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A two-part fractional regression model for the financial leverage decisions of micro, small, medium and large firms*

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Abstract

In this paper we examine the following two hypotheses which traditional theories of capital structure are relatively silent about: (i) the determinants of financial leverage decisions are different for micro, small, medium and large firms; and (ii) the factors that determine whether or not a firm issues debt are different from those that determine how much debt it issues. Using a binary choice model to explain the probability of a firm raising debt and a fractional regression model to explain the relative amount of debt issued, we find strong support for both hypotheses. Confirming recent empirical evidence, we find also that, although larger firms are more likely to use debt, conditional on having some debt firm size is negatively related to the proportion of debt used by firms.

Keywords: capital structure, financial leverage, zero leverage, micro firms, SMEs, fractional data, two-part model.
JEL Classification: C51, G32

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1 Introduction

Ever since Modigliani and Miller's (1958) pioneering contribution to the capital structure literature, a key theme in corporate finance has been to identify the main factors that affect the financing decisions of firms. For many years, most theoretical and empirical research on capital structure has focussed on large, listed firms. However, it is widely recognized today by scholars and policymakers that small and medium enterprises (SMEs) play a key role in economic and social development throughout the world. In Europe, the increasing attention dedicated to their role in the economy is clearly illustrated by the European Charter for Small Enterprises approved by the European Union leaders in 2000, where it is recognized that 'small enterprises must be considered as a main driver for innovation, employment as well as social and local integration'.[1] In the European Union, in 2003, SMEs represented 99.8% of all enterprises and contributed about 69.7% of employment and 57.3% of turnover (European Commission 2003).

Thus, in recent years there has been a substantial increment in the number of empirical studies on SMEs' debt policy decisions; see *inter alia* Cassar and Holmes (2003), Hall, Hutchinson and Michaelas (2004), Michaelas, Chittenden and Poutziouris (1999), Sogorb-Mira (2005) and Watson and Wilson (2002). Similarly to these authors, our main aim in this paper is to investigate whether and to what extent traditional capital structure theories provide also a satisfactory account of the capital structure choice of SMEs. In particular, we focus on the investigation of the main determinants of the financial leverage of Portuguese firms. This is relevant *per se* since, on the one hand, as shown by Hall, Hutchinson and Michaelas (2004), there are substantial variations in the effects of the determinants of capital structure across countries and, on the other hand, there are only a few studies on the Portuguese case (e.g. Hall, Hutchinson and Michaelas 2004 and Pindado, Rodrigues and de la Torre 2006). However, the contributions of this paper to the previous literature on SMEs (and, in fact, for the capital structure literature in general) go well beyond that.

First of all, as the data set that we use in this study comprises (using the new definitions recently adopted by the European Commission) large, medium, small and micro firms, we are able to make an integrated study and comparison of the main determinants of the capital structure of each one of those four size-based groups. In contrast, most previous studies on SMEs do not distinguish between micro, small and medium firms, treating all SMEs as a unique, uniform group and, thus, ignoring

[1] The European Charter for Small Enterprises is available online at http://europa.eu.int/comm/enterprise/enterprise_policy/charter/docs/charter_en.pdf.

that different factors might affect their capital structure choices in fundamentally different ways.[2] Moreover, note that the micro firm group *per se* clearly deserves a special attention. Indeed, according to European Commission (2003), within the group of European SMEs, the vast majority (92.5%) are micro enterprises, which contribute to 56.5% of the employment generated by SMEs. Similar patterns may be found around the world. However, to the best of our knowledge, there are no studies on the capital structure of micro firms.[3] Note also that most previous studies on SMEs are based on data sets covering only SMEs, see Voulgaris, Asteriou and Agiomirgianakis (2004) for an exception, which implies that all comparisons made in those papers with large enterprises (LEs) capital structure decisions are based on results for LEs described in other studies, which were obtained using other data sources and, sometimes, other econometric methodologies and frequently are relative to other countries and time spans.

The second major difference between our paper and other empirical analysis of SMEs' financing decisions concerns the econometric methodology employed. In particular, we show that the standard practice of using linear regression models to examine how a given set of potential explanatory variables influence some leverage (debt to capital assets) ratio is not the most appropriate choice. Indeed, since, by definition, a leverage ratio is observed only on the closed interval [0,1] and many firms have null leverage ratios[4], the effect of any explanatory variable on leverage ratios cannot be constant throughout its entire range. This is a critical issue since misspecification of the functional form of a regression model leads to biased results. However, this issue has attracted little attention in the capital structure empirical literature hitherto; see, for example, Frank and Goyal (2008), which discuss several econometric issues that *may affect* the regression analysis of leverage ratios (e.g. missing data, surviving bias, outliers) but ignore that the bounded nature of lever-

[2] The only exception to this practice seems to be Lopez-Gracia and Aybar-Arias (2000), which considered a partition of the SME group similar to ours but restricted their investigation to an analysis of variance of the influence of size and business sector on the financial behaviour of firms. There are also some recent papers which treat SMEs as a uniform group throughout most of the analysis but include robustness tests on firm size, reestimating their main models for size-based sub-samples (e.g. Cassar and Holmes 2003).

[3] Somewhat related papers to the study of the capital structure of micro firms are those examining the financing decisions of family business owners (e.g. Romano, Tanewski and Smyrnios 2001) since many micro firms are indeed family businesses. However, many family businesses cannot be classified as micro enterprises.

[4] Actually, there are two exceptions to this case: (i) some firms may have negative book values of equity, implying leverage ratios higher than 1; however, such firms are typically excluded from empirical studies on capital structures; and (ii) a small number of earlier applications focussed on debt to equity ratios, which are not bounded from above; however, using linear regression models to explain such ratios is still not appropriate since the (high) number of firms with null leverage ratios remains the same.

age ratios *conditions crucially* the range of approaches that should be adopted for modelling them. In our empirical analysis we found that, although in terms of the direction and significance of the regression coefficients very similar conclusions were achieved for both linear and more complex models, in terms of the magnitude of the partial effects estimated for each explanatory variable the differences may be substantial.

Given that methodologically it is not correct to use linear models for explaining leverage ratios, the empirical analysis undertaken in the paper is based on the (non-linear) fractional regression model developed by Papke and Wooldridge (1996) for continuously measured proportions with a finite number of boundary observations (i.e. 0s and 1s). As this model takes explicitly into account the restrictions on the values of leverage ratios, it could be directly applied to our data. However, based on a preliminary analysis of our data and on recent findings by Cassar (2004), Faulkender and Petersen (2006), Kurshev and Strebulaev (2007) and Strebulaev and Yang (2007), we decided to develop and apply a two-part fractional regression model that treats separately the decision of issuing debt or not and, conditional on this decision, the decision on the quantity of debt to issue. Indeed, when we first examined the data, we found a very interesting fact: while the proportion of firms that do not use debt financing is higher for micro firms, conditional on having debt this is also the group of firms that present the largest average leverage ratio. Moreover, in both cases small firms are ranked in second place, medium firms in third and large firms in fourth. Clearly, as this suggests that the factors that determine whether or not a firm uses debt at all may be different from the factors that determine how much debt are used by firms that do use debt, it seemed more realistic to allow the explanatory variables to influence in independent ways each decision. Therefore, in our empirical analysis the first decision is modelled as a binary choice model and the second as a fractional regression model that explains the relative amount of debt issued conditional upon the decision to issue debt. To the best of our knowledge, only Cassar (2004) and Cook, Kieschnick and McCullough (2004) have also used separate models to explain those decisions. However, they employed a different econometric methodology.

The remainder of this paper is organized as follows. In section 2 we briefly review some capital structure theories and the main empirical hypotheses that are implied by them for the leverage decisions of firms. Section 3 describes the data set used in our study and formulates the two main hypotheses that are examined in this paper. Section 4 explains the econometric methodology applied to the data. Section 5 presents the empirical results. Finally, section 6 summarizes and concludes the paper.

2 Standard determinants of capital structure

2.1 Alternative theories

Three of the most popular explanations of capital structure are the trade-off, the agency costs, and the pecking-order theories. Below we give a brief overview of each one of these theories; for more details see the recent surveys by Frank and Goyal (2008) and Prasade, Green and Murinde (2005).

The trade-off theory (TOT) claims the existence of an optimal capital structure that firms have to reach in order to maximize their value. The focus of this theory is on the benefits and costs of debt. The former include essentially the tax deductibility of interest paid (Modigliani and Miller 1958), while the latter are originated by an excessive amount of debt and the consequent potential bankruptcy costs (Kraus and Litzenberger 1973). Thus, firms set a target level for their debt-equity ratio that balances the tax advantages of additional debt against the costs of possible financial distress and bankruptcy.

The agency costs theory (ACT), initiated by Jensen and Meckling (1976), states that the optimal capital structure of each firm depends on the value of debt that mitigates the conflicts between stockholders and managers, on the one hand, and stockholders and debtholders, on the other hand. According to this theory, the stockholder-manager agency costs of free cash-flow push firms towards more debt in order to reduce the 'free' cash at managers' disposal (Jensen 1986), while the stockholder-debtholder agency costs of underinvestment and asset substitution push firms towards less leverage since large debt levels may be an incentive for rejecting value-increasing projects (Myers 1977) and pursuing risky projects (Jensen and Meckling 1976).[5]

The pecking-order theory (POT), which was originally developed by Myers (1984) and Myers and Majluf (1984), on the other hand, argues that firms do not possess an optimal capital structure although the financing decisions of their managers are not irrelevant for their value. Indeed, due to information asymmetries between firms' managers and potential outside financiers, which limit access to outside finance, firms tend to adopt a perfect hierarchical order of financing: first, they use internal

[5]Note that some authors consider the ACT as a part of the TOT since it focusses also on the benefits and costs of debt. However, in contrast to tax-based and bankruptcy theories, which are inter-dependent, the ACT originates a complete theory of capital structure, so we opted for considering it separately.

funds (retained earnings); in case external financing is needed, they issue low-risk debt; only as a last resort, when the firm exhausts its ability to issue safe debt, are new shares issued. In the absence of investment opportunities, firms retain earnings and build up financial slack to avoid having to raise external finance in the future. Hence, the firm leverage at each moment merely reflects its external financing requirements without a tendency to revert to any particular capital structure.

2.2 General empirical hypotheses

The three capital structure theories just described allow the identification of various factors as determinants of a firm's capital structure choice. Based on them, we next formulate a number of hypotheses for firms' financing decisions which are standard in the financial literature. In each case, we indicate briefly which and why a particular theory claims such behaviour, and provide some references where more detailed argumentation can be found.

1. *Non-debt tax shields are negatively related to debt.* Tax deduction for depreciation and investment tax credits act as substitutes for the tax benefits of debt, which implies that a firm with a large non-debt tax shield is likely to be less leveraged (TOT - DeAngelo and Masulis 1980).

2. *Tangibility is positively related to debt.* Firms with a greater percentage of their total assets composed of tangible assets have a higher capacity for raising debt since, in case of liquidation, these assets keep their value (TOT - Myers 1977). In firms with large tangible assets and poor cash-flows, stockholders may be better off by liquidating current operations; as managers may always want to continue the firm's current operations, debt can be considered a mechanism to increase default probability and give debt-holders the option to force liquidation (ACT - Harris and Raviv 1990). Due to asymmetric information, it is easier for the lender to establish the value of tangible assets, so firms with larger proportion of tangible assets have better access to the debt market (POT).

3. *Size is positively related to debt.* Larger firms tend to be more diversified, so their probability of bankruptcy is relatively smaller; moreover, large firms are more likely to have a credit rating and, thus, access to non-bank debt financing (TOT - Warner 1977). As informational asymmetries are less severe for larger firms, they find it easier to raise debt (POT - Myers, 1984).

4. *Profitability is:*

(a) *positively related to debt.* The higher the profitability of the firm, the higher the tax advantages of using debt and the less the probability of failing its interest payments (TOT) and the higher the free cash flows of the firm and the agency costs of equity, so a higher level of debt should be used to discipline the behaviour of management (ACT - Jensen and Meckling 1976).

(b) *negatively related to debt.* The more profitable the firm, the greater the availability of internal capital, the less the need for external funds (POT - Myers 1984).

5. *Expected growth is:*

   (a) *negatively related to debt.* As financial distress is more costly for firms with large expected growth prospects, firms may be reluctant to take on large amounts of debt in order to not increase their bankruptcy probability (TOT - Myers 1984). Firms with more investment opportunities have less need for the disciplining effect of debt payments to control free cash flows (ACT - Jensen 1986).

   (b) *positively related to debt.* Firms with more investment opportunities borrow more since their probability of outrunning internally generated funds is larger (POT - Shyam-Sunder and Myers 1999).

6. *Age is:*

   (a) *positively related to debt.* The longer the firm's history of repaying its debt, the lower will be its borrowing cost since lenders believe firms will not engage in asset substitution projects (ACT - Diamond 1989).

   (b) *negatively related to debt.* Older firms tend to accumulate retained earnings and, thus, require less external finance (POT - Petersen and Rajan 1994).

7. *Liquidity is negatively related to debt.* If firms prefer internal sources of finance, they tend to create liquid reserves from retained earnings in order to finance future investments, which reduces their need for external funds (POT - Myers and Majluf 1984).

3 Data and main hypotheses of the paper

In this section we first describe the data set used in our study and then formulate two further hypotheses which the three theories of capital structure considered above are relatively silent about.

3.1 Sample and variables

The data used in this study were provided by the *Banco de Portugal* Central Balance Sheet Data Office (CBSDO). From the CBSDO database we drew some information about balance sheets, income statements and other characteristics of many non-financial Portuguese firms for the year 1999.[6] In order to eliminate firms which were temporarily unoperational, or in the very early or very late stages of business operations, we discarded all firms with zero sales (15 firms) or negative earnings before interest, taxes and depreciation (283).[7] Firms with negative equity and 4 huge outliers were also excluded. This selection criteria produced a final sample of 4692 firms.

Similarly to Sogorb-Mira (2005), we use the definitions of micro, small, medium and large firms adopted by the European Commission (recommendation 2003/361/EC). Thus, the category of SMEs consists of enterprises which employ fewer than 250 persons and have either an annual turnover not exceeding 50 million euros, or an annual balance sheet total not exceeding 43 million euros. Within this group, small enterprises are defined as firms which employ fewer than 50 persons and whose annual turnover or annual balance sheet total does not exceed 10 million euros. Finally, micro enterprises are defined as firms which employ fewer than 10 persons and whose annual turnover or annual balance sheet total does not exceed 2 million euros. Panel A of Table 1 contains the breakdown of our sample by firm size.

Table 1 about here

In this paper we use as measure of financial leverage the ratio of long-term debt (LTD) to long-term capital assets (defined as the sum of LTD and equity); see

[6] Most authors argue that the capital structure of financial corporations must be analyzed separately because their financial responsibilities are not strictly comparable with those of other firms; see for example Rajan and Zingales (1995, p. 1424).

[7] In the latter case, another reason lead us to exclude such firms. As described in Table 2, our regression model uses the ratio between depreciation and negative earnings before interest, taxes and depreciation (EBITDA) as a proxy for non-debt tax shields (NDTS). Since the inclusion of firms with negative earnings would create a discontinuity in the NDTS measure at zero euros of EBITDA, we opted for discarding such firms (see Jensen, Solberg and Zorn 1992, p. 253, footnote 9, for a similar procedure in a different context).

Rajan and Zingales (1995) for an extensive discussion on these and other alternative measures of leverage. LTD is defined as the total company's debt due for repayment beyond one year. We use book values of both LTD and equity since our sample comprises mostly unlisted firms. We consider only LTD because the main focus of all (general) capital structure theories is the option that firms make between LTD and equity to finance their businesses. As our aim in this paper is to investigate whether those theories apply to all size-based groups of firms, we do not consider all the other possible financing alternatives of firms such as short-term debt and trade credit, which tend to be less important for larger firms.

As most of the factors that appear in the seven hypotheses formulated in section 2.2 correspond to unobservable theoretical attributes, in the econometric analysis undertaken later in the paper we use some explanatory variables that work as proxies for those attributes. The ones that we chose, which have been widely used in the empirical literature, are described in Table 2. We also made some experiments with other proxies but the results obtained will not be reported since they were very similar.[8] Some descriptive statistics for the explanatory variables are reported in Table 3. Since evidence from previous studies is mixed as to whether industry membership affects significantly firms' capital structure, see *inter alia* Jordan, Lowe and Taylor (1998) and Hall, Hutchinson and Michaelas (2000) for opposite findings regarding this issue, all the regressions performed in the paper include industry controls in order to ensure that our findings are not significantly affected by industry membership.[9]

Table 2 about here
Table 3 about here

3.2 Firm size and debt financing

Originally, the three theories of capital structure reviewed in section 2.1 were formulated to explain the observed practices of large, publicly traded corporations; as pointed out by Ang (1991), they were not developed with small business in mind. However, there has been an increasing recognition in the financial literature

[8] In particular, alternatively to the explanatory variables described in Table 2, we considered the following proxies: the ratio between tangible assets and total assets for the attribute "Tangibility", the natural logarithm of assets for "Size", the ratios between net income and assets and earnings before interest, taxes and depreciation and assets for "Profitability", and the percentage change in sales for "Growth".

[9] Due to data limitations, we considered only five categories of industries: Manufacturing (2905 firms), Construction (879), Wholesale and Retail Trade (124), Transport and Communication (455), and Other Industries (329).

that SMEs act differently and are affected differently from large firms in numerous aspects of their financial behaviour. For example, Ang (1992) states that 'small businesses (...) have different types of complexities, such as shorter expected life, presence of estate tax, intergenerational transfer problems, and prevalence of implicit contracts', while Scherr and Hulburt (2001) argues that 'small firms differ from large firms in taxability, ownership, flexibility, industry, economies of scale, financial market access, and level of information asymmetry'; see also Ang (1991) and Pettit and Singer (1985).

Thus, given that 'smaller firms are not larger firms scaled down' (Scherr and Hulburt 2001), there are many recent studies of capital structure that differentiate between SMEs and LEs. In fact, there seem to be various theoretical reasons why traditional capital structure theories may not apply directly to (at least the smallest size-based sub-groups of) SMEs. In particular, asymmetric information and agency problems are much more complex in the case of small businesses. Indeed, the asymmetric information problem is more serious in SMEs given the informational opacity that characterizes most of them: for example, in general, SMEs do not enter into contracts that are publicly visible or widely reported in the press, do not issue traded securities that are continuously priced in public markets and do not have audited financial statements that can be shared with any provider of outside finance (Berger and Udell 1998; see also Ang 1991). With regard to agency problems, in small businesses, as the managers are also the owners in many cases, while the stockholder-manager agency costs tend to be insignificant, agency problems between owners/managers and debtholders can be more severe due to the closely held nature of small firms (and the consequent added flexibility of changing the asset base and greater opportunity of owners/managers to consume perquisites and channel funds to themselves) and to the greater costs of dealing with them by means of monitoring and bonding (e.g. Pettit and Singer 1985, Ang 1991, Chittenden, Hall and Hutchinson 1996, Michaelas, Chittenden and Poutziouris 1999).

As a consequence of these aggravated debtholder-manager agency and asymmetric information problems, which affect the cost and availability of credit, SMEs tend to use less external funding than large firms. Indeed, in general, SMEs have no access to equity and public debt markets and have to depend on financial intermediaries, particularly commercial banks, which may not be willing to provide them all the funding they would like and usually impose higher interest rates and require collateral (Berger and Udell 1995). This reasoning lead to the 'finance gap theory', which states that the heavy reliance of SMEs on internal sources of finance is externally imposed, being the result of an institutional failure in providing them with an adequate amount of finance (e.g. Holmes and Kent 1991).

The recognition of the existence of gaps in the supply of finance for small firms led to the development of alternative capital structure theories, which were designed specifically for small firms. One of those theories is the financial bootstrapping theory, which explains how, given the limitations faced on their supplies of finance, small firms develop alternate means of acquiring and securing the use of resources without borrowing money or raising equity financing from traditional sources. Examples of those alternate sources of funding for small firms are loans from friends and relatives, credit cards, home equity loans, life insurance, supplier credit, leases and costumer financing; see Van Auken and Neeley (1996) for more details and many useful references regarding this subject. Other related theory to the finance gap theory is the financing life-cycle approach, which suggests that the type of financing alternatives available to firms varies through the life of the business (Ang 1991, Vos and Forlong 1996, Berger and Udell 1998). According to this theory, small businesses may be thought of as having a financial growth cycle in which financial options change as the firm grows and becomes less informationally opaque: smaller/younger/more opaque firms must rely mainly on initial insider finance; if they remain in existence and continue to grow, they are likely to be able to make use of other sources of funds such as trade credit and bank loans; eventually, they will gain access to public debt and equity markets.

While the theories just discussed are supply side in nature, alternative explanations that focus on the demand side and stress the influence of the entrepreneur on the predominance of internal sources of funding in the SME case are also popular. According to this alternative view, even in the absence of debt supply constraints, smaller firms would be less prone to use debt financing and more likely to use internal funds; see *inter alia* Hutchinson (1995), Vos and Forlong (1996) and Chandler and Hanks (1998). Indeed, many small firms are family businesses that do not pursue any high growth strategy and arguments like "being one's own boss" may be prominent in the entrepreneur's objective function, which implies that such firms may not need or wish to use debt financing. Actually, owners of small firms seem to have a strong preference for those financing options that minimize intrusion in their businesses and avoid the discipline inherent in other financing options than internal funds. Therefore, retained earnings and personal savings lie in the first place of their preference of financing and, in case internal funds are not enough, they will prefer debt to outside equity mainly because debt means lower level of intrusion and, hence, lower risk of losing control and decision-making power.

Therefore, it appears that both supply- and demand-side effects lead SMEs to use less proportion of debt in the financing of their activity than predicted by traditional capital structure theories for large firms. Instead, they have to and choose to use more internal funds. Although most of the discussion above refer to SMEs in general, 'small businesses are too heterogenous to be lumped into a single category' (Ang 1991) and 'the same influences that may cause differences between SMEs and larger listed forms, may also affect relationships within the SME group, due to wide variation of sizes present' (Cassar and Holmes 2003). We share this view and, therefore, in this paper we conjecture that the SME group is not homogeneous at all and that the smaller size-based groups are not just scaled down versions of the others. In particular, we test whether the seven factors listed in the previous section are important for the capital structure decisions of the four size-based group of firms considered in this paper and whether their influence is similar in all cases.[10] This hypothesis can be formulated as:

8. *Determinants of debt are different for micro, small, medium and large firms.*

3.3 To issue or not to issue debt versus how much debt to issue

The analysis of Panel B of Table 1 shows that 72.8% of the firms in our sample have zero leverage ratios. Other studies have also documented that a substantial proportion of firms follow a zero-debt policy. For example, Petersen and Rajan (1994) report that 28% of corporations and 45% of noncorporations in their U.S.A. sample do not have LTD and in the sample collected by Brounen, Jong and Koedik (2005) 25% of U.K. firms and 29% of French firms have no LTD at all. Very recently, Strebulaev and Yang (2007), based on accounting information from COMPUSTAT relative to U.S.A. firms, report that, on average, in the sample period 1962-2003, 13.2% of firm-years have no LTD, from a minimum of 9.3% in 1979 to a maximum of 23.7% in 2003. In their paper, which was suggestively entitled "The mystery of zero-leverage firms", these authors found that zero-leverage behaviour is a persistent phenomenon and that standard capital structure theories are unable to provide a reasonable explanation for it.

Panel B of Table 1 shows also that there is a clear size effect on the probability of a firm using LTD, with larger firms resorting to LTD more often than smaller firms: the percentage of firms that do not have LTD is 88.7%, 76.8%, 51.2% and 40.6% for

[10] Note that size is included in two different ways in our analysis, both as a quantitative variable (sales) and as a nominal variable (size-based group of firms), since we are assuming that the effects of size, as measured by sales, on the capital structure of firms may vary depending on whether the firm is in fact micro, small, medium or large-sized.

the groups of micro, small, medium and large firms, respectively. In Petersen and Rajan (1994), Brounen, Jong and Koedik (2005) and Strebulaev and Yang (2007) it is also evident that larger firms tend to use LTD more frequently. This suggests that the larger proportion of zero leverage ratios found in our case relative to the studies cited in the precedent paragraph may be explained by the larger proportion of SMEs (94.2%) in our sample and by the fact that, on average, Portuguese LEs are smaller than their U.S.A., U.K. and French counterparts.

The same size effect is apparent when we compare mean and median leverage ratios by category (panel C): typically, larger firms have larger leverage ratios. However, when we limit our comparison to firms that have LTD (panel D), we find contradictory results: once they decide and are able to use LTD, smaller firms seem to use it in a larger proportion than larger firms. For each one of the six possible pairs of size-based groups of firms, we tested the statistical significance of the differences between: (i) the proportion of firms that use LTD in each category; and (ii) the mean leverage ratios of each category considering only firms that do use LTD. In both cases, the tests revealed significant differences at a 1% level for all the six pairs of groups of firms.

Thus, firm size seems to affect in an inverse way the decisions on: (i) to issue or not to issue debt; and (ii) (for those firms that do decide to use debt) on how much debt to issue. Although international evidence suggests that in most countries leverage is strongly positively related to size, recent research provide some support to our conjecture. Like us, Faulkender and Petersen (2006) and Strebulaev and Yang (2007) found that while larger firms are more likely to have some debt, conditional on having some debt, larger firms are less levered. The former authors found also that excluding zero-debt firms from leverage regressions changes the sign of the size coefficient from positive to negative. Similarly, Kurshev and Strebulaev (2007) argue that 'the positive relationship (between firm size and leverage) is an artefact of the presence of small unlevered firms in the economy. When we control for unlevered firms, the relationship between firm size and leverage becomes slightly but statistically significant negative'. Finally, Cassar (2004) found that firm size affects in opposite ways the use and magnitude of LTD by business start-ups.

Kurshev and Strebulaev (2007) put forward a theoretical explanation for these opposite effects of firm size on leverage. They conjecture that it is the presence of fixed costs of external financing, and the consequent infrequent refinancing of firms, that causes these differences between small and large firms, since the former are much more affected in relative terms. According to these authors: (i) small firms choose higher leverage at the moment of refinancing to compensate for less frequent rebalancing, which explains why, conditional on having debt, they are more levered than large firms; (ii) as they wait longer times between refinancings, small firms have on average lower levels of leverage; and (iii) in each moment, there is a mass of firms opting for no leverage since small firms may find it optimal to postpone their debt issuances until their fortunes improve substantially relative to the costs of issuance.

All the discussion above focus on the conflicting effects of firm size over the use and proportion of LTD but other standard determinants of leverage identified by traditional capital structure theories may actually have the same double influence on leverage. For example, we may conjecture that older small firms are more likely to have access to and use LTD, as argued by the financing life-cycle approach, but, at the same time, as claimed by the pecking-order theory, they tend to use it in a lower proportion since, due to a large amount of accumulated retained earnings, they usually need less external finance. Moreover, even when one variable has the same type of effects (positive/negative) over the use and proportion of debt, it is still very likely that the magnitude of those effects is different for each decision.

Based on these findings and conjectures, it seems clear that using a simple model for analyzing leverage ratios will not be the most appropriate choice in most cases. Therefore, in the next section we develop an econometric model that recognizes the possibility that the decisions on the use and proportion of LTD may be taken independently and, hence, some factors may affect in different forms (at least in magnitude) each decision. Basically, contrary to the traditional practice in the capital structure empirical literature, we model separately the probability of a firm using debt and the expected value of the proportion of debt used by a firm when it does use debt. Our aim is to test the following hypothesis:

9. *The mechanisms that determine whether or not a firm uses debt at all are different from the mechanisms that determine the proportion of debt used by firms that do use debt.*

To the best of our knowledge, only Cassar (2004) and Cook, Kieschnick and McCullough (2004) have investigated a similar hypothesis and both of them found some support to it. Cook, Kieschnick and McCullough (2004) found that the predictive ability of a model that separates the two decisions were much larger than those of standard models that force the explanatory variables to affect in an identical manner both decisions, while Cassar (2004), as already referred to above, found that, in the case of LTD, the size of a firm, measured by the natural logarithm of its assets, affects in significant opposite ways each decision. The main difference between our approach and theirs is methodological since we use a different econometric model to analyze the second decision (Cassar 2004 uses a linear model and Cook, Kieschnick and McCullough 2004 uses a model that requires more heavy assumptions than ours; see the next section for details). Moreover, in contrast to them, we show how to combine the results obtained in each part of the model in order to calculate the overall (unconditional) effect of each explanatory variable on the proportion of debt used by all firms.

4 Econometric methodology

In this section we first discuss why, from a methodological point of view, standard regression models should not be used for modelling leverage ratios, then we briefly review Papke and Wooldridge's (1996) regression model for fractional data, and finally we present the two-part fractional regression model developed in this paper.

4.1 Standard regression models

Typically, empirical studies of capital structure specify linear regression models to explain observed leverage ratios, which are then estimated by least squares-based (LS) methods using cross sectional or panel company data; see for example the recent surveys by Frank and Goyal (2008) and Prasade, Green and Murinde (2005), which summarize the main methodologies used in capital structure empirical research. However, leverage ratios have two fundamental statistical properties that cannot be ignored econometrically: (i) by definition, they are bounded between 0 and 1; and (ii) many firms do not use debt in their financing. Therefore, since, under these circumstances, the effect of any explanatory variable cannot be constant throughout its entire range, the linearity assumption

$$E(Y|X) = X\beta, \tag{1}$$

where Y is the dependent variable (a leverage ratio), X denotes a matrix containing all explanatory variables and β is the vector of variable coefficients that we aim to estimate, is unlikely to hold. Moreover, specification (1) cannot guarantee that the predicted values of Y lie between 0 and 1 without severe constraints on the range of X or *ad hoc* adjustments to fitted values outside the unit interval.

Alternatively, as a typical random sample of firms contains many firms that do not use debt, some authors (e.g. Rajan and Zingales 1995 and Cassar 2004) have opted for using a tobit approach for data censored at zero. This model assumes a nonlinear relationship between Y and X given by

$$E(Y|X) = \Phi\left(\frac{X\beta}{\sigma}\right)X\beta + \sigma\phi\left(\frac{X\beta}{\sigma}\right), \quad (2)$$

where $\Phi(\cdot)$ and $\phi(\cdot)$ denote the standard normal distribution and density functions, respectively, and σ is the standard deviation of the error term of the latent linear model that implies (2). However, using the tobit to model leverage ratios suffers also from some drawbacks. First, equation (2), despite being limited from below at zero, still has no upper bound. Second, conceptually, as some authors argue (e.g. Maddala 1991), the latent model underlying (2) is appropriate to describe *censored* data in the interval [0,1] but its application to data *defined* only in that interval is not easy to justify: zero leverage ratios are a consequence of individual choices and not of censoring. Finally, the tobit model is very stringent in terms of assumptions: the error term of the latent model has to be homoskedastic and to possess a normal distribution. There are some modified tobit models that could be used (e.g. the heteroskedasticity-robust tobit estimator used by Wald 1999 or the two-limit variant of tobit employed by Johnson 1997 and Fluck, Holtz-Eakin and Rosen 1998 to take care for both the lower and upper limits of the distribution of leverage ratios) but none of them would solve simultaneously all the issues associated with the use of tobit models.

Another alternative used in previous research (e.g. Jordan, Lowe and Taylor 1998) to model leverage ratios is the utilization of the logistic transformation

$$E(Y|X) = \frac{e^{X\beta}}{1+e^{X\beta}}, \quad (3)$$

which is indeed a natural choice for modelling proportions since it ensures that $0 < E(Y|X) < 1$. However, instead of estimating (3) directly, which would require a nonlinear technique such as nonlinear least squares (NLS), most authors prefer to use LS to estimate the log-odds ratio model defined by

$$E\left(\log\frac{Y}{1-Y}\middle| X\right) = X\beta, \quad (4)$$

which basically corresponds to the linearization of the equation that results from solving $Y = e^{X\beta}/\left(1+e^{X\beta}\right)$ in order to $X\beta$. Again, a regression model defined by (4) is not adequate to explain leverage ratios because the transformed dependent variable is not well defined for the boundary values 0 and 1 of Y, requiring *ad hoc* adjustments (such as adding an arbitrarily chosen small constant to all observations of Y). Moreover, from (4) it would be very difficult to recover $E(Y|X)$ and, thus, interpret the model parameters in terms of the leverage ratio, which would still be our main interest.

4.2 Fractional regression model

As the correct specification of the conditional mean of Y is a crucial assumption for the validity of any regression model, the evidence found in papers assuming (1), (2) or (4) may be incorrect (to the best of our knowledge, in no case was that assumption tested) and should be validated using suitable econometric models. One of such models is the fractional regression model (FRM) developed by Papke and Wooldridge (1996) to deal with dependent variables defined on the closed interval [0,1]. In their model, they assume a functional form for Y that imposes the desired constraints on the values of the dependent variable:

$$E(Y|X) = G(X\beta), \tag{5}$$

where $G(\cdot)$ is a known nonlinear function satisfying $0 < G(\cdot) < 1$. Papke and Wooldridge (1996) suggest as possible specifications for $G(\cdot)$ any cumulative distribution function. Therefore, the logistic function (3) is a possible choice for $G(\cdot)$. However, instead of being first linearized as discussed above, the model defined by (5) is now estimated directly using nonlinear techniques.

Papke and Wooldridge (1996) showed that, although consistent estimators for β could be obtained by estimating (5) by NLS, it is more efficient to assume a Bernoulli distribution for Y conditional on X and estimate the parameters β in (5) by maximizing the quasi-likelihood function:

$$LL(\beta) = y \log [G(X\beta)] + (1-y) \log [1 - G(X\beta)]. \tag{6}$$

Indeed, as the Bernoulli distribution is a member of the linear exponential family, the resulting quasi-maximum likelihood (QML) estimator for β will always be consistent, regardless of the true distribution of Y conditional on X, provided that (5) is indeed correctly specified (see Gourieroux, Monfort and Trognon 1984 for details). Actually, as in no circumstances can the Bernoulli be the true conditional distribution of leverage ratios, robust standard errors have to be used. In this paper we compute them by applying Papke and Wooldridge's (1996) equation 9, which merely assumes (5).[11] Thus, similarly to the three regression models discussed in

[11] The fractional regression model that assumes a logistic specification for $G(.)$ can be easily

the previous section, the crucial assumption of the FRM is the correct formalization of $E(Y|X)$, which can be tested using the extension of the RESET test outlined in Papke and Wooldridge (1996).

4.3 Two-part fractional regression model

Although the FRM (5) may be used to explain the behaviour of a dependent variable characterized by a large number of zero values, theoretically, as discussed in section 3.3, it may be preferable to construct separate models to explain the decisions: (i) to issue or not to issue debt; and (ii) (for those firms that do decide to use debt) on how much debt to issue. Indeed, given that zero leverage ratios occur with too large a frequency than seems to be consistent with a simple model, the factors that explain the former decision may be not the same as those that affect the latter decision or their effect may be different. Therefore, in this section we extend Papke and Wooldridge's (1996) FRM and develop a two-part FRM (2P-FRM) that mirrors this two-part decision process.[12]

The first part of our 2P-FRM governs participation, i.e. specifies a binary outcome model to explain the probability of a firm choosing to use LTD or not. Define

$$Y^* = \begin{cases} 0 \text{ for } Y = 0 \\ 1 \text{ for } Y \in (0,1] \end{cases} . \tag{7}$$

Then,

$$\Pr(Y^* = 1|X) = \Pr(Y \in (0,1]\,|X) = F(X\theta), \tag{8}$$

where θ is a vector of variable coefficients and $F(\cdot)$ is the cumulative logistic or normal distribution function. The resulting logit or probit model may be estimated, as usual, by ML using the whole sample.

The second part of the 2P-FRM governs positive choices, i.e. the magnitude of nonzero leverage ratios. In this case, a $G(\cdot)$ function similar to the one defined above for the FRM is also a valid specification:

$$E(Y|X, Y \in (0,1]) = G(X\gamma). \tag{9}$$

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computed in Stata using the following command line:

glm *LR EV1 ... EVk*, link(logit) family(binomial) robust

where *LR* denotes the leverage ratio and EVj, $j = 1, ..., k$ are the explanatory variables. Stata includes also alternative specifications for $G(\cdot)$.

[12] Two-part (or hurdle) models are relatively common in the econometric literature of count data; see Mulhahy (1986) for a seminal paper.

As for the simple FRM, $G(X\gamma)$ may be estimated by QML but now using only data for firms with positive leverage ratios.

Noting that $E(Y|X)$ may be decomposed as

$$E(Y|X) = E(Y|X, Y=0) \cdot \Pr(Y=0|X) + E(Y|X, Y \in (0,1]) \cdot \Pr(Y \in (0,1]\,|X),$$

and that the first term on the right-hand side of this expression is identically zero, the 2P-FRM may be described simply by

$$\begin{aligned} E(Y|X) &= E(Y|X, Y \in (0,1]) \cdot \Pr(Y \in (0,1]\,|X) \\ &= G(X\gamma) \cdot F(X\theta), \end{aligned} \tag{10}$$

where their two components are to be estimated separately. As γ and θ are not required to be the same, this 2P-FRM allows the explanatory variables to influence in independent ways the firm's choice of using or not LTD and the firm's choice of LTD proportion, as Table 1 revealed that should be the case of Portuguese firms. Moreover, comparing (5) and (10) shows that if the mechanisms governing both decisions are indeed different, the functional form of the conditional mean will be affected. Hence, neglecting the special nature of the zero leverage ratios is likely to produce serious misspecification since the parameters β appearing in (5) are a mixture of the parameters γ and θ in (10) and have no clear interpretation.

The crucial assumption for estimating both γ and θ consistently is again the correct formalization of $E(Y|X)$ which, in turn, requires that both $E(Y|X, Y \in (0,1])$ and $\Pr(Y^* = 1|X)$ are properly specified.[13] In this paper we assume a logistic specification for both functions, that is:

$$E(Y|X) = \frac{e^{X(\gamma+\theta)}}{(1+e^{X\gamma})(1+e^{X\theta})}. \tag{11}$$

To test the assumption made for $G(X\gamma)$ we apply the same RESET test referred to above, while to test the specification adopted for $F(X\theta)$ we use Pagan and Vella's (1989) version of the RESET test and Davidson and MacKinnon's (1984)

[13] Recently, Cook, Kieschnick and McCullough (2004) used also a two-part model to explain capital structure choices. Their approach is similar to ours but differ in two important aspects. First, in the second part of the model, they assume a beta distribution for the conditional distribution of (the positive values of) Y given X and then estimate the parameters γ by ML. As the beta distribution is not a member of the linear exponential family, in addition to the correct specification of $E(Y|X, Y \in (0,1])$ and $\Pr(Y^* = 1|X)$ required by our model, in their case it is also essential that the true distribution of Y conditional on X is indeed the beta distribution. Second, while we *opted* for using a two-part model in order to be able to test a specific hypothesis about capital structure choices, they were *forced* to do so: the beta distribution can only be applied to observations on the open interval (0,1).

heteroskedasticity test.[14]

The information provided by the coefficients obtained from estimating the 2P-FRM can be used to estimate the effect of a change in the explanatory variable X_j on both the probability of using LTD,

$$\frac{\partial \Pr(Y^* = 1|X)}{\partial X_j} = \theta_j \frac{e^{X\theta}}{(1+e^{X\theta})^2}, \tag{12}$$

and, if the firm already uses LTD, on the proportion utilized:

$$\frac{\partial E(Y|X, Y \in (0,1])}{\partial X_j} = \gamma_j \frac{e^{X\gamma}}{(1+e^{X\gamma})^2}. \tag{13}$$

Moreover, from (10) or (11), we can also calculate the effect of a change in X_j on the LTD used by *all* firms:

$$\begin{aligned} \frac{\partial E(Y|X)}{\partial X_j} &= \frac{\partial G(X\gamma)}{\partial X_j} F(X\theta) + G(X\gamma) \frac{\partial F(X\theta)}{\partial X_j} & (14) \\ &= \gamma_j \frac{e^{X\gamma}}{(1+e^{X\gamma})^2} \frac{e^{X\theta}}{1+e^{X\theta}} + \theta_j \frac{e^{X\theta}}{(1+e^{X\theta})^2} \frac{e^{X\gamma}}{1+e^{X\gamma}}. & (15) \end{aligned}$$

Thus, the total change in LTD can be disaggregated in two parts: (i) the change in LTD of those that already use LTD, weighted by the probability of issuing debt; and (ii) the change in probability of using LTD, weighted by the expected value of LTD among those that already use LTD. This decomposition is similar to that found by McDonald and Moffitt (1980) for the tobit model.

5 Empirical results

5.1 Main findings

In Table 4 we report the empirical results obtained from the estimation of the two models implied by the 2P-FRM (to save space, we do not report the coefficients estimated for the industry constant dummies). Considering first the empirical adequacy of both models, it seems that they fit the data relatively well in all cases. Indeed, the RESET test provides no evidence of functional form misspecification; for the binary model, Davidson and MacKinnon's (1984) test for the null hypothesis of homoskedasticity is not significant; and the values found for the pseudo R^2,

[14] In the former case we do not need to test for heteroskedasticity since regression models for continuously measured proportions with a finite number of boundary observations are always heteroskedastic and the estimation method adopted, QML, has that into account.

although low, are usual in cross-sectional studies.

Table 4 about here

Relative to the decision of issuing debt or not, the estimates obtained for the binary choice model indicate that the only variables which significantly influence that decision for all the four groups of firms are $PROFITAB$ and $LIQUIDITY$. In all cases, the higher the profitability and the amount of liquid reserves of the firm, the less its probability of using LTD. Clearly, as implied by the pecking-order theory and in opposition to the other two capital structure theories considered in this paper, all types of firms seem to prefer internal resources to external ones to finance their activity.

On the other hand, as predicted by the three theories, we find positive relationships between the resort to LTD and the explanatory variables $TANGIB$ and $SIZE$, which are significant for most groups. Interestingly, the only group where $TANGIB$ does not affect significantly the probability of firms raising debt is that of micro firms, maybe because the most important source of collateral for micro firms is certainly the private collateral provided by their owners (see *inter alia* Hall, Hutchinson and Michaelas 2004). In contrast, only for micro firms is the variable AGE important to explain that probability. Therefore, it seems that, due to the informational opacity that characterizes most micro firms, lenders use AGE as a measure of their reputation: older micro firms are more prone to use LTD because they have better access to the debt market since their longer history of survival leads lenders to trust them more, as predicted by the agency costs theory. Moreover, older firms tend to have longer banking relationships and, hence, as argued by Berger and Udell (1995), pay lower interest rates and are less likely to pledge collateral. See also Egeln, Licht and Steil (1997) and Levenson and Willard (2000), who found that smaller and younger firms are less likely to receive outside financing, as claimed by the financing life-cycle theory.

We find also a statistically significant positive effect of $GROWTH$ on the probability of medium and large firms using LTD, which, again, is in line with the pecking-order theory and in opposition to the other two theories. With regard to $NDTS$, contrary to the trade-off theory, in no case did we find a significant correlation between this variable and the probability of using LTD. Finally, the joint significance of the industry dummies for micro, small and medium firms indicates that industry membership exhibits an important effect on SMEs capital structure.

Considering now the results of the second part of our model, which are based only on firms that do use LTD, we find that, as predicted by the pecking-order theory: (i) both $PROFITAB$ and $LIQUIDITY$ are negatively related to the relative amount of LTD issued, although only the effect of the former variable is significant; (ii) $GROWTH$ has a positive relationship with LTD, which is significant for small and large firms; and (iii) AGE affects negatively the proportion of LTD used in the financing of smaller firms. Interestingly, note the opposite effects that AGE has over the two levels of the model estimated for micro and small firms (although in some cases that effect is not significant): on the one hand, older firms are more prone to use LTD, for the reasons explained above; on the other hand, conditional upon the decision/ability to issue debt, they use a lower proportion of LTD in the financing of their businesses than younger firms. A possible reason for the latter effect is the accumulation of retained earnings over time by firms that are successful enough to survive for a long time, as suggested (in general) by the pecking-order theory. Indeed, part of those retained earnings may be used to repurchase some debt.

Also in contrast to the results obtained for the first part of our 2P-FRM, we find that (i) $TANGIB$ does not affect significantly the proportion of LTD used by firms; (ii) only for large firms does $NDTS$ seem to be an important determinant of the capital structure, maybe because large firms have generally higher marginal tax rates than smaller firms and, therefore, more tax deduction benefit of (debt and) non-debt tax shields; and (iii) $SIZE$ has a significant negative impact on the relative amount of LTD used by small and medium firms. The latter effect confirms recent findings by Cassar (2004) and Faulkender and Petersen (2006), which, as argued by Kurshev and Strebulaev (2007), see section 3.3, may be explained by the presence of transaction costs in the issuance of debt, which may result in minimum lower bonds in debt issued. Finally, we found again that the industry where micro and small firms operate is an important factor in explaining their LTD policy decisions.[15]

Overall, the results reported in table 4 suggest that the determinants of LTD for micro, small, medium and large firms differ in some aspects. For example, we find that AGE is an important determinant of the capital structure of micro and small firms, while $NDTS$ is important only for large firms. Even when the type of relationship (positive/negative) is the same for all groups, it seems that there are important differences in the magnitude of the coefficients in some cases. To formally test the hypothesis whether the same regression model describes in an appropriate way the capital structure choices for all size-based group of firms, we applied the Chow-type tests described in the Appendix. In Table 5 we report the p-

[15] In particular, we found that the LTD decisions of micro and small firms in the Construction sector are significantly different from those of their counterparts in other industries.

values estimated for both parts of the model for the null hypothesis of no significant differences between *all* the coefficients relative to each pair of size-based groups of firms.

Table 5 about here

Considering both parts of the model, we found significant differences in seven out of the twelve cases analyzed, which suggests that, when analyzing capital structure choices, three distinct size-based groups of firms should be considered (assuming that the European Commission definitions are used): (i) micro firms; (ii) small firms; and (iii) medium/large firms. Indeed, in no case did we reject the hypothesis of equality of the coefficients for the medium and large groups of firms, i.e. the determinants of the financing decisions of medium firms seem to be more similar to those of large firms than those of the other SMEs. This similarity between medium and large firms may be the reason why some of the previous studies on capital structures did not find significant differences between the financing decisions of SMEs and LEs: according to our results, the inclusion of medium-sized firms in the SME group is likely to diminish substantially the differences between SMEs and LEs in terms of capital structure choice.

The results reported in Table 4 also suggest that, as assumed in this paper, the main determinants of the probability of a firm using LTD are not exactly the same as those of the proportion of LTD used. Indeed, given that, for some groups, $TANGIB$, $LIQUIDITY$, AGE and $NDTS$ are important only for one of the decisions and $SIZE$ and AGE affect in opposite ways each decision, it seems that a two-part model such as the 2P-FRM that we employed is in fact a better option for explaining the capital structure of firms than standard one-part models. However, based exclusively on the coefficients reported in Table 4, we cannot know which is the overall effect of each variable on the proportion of LTD used by firms, especially for the variables that have opposite effects on the two parts of the model. For example, do larger small and medium firms use more or less LTD on average? To answer this question, in Table 6 we report the partial effects estimated for each variable, which are the averages of the partial effects calculated for each firm in the sample. We report three different partial effects: (i) the effect on the probability of using LTD (ΔP_1), which was defined in (12); (ii) the effect on the proportion of LTD used by firms that already use LTD (ΔE_1), defined in (13); and (iii) the effect on the proportion of LTD used by all firms (ΔE), defined in (15). It is this last effect that gives the combined effect of each variable on the unconditional proportion of LTD used by firms.

Table 6 about here

The total partial effects reported in the column labelled ΔE show that, overall, $NDTS$, $PROFITAB$ and $LIQUIDITY$ affect negatively the proportion of LTD used by firms, $SIZE$ influences it positively, and the effect of AGE and $GROWTH$ is approximately nil in all cases. For micro firms the overall effect of $TANGIB$ is nil, while for the other size-based groups it is positive. Clearly, given the signs found for $PROFITAB$ and $LIQUIDITY$, the pecking-order theory seems to be the one that best describes the capital structure of firms, as already suggested above. Note the positive effect of $SIZE$, which is consistent with previous empirical research that do not use separate models for the use and proportion of debt.

5.2 Comparison with alternative models

In Table 7 we report the results obtained by considering two other formulations for the capital structure decisions of firms: the simple linear model used by most of the previous papers and a standard FRM that uses all observations to estimate a single equation. As expected, the linear model is not at all adequate for modelling capital structure choices. Indeed, the RESET test rejects the hypothesis of correct functional form specification in three out of four cases and the estimated models originate predictions outside the unit interval for all groups. In contrast, only in one case (and only at the 10% level) the RESET test indicates that the functional form used by the FRM is misspecified. This was also expected since, as we said before, from an econometric point of view, the FRM is appropriate to deal with fractional dependent variables characterized by a large number of zeros. The main disadvantage of the FRM is that identified above: using this model, it is impossible to quantify the different, sometimes conflicting, impacts that each explanatory variable has on the two sequential capital structure decisions made by firms.

Table 7 about here

Despite the clear econometric inappropriateness of the linear model, note that, in terms of the significance of the variables, identical conclusions are achieved for both one-part models. To be able to compare in terms of magnitude the results obtained in each one of the three models estimated, in Table 8 we report again the total partial effects computed before for the 2P-FRM and present also those calculated for the linear model (which assumes that they are constant for all individuals and, hence, are simply given by the estimated coefficients) and for the FRM (which were calculated using an expression similar to (13) but based on the full sample and on the FRM estimates for β). In almost all cases the estimated sign of the relationship between each explanatory variable and the proportion of LTD used by firms is the same for all models. In contrast, the magnitude of the estimated effects for each model is somewhat different in some cases, particularly for the group of micro firms, where the linear model underestimates substantially the effect of some variables, namely $PROFITAB$, $LIQUIDITY$ and $SIZE$. Note that this is precisely the case where linear models are expected to be more inadequate since the number of firms with zero leverage is very large.

Table 8 about here

Overall, the results obtained in this section suggest that, despite producing biased results, using simple linear models for explaining leverage ratios may still yield useful results in the sense that the sign and significance of the parameters of the model does not seem to be largely affected. However, in case we are interested also in the magnitude of the effects of the explanatory variables or in the potentially different impacts that they have on the two sequential capital structure decisions made by firms, then using linear models will rarely be the best option, as the RESET test indicates in our case. As a minimum, empirical researchers should start to apply and report the result of the RESET (or a similar) test in order to show how reliable are their results.

6 Conclusion

In this paper we study the leverage decisions of Portuguese firms in order to test the following two hypotheses about which traditional theories of capital structure do not provide clear answers: (i) the determinants of capital structure are different for micro, small, medium and large firms; and (ii) the factors that determine whether or not a firm issues debt are different from those that determine how much debt it issues. To be able to test the second hypothesis, we developed a 2P-FRM, which can be used to determine both changes in the probability of using LTD and changes in the proportion of LTD used by firms that already use it. The former changes are estimated using a binary choice model, while for the latter we use a fractional regression model that takes into account the bounded nature of leverage ratios. The results obtained with the proposed model are quite encouraging since all the econometric tests applied provided no evidence of any type of model misspecification.

We found strong support for both hypotheses. On the one hand, for the four different size-based groups of firms considered in the paper we found differences in terms of magnitude, direction and significance of some regression coefficients of the different capital structure determinants. Nevertheless, the effects on leverage found for $PROFITAB$ (-), $LIQUIDITY$ (-) and $GROWTH$ (+) suggest that the pecking-order theory may be more suitable to describe the capital structure choices made by all size-based groups of firms. On the other hand, our empirical results show that some variables, namely AGE and $SIZE$, may have opposite effects on the two levels of the model, while others are important only for one of the two financial leverage decisions analyzed in the paper. Regarding $SIZE$, our results confirm recent evidence by Cassar (2004), Faulkender and Petersen (2006) and Kurshev and Strebulaev (2007) that, conditional on having debt, firm size is negatively related to the proportion of LTD used by firms. Another interesting result of the paper is that older micro firms are more prone to use LTD, which may be explained by Berger and Udell's (1995) findings that, in the case of smaller firms, older firms (with, presumably, longer banking relationships) pay lower interest rates and are less likely to pledge collateral.

7 Appendix: Chow-type statistics for testing for differences in regression functions across groups

In linear models, it is usual to apply the Chow statistic to test whether the same regression model describes correctly the dependent variable for two specific groups of individuals. In such a case, this test may be implemented as a simple F test for the null hypothesis $H_0 : \delta = 0$, where δ is the vector of parameters associated with the interaction terms $d \cdot X$ of the equation

$$E\left(Y|X\right) = X\beta + \left(d \cdot X\right)\delta,$$

where d is a dummy variable which takes on the value one for one group (e.g. micro firms) and the value zero for other group (e.g. small firms). Under the null hypothesis there are no significant differences between the two groups and the same regression model may be used for both groups.

The extension of this test for the binary choice model of the 2P-FRM is straightforward since that model is estimated by ML. In addition to the model defined in (8), $\Pr\left(Y^* = 1|X\right) = F\left(X\theta\right)$, we simply have to estimate the augmented model

$$\Pr\left(Y^* = 1|X\right) = F\left[X\theta + \left(d \cdot X\right)\delta\right]$$

and apply a conventional likelihood-ratio test for $H_0 : \delta = 0$.

Similarly, for the FRM defined in (9), $E(Y|X, Y \in (0,1]) = G(X\gamma)$, the alternative model is given by:

$$E(Y|X, Y \in (0,1]) = G[X\gamma + (d \cdot X)\delta].$$

However, as the model is estimated by QML and we have to use robust estimation of the covariance matrix, a Chow-type test constructed along the lines of the robust RESET test outlined in Papke and Wooldridge (1996) has to be used. See also Wooldridge (2003, pp. 262-263).

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Table 1: Sample statistics

		Micro	Small	Medium	Large	Total
Panel A: Distribution of sample by firm size	#	1446	1951	1024	271	4692
	%	30.8	41.6	21.8	5.8	100.0
Panel B: Firms with null leverage ratios	#	1282	1499	524	110	3415
	%	88.7	76.8	51.2	40.6	72.8
Panel C: Leverage ratios for the whole sample	Mean	0.053	0.089	0.147	0.152	0.094
	Median	0.000	0.000	0.000	0.050	0.000
Panel D: Leverage ratios for firms that use debt	Mean	0.466	0.385	0.302	0.256	0.347
	Median	0.432	0.355	0.284	0.242	0.316

Table 2: Explanatory variables

Attribute	Proxy	
	Name	Definition
1. Non-debt tax shields	NDTS	ratio between depreciation and earnings before interest, taxes and depreciation
2. Tangibility	*TANGIB*	sum of tangible assets and inventories, divided by total assets
3. Size	SIZE	natural logarithm of sales
4. Profitability	PROFITAB	ratio between earnings before interest and taxes and total assets
5. Expected growth	GROWTH	percentage change in total assets
6. Age	AGE	years since foundation
7. Liquidity	LIQUIDITY	sum of cash and marketable securities, divided by current assets

Table 3: Summary statistics for the explanatory variables

Variable		Micro	Small	Medium	Large	Total
NDTS	Mean	0.866	0.802	0.809	0.902	0.829
	Median	0.503	0.576	0.629	0.623	0.569
TANGIB	Mean	0.355	0.420	0.466	0.443	0.411
	Median	0.322	0.414	0.474	0.462	0.412
SIZE	Mean	12.063	13.765	15.464	17.445	13.824
	Median	12.080	13.715	15.446	17.406	13.736
PROFITAB	Mean	0.075	0.062	0.055	0.051	0.064
	Median	0.047	0.047	0.042	0.035	0.045
GROWTH	Mean	17.547	12.979	9.294	7.451	13.263
	Median	6.436	6.637	4.990	5.013	6.060
AGE	Mean	16.172	19.820	27.331	34.203	21.166
	Median	12.000	17.000	22.000	29.000	17.000
LIQUIDITY	Mean	0.296	0.175	0.124	0.107	0.197
	Median	0.192	0.103	0.059	0.053	0.104

Table 4: Regression results

	Part I: Binary model				Part II: Fractional regression model			
	Micro	Small	Medium	Large	Micro	Small	Medium	Large
NDTS	-0.181	-0.037	-0.077	-0.147	0.110	0.033	-0.057	-0.208***
	(-1.39)	(-0.89)	(-1.34)	(-1.46)	(0.68)	(1.01)	(-0.99)	(-3.03)
TANGIB	0.266	1.246***	1.736***	1.814**	-0.238	-0.335	-0.150	0.246
	(0.69)	(4.33)	(4.35)	(2.31)	(-0.70)	(-1.40)	(-0.59)	(0.42)
SIZE	0.712***	0.476***	0.373***	0.086	0.057	-0.164***	-0.154***	0.026
	(7.85)	(7.48)	(4.75)	(0.70)	(0.72)	(-2.80)	(-2.91)	(0.34)
PROFITAB	-3.320**	-4.069***	-5.982***	-4.943**	-2.666**	-1.699*	-2.831***	-5.468***
	(-2.35)	(-4.02)	(-4.87)	(-2.12)	(-2.12)	(-1.90)	(-3.22)	(-2.92)
GROWTH	-0.001	0.002	0.009***	0.016**	0.003	0.004**	0.004	0.009*
	(-0.49)	(0.99)	(2.91)	(2.05)	(1.38)	(2.13)	(1.47)	(1.71)
AGE	0.020**	0.005	-0.001	0.004	-0.009	-0.009**	-0.001	0.002
	(2.47)	(1.20)	(-0.16)	(0.81)	(-1.12)	(-2.59)	(-0.63)	(0.50)
LIQUIDITY	-1.141***	-1.720***	-2.306***	-1.707*	-0.414	-0.318	-0.407	-0.368
	(-2.66)	(-4.50)	(-4.81)	(-1.71)	(-1.10)	(-0.98)	(-1.19)	(-0.32)
CONSTANT	-9.965***	-7.523***	-5.325***	-1.194	-0.891	2.139**	1.890**	-0.965
	(-8.06)	(-7.98)	(-4.19)	(-0.54)	(-0.84)	(2.42)	(2.28)	(-0.60)
Number of observations	1446	1951	1024	271	164	452	500	161
Pseudo R^2	0.127	0.074	0.086	0.066	0.291	0.145	0.078	0.110
RESET test	0.505	0.203	0.916	0.809	0.411	0.135	0.333	0.726
Heteroskedasticity test	0.261	0.710	0.315	0.288	—	—	—	—
LR/LM tests for industry dummies	0.000***	0.001***	0.040**	0.823	0.000***	0.000***	0.110	0.481

Notes: below the coefficients we report t-statistics in parentheses; for the test statistics we report p-values; ***, ** and * denote coefficients or test statistics which are significant at 1%, 5% or 10%, respectively; for the binary model, the joint significance of the industry dummies was tested using a standard LR statistic, while the pseudo R^2 and the RESET and heteroskedasticity tests were computed as described in McFadden (1974), Pagan and Vella (1989) and Davidson and MacKinnon (1984), respectively; for the fractional model, the pseudo R^2 was calculated as the correlation between the predicted and the actual values of LTD, while the RESET and LM tests were implemented as described in Papke and Wooldridge (1996).

Table 5: Chow-type statistics (p-values)

	Part I: Binary model			Part II: Fractional model		
	Small	Medium	Large	Small	Medium	Large
Micro	0.008***	0.000***	0.000***	0.184	0.018**	0.002***
Small	—	0.016**	0.177	—	0.512	0.049**
Medium	—	—	0.895	—	—	0.582

Notes: the Chow-type statistics were calculated as described in the Appendix; ***, ** and * denote test statistics which are significant at 1%, 5% or 10%, respectively.

Table 6: Partial effects for the two-part fractional regression models

	Micro			Small			Medium			Large		
	ΔP_1	ΔE_1	ΔE	ΔP_1	ΔE_1	ΔE	ΔP_1	ΔE_1	ΔE	ΔP_1	ΔE_1	ΔE
NDTS	-0.028	0.025	-0.004	-0.006	0.007	0.000	-0.014	-0.013	-0.009	-0.031	-0.035	-0.025
TANGIB	0.042	-0.054	0.000	0.195	-0.075	0.053	0.308	-0.033	0.099	0.381	0.042	0.110
SIZE	0.112	0.013	0.055	0.074	-0.036	0.018	0.066	-0.034	0.013	0.018	0.004	0.006
PROFITAB	-0.522	-0.607	-0.452	-0.636	-0.378	-0.327	-1.060	-0.626	-0.585	-1.039	-0.923	-0.712
GROWTH	0.000	0.001	0.000	0.000	0.001	0.000	0.002	0.001	0.001	0.003	0.001	0.002
AGE	0.003	-0.002	0.001	0.001	-0.002	0.000	0.000	0.000	0.000	0.001	0.000	0.000
LIQUIDITY	-0.179	-0.094	-0.115	-0.269	-0.071	-0.116	-0.409	-0.090	-0.176	-0.359	-0.062	-0.115

Notes: ΔP_1 is the effect on the probability of using long-term debt, ΔE_1 is the effect on the proportion of long-term debt used by firms that already use it, and ΔE is the effect on the proportion of long-term debt used by any firm; each effect was calculated as the average of the effects computed for each firm in the sample using expressions (12), (13) and (15), respectively.

Table 7: Regression results for the linear and fractional regression models

	Linear model				Fractional regression model			
	Micro	Small	Medium	Large	Micro	Small	Medium	Large
NDTS	0.000	-0.001	-0.005	-0.021***	-0.173	-0.019	-0.088	-0.319***
	(-0.07)	(-0.66)	(-1.54)	(-3.85)	(-1.12)	(-0.73)	(-1.62)	(-2.78)
TANGIB	-0.017	0.055**	0.106***	0.124	0.037	0.740**	0.894***	0.987
	(-1.05)	(2.46)	(2.81)	(1.31)	(0.11)	(2.51)	(2.85)	(1.43)
SIZE	0.028***	0.022***	0.011	0.007	0.647***	0.290***	0.095	0.074
	(6.67)	(4.85)	(1.64)	(0.61)	(6.67)	(4.73)	(1.61)	(0.87)
PROFITAB	-0.069***	-0.228***	-0.448***	-0.605***	-4.942***	-4.090***	-5.707***	-7.357***
	(-2.71)	(-5.20)	(-5.09)	(-3.87)	(-3.23)	(-4.51)	(-5.86)	(-3.73)
GROWTH	0.000	0.000	0.001**	0.002**	-0.001	0.003	0.008***	0.013**
	(-0.38)	(1.63)	(2.55)	(2.32)	(-0.43)	(1.63)	(3.17)	(2.47)
AGE	0.001*	0.000	0.000	0.000	0.014*	-0.002	-0.001	0.004
	(1.78)	(-0.28)	(-0.40)	(0.87)	(1.65)	(-0.36)	(-0.24)	(0.98)
LIQUIDITY	-0.039***	-0.093***	-0.177***	-0.140	-1.011**	-1.629***	-1.911***	-1.411
	(-3.19)	(-4.16)	(-4.96)	(-1.27)	(-2.34)	(-3.51)	(-4.22)	(-1.17)
CONSTANT	-0.258***	-0.182***	0.022	0.091	-10.151***	-5.916***	-2.746***	-2.363
	(-5.10)	(-2.63)	(0.20)	(0.41)	(-7.83)	(-6.24)	(-3.00)	(-1.35)
Number of observations	1446	1951	1024	271	1446	1951	1024	271
RESET test	0.000***	0.038**	0.008***	0.316	0.375	0.065*	0.750	0.675
% of predictions outside the unit interval	11.07	3.18	1.46	2.58	—	—	—	—

Notes: below the coefficients we report t-statistics in parentheses; for the test statistics we report p-values; ***, ** and * denote coefficients or test statistics which are significant at 1%, 5% or 10%, respectively; the RESET test applied to the linear and fractional models was implemented as described in Ramsey (1969) and Papke and Wooldridge (1996), respectively.

Table 8: Total partial effects

	Micro			Small			Medium			Large		
	LS	FRM	2P-FRM	LS	FRM	2P-FRM	LS	FRM	2P-FRM	LS	FRM	2P-FRM
NDTS	0.000	-0.020	-0.004	-0.001	-0.002	0.000	-0.005	-0.009	-0.009	-0.021	-0.031	-0.025
TANGIB	-0.017	0.004	0.000	0.055	0.062	0.053	0.106	0.092	0.099	0.124	0.096	0.110
SIZE	0.028	0.076	0.055	0.022	0.024	0.018	0.011	0.010	0.013	0.007	0.007	0.006
PROFITAB	-0.069	-0.577	-0.452	-0.228	-0.341	-0.327	-0.448	-0.585	-0.585	-0.605	-0.714	-0.712
GROWTH	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.001	0.002
AGE	0.001	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LIQUIDITY	-0.039	-0.118	-0.115	-0.093	-0.136	-0.116	-0.177	-0.196	-0.176	-0.140	-0.137	-0.115