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Capital Structure, Risk and Asymmetric Information:
Theory and Evidence

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Abstract: This paper proposes a principal-agent model between banks and firms with risk and asymmetric information. A mixed form of finance to firms is assumed. The capital structure of firms is a relevant cause for the final aggregate level of investment in the economy. In the model analyzed, there may be a separating equilibrium, which is not economically efficient, because aggregate investments fall short of the first-best level. Based on European firm-level data, an empirical model is presented which validates the result of the relevance of the capital structure of firms. The relative magnitude of equity in the capital structure makes a real difference to the profits obtained by firms in the economy.

Key-words: Risk, asymmetric information, credit and capital structure.

Jel Classification: D81, D82, G21 and G32

1. Introduction

Both in theoretical and empirical analyses, many scholars have been addressing thoughts to the mix of capital structure which could explain a healthy functioning of companies in free market economies.[2] In the present climate of worldwide economic crisis, the interest in this issue has again assumed a vital relevance.[3]

Following the groundbreaking article written by Modigliani and Miller (1958), the Modigliani-Miller theorem formed the basis for modern thinking on capital structure. This basic theorem states that, under a competitive, efficient market process, in the absence of taxes, bankruptcy costs and asymmetric information, the value of a firm is unaltered by the manner in which it is financed. In other words, it does not matter if the company capital is funded by issuing stock or raising debt from financial institutions. In substance, this theorem proposes what is often called

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[1] Ibrahimo and Barros both teach at the Universidade Técnica de Lisboa, Instituto Superior de Economia e Gestão.

[2] A good survey on capital structure is Rizov (2008). In relation to mix form of capital structure, see Hellmann and Stiglitz (2000).

[3] On the recent economic crisis and the need for a sound capital structure, see for example Adrian and Shin (forthcoming), Koziol and Lawrenz (2009) Akerlof and Shiller (2009), Brunnermeier (2009), Caballero and Krishnamurthy (2009), Soros (2009), Zandi (2008), Shiller (2008), and Allen and Gale

the *capital structure irrelevance principle*.

Subsequently, by considering corporate taxes in the former model, Modigliani and Miller (1963) and Miller (1977) reached the conclusion that debt-leverage is an important way to increase the net income of firms, due to fiscal savings. This is clear in their model of valuing a firm through the notion of *adjusted present value*. While it is hard to agree on the exact extent to which the results of Modigliani and Miller have shaped the capital markets, the argument used to support the expansion of leverage does seem logical. With little doubt, their results can be used to justify the near-limitlessness of financial leverage. Recently, in a different setting, under the context of asymmetric information, Ibrahimo and Barros (2009b) have developed a study in which a similar result is derived. In this paper, the *animal spirit behavior* of economic agents plays a crucial role in determining the high level of debt in free market economies.

However, Gordon (1989), based on many studies, disputed the Modigliani-Miller capital structure theory. For example, the *pecking order theory*, developed by Myers and Majluf (1984), asserts that firms perform much better if capital structure is predominantly supported by internal funds rather than by external funds. Thus, capital structure does matter for the adequate performance of companies.

Recently, a number of empirical studies carried out in relation to the roles and the efficiency of different forms of capital have not proved conclusive. Examples of these studies are: Margaritis and Psillaki (2010) Yu and Aquino (2008), López-Iturriaga and Rodriguez-Sanz (2008), Kim, Hesmati and Aoun (2006), Fattouh, Scaramozzino and Harris (2005), Tong and Green (2005), and Hovakimian, Opler, and Titman (2002).

However, as concluded by Ibrahimo and Barros (2009b), we believe that companies have a real incentive to become highly debt-leveraged, which explains the credit crunch and the consequent present economic crisis.

Given the tendency of firms towards a high level of leverage, it is logical that the financiers call for the need of firms to hold in their balance sheets a minimum level of own capital so as to be financed for their investment projects. Theories of optimal financial structure can be derived, with the optimal structure depending on the nature of the information problem being faced by the principal and agents. However, this outcome would imply the elimination of the problem of uncertainty faced by all participants in the financial market. Thus, the constraints imposed by banks as to the critical level of own equity of firms makes sense.

In many theoretical papers, the optimal financial contracts between two parties assume either the form of debt, as in de Meza and Webb (1987), Gale and Hellwig (1985), and Williamson (1987), or the form of equity, as shown by de Meza and Webb in Stiglitz and Weiss (1981). As

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(2007).

mentioned above, empirical studies are not consistent with regard to the optimality of capital structure.

By fixing a minimum level of the proportion of outside equity, we attempt to determine, in the present study, the constrained-optimal level of capital structure and the nature of equilibrium in the financial market under the context of asymmetric information. Moreover, as the empirical findings remain inconsistent and debatable regarding the different impacts of debt and equity on the performance of firms and accordingly on the aggregate level of investment, we test these effects with data on 15 European markets over the period 1995-2007, compiled by Worldscope.

Assuming the framework of de Meza and Webb (1990) and Ibrahimo and Barros (2009a), the structure of the model is defined in Section 2. The context is a simple one-period partial equilibrium model of investment with informational asymmetries between risk-neutral banks, which offer financial contracts, and risk-averse entrepreneurs, who demand funds for their projects.

Section 3 develops the model with a mixed form of financial contracts. With this assumption rather than debt finance alone, a non-efficient separating equilibrium is derived. In this equilibrium, aggregate investment falls short of the first-best level. The resulting under-investment (or under-lending) may be seen as a counter-intuitive outcome. However, it must be noted that this is one side of a dual-market phenomenon, which affects the real economy, since the other side of the duality must be the over-investment (or over-lending) effect in the use of funds by financiers for pure speculation in financial products.

Another central result determined in this section is that the capital structure of firms does matter, i.e. the relative magnitude of outside equity makes a real difference to the quantity of aggregate investment and thus, to the level of aggregate profits in the real economy.

Section 4 proposes an empirical study testing the relevance of capital structure, with data on 15 European markets over the period 1995-2007, compiled by Worldscope. A random profit frontier is estimated, which concludes that equity and debt have different impacts and roles in the performance of companies. Finally, Section 5 offers a concise discussion of the pertinent issues raised and also presents some concluding remarks.

2. A principal-agent model of finance

The economic environment is a simple one-period partial equilibrium model with *ex ante* asymmetric information between banks and entrepreneurs. The analysis aims to determine: (a) the nature of equilibrium; (b) the effects of the capital structure of firms; (c) and the causes of market failures.

The basic assumptions of the model and the behavior of economic participants are

defined below. Entrepreneurs' projects differ in terms of their level and nature of risk and the problem analyzed is that of financing them by own equity, debt and outside equity. This method of financing investors, which is common in the capital markets, is analogous to that proposed in the study of de Meza and Webb (1990). The specific notion of risk is taken from the model of Stiglitz and Weiss (1981).

Let us assume a capital market, in which there are only two classes of economic agents: firms or entrepreneurs, who are in need of finance, and banks or financial institutions, which make it available.

Entrepreneurs are risk-averse, expected utility-maximizers, all with an identical quasi-concave utility function of end-of-period wealth, U (W). They each have the same initial wealth, W_0, which can be invested either in an indivisible amount of investment, K, or in a safe asset, yielding the same interest rate ρ. For the sake of simplicity, it is assumed that the deposit is the sole safe asset in the market, so that if projects are not carried out, W_0 is deposited with banks. The ith project, if executed, yields a random return R_i of R_i^s if it succeeds and R_i^f if it fails. Adaptation of the mean preserving spread criterion of Rothschild and Stiglitz (1970) implies that all projects have a common expected return μ:

(1) $$p_i(R_i^s)R_i^s + [1 - p_i(R_i^s)]R_i^f = \mu, \text{ for all i.}$$

In this equation, p_i, defined by [0, 1], is the success probability of the ith project. To simplify the model, we assume that $R_i^f = R^f$ for all i. Projects differ in risk and since p_i depends on R_i^s, so they differ in successful return. In the present analysis, it is sufficient to assume only two categories of entrepreneurs[4]: high-risk individuals with success probability $p_H(R_H^s)$ and low-risk individuals with success probability $p_L(R_L^s) > p_H(R_H^s)$. This condition with (1) implies that projects are ranked by the mean preserving spread criterion. In what follows the subscript i will denote the entrepreneur's category.

To cause the need for external finance, it is assumed that $W_0 < K$, so if a project is to be carried out, additional funds must be raised. This is done through the issuance of outside equity and/or debt securities. Debt security of current value B pays in the successful state a sum D = (1 + r)B, in which r is the borrowing loan rate, or else pays the entire project return to the bank in the event of bankruptcy. Then, the return on debt is min (D, R^j) and the return on equity is max $(R^j - D, 0)$, where j = s, f. The proportion of inside equity in the

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[4] The terms entrepreneur and project are used interchangeably.

project is $0 \leq \alpha \leq 1$, which is held by the entrepreneur, and the remainder — the outside equity — is sold to a bank. For the purchase of debt security, with face value of repayment D, and the proportion $(1 - \alpha)$ of the equity, the bank agrees to pay an amount F.

Successful states must pay off both entrepreneurs and banks. Therefore, it is reasonable to assume $R_i^s > D$. If a project of category i is successful, the entrepreneur's end-of-period wealth is:

(2) $$W_i^s = \alpha(R_i^s - D) + (1 + \rho)(F + W_0 - K).$$

In the unsuccessful state, he obtains[5]:

(3) $$W_i^f = W^f = \alpha[\max(R^f - D, 0)] + (1 + \rho)(F + W_0 - K).$$

From the expected utility theorem, the entrepreneur's preferences for income in the two states of nature are described by the following function[6]:

(4) $$EU(W_i) = p_i U(W_i^s) + (1 - p_i)U(W^f), \text{ in which } i = H, L.$$

The entrepreneur of category i will carry out his project if:

(5) $$EU(W_i) \geq U[(1 + \rho)W_0].$$

A small group of large banks is willing to offer funds. They are assumed to be competitive, risk-neutral, expected profit-maximizers. Competition is of Bertrand type in price strategies. Banks pay for each unit of deposits a safe interest rate ρ; other costs of banks are ignored. The supply of funds to a bank is assumed to be non-decreasing in the safe rate of interest. It is assumed that banks have knowledge of the proportion of each of the two categories of entrepreneurs, $\lambda_i \in [0,1]$ with $\lambda_L + \lambda_H = 1$. Moreover, they know the success probability p_i of each type. However, banks cannot distinguish *ex ante* the characteristics of each entrepreneur's project. This assumption introduces the key asymmetry of information into the model. Once finance is made available, the financial contract specifies its terms F, α and D. With this contract offered to an entrepreneur of category i, in the successful state the bank makes a profit of:

(6) $$\pi_{Bi}^s = D + (1 - \alpha)(R_i^s - D) - (1 + \rho)F, \quad i = H, L.$$

The bank's profit in the low state is:

(7) $$\pi_{Bi}^f = \pi_B^f = \min(D, R^f) + (1 - \alpha)\max(R^f - D, 0) - (1 + \rho)F.$$

The value of R^f can be greater or smaller than D. Therefore, the expected profit to the

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[5] For a given contract, note that $W_i^f = W^f$, for all i, since $R_i^f = R^f$.

[6] Utilities are assumed not to be state-dependent.

bank from a project of category i resulting from the financial contract offered:

$$(8) \qquad\qquad E(\pi_{Bi}) = p_i \pi_{Bi}^s + (1 - p_i) \pi_B^f.$$

Note that $p_i = p_i(R_i^s)$.

In the present model, collusion between banks is ruled out and each entrepreneur can only carry out one project.

The following definition is now established:

Definition 1: Equilibrium in the competitive capital market is specified by a set of financial contracts, such that all contracts in the equilibrium set generate a zero expected profit to banks; and there exists no other contract in the exterior of the equilibrium set, which - if offered - yields a non-negative expected profit.

Definition 1 means that there is a Bertrand competition between banks. In other words, each bank expects that the rivals will maintain the terms of financial contracts invariable, in spite of its own decisions.

Next, we develop the model under the constrained-mixed form of finance and the properties of the market equilibrium are then examined.

3. Financial equilibrium in a model of the mixed form of finance

The theory of financial markets with asymmetric information, with few exceptions, treats debt and equity as extreme, alternative means of finance. This is so because optimal contracts are derived under very restrictive assumptions. On this matter, it seems that the theory of the capital structure of modern corporations uses an approach more consistent with the real world. For example, Jensen and Meckling (1976) argue that in entrepreneurial firms where the resources of entrepreneurs are limited, projects are not in general exclusively funded by means of just one source of finance. In this study, it is illustrated that an optimal combination of debt and equity can be obtained if the effects of adverse incentives - from issuing new equity - and risk distortions - from issuing debt - are equalised at the margin. An analogous point of view is advanced by Williamson (1988). Thus, it seems constructive to study the effects of a mixed form of finance of the capital needed by firms for their entrepreneurial projects.

Accordingly, we presume a particular combination of debt and equity. In all financial contracts offered, let α be fixed and greater than $\varphi = [- W^f + \mu + (1 + \rho)(W_0 - K)] / (\mu - R^f)$, i.e. $\alpha = \bar{\alpha} > \varphi$. This constraint is not implausible and allows a clearer comparison with the

Stiglitz and Weiss (1981) model. As in this study, if $\bar{\alpha} > \varphi$, riskier projects yield a lower expected profit for banks. In addition, let D_{max} be the maximum amount of debt allowed for both categories of entrepreneurs. The assumptions of the model indicate that if finance is made available, $D \leq D_{max} < R_L^s < R_H^s$. Let us also consider that $0 < R^f < D$. Now, for a given contract (F^*, α^*, D^*), equations (2) and (3) become:

(9) $$W_i^s = \bar{\alpha}\,(R_i^s - D + (1+\rho)(F + W_0 - K),$$

(10) $$W_i^f = W^f = (1+\rho)(F + W_0 - K)$$

Equations (6) and (7) become:

(11) $$\pi_{Bi}^s = D + (1-\bar{\alpha})(R_i^s - D) - (1+\rho)F,$$

(12) $$\pi_{Bi}^f = \pi_B^f = R^f - (1+\rho)F.$$

In equilibrium, equation (8) must be equal to zero, for a separating equilibrium if i = H, L, and for a pooling equilibrium if i = A. Using equations (9), (10), (11) and (12) in the zero expected profit condition, the mathematical function for the offer curves is obtained in (F, D) space:

(13) $$D = [(1+\rho)\,/\,p_i\bar{\alpha}]\,F + R_i^s - \mu\,/\,p_i\bar{\alpha}.$$

In this equation, the measure of slope is $(1+\rho)/p_i\alpha$, which is clearly steeper for the riskier category of entrepreneurs. If $p_i = p_A = \lambda_L p_L + (1-\lambda_L) p_H$ and $R_i^s = R_A^s$, equation (13) describes the pooling offer curve.

Indifference curves of entrepreneurs are obtained by substituting equations (9) and (10) for W_i^s and W^f into equation (4):

(14) $$p_i\,U\,[\,\bar{\alpha}\,(R_i^S - D) + (1+\rho)(F + W_0 - K)] +$$
$$+ (1 + p_i)\,U\,[(1+\rho)(F + W_0 - K)] = \bar{u}.$$

In this functional relationship, $\bar{u}$ is a constant and denotes a utility level. It can easily be shown that these curves are concave and steeper, at any geometric point, for the riskier projects. Furthermore, indifference curves of each category are steeper, at any geometric contract-point, than the banks' respective increasing offer line

Now, equilibrium in the model with asymmetric information is exposed. The next definition is advanced.

Definition 2: Let v_H and v_L be contracts selected by the high- and low-risk entrepreneurs, respectively. If they involve equilibrium and cannot be displaced by any other contract on offer, then v_H and v_L are said to be dominant contracts.

This definition requires an incentive-compatibility relationship between banks and entrepreneurs. With $v_H = v_L$, equilibrium will be settled through a pooling contract, and with $v_H \neq v_L$ through a pair of separating contracts.

Taking into account Definition 2 and with very restrictive assumptions, pooling equilibrium may exist. Nevertheless, under plausible conditions, equilibrium, if it exists, must be settled through a pair of separating contracts. These results are shown by Ibrahimo and Barros (2009a).

We now discuss the welfare properties of the equilibrium and the consequent policy implications. Some models of the credit market show that - from a production point of view - separating equilibrium involves the first-best solution (e.g. de Meza and Webb, 1990; Bester, 1985). However, diverging from this result, the following proposition is established.

Proposition 1: With plausible assumptions such that $\alpha = \overline{\alpha} > \varphi$ and $\mu_i = \mu$ for all i, at the competitive separating equilibrium, aggregate investment is below its respective socially efficient level.

The proof of this is rather complex and is offered in the study of Ibrahimo (1993).

The particular case of the market considered here exhibits in equilibrium an efficiency problem. As in the Rothschild and Stiglitz model, there is a negative externality of high-risk categories on low-risk categories. The externality is purely dissipative. In other words, utilities in social terms are wasted. Comparing with the solution of perfect information, low-risk categories are worse off, but high-risk categories are no better off. It is worth mentioning that this type of externality - which is due to the nature of asymmetric information - is the main cause of inefficiency that arises in the quantity of aggregate investment. In reality, the presence of high-risk entrepreneurs in the market induces low-risk entrepreneurs to demand lower amounts of debt than they would if information were perfect. With a large number of entrepreneurial categories (i.e. not just two categories), since for each category a lower debt involves a lower value paid by banks in exchange for bonds, the categories of projects with the highest success probabilities become unprofitable from the point of view of entrepreneurs and hence are not carried out. Thus, in equilibrium the quantity of aggregate investment falls short of the first-best level.

The under-investment result suggests that a policy aimed at improving efficiency should encourage more investment which could be achieved by a subsidy on bank financing. It does appear, however, that such a policy must be second-best, since it would not dispose of negative externality on low-risk individuals.

The present section also demonstrates that real economic decisions are not independent of the corporate financial structures. Against the conclusions resulting from the Modigliani-Miller proposition, it has been shown that the capital structure of firms does matter. Clearly, the

relative value of outside equity in the capital structure of firms produces a real difference in the level of aggregate investment in equilibrium.

4. An empirical study related to the model

In order to test the above model, this section uses the profit frontier model of (Berger, Hancock and Humphey, 1993; Mester, 1997) to test the relationship between profits and capital structure, using the data on 15 European markets over the period 1995-2007, compiled by Worldscope. The stochastic frontier model is characterized by the utilization of a two-component error term. A symmetric component captures the random variation of the frontier across firms, statistical noise, measurement error, and random shocks external to firm control. The other component is a one-sided variable capturing inefficiency relative to the frontier. The stochastic profit frontier is written as:

$$(15) \qquad R_{it} = (X_{it}\beta).e^{v_{it}+u_{it}} \; ; \; i=1,2,\ldots N, t=1,2,\ldots T$$

where R_{it} represents a scalar profit of company i in the t-th period; X_{it} is a vector of known inputs and outputs; β is a vector of unknown parameters to be estimated; the error term v_{it} is assumed to be independent and identically distributed and represents the effect of random shocks (noise). It is independent of u_{it}, which represents technical inefficiencies and is assumed to be positive and to follow a $N(0, s_u^2)$ distribution. The disturbance u_{it} is reflected in a half-normal independent distribution truncated at zero, signifying that the profit of each firm must lie on or above its profit frontier, implying that deviations from the frontier are caused by factors controlled by the firm's management. The variance of u_{it} is $\sigma_u^2(\pi-2)/\pi$.

The parameterization of the different elements to the total variation is given as: $\sigma_v^2 = \sigma^2/(1+\lambda^2)$ and $\sigma_u^2 = \sigma^2\lambda^2/(1+\lambda^2)$; where $\lambda = \sigma_u/\sigma_v$, which provides an indication of the relative contribution of u and v to $\varepsilon_i = u_i - v_i$, since estimation of equation 1 yields merely the residualε, rather than u, the latter must be calculated indirectly (Greene, 2003). For panel data analysis, Battese and Coelli (1988) used the expectation of u_{it} conditioned on the realized value of $\varepsilon_{it} = u_{it} - v_{it}$, as an estimator of u_{it}. In other words, $E[u_{it}|\varepsilon_i]$ is the mean productive profit inefficiency for company i at time t. However, the inefficiency can also be due to the companies' heterogeneity, which implies the use of a random effects model:

$$(16) \qquad R_{it} = (\alpha_0 + w_i) + \beta''x_{it} + v_{it} \quad Su_{it}$$

where the variables are in logs and w_i is a time-invariant specific random term that captures individual heterogeneity. u_i is the time-varying inefficiency. The sign of the inefficiency term, S depends on whether the frontier describes production or cost function. Any heterogeneity is either absent or contained in the profit function absorbed in two parameters, first, the time invariant w_i, which is interpreted as 'producer profit inefficiency due perhaps to omitted inputs and second, in the inefficiency time-varying term u.

The model is estimated in the following form:

$$
\begin{aligned}
R_{it} &= \alpha_i + \beta' x_{it} + v_{it} \quad u_{it} \\
v_{it} &\sim N\left[0, \sigma_v^2\right] \\
u_{it} &= \left|U_{it}\right|, U_{it} \sim N\left[0, \sigma_u^2\right] \\
\alpha_i &= \alpha + w_i \\
w_i &\sim N\left[0, \alpha_w^2\right]
\end{aligned}
$$

(17)

Concerning the stochastic specification of the inefficiency term u, the half-normal distribution is assumed to be time-variant. For the likelihood function, we follow the approach proposed by Greene (2005), where the conditional density is:

(18)
$$
f(\varepsilon_{it}) = \frac{\Phi(\varepsilon_{it}\lambda/\sigma)}{\Phi(0)} \frac{1}{\sigma} \varphi(\frac{\varepsilon_{it}}{\sigma})
$$

where Φ is the standard normal distribution and φ is the cumulative distribution function. Conditioned on w_i, the T observations for company i are independent.

The log likelihood is computed by simulation (Greene, 2005, equation 31).

The equation to be estimated is the following:

(18)

$$\ln(R / p_3) = \alpha + \tau_1 T + \frac{1}{2}\tau_{11}T^2 + \sum_{i=l}^{3}\beta_i \ln(Q_i / p_3) + \sum_{k=l}^{3}\varphi_l \ln(P_k / p_3) + \sum_{r=l}^{2}\phi_l \ln(z_r / p_3)$$

$$+ \sum_{i=1}^{3}\lambda_i \ln(Q_i / p_3)T + \sum_{k=1}^{3}\lambda_k \ln(P_k / p_3)T + \sum_{k=1}^{2}\lambda_r \ln(Z_r / p_3)T$$

$$+ \frac{1}{2}\left[\sum_{i=1}^{3}\sum_{j=1}^{3}\theta_{ij} \ln(Q_i / p_3)\ln(Q_j / p_3) + \sum_{k=1}^{3}\sum_{m=1}^{2}\varphi_{km} \ln(P_k / p_3)\ln(P_m / p_3) + \sum_{r=1}^{2}\sum_{s=1}^{2}\phi_{rs} \ln(Z_r / p_3)\ln(Z_s / p_3)\right]$$

$$+ \sum_{k=1}^{3}\sum_{r=1}^{2}\Omega_{ik} \ln(Q_i / p_3)\ln(P_k / p_3) + \sum_{i=1}^{3}\sum_{r=1}^{2}\kappa_{ir} \ln(Q_i / p_3)\ln(Z_r / p_3) + \sum_{k=1}^{3}\sum_{r=1}^{2}\varpi_{kr} \ln(P_k / p_3)\ln(Z_r / p_3)$$

$$+ \rho_1 \ln(RSC_i) + \sum_{i=1}^{15}\kappa_i D_i + \ln \varepsilon_c + \ln \mu_c$$

where:

ln R is the natural logarithm of operating profit. A constant term ϕ is added if the firm reports an operating loss. ϕ is equal to the absolute minimum operating profit plus one, so that the natural log is taken of a positive number;

T is a time trend;

lnQ is the natural logarithm of firm output (sales or revenues);

lnP_k is the natural logarithm of ith variable input prices (P1-the prices of labor defined as the wages divided by the number of equivalent employees), P2-price of capital-premises (amortizations divided by fixed assets) and P3-price of other assets (total costs minus wages/fixed assets).P3 is used to normalize the function and therefore disappears from Table 1;

lnZ_r is the natural logarithm of fixed netput quantities z1-equity: 1-D and z2-debit: D);

$lnRSC_i$ is the natural logarithm of interest expense on debt. It is a proxy for the risk structure of capital of each firm;

Mi is a country dummy;

ε_i are identical and independently distributed random variables, which are independent of the μ_i, which are non-negative random variables that are assumed to account for inefficiency;

α, τ, β, ψ, λ, θ, ϕ, κ, Ω, ϖ, ρ, and κ are the parameters to be estimated using maximum likelihood methods.

We obtained firm balance-sheet and income statements annual data (n euros and in real prices) from Worldscope from 1995-2007. We selected the European countries listed in Table 1. There are 20085 observations and the countries used to control the dummy trap are Turkey and

Finland. We exclude firms whose capital decisions may reflect special factors: The financial sector (SIC codes 6000-6999) and regulated enterprises (SIC codes 4000-4999).

Standard restrictions of linear homogeneity in input prices and symmetry of the second-order parameters are imposed on the profit function. Whilst the profit function must be non-increasing and convex with regard to the level of fixed input and non-decreasing and concave with regard to prices of the variable inputs, these conditions are not imposed, but may be inspected to determine whether the cost function is well-behaved at each point within a given data set.

Table 1 here

Table 1 presents the characteristics of the variables and Table 2 below presents the results. We estimate the random stochastic profit frontier model in equation and report the estimated parameters in Table 2. For comparison, we report also the parameters derived from a non-random specification of the profit function. How do we interpret these results? We can conclude that the random frontier model better describes the underlying profit structure of European firms the non-random or homogenous frontier model. This result supports claims that non-random frontier models fail to disentangle firm-level heterogeneity from inefficiency with the implication that inefficiency will be biased. In our models, the estimated lambda from the random frontier implies that 25.9% of firms are attributable to inefficiency, whereas the comparative figure is 66.3% for the non-random frontier. This means that 40.4% of firms' costs can be explained by heterogeneity within the sample firms. Thus, failing to account for heterogeneity in the specification of the profit function will seriously bias estimated efficiencies, which has implications for the design of public policy since it is clear that one hat will not fit all. Similar conclusions are reached by Greene (2004, 2005b). Further support for the specification of the random frontier is drawn from a likelihood test of the goodness-of-fit between the two models. Since the likelihood test has a higher chi-square distribution for the random frontier, we conclude that the random model better fits the data than the non-random model (see Table 1).

Table 2 here

Generally speaking, the estimated parameters from the non-random and random profit frontiers tend to have the same signs, although the magnitude of coefficients and their T-statistics can vary. The models appear to be consistent with expectations: profit increases with output, one input price, and netput. The estimated parameters on the time trend and its quadratic term indicate that the cost of European firms is increasing at a diminishing rate over time. We identify one random parameter, which are firm sales or receipts. This implies that the source of

heterogeneity between firms operating in Europe between 1995 and 2007 resides in their income statement sheet structures, which may be an indication of specialization in production, possibly relating to firm size. This result also signifies that European firms are relatively homogenous on the other variables.

Relative to the debt and stock, we verify that both contribute to increased profits, validating the Modigliani-Miller hypothesis, but the square term of stock is positive, signifying that it increases profits in an increasing rate, while the square term of debt is negative, signifying that it increases profit at a decreasing rate. Moreover, the coefficient of stock is higher than that for debt, which is logical given the risk related to debt. Furthermore, the proportion of interest expense on debt indicates the level of credit risk assumed by a firm. If the amount of interest expenses is high, this may be an indication that a firm has expended too much based on credit. This is evidence of skimping behavior which states that companies deliberately choose not to expand, but produce excessively risky credit as a direct consequence of their decision. The parameter estimates for the non-random frontier show a very large and significant coefficient for RSC (-0.532). This suggests that riskier firms with larger proportions of risk credit have lower profits, which is evidence of financial stress. Based on these findings, it would be reasonable for bank regulators to take corrective action against excessive debt. Therefore, it can be concluded that too much debt can be detrimental to enterprises' profits.

5. Discussion and concluding remarks

This paper argues that, contrary to the traditional views, but nevertheless in accordance with the standpoints of some researchers as to the relevance of the capital structure of modern corporations, there may be a constrained-optimal combination of debt and equity for the capital structure of firms. Thus, the present study has developed a principal-agent model for the financial market, in which the financial contracts offered by financiers to entrepreneurs assume a mixed form of debt and equity. If the proportion of inside equity is relatively outsized, the equilibrium, if it exists, may be unique and entails an offering of separating contracts to investment projects with different risk categories. A novel result is that separating equilibrium generates too little aggregate investment. Therefore, a subsidy on bank financing could be Pareto-improving. However, because of negative externalities due to the presence of high-risk individuals, it seems that the best a policymaker could hope for would be to achieve a second-best allocation of credit.

The under-lending result achieved could be seen as counter-intuitive. However, it must be noted that this is the phenomenon which affects the real-economy. Under this circumstance, there is generally an incentive to use the excess money in banks for the purpose of speculation, which could explain the over-lending for the purchase of innovative financial products.

The empirical work shows that debt may impact negatively on companies' profits and the contribution of stock is higher than debt for higher profits, justifying parsimonious use of debt in investment projects. The present financial crisis highlights the depressing role of high levels of debt in the capital structure of companies, which in contexts of economic crisis may lead firms to bankruptcy. Hence, the present study argues that whilst debt may leverage the stock of companies, too much debt is detrimental.

The fundamental result of our study also corroborates the views of some alternative theories as to the importance of the soundness of the capital structure of firms, namely the *pecking order theory*, in which it is argued that, due to the adverse selection problems, firms should prefer internal to external finance. However, when outside funds are needed, firms should prefer debt to equity, due to the lower information costs associated with debt issues. Under this condition, equity is not often issued. These ideas were refined into a key testable prediction by Shyam-Sunder and Myers (1999). The financing of deficit should normally be matched dollar-for-dollar by a change in the corporate debt. Debt financing does dominate equity financing in magnitude. Net equity issues do not track the financing decisions of companies. The underlying view of this theory is that financial stress and the consequent economic crisis are most likely the effects of the financing decisions of companies. However, it must be noted that the evidence relative to this theory is mixed, as argued by Frank and Goyal (2003).

The general conclusion of the *pecking order theory* is that debt initially leverages the company's capital, but afterwards may be detrimental for profits and may cause the bankruptcy of the firm. Summing up, this proposition is necessarily an essential issue for further empirical research.

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Table 1: Descriptive Statistics (in natural logarithms)

Variable	Description	Minimum	Maximum	Mean	Standard deviation
OP	Natural logarithm of operating profit	-3.987	1.100	-1.417	0.916
T	Time	1	36	17.45	10.37
T^2	Time squared	1	1296	412	387.07
Q1	Logarithm of Sales	0.108	2.721	1.202	0.605
P1	Price of labor defined as wages divided by the number of equivalent employees	0.0006	0.698	0.367	0.151
P2	Price of capital-premises defined as amortizations divided by fixed assets	0.0006	0.826	0.385	0.166
Z1	Logarithm of fixed netput quantities-equity	-0.013	0.876	0.430	0.167
Z2	Logarithm of fixed netput quantities - debt	0	1.837	0.774	1.026
RSC	Logarithm of interest expense on debt.	0.609	0.812	0.707	0.025
Austria	Dummy variable for the country	0	1	0.016	—
Belgium	Dummy variable for the country	0	1	0.028	—
Denmark	Dummy variable for the country	0	1	0.037	—
France	Dummy variable for the country	0	1	0.154	—
Germany	Dummy variable for the country	0	1	0.169	—
Greece	Dummy variable for the country	0	1	0.058	—
Italy	Dummy variable for the country	0	1	0.045	—
Ireland	Dummy variable for the country	0	1	0.012	—
Netherlands	Dummy variable for the country	0	1	0.040	—
Norway	Dummy variable for the country	0	1	0.025	—
Portugal	Dummy variable for the country	0	1	0.015	—
Spain	Dummy variable for the country	0	1	0.031	—
Sweden	Dummy variable for the country	0	1	0.065	—

Switzerland	Dummy variable for the country	0	1	0.048	—
UK	Dummy variable for the country	0	1	0.257	—

Table 2: Parameter estimates: Non-Random and Random Stochastic Frontiers

	Non-random frontier	Random frontier		Non-random frontier	Random frontier
Variables	Coefficients (t-ratio)	Coefficients (t-ratio)	Variables	Coefficients (t-ratio)	Coefficients (t-ratio)
Constant	0.864 (-0.106)	-0.213* (-2.286)	Z1Z2	0.314 (1.446)	0.347 (2.927)
T	-0.066** (-11.912)	-0.04* (-2.157)	RSC	-1.232 (-2.873)	-0.532 (3.452)
Q1	0.0006** (7.372)	0.052** (3.218)	Austria	1.035 (2.294)	1.134 (7.427)
P1	1.546** (8.878)	0.832** (4.392)	Belgium	0.051 (1.687)	0.030 (1.316)
P2	1.028 (1.098)	0.935** (2.782)	Denmark	1.718 (4.334)	1.989 (5.107)
Z1	0.228 (2.030)	0.400** (4.388)	France	0.203 (4.102)	0.303 (6.932)
Z2	0.145 (1.808)	0.157** (3.782)	Germany	0.394 (3.446)	0.347 (2.927)
$1/2T^2$	0.321* (3.145)	0.352* (3.531)	Greece	1.334 (2.109)	1.709 (4.957)
$1/2Q1^2$	-0.007** (-4.505)	-0.019** (-2.694)	Italy	0.005 (2.791)	0.001 (3.252)
$1/2P1^2$	0.061** (3.348)	0.018* (3.293)	Ireland	0.904 (2.462)	0.812 (2.646)
$1/2P2^2$	0.049** (8.315)	0.015** (3.732)	Netherlands	0.357 (0.752)	1.272 (2.855)
$1/2Z1^2$	0.373 (11.674)	0.527 (3.728)	Norway	1.035 (2.294)	1.134 (7.427)
$1/2Z2^2$	-0.231 (-4.218)	-0.127 (-3.178)	Portugal	0.051 (1.687)	0.030 (1.316)
Q1T	0.125 (2.183)	0.274 (3.921)	Spain	3.718 (4.334)	1.989 (5.107)
P1T	-0.053 (-0.506)	-0.052 (-3.518)	Sweden	0.203 (4.102)	0.303 (6.932)
P2T	-0.109 (-0.966)	-0.021 (-1.782)	Switzerland	0.394 (1.446)	0.347 (2.927)
Z1T	0.232 (2.191)	0.126 (3.278)	UK	1.334 (2.109)	1.709 (-4.957)
Z2T	0.136 (2.126)	0.218 (3.031)	Mean for random parameters		
Q1P1	1.035 (2.294)	0.303 (6.932)	Q1	—	0.254 (3.867)
Q1P2	-1.152** (-4.819)	-0.031* (-2.568)	Scale parameters for Dists. Of Random Parameters		1.837 (8.228)
Q1Z1	-1.152** (-4.819)	-0.031* (-2.568)	Q1	—	0.112 (7.622)
Q1Z2	-2.095** (-10.394)	-0.984** (-3.218)	$\lambda = \dfrac{\sigma_u}{\sigma_v}$	0.663** (3.919)	0.259** (5.118)

P1P2	6.829** (5.763)	0.523 (1.784)	$\sigma = \left[\sigma_v^2 + \sigma_u^2\right]^{1/2}$	0.263 (13.975)	0.124 (4.586)
P1Z1	(0.188) (0.188)	(2.452) (2.452)	Log likelihood	29.915	32.108
P1Z2	-6.315** (-2.963)	-0.945 (-1.218)	Likelihood ratio test	6.179	9.218
P2Z1	0.357 (2.796)	0.164 (1.245)	Observations	16738	16738
P2Z2	2.26 (1.629)	0.735** (4.215)			