^2(6) = 11{,}697.464$; $p<0.001$ test in the final model is almost exactly the same as the one obtained in the "enter" method. All three R^2 present the same poor values as previously. From Table 6-16 we can observe that the R^2 increase in the last four steps is quite small, representing an increase in model fit almost null. The Hosmer and Lemeshow test (see Table 6-17) indicates once more the existence of significant differences between the actual and predicted probabilities.

From the classification table (Table 6-18) we can derive some important issues. The overall percentage of correct classification (69.1%) is the same as in the previous model as are the sensitivity and specificity of the model. We can also observe that the last five variables

[35] Once again we also ran the regression with an analysis sample and a holdout sample (splits of 50/50 and 80/20). The results are very similar to those obtained for the full sample and are not reported.

introduced in the model only increased the overall correct classification in 2.1 pp and that the last three in only 0.2 pp. If we look at Table 6-19 we conclude that the first two variables to enter the model (*Real_size* and *Asset_maturity*) are the most influential in correctly classifying the sample cases. The ROC curve analysis is not reported since it is the same as in the previous model.

The final model has six variables, all statistically significant at the 0.01 level. From the previous model, as expected, the three non significant variables were left out (see Table 6-20). At the firm specific level only the *Abnormal_earnings* (proxy for firm quality) was not included in the model. At the macroeconomic level only the *2_year_equity_market_return* entered the model and that happened at the last step, denoting the weak predictive power of the chosen macroeconomic variables. The sign of the variables coefficients included in the model is the same as before and their magnitude quite identical.

6.4.2 Debt maturity in homogeneous groups

We perform a two step cluster analysis on our full sample from 1974 to 2004. The characteristics used to find different homogeneous groups are represented by the firm-specific independent variables described in section 6.2. We ran the two step cluster algorithm five times on the same sample with five different ordered observations to observe if changing the sample order would yield relevant different results and conclusions. The five results obtained all identify only two clusters. The differences from sample to sample, by cluster, are presented next on Table 6-3 and Table 6-4.

Table 6-3 - Summary results for cluster 1

	Samples				
Variables	**1**	**2**	**3**	**4**	**5**
Market_to_book	.7844	.7594	.7829	.7509	.7562
Taxes	.3931	.3846	.3871	.3883	.3912
Asset_maturity	13.4735	13.6203	13.5118	13.6643	13.6063
Abnormal_earnings	.0132	.0163	.0150	.0026	.0114
Regulation_dummy	.0086	.0087	.0084	.0091	.0089
Real_size	5.4557	5.5655	5.4645	5.6063	5.5758
n	43,670	43,459	44,656	41,204	42,235
%	76.93%	76.56%	78.66%	72.58%	74.40%

Table 6-4 - Summary results for cluster 2

	Samples				
Variables	**1**	**2**	**3**	**4**	**5**
Market_to_book	1.3387	1.4117	1.3896	1.3397	1.3660
Taxes	.0606	.0936	.0558	.1259	.0991
Asset_maturity	11.1559	10.7134	10.8262	11.0181	10.9987
Abnormal_earnings	.0070	-.0031	.0001	.0363	.0130
Regulation_dummy	.0001	.0001	.0001	.0003	.0001
Real_size	3.7827	3.4506	3.6141	3.6492	3.5988
n	13,098	13,309	12,112	15,564	14,533
%	23.07%	23.44%	21.34%	27.42%	25.60%

From the previous tables, though some differences do exist, the main attributes of each cluster remain the same through all the samples. To proceed our study we chose the second sample, since it is the one with mid values for subject separation between clusters. As we can see, cluster 1 has a total of 43,459 cases representing 76.56% of the entire sample, while cluster 2 has 13,309 cases which represent the remaining 23.44% of the total sample. The discrepancy in size is relevant between the two clusters, with cluster 1 being more than 3 times larger than cluster 2.

Output 3 shows some of the main results obtained from the cluster analysis and some additional information relating to the previously identified two clusters. From the Auto-Clustering table (Table 6-21) we can observe the evolution in the Schwarz's Bayesian Criterion (BIC)[36] when additional clusters are added to the solution. In this case the algorithm chooses two clusters, where the ratio of distances measures (last column of the table) is the highest. From three clusters on this ratio has always lower values being the nearest one associated with a six clusters number.

Next we try to identify how important the different variables are for the formation of the clusters. Beginning with the categorical variable – *Regulation_dummy* – we find that less than 0.7% ($\frac{378}{56,768}$) of the total cases are classified as regulated firms and of those, 99.7% are included in the first cluster (see Table 6-22). For categorical variables the SPSS package calculates a chi-square value that compares the observed distribution of values of the variable

[36] The same results can be obtained using the Akaike's Information Criterion (AIC).

within each cluster to the overall distribution of values. The Figure 6-4 presented in Output 3 shows large values obtained for the chi-square statistic indicating that the *Regulation_dummy* distribution in both clusters differs from the overall distribution. Since the chi-square values are far from the critical line, there is an indication that the *Regulation_dummy* variable is important in distinguishing both clusters.

We now turn our focus to the other (continuous) variables considered in the cluster analysis. SPSS provides the independent samples t-test to compare each variable mean in each cluster with the overall mean for that variable. We consider a confidence interval value of 95%. Analyzing the variables importance in cluster 1 (see Figure 6-5) we find that all variables are statistically significant. The most important firm characteristics in differentiating this cluster are the growth options level (proxied by the *Market_to_book* variable), the effective tax rate (proxied by the *Taxes* variable) and the firm size (proxied by the *Real_size* variable). The firm quality, proxied by the *Abnormal_earnings* variable is the least relevant factor in this cluster identity.

In cluster 2 we also find that all variables have significant different means than the overall means. The most important factors in this cluster composition are the same as in the first cluster, though with a different order: the effective taxe rate is the most important, followed by the firm size and then by the growth options level (see Figure 6-6).

In Table 6-23 we present the main descriptive statistics for the continuous variables considered in our analysis and also for the *Debt_maturity* variable (see section 6.2), by cluster[37]. We aim at identifying the main differences between the two clusters and elaborate each profile. In cluster 1 we find firms that on average:

- Have significant less growth opportunities (the *Market_to_book* ratio is 53.79% lower than in cluster 2);
- Are subject to substantial higher effective tax rates (on average pay more than 4 times than firms in cluster 2);
- Have assets in place with higher maturity (more than 27% than firms in cluster 2);

[37] On all variables we first apply the Levene's (Levene, 1960) test for equality of variances and reject the null hypothesis (p-value<0.001). We then use the t-test (with equal variances not assumed) and reject the null hypothesis in all cases (p-value<0.001), thus indicating statistical significant differences in the means between the two clusters.

- Have average positive abnormal earnings (conversely firms in cluster 2 have on average negative abnormal earnings). According to the proxy used, in average firms in cluster 1 have more quality than firms in cluster 2;
- Are much larger, in average, than firms in cluster 2. The average book value of assets of firms in this cluster is more than seven times higher than firms in cluster 2[38].

With the exception of the maximum value for the *Market_to_book* variable, both clusters have similar minimum and maximum values for all other variables. To help us better understand the dispersion of firm characteristics between the two clusters we perform a crosstabulation between each cluster and each variables' quartiles. These results can be found at the end of output 3 and provide the following main conclusions:

- For the *Market_to_book* variable (Table 6-25), in cluster 1 more than 60% of cases have values in the first two quartiles and only 12% are in the last quartile while in cluster 2 we find less dispersion with more than 84% of cases belonging to the third and fourth quartile;
- In the *Taxes* variable (Table 6-26), cluster 1 shows a similar split of cases between the last 3 quartiles, summing up more than 93% of cases. In cluster 2 almost 82% of cases belong to the first quartile. The substantial different dispersion between the two clusters culminate in the big discrepancy in the average tax rate previously reported;
- In the *Assets_maturity* variable (Table 6-27) we find that the cases are almost evenly dispersed between all quartiles in cluster 1. In cluster 2 cases are more concentrated in the first two quartiles (more than 69% of cases), thus the lower average asset maturity than firms in cluster 1;
- For the *Abnormal_earnings* variable (Table 6-28) we find that almost half of the number of cases belong to the first two quartiles and the other half to the last two, in the first cluster. In the second cluster we find a U-shape dispersion of cases with 39% in the first quartile and 29% in the last, which is a bit surprising given the negative mean value obtained for this cluster;
- Finally, in the *Real_size* variable (Table 6-29) the differences between both clusters cases quartiles dispersion is evident. In the first cluster only 12.3% of cases are found in the first quartile. The percentage of cases continuously increases from a 25.9% value in the second quartile to a 31.9% value in the last. In cluster 2, almost two thirds

[38] Remember that the *Real_size* variable is the natural logarithm of the inflated value of assets in 2004 dollars.

of cases are found in the first quartile while only 8.9% are part of the third and 2.6% of the last.

Now that the differences between the two clusters have been accessed and after identifying the average profile of the type of firm existent in each group we turn our focus to the main firm characteristic in our study - the debt maturity. From Table 6-23 we can easily conclude that there are visible differences between clusters in the average value for the debt maturity ratio. As previously reported, these differences are also statistically significant. Cluster 1 has a mean value for the *Debt_maturity* variable of 0.5029 which is more than 77% higher than the 0.2837 value found in cluster 2. The differences found in the median are even bigger – cluster 1 has a value more than three times higher than cluster 2.

When we look at the crosstabulation between each cluster and the *Debt_maturity* quartiles (see Table 6-24) we find, as expected, that the dispersion of cases is quite different in the two clusters. Cluster 1 has a relative well balanced dispersion of cases which gradually increases from an initial value of 18.1% in the first quartile to a final value of 29% in the last quartile. The reality in cluster 2 is quite different with almost 50% of cases belonging to the first quartile and less than 26% found in the last two.

The final steps in our analysis is to associate the characteristics of each type of firm found in the two clusters to the debt maturity value and find the necessary support in the existent theoretical work. In cluster 1, where the average debt maturity is substantially higher, we find larger firms, with more quality, that have less growth opportunities, pay much higher effective tax rates and have longer maturity assets. According to the most relevant theoretical work, we should expect a positive relation between size and debt maturity. Supporting the agency costs hypothesis, we should find that the maturity structure of firms increases as the proportion of growth options in the firm's investment opportunity set decreases. The maturity matching hypothesis should be supported, reflecting a positive relation between the maturity of assets and the maturity of debt. Being a regulated firm should represent (other things equal) an increase in the proportion of long-term debt. All these hypothesis find strong support in our results.

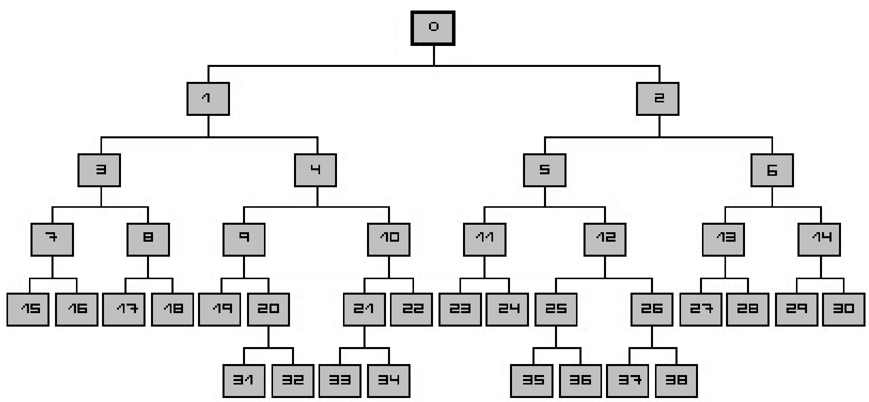
The only contradictory result is the one represented by the *Abnormal_earnigs* variable, where firms with higher future earnings have more short-term debt. However, we have seen that this variable is the least relevant in differentiating our two types of firms. The relation between taxes and debt maturity is not clear in the literature, though our results are contrary to

Kane *et al.* (1985) argument that firms increase their maturity structure as the tax advantage of debt decreases. We should point out that all these results are in line with those obtained in the previous chapters.

6.4.3 Debt maturity estimation and classification using decision trees

With the debt maturity ratio as our dependent variable (*Debt_maturity*), and using the full sample, the CRT algorithm generates a tree with five levels of depth (the maximum number chosen) and 39 nodes, of which 20 are terminal nodes (Figure 6-1).

Figure 6-1 - Regression tree diagram



According to the risk estimate of 0.07 (see Table 6-30) and an adjusted standard deviation of the first node of 0.305 (see Table 6-32) we find that the proportion of the total variance of the debt maturity ratio explained by the independent variables is 0.2477[39], thus the model explains 24.77% of the total variance. The results show a weak predictive capability of the model although similar results were obtained when using multiple regression (see Chapter 5)[40].

[39] $$R^2 = 1 - \frac{0.07}{0.305^2 \times \frac{56767}{56768}} = 0.2477$$

[40] In non reported results we also performed the same tree with a 10 fold sample cross validation and with a training and test samples (50%/50% and 80%/20% splits) and obtained similar results. Since some of the terminal nodes still have a large number of cases, we increase the tree depth to six levels but obtain the same results because the improvement limit was reached. When we lower the improvement value to 0.00001 we have a gain in the R^2 of less than 2 pp and a substantial increase in the model's complexity (with a total of 63 nodes).

From the initial nine variables introduced as predictors, only four are chosen to generate the tree and estimate the debt maturity ratio. The variables are the *Real_size*, the *Asset_maturity*, *Taxes* and *Market_to_book*. None of the macroeconomic variables are present. In Table 6-31 we find the normalized importance of each variable[41]. The *Real_size* variable is the most important in explaining the dependent variable, being closely followed by the *Asset_maturity*. Further away are the *Taxes* and *Market_to_book* variables with less of half the importance of the *Real_size*. The excluded variables all have residual importance of less than 2%.

Table 6-33 shows the six nodes from the first two levels. The first tree ramification uses the *Real_size* variable, with one branch (left) corresponding to firms with an asset's value in 2004 dollars equal or less than 158.222 million[42] (*Real_size* <= 5.064) and the other branch (right) corresponding to larger firms. Node 1 has 28,980 cases and represents firms with lower debt maturity ratios (average value of 0.340) while the opposite occurs in node 2 with almost the same number of cases (27,788) but with an average debt maturity ratio substantially higher (a value of 0.568). The left branch is then split in two according to the *Asset_maturity* variable (cut value of 9.349), where firms with less asset maturity (node 3) have the lowest mean debt maturity ratio of 0.219. Conversely, the highest average debt maturity (mean value of 0.621) in the second level of the right branch is concentrated in node 6 where firms have asset's value over 508.772 million dollars (again the split variable was the *Real_size* with a cut value of 6.232).

Table 6-34 presents the complete left ramification of the tree, corresponding to the smaller firms. In this branch the terminal node which reflects the lowest average debt maturity ratio is node 15. This node aggregates all smaller firms (with asset's value equal or lower than 51.111 million dollars – *Real_size* ≤ 3.934) and with less mature assets (*Asset_maturity* equal or lower than 6.921). In this left branch the node that has the highest average debt maturity ratio (mean value of 0.495) is number 22. To be included in this node firms must have an

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We find that the small increase in the model's predictability comes with a high increase in complexity and decide to keep the former solution.

[41] Normalized Importance $X_i = \frac{\text{Importance } X_i}{\text{Importance Maximum}} \times 100$. This is a relative measure of importance where each variable's importance is compared with the most important variable.

[42] Remember that *Real_size* = $\text{Ln}(\text{Assets}_{\text{2004 dollars}})$.

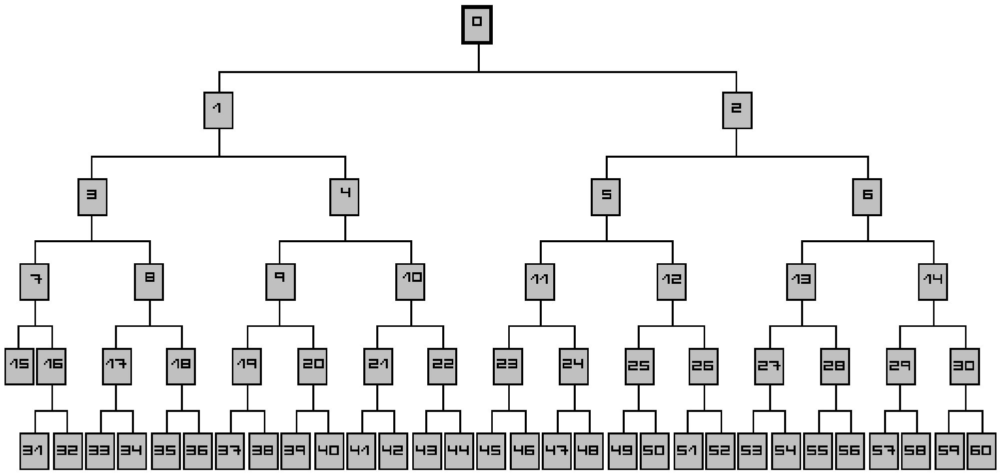
asset's value equal or lower than 158.222 million dollars (*Real_size* ≤ 5.064) but higher than 29.934 million dollars (*Real_size* > 3.399). They must also have an asset maturity ratio superior to 9.349 and have an effective tax rate higher than 40.2%.

In the right branch (see Table 4-35), corresponding to larger firms, the node with the highest average debt maturity ratio is number 30 and includes the largest firms (*Real_size* > 6.894 corresponding to an asset's value of 986.339 million dollars) and with highest assets maturity (*Asset_maturity* > 11.660). Firms with assets over 508.772 million dollars but inferior or equal to 986.339 million dollars and with the same level of assets maturity than those in node 30 have an average debt maturity ratio 6 pp lower than the latter (see node 29 which represents the second node with highest average debt maturity ratio). On the other hand, node 23 represents in this right branch the group of firms with the lowest average debt maturity ratio. To be included in this node firms must have assets under 508.772 million dollars (*Real_size* ≤ 6.232) but equal or higher than 158.222 million (*Real_size* > 5.064), have an assets maturity ratio equal or inferior to a 8.823 value and a market-to-book ratio equal or inferior to 0.684 value.

It is important to notice that the *Real_size* and *Asset_maturity* variables are cut variables at several stages and the only two needed in the first three levels. Also, these two variables alone allow us to discriminate those firms with the lowest (node 15) and highest (node 30) average debt maturity ratios. The *Market_to_book* variable only appears twice as a cut variable and only in the right side of the tree. However, though not reported, this variable is, with only one exception, the surrogate to all the primary variables used by the algorithm. The *Taxes* variable is used in the fourth and fifth levels and in both tree branches. Its' values alone are not sufficient to give us an indication if we are in the presence of high or low average debt maturity firms. For example, firms present in node 18 with tax rate a higher than 0.412 have an average debt maturity ratio of 0.362 (less 9 pp than the overall mean) while firms present in node 36 with a tax rate higher than 0.413 have an average debt maturity ratio of 0.537 (8.5 pp higher than the overall mean).

We now turn our focus to the results of the classification tree. Our dependent variable is the same that we use in section 6.3.1, a dichotomous variable with value 1 for cases with a debt maturity ratio higher than 0.4515 (the mean value of the all sample) and with value 0 otherwise. Figure 6-2 shows the final tree.

Figure 6-2 - Classification tree diagram



The CRT algorithm generates a tree with five levels of depth (again reaching the maximum number chosen) and 61 nodes, of which 31 are terminal nodes. The risk estimate of 0.305 (see Table 6-36) indicates the percentage of cases misclassified (30.5%). The model overall correctly classifies 69.5% of cases (see Table 6-37), doing a better job in predicting which firms have a debt maturity ratio superior to the mean value (78.0%) than those that have an inferior one (59.6%). The main fault in the model is that 40.4% of firms with low debt maturity are inaccurately classified has having high debt maturity.

When we compare these findings with those obtained in section 6.4.1 using logistic regression we can observe the similarities between the two. Overall, the classification tree algorithm is slightly better than the logistic regression, correctly classifying more 0.4 pp. The CRT is 4 pp better in classifying firms with a debt maturity ratio higher than the average (78.0% versus 74.0%) while the logistic regression is 3.9 pp better in the opposite case (63.5% versus 59.6%).

To find if both methodologies classify the same way the same cases we perform a cross tabulation between the two. From Table 6-38 we find that from a total of 24,631 cases classified as low debt maturity in the logistic regression, 82.2% were also classified the same way by the classification tree. This percentage increases to 90.4% when we consider the opposite relationship. For the high debt maturity cases we find a stronger match with 93.3% of the total cases classified using the logistic regression also being classified the same way when using the CRT algorithm. In the opposite relation the percentage slightly decreases to

87.3%. Overall, the matching between the two methodologies is quite high, with a total value of 88.5%.

The most relevant predictor of high/low debt maturity is the firm size (*Real_size* variable). The assets maturity is the next most significant predictor, followed by the effective tax rate and the market-to-book ratio. All other variables have residual importance in the model (see Table 6-39).

Table 6-41 shows the first two levels of the tree. The first split uses the *Real_size* variable with a cut value of 5.089. The left branch of the tree (starting in node 1), which represents smaller firms with total assets under or equal to 162.228 million dollars, have a higher probability of having a debt maturity ratio lower than the average value. The probability of a firm having less than average debt maturity is nearly 0.627. Larger firms are represented by the right side of the tree (starting in node 2). In node 2, a firm has 0.710 probability of being classified has a high debt maturity firm.

In level 2 the next best predictor is the *Asset_maturity* variable for both branches. For the smaller firms, the cut value is 10.027 while for the larger firms group the cut value is 11.219. Smaller firms with less assets maturity (node 3) have an increase in the probability (0.781) of being classified has low debt maturity firms while the opposite occurs in smaller firms with higher assets maturity (node 4), where the probability decreases to 0.531. Node 5 represents larger firms with lower assets maturity. The probability of a case being classified as a high debt maturity firm decreases 0.129. Conversely, larger firms with higher assets maturity increase their probability by 0.053.

Table 6-42 and Table 6-43 present the remaining branches and nodes for the smaller firms (left branch). The only new variable introduced by the algorithm in the remaining three levels is the effective tax rate (*Taxes*). The *Real_size* and *Asset_maturity*, already introduced in the major splitting of the tree (first two levels) are still used several times in different nodes and levels to further enhance the model. Firms with an assets value equal or lower than 51.111 million dollars (*Real_size* $\leq$ 3.934) and with an asset maturity ratio equal or under 6.847 are the most likely to be classified as low debt maturity firms, with a 0.877 probability (node 15). Being in the smaller firm's branch doesn't necessarily indicate a higher probability of being classified as a low debt maturity firm. For example, firms with an assets value between 88.588 million dollars (*Real_size* > 4.484) and 162.228 million (*Real_size* $\leq$ 5.089), with an asset maturity ratio under 10.027 and with an effective tax rate over 39.8% (node 44) have substantially higher probability of being classified as high debt maturity firms (0.651) than as low (0.349).

Table 6-44 and Table 6-45 show the remaining tree which reflect the model extended classification for the larger firms. The *Market_to_book* variable is introduced for the first time and has a special relevance in splitting the nodes from level 3 to level 4. The *Taxes* variable is only used once to split node 27 into nodes 53 and 54, with a cut value of 0.414. One particular note to the only macroeconomic variable used by the algorithm, the *2_year_market_return*. It appears only in the last stage to split node 28 into nodes 55 and 56 and helps discriminate 922 cases (11%) out of the 8,308 existent in node 28. The cut value is 0.028. Firms with assets over 986.339 million dollars (*Real_size* > 6.894) and an asset maturity ratio higher than 15.008 have the highest probability (0.886) of being classified as high debt maturity firms (node 60). Nodes 36, 40, 42, 47, 53 aggregate those cases with a nearly even probability of being classified as low or high debt maturity firms. They are found in both the smaller and larger firm groups.

6.5 Summary

In this chapter we use several econometric methods with a double purpose: to increase our knowledge about the debt maturity of firms and to compare results with those previously obtained using different approaches. First, we use logistic regression to study the probability of a firm having high debt maturity (debt maturity above average) and classify it accordingly. The model obtained correctly classifies 69.1% of cases, doing better in classifying the successful cases (correctly classifies 74.0%) than the low debt maturity firms (correctly classifies 63.5%). Using the firm size alone, the model is able to correctly classify 67.0% of cases, which gives a clear indication of the importance of this firm characteristic. Other measures used indicate an overall poor model fit.

We find that all the estimated coefficients have a positive relation with the dependent variable, thus indicating higher probability of a firm having high debt maturity with an increase in the independent variable, other things equal. When observing the most significant relationships between the dependent variable and its covariates we find that larger firms with more growing opportunities and asset maturity and that pay higher taxes are the most likely to have high debt maturity in their capital structure.

Second, we use cluster analysis to split our sample in homogeneous groups using the firm specific debt maturity determinants as discriminators. We clearly identify two groups with substantial different profiles: one larger group (76.56% of the sample cases) where firms have much less investment opportunities, pay higher tax rates, have assets with higher maturity, have more quality and are much larger than firms in the smaller group (containing 24.44% of the sample cases).

When studying the debt maturity of firms in each group we were able to find statistically significant differences between the two. In average, the debt maturity ratio is considerably higher in the larger group than in the smaller one (50.29% versus 28.37%). These results give strong support to the existing theoretical work where larger firms, with less growth opportunities and with longer maturity assets are expected to have more long-term debt. The contradictory result obtained for firm quality, where firms with higher future earnings are expected to hold more short-term debt instead of long-term, is based on the least relevant variable (*Abnormal_eranings*) in discriminating both groups of firms.

Third, we use decision tree analysis (CRT algorithm) to generate a regression tree with the debt maturity ratio as our dependent variable and to generate a classification tree that enable us to identify high or low debt maturity firms. The regression tree model explains 24.77% of the total variance of our dependent variable, which shows a weak predictive capability however in line with the results obtained in previous studies using multiple linear regression. The model only uses four (*Real_size*, *Asset_maturity*, *Taxes* and *Market_to_book*) out of the nine initial variables to produce the tree. The size of the firm and its assets' maturity are by far the two most relevant variables when building the tree and alone enable us to identify those firms with the expected highest and lowest average debt maturity ratios. Overall, the largest firms and those with highest assets maturity are expected to have, in average, the highest debt maturity ratios (0.670). Conversely, the smallest firms with the lowest assets maturity are expected to have, in average, the lowest debt maturity ratios (0.149).

The classification tree model correctly classifies 69.5% of cases, classifying correctly 78.0% of the high debt maturity firms against 59.6% for the low debt maturity firms. These results are very similar to those obtained using the logistic regression technique and the matching between both for the correctly classified cases is quite high (88.5%). The most important predictors are the same as those used in the regression tree model. The smallest firms with lowest assets maturity are most likely to be classified as low debt maturity firms (with a 0.877 probability). On the other end of the spectrum, largest firms with highest assets maturity have the highest probability (0.886) of being classified as high debt maturity firms.

The several results obtained in this chapter overall lead to similar conclusions amongst them and are in line with those obtained in previous chapters using different methodologies. With few exceptions they find good support in the existing theoretical work, though the quality and fitness of the models obtained should be improved.

Output 1 – A direct logistic regression analysis is performed on the full sample from 1974 to 2004, using the enter method.

The dependent variable is the *Debt_maturity_d* (coded 1 when the ratio of debt maturing in more than three years over total debt is greater than the mean value of 0.4515 and coded 0 otherwise). Six firm level predictors are introduced - The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets; *Real_size* is defined as the natural logarithm of total assets inflated using the CPI into 2004 dollars; *Taxes* is obtained from the ratio of income taxes over pretax income; The *Asset_maturity* is measured from the property, plant and equipment over amortization and depreciation expenses ratio and *Abnormal_earnings* is measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. The *Regulation_dummy* has the value 1 for regulated firms and 0 otherwise. Three macroeconomic predictors join the firm level predictors - The *2_year_equity_market_return* is the return on CRSP value weighted index of stocks traded on NYSE, AMEX, and Nasdaq; The *2_year_corporate_growth* is computed using the annual data from the Flow of Funds; The *Commercial_paper_spread* is the difference between the annualized rate on the three-month commercial paper and the three-month Treasury bill.

Table 6-5 - Case processing summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	56,768	100.0
	Missing Cases	0	.0
	Total	56,768	100.0
Unselected Cases		0	.0
Total		56,768	100.0

a. If weight is in effect, see classification table for the total number of cases.

Block 0: Beginning Block

Table 6-6 - Classification table

			Predicted		
			Debt_maturity_d		Percentage Correct
		Observed	0	1	
Step 0	*Debt_maturity_d*	0	0	26,326	.0
		1	0	30,442	100.0
	Overall Percentage				53.6

Notes: Constant is included in the model. The cut value is 0.5.

Table 6-7 - Variables in the equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	.145	.008	297.909	1	.000	1.156

Block 1: Method = Enter

Table 6-8 - Omnibus tests of model coefficients

		Chi-square	df	Sig.
Step 1	Step	11,697.929	9	.000
	Block	11,697.929	9	.000
	Model	11,697.929	9	.000

Table 6-9 - Model summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	66,700.534[a]	.186	.249

Note: Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Table 6-10 - Hosmer and Lemeshow test

Step	Chi-square	df	Sig.
1	54.479	8	.000

Table 6-11 - Classification table

		Observed	Predicted *Debt_maturity_d* 0	Predicted *Debt_maturity_d* 1	Predicted Percentage Correct
Step 1	*Debt_maturity_d*	0	16,704	9,622	63.5
		1	7,927	22,515	74.0
	Overall Percentage				69.1

Note: The cut value is 0.5.

Table 6-12 - Variables in the equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	*Market_to_book*	.349	.025	196.308	1	.000	1.418
	Taxes	1.349	.062	466.360	1	.000	3.853
	Asset_maturity	.088	.002	1,936.669	1	.000	1.092
	Abnormal_earnings	.037	.084	.192	1	.661	1.037
	Regulation_dummy	.844	.141	35.982	1	.000	2.325
	Real_size	.506	.008	4,473.910	1	.000	1.659
	2_year_equity_market_return	.229	.038	36.425	1	.000	1.258
	Commercial_paper_spread	.733	3.006	.059	1	.807	2.081
	2_year_corporate_growth	.014	.034	.170	1	.680	1.014
	Constant	-4.339	.066	4,310.287	1	.000	.013

a. Variable(s) entered on step 1: *Market_to_book*, *Taxes*, *Asset_maturity*, *Abnormal_earnings*, *Regulation_dummy*, *Real_size*, *2_year_equity_market_return*, *Commercial_paper_spread*, *2_year_corporate_growth*.

ROC Curve

Table 6-13 - Case processing summary

Above Average Debt Maturity	Valid N (listwise)
Positive[a]	30,442
Negative	26,326

Larger values of the test result variable(s) indicate stronger evidence for a positive actual state.

a. The positive actual state is 1.

Figure 6-3 - ROC curve

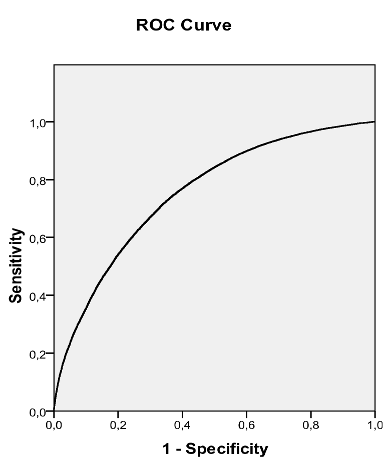


Table 6-14 - Area under the curve

Test Result Variable(s): Predicted probability

Area
.752

Output 2 – A direct logistic regression analysis is performed on the full sample from 1974 to 2004, using the forward LR method.
The dependent variable is the *Debt_maturity_d* (coded 1 when the ratio of debt maturing in more than three years over total debt is greater than the mean value of 0.4515 and coded 0 otherwise). Six firm level predictors are introduced - The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets; *Real_size* is defined as the natural logarithm of total assets inflated using the CPI into 2004 dollars; *Taxes* is obtained from the ratio of income taxes over pretax income; The *Asset_maturity* is measured from the property, plant and equipment over amortization and depreciation expenses ratio and *Abnormal_earnings* is measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. The *Regulation_dummy* has the value 1 for regulated firms and 0 otherwise. Three macroeconomic predictors join the firm level predictors - The *2_year_equity_market_return* is the return on CRSP value weighted index of stocks traded on NYSE, AMEX, and Nasdaq; The *2_year_corporate_growth* is computed using the annual data from the Flow of Funds; The *Commercial_paper_spread* is the difference between the annualized rate on the three-month commercial paper and the three-month Treasury bill.

Block 1: Method = Forward Stepwise (Likelihood Ratio)

Table 6-15 - Omnibus tests of model coefficients

		Chi-square	df	Sig.
Step 1	Step	8,853.730	1	.000
	Model	8,853.730	1	.000
Step 2	Step	2,206.371	1	.000
	Model	11,060.101	2	.000
Step 3	Step	367.960	1	.000
	Model	11,428.061	3	.000
Step 4	Step	194.290	1	.000
	Model	11,622.351	4	.000
Step 5	Step	38.856	1	.000
	Model	11,661.207	5	.000
Step 6	Step	36.258	1	.000
	Model	11,697.464	6	.000

Table 6-16 - Model summary

Step	-2 Log likelihood	Cox & Snell R	Nagelkerke R
1	69,544.733[a]	.144	.193
2	67,338.362[a]	.177	.236
3	66,970.402[a]	.182	.244
4	66,776.112[a]	.185	.247
5	66,737.257[a]	.186	.248
6	66,700.999[a]	.186	.249

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Table 6-17 - Hosmer and Lemeshow test

Step	Chi-square	df	Sig.
1	57.812	8	.000
2	80.632	8	.000
3	40.719	8	.000
4	66.182	8	.000
5	64.632	8	.000
6	56.276	8	.000

Table 6-18 - Classification table

			Predicted		
			Debt_maturity_d		Percentage Correct
		Observed	0	1	
Step 1	*Debt_maturity_d*	0	16,231	10,095	61.7
		1	8,637	21,805	71.6
	Overall Percentage				67.0
Step 2	*Debt_maturity_d*	0	16,579	9,747	63.0
		1	8,180	22,262	73.1
	Overall Percentage				68.4
Step 3	*Debt_maturity_d*	0	16,408	9,918	62.3
		1	7,734	22,708	74.6
	Overall Percentage				68.9
Step 4	*Debt_maturity_d*	0	16,658	9,668	63.3
		1	7,909	22,533	74.0
	Overall Percentage				69.0
Step 5	*Debt_maturity_d*	0	16,679	9,647	63.4
		1	7,922	22,520	74.0
	Overall Percentage				69.1
Step 6	*Debt_maturity_d*	0	16,713	9,613	63.5
		1	7,921	22,521	74.0
	Overall Percentage				69.1

Note: The cut value is 0.5.

Table 6-19 - Variables in the equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	*Real_size*	.521	.006	7,317.608	1	.000	1.683
	Constant	-2.465	.032	6,117.661	1	.000	.085
Step 2[b]	*Asset_maturity*	.090	.002	2,098.960	1	.000	1.094
	Real_size	.482	.006	6,020.227	1	.000	1.619
	Constant	-3.429	.040	7,508.602	1	.000	.032
Step 3[c]	*Taxes*	1.161	.061	365.398	1	.000	3.193
	Asset_maturity	.087	.002	1,906.464	1	.000	1.090
	Real_size	.452	.006	5,021.360	1	.000	1.571
	Constant	-3.605	.041	7,656.965	1	.000	.027
Step 4[d]	*Market_to_book*	.352	.025	200.791	1	.000	1.422
	Taxes	1.340	.062	464.286	1	.000	3.819
	Asset_maturity	.087	.002	1,924.620	1	.000	1.091
	Real_size	.506	.008	4,493.863	1	.000	1.659
	Constant	-4.257	.063	4,581.815	1	.000	.014
Step 5[e]	*Market_to_book*	.349	.025	197.247	1	.000	1.418
	Taxes	1.335	.062	460.420	1	.000	3.801
	Asset_maturity	.087	.002	1,917.285	1	.000	1.091
	Regulation_dummy	.822	.141	34.158	1	.000	2.274
	Real_size	.504	.008	4,458.677	1	.000	1.656
	Constant	-4.247	.063	4,556.176	1	.000	.014
Step 6[f]	*Market_to_book*	.349	.025	197.108	1	.000	1.418
	Taxes	1.351	.062	470.149	1	.000	3.862
	Asset_maturity	.088	.002	1,939.441	1	.000	1.092
	Regulation_dummy	.846	.141	36.238	1	.000	2.331
	Real_size	.506	.008	4,474.856	1	.000	1.659
	2_year_equity_market_return	.226	.038	36.226	1	.000	1.254
	Constant	-4.334	.065	4,486.952	1	.000	.013

a. Variable(s) entered on step 1: *Real_size*.
b. Variable(s) entered on step 2: *Asset_maturity*.
c. Variable(s) entered on step 3: *Taxes*.
d. Variable(s) entered on step 4: *Market_to_book*.
e. Variable(s) entered on step 5: *Regulation_dummy*.
f. Variable(s) entered on step 6: *2_year_equity_market_return*.

Table 6-20 - Variables not in the equation

			Score	df	Sig.
Step 6	Variables	*Abnormal_earnings*	.207	1	.649
		Commercial_paper_spread	.085	1	.771
		2_year_corporate_growth	.216	1	.642
	Overall Statistics		.465	3	.927

Output 3 – A two step cluster analysis performed on the full sample from 1974 to 2004.

Five firm level variables are introduced as continuous - The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets; *Real_size* is defined as the natural logarithm of total assets inflated using the CPI into 2004 dollars; *Taxes* is obtained from the ratio of income taxes over pretax income; The *Asset_maturity* is measured from the property, plant and equipment over amortization and depreciation expenses ratio and *Abnormal_earnings* is measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. One firm level variable is introduced as categorical – The *Regulation_dummy* has the value 1 for regulated firms and 0 otherwise. All continuous variables are standardized.

Table 6-21 – Auto-clustering

Number of Clusters	Schwarz's Bayesian Criterion (BIC)	BIC Change[a]	Ratio of BIC Changes[b]	Ratio of Distance Measures[c]
1	201,403.234			
2	162,684.862	-38,718.371	1.000	2.201
3	145,160.810	-17,524.053	.453	1.237
4	131,017.643	-14,143.167	.365	1.409
5	121,017.584	-10,000.059	.258	1.197
6	112,683.783	-8,333.801	.215	1.656
7	107,697.927	-4,985.856	.129	1.030
8	102,858.629	-4,839.298	.125	1.071
9	98,349.242	-4,509.387	.116	1.243
10	94,745.167	-3,604.074	.093	1.015
11	91,197.141	-3,548.026	.092	1.122
12	88,049.404	-3,147.737	.081	1.301
13	85,657.669	-2,391.735	.062	1.051
14	83,387.584	-2,270.085	.059	1.121
15	81,375.652	-2,011.931	.052	1.152

a. The changes are from the previous number of clusters in the table.

b. The ratios of changes are relative to the change for the two cluster solution.

c. The ratios of distance measures are based on the current number of clusters against the previous number of clusters.

Table 6-22 - *Regulation_dummy* frequencies

		0		1	
		Frequency	Percent	Frequency	Percent
Cluster	1	43,082	76.4%	377	99.7%
	2	13,308	23.6%	1	.3%
	Combined	56,390	100.0%	378	100.0%

Figure 6-4 - *Regulation_dummy* importance, by cluster

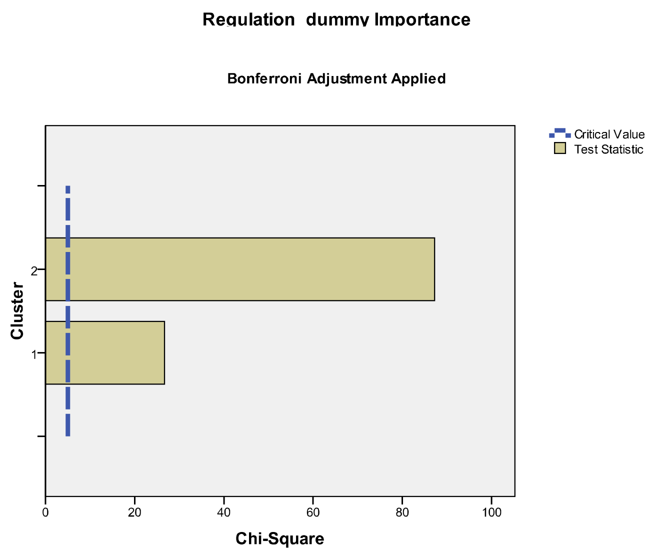


Figure 6-5 - Continuous variables importance in cluster 1

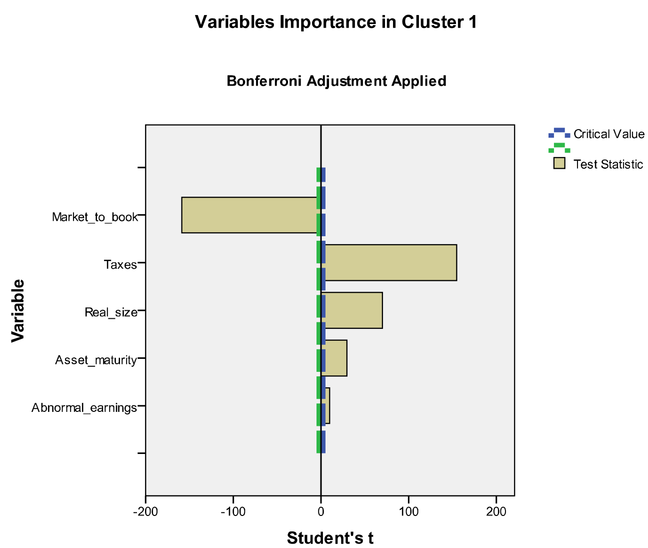


Figure 6-6 - Continuous variables importance in cluster 2

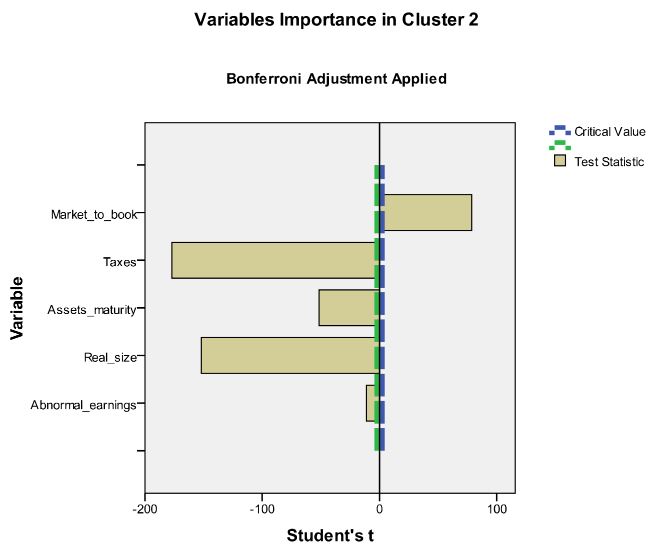


Table 6-23 - Descriptive statistics for continuous variables and *Debt_maturity*, per cluster

	Statistics	*Debt_ maturity*	*Market_to_ book*	*Taxes*	*Asset_ maturity*	*Abnormal_ earnings*	*Real_ size*
Cluster 1	Mean	.5029	.7594	.3846	13.6203	.0163	5.5655
	n	43,459	43,459	43,459	43,459	43,459	43459
	Std. Deviation	.28994	.20095	.09184	4.77894	.09589	1.47366
	Median	.5623	.7241	.3950	13.4213	.0082	5.4747
	Minimum	.00	.46	-.05	3.50	-.35	1.48
	Maximum	.95	2.07	.53	26.42	.51	8.72
Cluster 2	Mean	.2837	1.4117	.0936	10.7134	-.0031	3.4506
	n	13,309	13,309	13,309	13,309	13,309	13,309
	Std. Deviation	.29375	.73209	.14514	4.97113	.15362	1.22868
	Median	.1817	1.2070	.0000	9.7391	-.0045	3.2744
	Minimum	.00	.46	-.05	3.50	-.35	1.45
	Maximum	.95	4.27	.53	26.41	.51	8.70
Total	Mean	.4515	.9123	.3164	12.9388	.0118	5.0697
	n	56,768	56,768	56,768	56,768	56,768	56,768
	Std. Deviation	.30531	.48263	.16307	4.97933	.11242	1.67906
	Median	.4931	.7741	.3750	12.7247	.0067	5.0145
	Minimum	.00	.46	-.05	3.50	-.35	1.45
	Maximum	.95	4.27	.53	26.42	.51	8.72

Table 6-24 - Cluster x *Debt_maturity* quartiles (DM_Quartiles) crosstabulation

		DM_Quartiles				Total
		1	2	3	4	
Cluster 1	n	7,887	10,739	12,226	12,607	43,459
	% within Cluster	18.1%	24.7%	28.1%	29.0%	100.0%
	% within DM_Quartiles	55.6%	75.7%	86.1%	88.8%	76.6%
	% of Total	13.9%	18.9%	21.5%	22.2%	76.6%
Cluster 2	n	6,305	3,453	1,966	1,585	13,309
	% within Cluster	47.4%	25.9%	14.8%	11.9%	100.0%
	% within DM_Quartiles	44.4%	24.3%	13.9%	11.2%	23.4%
	% of Total	11.1%	6.1%	3.5%	2.8%	23.4%

Table 6-25 - Cluster x *Market_to_book* quartiles (MB_Quartiles) crosstabulation

		MB_Quartiles				Total
		1	2	3	4	
Cluster 1	n	13,320	13,012	11,831	5,296	43,459
	% within Cluster	30.6%	29.9%	27.2%	12.2%	100.0%
	% within MB_Quartiles	93.9%	91.7%	83.4%	37.3%	76.6%
	% of Total	23.5%	22.9%	20.8%	9.3%	76.6%
Cluster 2	n	872	1,180	2,361	8,896	13,309
	% within Cluster	6.6%	8.9%	17.7%	66.8%	100.0%
	% within MB_Quartiles	6.1%	8.3%	16.6%	62.7%	23.4%
	% of Total	1.5%	2.1%	4.2%	15.7%	23.4%

Table 6-26 - Cluster x *Taxes* quartiles (TX_Quartiles) crosstabulation

		TX_Quartiles				Total
		1	2	3	4	
Cluster 1	n	3,293	12,894	13,584	13,688	43,459
	% within Cluster	7.6%	29.7%	31.3%	31.5%	100.0%
	% within TX_Quartiles	23.2%	90.9%	95.7%	96.4%	76.6%
	% of Total	5.8%	22.7%	23.9%	24.1%	76.6%
Cluster 2	n	10,899	1,298	608	504	13,309
	% within Cluster	81.9%	9.8%	4.6%	3.8%	100.0%
	% within TX_Quartiles	76.8%	9.1%	4.3%	3.6%	23.4%
	% of Total	19.2%	2.3%	1.1%	.9%	23.4%

Table 6-27 - Cluster x *Asset_maturity* quartiles (AM_quartiles) crosstabulation

		AM_Quartiles 1	2	3	4	Total
Cluster 1	n	8,089	11,091	12,057	12,222	43,459
	% within Cluster	18.6%	25.5%	27.7%	28.1%	100.0%
	% within AM_Quartiles	57.0%	78.1%	85.0%	86.1%	76.6%
	% of Total	14.2%	19.5%	21.2%	21.5%	76.6%
Cluster 2	n	6,103	3,101	2,135	1,970	13,309
	% within Cluster	45.9%	23.3%	16.0%	14.8%	100.0%
	% within AM_Quartiles	43.0%	21.9%	15.0%	13.9%	23.4%
	% of Total	10.8%	5.5%	3.8%	3.5%	23.4%

Table 6-28 - Cluster x *Abnormal_earnings* quartiles (AE_Quartiles) crosstabulation

		AE_Quartiles 1	2	3	4	Total
Cluster 1	n	8,970	11,929	12,209	10,351	43,459
	% within Cluster	20.6%	27.4%	28.1%	23.8%	100.0%
	% within AE_Quartiles	63.2%	84.1%	86.0%	72.9%	76.6%
	% of Total	15.8%	21.0%	21.5%	18.2%	76.6%
Cluster 2	n	5,222	2,263	1,983	3,841	13,309
	% within Cluster	39.2%	17.0%	14.9%	28.9%	100.0%
	% within AE_Quartiles	36.8%	15.9%	14.0%	27.1%	23.4%
	% of Total	9.2%	4.0%	3.5%	6.8%	23.4%

Table 6-29 - Cluster x *Real_size* quartiles (RS_Quartiles) crosstabulation

		RS_Quartiles 1	2	3	4	Total
Cluster 1	n	5,356	11,244	13,011	13,848	43,459
	% within Cluster	12.3%	25.9%	29.9%	31.9%	100.0%
	% within RS_Quartiles	37.7%	79.2%	91.7%	97.6%	76.6%
	% of Total	9.4%	19.8%	22.9%	24.4%	76.6%
Cluster 2	n	8,836	2,948	1,181	344	13,309
	% within Cluster	66.4%	22.2%	8.9%	2.6%	100.0%
	% within RS_Quartile	62.3%	20.8%	8.3%	2.4%	23.4%
	% of Total	15.6%	5.2%	2.1%	.6%	23.4%

Output 4 – A regression tree is constructed with the full sample from 1974 to 2004, using the CRT algorithm.

The dependent variable is the *Debt_maturity* (the ratio of debt maturing in more than three years over total debt). Six firm level predictors are introduced - The *Market_to_book* is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets; *Real_size* is defined as the natural logarithm of total assets inflated using the CPI into 2004 dollars; *Taxes* is obtained from the ratio of income taxes over pretax income; The *Asset_maturity* is measured from the property, plant and equipment over amortization and depreciation expenses ratio and *Abnormal_earnings* is measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. The *Regulation_dummy* has the value 1 for regulated firms and 0 otherwise. Three macroeconomic predictors join the firm level predictors - The *2_year_equity_market_return* is the return on CRSP value weighted index of stocks traded on NYSE, AMEX, and Nasdaq; The *2_year_corporate_growth* is computed using the annual data from the Flow of Funds; The *Commercial_paper_spread* is the difference between the annualized rate on the three-month commercial paper and the three-month Treasury bill.

Table 6-30 – Regression tree risk estimate

Estimate	Std. Error
.070	.000

Notes: Growing Method: CRT; Dependent Variable: *Debt_maturity*

Table 6-31 – Regression tree independent variable importance

Independent Variable	Importance	Normalized
Real_size	.017	100.0%
Asset_maturity	.014	85.5%
Taxes	.008	48.3%
Market_to_book	.005	32.7%
Regulation_dummy	.000	1.7%
Commercial_paper_spread	.000	1.5%
Abnormal_earnings	.000	1.3%
2_year_corporate_growth	.000	1.1%
2_year_equity_market_return	.000	1.1%

Notes: Growing Method: CRT; Dependent Variable: *Debt_maturity*

Table 6-32 - Regression tree root node

Level 0
Node 0 • n = 56,768 • Mean = 0.452 • Std. Dev. = 0.305

Table 6-33 - First two levels of the regression tree

Level 1	Level 2
Node 1 • n = 28,980 • Mean = 0.340 • *Real_size* <= 5.064	**Node 3** • n = 9,779 • Mean = 0.219 • *Asset_maturity* <= 9.349
	Node 4 • n = 19,201 • Mean = 0.401 • *Asset_maturity* > 9.349
Node 2 • n = 27,788 • Mean = 0.568 • *Real_size* > 5.064	**Node 5** • n = 13,375 • Mean = 0.512 • *Real_size* <= 6.232
	Node 6 • n = 14,413 • Mean = 0.621 • *Real_size* > 6.232

Table 6-34 - Regression tree left branch nodes

<table>
<tr><th>Level 2</th><th>Level 3</th><th>Level 4</th><th>Level 5</th></tr>
<tr><td rowspan="4">Node 3
• n = 9,779
• Mean = 0.219
• Asset_maturity <= 9.349</td><td rowspan="2">Node 7
• n = 5,997
• Mean = 0.181
• Real_size <= 3.934</td><td>Node 15
• n = 3,224
• Mean = 0.149
• Asset_maturity <= 6.921</td><td></td></tr>
<tr><td>Node 16
• n = 2,773
• Mean = 0.218
• Asset_maturity > 6.921</td><td></td></tr>
<tr><td rowspan="2">Node 8
• n = 3,782
• Mean = 0.279
• Real_size > 3.934</td><td>Node 17
• n = 2,821
• Mean = 0.251
• Taxes <= 0.412</td><td></td></tr>
<tr><td>Node 18
• n = 961
• Mean = 0.362
• Taxes > 0.412</td><td></td></tr>
<tr><td rowspan="6">Node 4
• n = 19,201
• Mean = 0.401
• Asset_maturity > 9.349</td><td rowspan="3">Node 9
• n = 5,748
• Mean = 0.319
• Real_size <= 3.399</td><td>Node 19
• n = 2,746
• Mean = 0.278
Taxes <= 0.252</td><td></td></tr>
<tr><td rowspan="2">Node 20
• n = 3,002
• Mean = 0.356
• Taxes > 0.252</td><td>Node 31
• n = 937
• Mean = 0.285
• Asset_maturity <= 12.176</td></tr>
<tr><td>Node 32
• n = 2,065
• Mean = 0.389
• Asset_maturity > 12.176</td></tr>
<tr><td rowspan="3">Node 10
• n = 13,453
• Mean = 0.436
• Real_size > 3.399</td><td rowspan="2">Node 21
• n = 7,795
• Mean = 0.393
• Taxes <= 0.402</td><td>Node 33
• n = 3,116
• Mean = 0.359
• Real_size <= 4.121</td></tr>
<tr><td>Node 34
• n = 4,679
• Mean = 0.416
• Real_size > 4.121</td></tr>
<tr><td>Node 22
• n = 5,658
• Mean = 0.495
• Taxes > 0.402</td><td></td></tr>
</table>

Table 6-35 - Regression tree right branch nodes

Level 2	Level 3	Level 4	Level 5
Node 5 • n = 13,375 • Mean = 0.512 • *Real_size* <= 6.232	**Node 11** • n = 2,384 • Mean = 0.396 • *Asset_maturity* <= 8.823	**Node 23** • n = 1,036 • Mean = 0.312 • *Market_to_book* <= 0.684	
		Node 24 • n = 1,348 • Mean = 0.460 • *Market_to_book* > 0.684	
	Node 12 • n = 10,991 • Mean = 0.537 • *Asset_maturity* > 8.823	**Node 25** • n = 2,389 • Mean = 0.458 • *Market_to_book* <= 0.596	**Node 35** • n = 1,572 • Mean = 0.418 • *Taxes* <= 0.413
			Node 36 • n = 817 • Mean = 0.537 • *Taxes* > 0.413
		Node 26 • n = 8,602 • Mean = 0.558 • *Market_to_book* > 0.596	**Node 37** • n = 4,418 • Mean = 0.530 • *Taxes* <= 0.400
			Node 38 • n = 4,184 • Mean = 0.588 • *Taxes* > 0.400
Node 6 • n = 14,413 • Mean = 0.621 • *Real_size* > 6.232	**Node 13** • n = 4,187 • Mean = 0.553 • *Asset_maturity* <= 11.660	**Node 27** • n = 1,769 • Mean = 0.499 • *Market_to_book* <= 0.639	
		Node 28 • n = 2,418 • Mean = 0.592 *Market_to_book* > 0.639	
	Node 14 • n = 10,226 • Mean = 0.649 • *Asset_maturity* > 11.660	**Node 29** • n = 3,611 • Mean = 0.610 • *Real_size* <= 6.894	
		Node 30 • n = 6,615 • Mean = 0.670 • *Real_size* > 6.894	

Output 5 – A classification tree is constructed with the full sample from 1974 to 2004, using the CRT algorithm.

The dependent variable is the *Debt_maturity_d* (coded 1 when the ratio of debt maturing in more than three years over total debt is greater than the mean value of 0.4515 and coded 0 otherwise). Six firm level predictors are introduced - The *Market_to_book* ratio is measured as the book value of assets, less the book value of equity, plus the market value of equity, divided by assets; *Real_size* is defined as the natural logarithm of total assets inflated using the CPI into 2004 dollars; *Taxes* is obtained from the ratio of income taxes over pretax income; The *Asset_maturity* is measured from the property, plant and equipment over amortization and depreciation expenses ratio and *Abnormal_earnings* is measured as the difference in earnings per share between time t and t-1, divided by time t-1 share price. The *Regulation_dummy* has the value 1 for regulated firms and 0 otherwise. Three macroeconomic predictors join the firm level predictors - The *2_year_equity_market_return* is the return on CRSP value weighted index of stocks traded on NYSE, AMEX, and Nasdaq; The *2_year_corporate_growth* is computed using the annual data from the Flow of Funds; The *Commercial_paper_spread* is the difference between the annualized rate on the three-month commercial paper and the three-month Treasury bill.

Table 6-36 - Classification tree risk estimate

Estimate	Std. Error
.305	.002

Notes: Growing Method: CRT; Dependent Variable: *Debt_maturity_d*

Table 6-37 - Classification

Observed	Predicted		
	0	1	Percent Correct
0	15,695	10,631	59.6%
1	6,708	23,734	78.0%
Overall Percentage			69.5%

Notes: Growing Method: CRT; Dependent Variable: *Debt_maturity_d*

Table 6-38 - Logistic regression (predicted group) x Classification tree (predicted value) crosstabulation

			Predicted Value		Total
			0	1	
Predicted group	0	n	20,253	4,378	24,631
		% within Predicted group	82.2%	17.8%	100,0%
		% within Predicted Value	90.4%	12.7%	43,4%
		% of Total	35.7%	7.7%	43,4%
	1	n	2,150	29,987	32,137
		% within Predicted group	6.7%	93.3%	100,0%
		% within Predicted Value	9.6%	87.3%	56,6%
		% of Total	3.8%	52.8%	56,6%
Total		n	22,403	34,365	56,768
		% within Predicted group	39,5%	60.5%	100.0%
		% within Predicted Value	100,0%	100.0%	100.0%
		% of Total	39,5%	60.5%	100.0%

Table 6-39 - Classification tree independent variable importance

Independent Variable	Importance	Normalized
Real_size	.071	100.0%
Asset_maturity	.060	83.5%
Taxes	.030	42.0%
Market_to_book	.023	32.4%
2_year_equity_market_return	.002	2.4%
Regulation_dummy	.001	1.9%
Commercial_paper_spread	.001	1.8%
Abnormal_earnings	.001	1.6%
2_year_corporate_growth	.001	.8%

Growing Method: CRT; Dependent Variable: *Debt_maturity_d*

Table 6-40 - Classification tree root node

Level 0
Node 0 • n = 56,768 • 0 (46.4%) • 1 (53.6%)

Table 6-41 - Classification tree first two levels

Level 1	Level 2
Node 1 • n = 29,267 • 0 (62.7%) • 1 (37.3%) • *Real_size* <= 5.089	**Node 3** • n = 11,241 • 0 (78.1%) • 1 (21.9%) • *Asset_maturity* <= 10.027
	Node 4 • n = 18,026 • 0 (53.1%) • 1 (46.9%) • *Asset_maturity* > 10.027
Node 2 • n = 27,501 • 0 (29.0%) • 1 (71.0%) • *Real_size* > 5.089	**Node 5** • n = 7,986 • 0 (41.9%) • 1 (58.1%) • *Asset_maturity* <= 11.219
	Node 6 • n = 19,515 • 0 (23.7%) • 1 (76.3%) • *Asset_maturity* > 11.219

Table 6-42 - Classification tree outside left branch nodes

<table>
<thead>
<tr><th>Level 2</th><th>Level 3</th><th>Level 4</th><th>Level 5</th></tr>
</thead>
<tbody>
<tr>
<td rowspan="7">Node 3
• n = 11,241
• 0 (78.1%)
• 1 (21.9%)
• Asset_maturity <= 10.027</td>
<td rowspan="3">Node 7
• n = 6,724
• 0 (83.3%)
• 1 (16.7%)
• Real_size <= 3.934</td>
<td>Node 15
• n = 3,139
• 0 (87.7%)
• 1 (12.3%)
• Asset_maturity <= 6.847</td>
<td></td>
</tr>
<tr>
<td rowspan="2">Node 16
• n = 3,585
• 0 (79.4%)
• 1 (20.6%)
• Asset_maturity > 6.847</td>
<td>Node 31
• n = 1,637
• 0 (84.4%)
• 1 (15.6%)
• Real_size <= 2.977</td>
</tr>
<tr>
<td>Node 32
• n = 1,948
• 0 (75.1%)
• 1 (24.9%)
• Real_size > 2.977</td>
</tr>
<tr>
<td rowspan="4">Node 8
• n = 4,517
• 0 (70.3%)
• 1 (29.7%)
• Real_size > 3.934</td>
<td rowspan="2">Node 17
• n = 3,433
• 0 (73.8%)
• 1 (26.2%)
• Taxes <= 0.417</td>
<td>Node 33
• n = 1,527
• 0 (79.6%)
• 1 (20.4%)
• Asset_maturity <= 7.019</td>
</tr>
<tr>
<td>Node 34
• n = 1,906
• 0 (69.2%)
• 1 (30.8%)
• Asset_maturity > 7.019</td>
</tr>
<tr>
<td rowspan="2">Node 18
• n = 1,084
• 0 (59.0%)
• 1 (41.0%)
• Taxes > 0.417</td>
<td>Node 35
• n = 428
• 0 (69.2%)
• 1 (30.8%)
• Asset_maturity <= 7.227</td>
</tr>
<tr>
<td>Node 36
• n = 656
• 0 (52.4%)
• 1 (47.6%)
• Asset_maturity > 7.227</td>
</tr>
</tbody>
</table>

Table 6-43 - Classification tree inside left branch nodes

Level 2	Level 3	Level 4	Level 5
Node 4 • n = 18,026 • 0 (53.1%) • 1 (46.9%) • *Asset_maturity* > 10.027	**Node 9** • n = 10,942 • 0 (59.4%) • 1 (40.6%) • *Taxes* <= 0.398	**Node 19** • n = 6,372 • 0 (65.2%) • 1 (34.8%) • *Real_size* <= 4.046	**Node 37** • n = 2,978 • 0 (69.6%) • 1 (30.4%) • *Taxes* <= 0.145
			Node 38 • n = 3,394 • 0 (61.3%) • 1 (38.7%) • *Taxes* > 0.145
		Node 20 • n = 4,570 • 0 (51.3%) • 1 (48.7%) • *Real_size* > 4.046	**Node 39** • n = 1,051 • 0 (58.7%) • 1 (41.3%) • *Taxes* <= 0.129
			Node 40 • n = 3,519 • 0 (49.1%) • 1 (50.9%) • *Taxes* > 0.129
	Node 10 • n = 7,084 • 0 (43.5%) • 1 (56.5%) • *Taxes* > 0.398	**Node 21** • n = 1,365 • 0 (57.1%) • 1 (42.9%) • *Real_size* <= 3.419	**Node 41** • n = 362 • 0 (69.3%) • 1 (30.7%) • *Asset_maturity* <= 12.222
			Node 42 • n = 1,003 • 0 (52.7%) • 1 (47.3%) • *Asset_maturity* > 12.222
		Node 22 • n = 5,719 • 0 (40.3%) • 1 (59.7%) • *Real_size* > 3.419	**Node 43** • n = 3,237 • 0 (44.4%) • 1 (55.6%) • *Real_size* <= 4.484
			Node 44 • n = 2,482 • 0 (34.9%) • 1 (65.1%) • *Real_size* > 4.484

Table 6-44 - Classification tree inside right branch nodes

Level 2	Level 3	Level 4	Level 5
Node 5 • n = 7,986 • 0 (41.9%) • 1 (58.1%) • *Asset_maturity* <= 11.219	**Node 11** • n = 4,128 • 0 (49.1%) • 1 (50.9%) • *Real_size* <= 6.179	**Node 23** • n = 908 • 0 (65.0%) • 1 (35.0%) • *Market_to_book* <= 0.588	**Node 45** • n = 270 • 0 (81.5%) • 1 (18.5%) • *Asset_maturity* <=7.016
			Node 46 • n = 638 • 0 (58.0%) • 1 (42.0%) • *Asset_maturity* >7.016
		Node 24 • n = 3,220 • 0 (44.6%) • 1 (55.4%) • *Market_to_book* > 0.588	**Node 47** • n = 1,102 • 0 (52.9%) • 1 (47.1%) • *Asset_maturity* <= 7.431
			Node 48 • n = 2,118 • 0 (40.3%) • 1 (59.7%) • *Asset_maturity* > 7.431
	Node 12 • n = 3,858 • 0 (34.2%) • 1 (65.8%) • *Real_size* > 6.179	**Node 25** • n = 814 • 0 (45.2%) • 1 (54.8%) • *Market_to_book* <= 0.564	**Node 49** • n = 364 • 0 (54.4%) • 1 (45.6%) • *Real_size* <= 7.042
			Node 50 • n = 450 • 0 (37.8%) • 1 (62.2%) • *Real_size* > 7.042
		Node 26 • n = 3,044 • 0 (31.3%) • 1 (68.7%) • *Market_to_book* > 0.564	**Node 51** • n = 1,442 • 0 (36.7%) • 1 (63.3%) • *Asset_maturity* <= 8.548
			Node 52 • n = 1,602 • 0 (26.5%) • 1 (73.5%) • *Asset_maturity* > 8.548

Table 6-45 - Classification tree outside right branch nodes

<table>
<tr><th>Level 2</th><th>Level 3</th><th>Level 4</th><th>Level 5</th></tr>
<tr><td rowspan="8">Node 6
• n = 19,515
• 0 (23.7%)
• 1 (76.3%)
• Asset_maturity > 11.219</td><td rowspan="4">Node 13
• n = 10,265
• 0 (30.5%)
• 1 (69.5%)
• Real_size <= 6.459</td><td rowspan="2">Node 27
• n = 1,957
• 0 (42.2%)
• 1 (57.8%)
• Market_to_book <= 0.580</td><td>Node 53
• n = 1,237
• 0 (48.6%)
• 1 (51.4%)
• Taxes <= 0.414</td></tr>
<tr><td>Node 54
• n = 720
• 0 (31.1%)
• 1 (68.9%)
• Taxes > 0.414</td></tr>
<tr><td rowspan="2">Node 28
• n = 8,308
• 0 (27.8%)
• 1 (72.2%)
• Market_to_book > 0.580</td><td>Node 55
• n = 922
• 0 (40.6%)
• 1 (59.4%)
• 2_year_market_return <= 0.028</td></tr>
<tr><td>Node 56
• n = 7,386
• 0 (26.2%)
• 1 (73.8%)
• 2_year_market_return > 0.028</td></tr>
<tr><td rowspan="4">Node 14
• n = 9,250
• 0 (16.2%)
• 1 (83.8%)
• Real_size > 6.459</td><td rowspan="2">Node 29
• n = 3,775
• 0 (20.5%)
• 1 (79.5%)
• Asset_maturity <= 15.008</td><td>Node 57
• n = 122
• 0 (45.9%)
• 1 (54.1%)
• Market_to_book <=0.478</td></tr>
<tr><td>Node 58
• n = 3,653
• 0 (19.6%)
• 1 (80.4%)
• Market_to_book >0.478</td></tr>
<tr><td rowspan="2">Node 30
• n = 5,475
• 0 (13.2%)
• 1 (86.8%)
• Asset_maturity > 15.008</td><td>Node 59
• n = 1,265
• 0 (19.1%)
• 1 (80.9%
• Real_size <= 6.894</td></tr>
<tr><td>Node 60
• n = 4,210
• 0 (11.4%)
• 1 (88.6%)
• Real_size > 6.894</td></tr>
</table>

Chapter 7 Conclusions

In this chapter we present the overall conclusions of the empirical studies performed on a panel data of US firms for the period ranging from 1974 to 2004. All studies are on the debt maturity held by firms and we measure debt maturity as the proportion of total debt that matures in more than three years.

We document a statistically significant downtrend in the average debt maturity in the last 25 years of our sample period. We split our sample in financially constrained and unconstrained firms according to three criteria: size, constrain dummy and Tobin's Q. We show that this decrease also occurs in both financially constrained and unconstrained firms. However, this time trend is more severe in smaller firms than in larger firms (the trend is not statistically significant for the latter group). We also find that independently of the criteria used, unconstrained firms have higher average debt maturity than constrained firms, although this difference is not statistically significant when using the Tobin's Q criterion.

Using the most relevant firm-specific debt maturity determinants found in the literature (size, growth options, tax rate, being a regulated firm, abnormal earnings and asset maturity), we model the average debt maturity for the 1980s period and investigate the model's predicting power in an out of the sample from 1990 to 2004. We find that our model has a poor predicting quality since significantly overestimates the level of the average debt maturity for the out of the sample period, in particular in the latest years. This result, as expected, is less relevant for the subsamples where the downward trend is less clear.

We find that firm characteristics change over time, from the base period to the 1990-2004 period. In average, firms have slightly less growth options, are subject to lower tax rates and have less asset maturity. Firms are larger and have more abnormal earnings in the most recent years and we find no regulated firms during that period. The economic relevance of the debt maturity determinants also change between the two sample periods. The firm size and the existence of growth have more economic impact on the average debt maturity ratio, while all other factors decline in importance. Overall, we conclude that these changes are not sufficient in explaining the previously reported significant decrease in the average debt maturity ratio.

We model the average debt maturity ratio of firms from 1974-2004, for the whole sample and financially constrained and unconstrained subsamples. Additionally to the firms-specific determinants we introduce three macroeconomic variables to proxy for macroeconomic conditions. We find mix results when compared to the existing theories and to the most relevant empirical studies. In line with Diamond (1991a) we find a positive relation between growth options and debt maturity, with a stronger economic impact in the unconstrained group of firms. Larger firms hold more long-term debt, as do firms with more assets' maturity (in particular for constrained firms), confirming Myers (1977) matching principle. In line with Stohs and Mauer (1996) and Danisevská (2002) but contradictory to Barclay and Smith (1995) and Guedes and Opler (1996), the agency costs hypothesis finds no support in the results. Opposed to Barclay and Smith (1995), we find no evidence that being a regulated firm has any significant influence on debt maturity choice. We also find no evidence that supports the signaling mechanism in which firms use their debt maturity choice to signal their quality to the market. Contradicting Kane *et al.* (1985), the results show that firms subject to higher effective tax rates borrow more long-term. This result is also supported in the financially constrained and unconstrained subsamples, though to a lesser extent.

At the macroeconomic level our results are weak. In line with our predictions we find some support that firms hold more short-term debt during economic recession, however, the results lack further confirmation. In the financially constrained and unconstrained firms we obtain mix results which inhibits us from taking relevant conclusions as to the impact on the debt maturity level of firms during periods of economic expansion or recession.

Overall, the models estimated to predict the average debt maturity have poor predictive power and should be improved. From the nine determinants used we find that several give little improvement to our models. The size of the firm, the maturity of assets, the supported tax rate and the growing options available to firms are the most relevant determinants of the debt maturity level. The size of the firm and its assets' maturity alone enable us to identify those firms with expected highest and lowest average debt maturity ratios: the largest firms with the highest assets' maturity are expected to have, on average, the highest debt maturity ratios, while the smallest firms with the lowest assets' maturity are expected to have, on average, the lowest debt maturity ratios. The macroeconomic variables have little relevance in predicting the debt maturity level held by firms in their capital structure.

Considering high debt maturity firms, firms with debt maturity above average, our results show that, other things equal, an increase in each of the determinants used produces an increase in the probability of a firm being classified as high debt maturity firm. This is particularly true in larger firms with more growing opportunities and assets' maturity and that are subject to higher tax rates. The size of the firm is of the outmost importance when performing this classification.

Despite the robust results obtained regarding some of the existing theories, in particular at the firm-specific level, further studies should be conducted in order to better understand the debt maturity level of firms. Despite the recent developments regarding the subject, there seems to be room for new theories and hypothesis as to what influences the debt maturity choice. Some of these new hypothesis are already being tested, as is the case of the relation between ownership structure and debt maturity. At the macroeconomic level and despite the fact of our results giving some indication on the influence of business conditions in the debt maturity choice framework, further studies must be conducted in order to achieve robust conclusions. It could be interesting to see if the conclusions are the same for different countries or for specific time frames with strong macroeconomic trends.

Chapter 8 References

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