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Determinants of Firm Leverage in Chile: Evidence from Panel Data

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Abstract

There is an extensive literature on the determinants of capital structure for developed countries, but little has been said about emerging economies. This article analyzes the driving forces of capital structure in Chile for the period 1990-2002. We study interest-bearing liabilities for firms classified by economic sectors. Our results give more support to the trade-off theory than to the pecking-order hypothesis.
The contribution of our work is also methodological. Our econometric specification is based on a random-effects panel data model for censored data developed by Anderson (1986) and extended by Kim and Maddala (1992). We extend Anderson-Kim-Maddala's work to panel data models for uncensored data, and devise specification tests for non-nested random-effects models. Most literature on capital structure focuses on the cross-section variation of the data by averaging observations over time.

JEL: G32 Keywords: trade-off theory, pecking-order theory, random-effects.

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Extracto

Existe abundante literatura sobre los determinantes de la estructura de capital para países desarrollados, pero poco se ha dicho acerca de las economías emergentes. Este artículo analiza los factores determinantes de la estructura de capital en Chile para el período 1990-2002. En particular, estudiamos el endeudamiento de las empresas según sector económico. Nuestros resultados dan un respaldo mayor a la teoría del *trade-off* que a la del *pecking order*.

La contribución de nuestro trabajo es también metodológica. En efecto, nuestra especificación econométrica se basa en un modelo de datos de panel, con efectos aleatorios, para el caso en que la variable dependiente está censurada, el cual fue desarrollado por Anderson (1986) y extendido por Kim and Maddala (1992). Bajo dicho marco teórico, desarrollamos tests de especificación para modelos de efectos aleatorios no anidados. La mayoría de los estudios sobre estructura de capital se centra en la variación de corte transversal, ignorando el componente dinámico que nosotros también analizamos.

1. Introduction

Several regularities in capital structure have been observed throughout the world (see Megginson, chapter 7). First, capital structures vary across countries. For instance, American, German, and Canadian firms have lower book debt ratios than do their counterparts in other industrialized nations, such as Japan, France, and Italy (e.g., Rajan and Zingales, 1996). In addition, there are differences in the correlation between long-term leverage ratios and firms' profitability, size, growth, and riskiness across countries, due to differences in tax policies and agency costs (e.g., Wald, 1999).

Second, capital structures display industry pattern, which are similar around the world. Utilities, transportation companies, and capital-intensive manufacturing firms have high debt-to-equity ratios as opposed to service firms, mining companies, and technology-based manufacturing firms, which employ very little long-term debt, if some at all. Third, within industries, leverage is inversely associated with profitability. This evidence contradicts the tax-based capital structures theories, which predict that more profitable firms should borrow more intensively to reduce their tax load. One interpretation of this pattern is that capital structure may not necessarily arise from a deliberate policy choice, but it may be rather an artifact of historic profitability and dividend policy.

A fourth stylized fact of capital structure is that taxes are important but not crucial to determine debt usage. Evidence for the United States shows that capital structures for American firms has remained fairly constant over the period 1929-1980, despite major changes in tax rates and regulatory structures that took place over that time period. Fifth, leverage ratios seem to be negatively associated with perceived costs of bankruptcy and financial distress. For instance, firms rich in collateralizeable assets (e.g., commercial real state and transportation) are able to tolerate higher debt ratios than firms whose principal assets are human capital, brand image or intangible assets. Sixth, several empirical studies have shown that when a firm announces a leverage-increasing event (e.g., debt-for-equity exchange offers, debt-financed share repurchases), its stock price rises. Conversely, leverage-decreasing events (e.g., new stock offerings) are most of the time associated with a decline in stock prices.

Moreover, the change in the cost of issuing new debt and equity securities has had little effect on capital structure, despite its declining trend over time worldwide. On the other hand, capital structure appears to be influenced by ownership structure. For instance, managers who place a high value on the personal benefits associated with controlling a firm will favor debt over equity in order to minimize dilution of ownership stake. Finally, when a firm deviates from its preferred capital structure tends to return to it over time. In general, firms operate with target leverage zones, and they issue new equity when debt ratios get too high, and issue debt if they get too low.

There are three major theoretical models to explain the choice of capital structure: the trade-off/agency cost model, the pecking order theory, and the free-cash flow theory (see Myers, 2001). The trade-off/agency cost model has evolved from modifications to the Modigliani and Miller capital structure irrelevance hypothesis. It states that capital structure is the result of an individual firm's trading off the benefits of increased leverage (e.g., a tax shield) against the potential financial distress caused by heavy indebtedness. Financial distress includes the costs of bankruptcy or reorganization, and the agency costs that arise when the firm's solvency is called into question. Accordingly, the trade-off theory predicts moderate debt ratios.

However, as Jensen and Meckling (1976)'s pioneering work showed, firms will seek target debt ratios even in the absence of taxes or bankruptcy costs. The reason is that a firm's expected cash flows are not independent of the ownership structure. In particular, if a fraction α is sold to outside investors, corporate managers are responsible for only a fraction $1-\alpha$ of their actions (i.e., the agency cost of outside equity). Therefore, they have an incentive to consume perquisites. External debt can overcome this agency cost because the cost of excessive perk consumption will make corporate managers lose control of the firm, in the event of default.

Agency costs may be also associated with the issuance of new debt. Given that equity is a residual claim, managers might be tempted to shift to riskier operating strategies to transfer wealth from debt to stock holders. Given that debt investors are aware of this conflict of interest, debt covenants will restrict excessive borrowing. And, therefore, firms will operate at a conservative debt ratio.

The empirical support for the trade-off theory is mixed. Bradley, Jarrel, and Kim (1984) develop a model where optimal leverage is inversely related to expected costs of financial distress and to non-debt tax shields. For a sample of 20-year average leverage ratios of over 800 firms, they find that the volatility of firm earnings and the intensity of R&D and advertising expenditures are inversely related to leverage. This is consistent with the trade-off theory. But, they surprisingly find a strong and positive relation between firm leverage and the amount of non-debt tax shields.

Further evidence on the trade-off theory are in MacKie-Mason (1990), who finds that companies with low marginal rates are more likely to issue equity; and, Graham (1996), who concludes that changes in the long-term debt are positively related to the firm's effective marginal tax rate. More recently, Graham and Harvey (2001) surveyed over 300 chief financial officers, and found that 44 percent of them reported that their firms had target capital structures, as the trade-off theory would predict. Tax deductibility of interest payments, cash flows volatility, and flexibility were mentioned as relevant factors to set target debt ratios. Later work by Baker and Wurgler (2002) stresses the importance of equity market timing, that is, the practice of issuing shares at high prices and repurchasing at low prices in order to exploit temporary fluctuations in the cost of equity relative to the cost of other forms of capital. Their main finding is that low leverage firms are those that raise funds when their market valuations are high, as measured by the market-to-book ratio, while high leverage firms are those that raise funds when their market valuations are low.

However, Graham (2000) finds that firms' leverage is persistently conservative. This holds, in particular, for large, profitable, and liquid firms, in stable industries, which face low ex-ante costs of distress. Nevertheless, those firms also have growth options and relatively few tangible assets. Debt conservatism is also positively related to excess cash holdings. Graham (2003) points out that more research is called for to understand the underlevered paradox. In particular, non-debt tax shields, such as employee stock options deductions and accumulated foreign tax credits, might be an explanation to such underleverage.

Myers and Majluf (1984)'s pecking order theory -which is further discussed in Myers (1984)[1]- offers an alternative framework

[1]The pecking-order theory falls into the category of signaling hypotheses, which assume that market prices do not reflect all information, in particular that which is not publicly available. Changes in capital structure are then a signaling device to convey information to the market. The first signaling model based on asymmetric information problems between well-informed managers and poorly-informed investors was developed by Ross (1977). In order to differentiate itself from competitors, a highly valuable company will use a costly and credible signal: a high levered capital structure. Less valuable firms are unwilling to use so much debt because they are more likely to go bankrupt. Ross shows that there is a separating equilibrium where high-value firms are highly levered, and low-value firms rely more heavily on equity financing.

for understanding the driving forces of corporate leverage. The pecking order theory is based on the assumptions that managers are better informed about the firm's investment opportunities than outsiders, and that corporate managers act in the best interest of existing shareholders. Myers and Majluf show that, under these assumptions, firms will sometimes forego positive-net present value projects if accepting them requires issuing new equity at a price that does not reflect the true value of the firm's investment opportunities. This helps explain why firms value financial slack (e.g., cash and marketable securities) and unused debt capacity.

The pecking-order hypothesis has received attention because it is able to explain some regularities observed empirically, which we referred to earlier: (1) debt ratios and profitability are inversely related; (2) markets react negatively to new equity issues, and managers resorts to such issues only when they do not have other choice or when they think that equity is over-valued, and (3) managers sometimes choose to hold more cash and issue less debt than the trade-off theory would predict. While the trade-off theory is good at explaining observed corporate debt levels (i.e., static viewpoint), the pecking order hypothesis is more suitable to explaining observed changes in capital structure (i.e., dynamic viewpoint).

Shyam-Sunder and Myers (1999) compare the pecking order theory with the trade-off theory. The former predicts that the change in debt each year depends on the funds flow deficit that year: if the deficit is positive, the firm issues debt, whereas if the deficit is negative, the firm retires debt. The latter, by contrast, predicts that changes in debt will revert toward the firm's target debt ratio. The authors find that the speed of adjustment toward the target debt ratio is too slow to support the trade-off theory, whereas the evidence strongly favors the pecking-order theory. Shyam-Sunder and Myers' conclusions were later challenged by Chirinko and Singha (2000). In turn, Fama and French (2002) find support for both theories when analyzing dividend and debt policies.

More recently, Frank and Goyal (2003) tested the pecking-order theory for a sample of publicly traded US firms for 1971-1998, and found little support for it. First, net equity issues track the financing deficit more closely than do debt issues. In addition, when estimating leverage regressions -in the trade-off theory's spirit- they find that the financing deficit has some explanatory power but it does not annihilate the effect of conventional variables, such as tangibility, size, and profitability.

In the context of the free-cash flow theory, Jensen (1986) analyses the agency costs associated with conflicts between managers and shareholders over the payout of free cash flows. These are defined as cash flows in excess of the amount necessary to fund positive-PV projects. Jensen states that if firms are to be efficient and maximize their stock value, free-cash flows must be paid out to shareholders. Intuitively, such strategy reduces the amount of resources available to managers, and, consequently, their power. In addition, managers are more likely to be monitored by the market when they need to raise extra capital. Jensen's free-cash flow hypothesis also states that managers should commit themselves to pay out future cash flows. One way to achieve this goal is issuing debt in exchange for stock, without retaining the proceeds. An optimal debt-to-equity ratio will be achieved when the marginal costs of debt equal the marginal benefits of debt. An article in this strand of the literature is Wruck (1995).

Very recent contributions in the area of capital structure are Leary and Roberts (2005), who analyze whether firms engage in dynamic rebalancing of their capital structures while allowing for costly adjustment; Molina (2005), who studies the effect of firms' leverage on default probabilities and the consequent impact of leverage on the ex ante costs of financial distress; and Henessy and Whited (2005), who develop a dynamic trade-off model with endogenous choice of leverage.

The contribution of this article is two-fold. First, the literature on capital structure has focused primarily on developed economies. Some exceptions are international comparisons that include emerging economies. For instance, Booth, Aivazian, Demirgue-Kunt, and Maksimovic (2001) analyze the determinants of capital structures of ten developing countries, including two Latin American countries: Brazil and Mexico. Their data base, however, only contains annual financial statements.

Fan, Titman, and Twite (2003) in turn carry out a more ambitious study, where they analyze a sample of 35 countries, which also includes emerging countries (e. g., Chile, Indonesia, Peru). Their data are also annual, and the sample size for each country is generally small. In particular, Fan et al.'s data base includes only 16 Chilean firms for a 10-year period. By contrast, our data base has complete information for 64 firms, at a quarterly frequency, for 13 years.

Second, we extend Anderson (1986)-Kim-Maddala (1992)'s work to panel data models for uncensored data, and devise specification tests for non-nested random-effect models. Most literature on capital structure focuses on the cross-section variation of the data by averaging observations over time. In addition, we model different sorts of financial leverage for a sample of firms[2], and analyze on how our findings change when firms are classified by economic sector.

This article is organized as follows. Section 2 discusses our econometric specification. Section 3 presents descriptive statistics of the data and our estimation results. Section 4 concludes.

2. Econometric Model

Our econometric specification is based on Kim and Maddala (1992)'s model, who study the determinants of dividend policy for firms in the U.S. manufacturing sector. Given that firms do not necessarily pay dividends in all periods, Kim and Maddala utilize a

[2]Although we use a different econometric technique, our study goes in line with Sheridan and Titman (1988) in that alternative measures of leverage are considered and potentially relevant determinants of leverage, such as economic growth and tightness of monetary policy, which have been neglected in previous studies, are included.

censored panel data model. Specifically, they propose a random-effect model of the form:

$$y_{it}=\boldsymbol{\beta}'\mathbf{x}_{it}+\varepsilon_{it} \qquad (1)$$

where

$$\varepsilon_{it}=\upsilon_{it}+\omega_{it}$$

with υ_{it}, ω_{it} independent normal, $\mathrm{var}(\upsilon_{it})=\sigma_i^2$ and $\mathrm{var}(\omega_{it})=\theta_t^2$. That is, errors are heteroskedastic, with firm- and time-specific components[3], but uncorrelated:

$$E(\varepsilon_{it}\varepsilon_{js})=\begin{cases}\sigma_i^2+\theta_t^2 & i=j,\ t=s;\ \ i,j=1,\dots,N;\ \ t,s=1,\dots,T \\ 0 & \text{otherwise}\end{cases}. \qquad (2)$$

Kim and Maddala choose this specification because it circumvents the problem of having to use numerical integration to maximize the log-likelihood function of the data in the presence of censored data.

Under the usual specification of the random-effects model, errors are homoskedastic and equicorrelated. That is, $\varepsilon_{it}=\upsilon_i+\omega_{it}$, and $E(\varepsilon_{it}\varepsilon_{js})=\sigma_\upsilon^2+\theta^2$ for i=j, t=s, $E(\varepsilon_{it}\varepsilon_{js})=\sigma_\upsilon^2$ for i=j, t≠s, and $E(\varepsilon_{it}\varepsilon_{js})=0$, otherwise.

Kim and Maddala focus on the case where y_{it} is censored at zero[4]. We will consider that case later, when analyzing the determinants of leverage by type and maturity. We first extend Kim and Maddala's model for the case in which y_{it} is uncensored. In this case, the log-likelihood function boils down to

[3]Kim and Maddala also consider a multiplicative heteroskedastic specification due to Anderson (1986), in which $E(\varepsilon_{it}\varepsilon_{js})=\sigma_i^2\theta_t^2$ for i=j, t=s, i, j=1,…, N; s, t =1,..,T; 0, otherwise.

[4]Maddala (1987) presents a survey of the estimation methods applied to limited-dependent variables models using panel data.

$$\ln \mathrm{L} \propto -\frac{1}{2}\sum_{i=1}^{N}\sum_{t=1}^{T}\ln(\sigma_i^2+\theta_t^2)-\frac{1}{2}\sum_{i=1}^{N}\sum_{t=1}^{T}\frac{(y_{it}-\boldsymbol{\beta}'\mathbf{x}_{it})^2}{\sigma_i^2+\theta_t^2}\,. \qquad (3)$$

The first-order conditions are given by

$$\frac{\partial \ln \mathrm{L}}{\partial \boldsymbol{\beta}}=\sum_{i=1}^{N}\sum_{t=1}^{T}\frac{(y_{it}-\boldsymbol{\beta}'\mathbf{x}_{it})\mathbf{x}_{it}}{\sigma_i^2+\theta_t^2}=0 \qquad (4a)$$

$$\frac{\partial \ln L}{\partial \sigma_i^2}=-\frac{1}{2}\sum_{i=1}^{T}\frac{1}{\sigma_i^2+\theta_t^2}+\frac{1}{2}\sum_{i=1}^{T}\frac{(y_{it}-\boldsymbol{\beta}'\mathbf{x}_{it})^2}{(\sigma_i^2+\theta_t^2)^2}=0 \qquad i=1, 2,\ldots,N \ (4b)$$

$$\frac{\partial \ln \mathrm{L}}{\partial \theta_t^2}=-\frac{1}{2}\sum_{i=1}^{N}\frac{1}{\sigma_i^2+\theta_t^2}+\frac{1}{2}\sum_{i=1}^{N}\frac{(y_{it}-\boldsymbol{\beta}'\mathbf{x}_{it})^2}{(\sigma_i^2+\theta_t^2)^2}=0 \qquad t=1, 2,\ldots,T. \ (4c)$$

The number of parameters to be estimated is k+N+T, where k is the dimension of β. In order to reduce the dimension of the parameter space, we follow a line of reasoning similar to Kim and Maddala's, and first obtain estimates of σ_i^2 and θ_t^2 as[5]:

$$\hat{\sigma}_i^2=\frac{1}{T}\sum_{t=1}^{T}(y_{it}-\boldsymbol{\beta}'\mathbf{x}_{it})^2 \qquad i=1, 2,\ldots, N \qquad (5)$$

$$\hat{\theta}_t^2=\frac{1}{N}\sum_{i=1}^{N}(y_{it}-\boldsymbol{\beta}'\mathbf{x}_{it})^2 \qquad t=1, 2,\ldots, T.$$

These estimates are substituted into (3), and we maximize the concentrated log-likelihood function with respect to β. The number

[5]In the absence of a time-specific component, σ_i^2 can be directly obtained as $\hat{\sigma}_i^2=\frac{1}{T}\sum_{t=1}^{T}(y_{it}-\boldsymbol{\beta}'\mathbf{x}_{it})^2$ from equation (4b). In turn, in the absence of a specific firm-component, θ_t^2 can be obtained as $\hat{\theta}_t^2=\frac{1}{N}\sum_{i=1}^{N}(y_{it}-\boldsymbol{\beta}'\mathbf{x}_{it})^2$ from equation (4c).

of parameters to be estimated reduces to k. After obtaining a new estimate of β, we recompute the estimates of σ_i^2 and θ_t^2, and maximize the concentrated log-likelihood with respect to β. This iterative procedure is repeated until convergence is reached. In order to start up the iterations, we use the pooled ordinary least-squares estimate of β.

The parameter estimates and their variance-covariance matrix can be obtained as:

$$\hat{\boldsymbol{\beta}} = \left(\sum_{i=1}^{N} \mathbf{X}_i' \hat{\boldsymbol{\Sigma}}_{ii}^{-1} \mathbf{X}_i\right)^{-1} \left(\sum_{i=1}^{N} \mathbf{X}_i' \hat{\boldsymbol{\Sigma}}_{ii}^{-1} \mathbf{Y}_i\right) \quad \mathrm{Var}(\hat{\boldsymbol{\beta}}) = \left(\sum_{i=1}^{N} \mathbf{X}_i' \hat{\boldsymbol{\Sigma}}_{ii}^{-1} \mathbf{X}_i\right)^{-1} \tag{6}$$

where:

$\mathbf{X}_i = (\mathbf{x}_{i1}\ \mathbf{x}_{i2} \ldots \mathbf{x}_{iT})'$, $\mathbf{Y}_i = (y_{i1}\ y_{i2} \ldots y_{iT})'$,

$$\hat{\boldsymbol{\Sigma}}_{ii} = \begin{pmatrix} \hat{\sigma}_i^2 + \hat{\theta}_1^2 & 0 & \ldots & 0 \\ 0 & \hat{\sigma}_i^2 + \hat{\theta}_2^2 & \cdots & 0 \\ \ldots & \ldots & \ddots & \ldots \\ 0 & 0 & \ldots & \hat{\sigma}_i^2 + \hat{\theta}_T^2 \end{pmatrix},$$

i=1,..,N, and $\hat{\sigma}_i^2$ and $\hat{\theta}_t^2$ are obtained from (5).

When the dependent variable is censored at zero, that is, $y_{it}^* = \boldsymbol{\beta}'\mathbf{x}_{it} + \varepsilon_{it}$; $y_{it} = y_{it}^*$ if $y_{it}^* > 0$, the log-likelihood function is given by

$$\ln L \propto \sum_{i=1}^{N} \sum_{\substack{t=1 \\ y_{it}=0}}^{T} \ln(1 - \Phi_{it}) - \frac{1}{2} \sum_{i=1}^{N} \sum_{\substack{t=1 \\ y_{it}>0}}^{T} \ln(\sigma_i^2 + \theta_t^2) - \frac{1}{2} \sum_{i=1}^{N} \sum_{\substack{t=1 \\ y_{it}>0}}^{T} \frac{(y_{it} - \boldsymbol{\beta}'\mathbf{x}_{it})^2}{\sigma_i^2 + \theta_t^2} \tag{7}$$

where

$$\Phi_{it} = \Phi\left(\frac{\boldsymbol{\beta}'\mathbf{x}_{it}}{\sqrt{\sigma_i^2 + \theta_t^2}}\right),$$

and $\Phi(.)$ is the cumulative distribution function of the standard normal.

The first-order conditions are given in this case by

$$\frac{\partial \ln L}{\partial \boldsymbol{\beta}} = -\sum_{i=1}^{N}\sum_{\substack{t=1\\ y=0}}^{T}\frac{\phi_{it}}{(1-\Phi_{it})}\frac{\mathbf{x}_{it}}{\sqrt{\sigma_i^2+\theta_t^2}} + \sum_{i=1}^{N}\sum_{\substack{t=1\\ y>0}}^{T}\frac{(y_{it}-\boldsymbol{\beta}'\mathbf{x}_{it})\mathbf{x}_{it}}{\sigma_i^2+\theta_t^2} = 0 \qquad \text{(8a)}$$

$$\frac{\partial \ln L}{\partial \sigma_i^2} = \frac{1}{2}\sum_{\substack{i=1\\ y=0}}^{T}\frac{\phi_{it}}{(1-\Phi_{it})}\frac{\boldsymbol{\beta}'\mathbf{x}_{it}}{(\sigma_i^2+\theta_t^2)^{3/2}} - \frac{1}{2}\sum_{\substack{t=1\\ y>0}}^{T}\frac{1}{\sigma_i^2+\theta_t^2} + \frac{1}{2}\sum_{\substack{i=1\\ y>0}}^{T}\frac{(y_{it}-\boldsymbol{\beta}'\mathbf{x}_{it})^2}{(\sigma_i^2+\theta_t^2)^2} = 0 \quad i=1,2,\ldots,N \qquad \text{(8b)}$$

$$\frac{\partial \ln L}{\partial \theta_t^2} = \frac{1}{2}\sum_{\substack{i=1\\ y_{it}=0}}^{N}\frac{\phi_{it}}{(1-\Phi_{it})}\frac{\boldsymbol{\beta}'\mathbf{x}_{it}}{(\sigma_i^2+\theta_t^2)^{3/2}} - \frac{1}{2}\sum_{\substack{i=1\\ y>0}}^{N}\frac{1}{\sigma_i^2+\theta_t^2} + \frac{1}{2}\sum_{\substack{i=1\\ y_{it}>0}}^{N}\frac{(y_{it}-\boldsymbol{\beta}'\mathbf{x}_{it})^2}{(\sigma_i^2+\theta_t^2)^2} = 0 \quad t=1,2,\ldots,T \qquad \text{(8c)}$$

where

$$\phi_{it} = \phi\left(\frac{\boldsymbol{\beta}'\mathbf{x}_{it}}{\sqrt{\sigma_i^2+\theta_t^2}}\right),$$

and $\phi(.)$ is the density function of the standard normal.

Following Kim and Maddala, $\hat{\sigma}_i^2$ and $\hat{\theta}_t^2$ can be approximated by

$$\hat{\sigma}_i^2 = \frac{1}{T}\sum_{\substack{t=1\\ y_{it}>0}}^{T}(y_{it}-\boldsymbol{\beta}'\mathbf{x}_{it})y_{it} \qquad i=1,2,\ldots,N \qquad \text{(9)}$$

$$\hat{\theta}_t^2 = \frac{1}{N}\sum_{\substack{i=1\\ y_{it}>0}}^{N}(y_{it}-\boldsymbol{\beta}'\mathbf{x}_{it})y_{it} \qquad t=1,2,\ldots,T$$

After substituting (9) in (7), we can maximize the concentrated log-likelihood function with respect to $\boldsymbol{\beta}$. The solution will be given by

$$\hat{\boldsymbol{\beta}} = \left(\sum_{i=1}^{N} \mathbf{X}_i' \hat{\boldsymbol{\Sigma}}_{ii}^{-1} \mathbf{X}_i\right)^{-1} \left(\sum_{i=1}^{N} \mathbf{X}_i' \hat{\boldsymbol{\Sigma}}_{ii}^{-1} \mathbf{Y}_i\right)_{|y>0} - \left(\sum_{i=1}^{N} \mathbf{X}_i' \hat{\boldsymbol{\Sigma}}_{ii}^{-1} \mathbf{X}_i\right)^{-1} \left(\sum_{i=1}^{N} \mathbf{X}_i' \hat{\boldsymbol{\Sigma}}_{ii}^{-1} \hat{\boldsymbol{\gamma}}_i\right)_{|y=0} \tag{10}$$

where $\hat{\boldsymbol{\gamma}}_{\mathbf{i}} = \begin{bmatrix} \phi\left(\dfrac{\boldsymbol{\beta}'\mathbf{x}_{i1}}{\sqrt{\hat{\sigma}_i^2 + \hat{\theta}_t^2}}\right) \Big/ \left(1 - \Phi\left(\dfrac{\boldsymbol{\beta}'\mathbf{x}_{i1}}{\sqrt{\hat{\sigma}_i^2 + \hat{\theta}_t^2}}\right)\right) \\ \ldots \\ \phi\left(\dfrac{\boldsymbol{\beta}'\mathbf{x}_{iT}}{\sqrt{\hat{\sigma}_i^2 + \hat{\theta}_t^2}}\right) \Big/ \left(1 - \Phi\left(\dfrac{\boldsymbol{\beta}'\mathbf{x}_{iT}}{\sqrt{\hat{\sigma}_i^2 + \hat{\theta}_t^2}}\right)\right) \end{bmatrix}$,

$\mathbf{X}_i$, $\boldsymbol{\Sigma}_{ii}$, and $\mathbf{Y}_i$ are as defined above.

As before, after obtaining a new estimate of β, we recompute $\hat{\sigma}_i^2$ and $\hat{\theta}_t^2$, and maximize the concentrated log-likelihood with respect to β. A consistent estimate of β to start up the iterations is provided by the pooled Tobit model. If at any given iteration, $\hat{\sigma}_i^2$ and/or $\hat{\theta}_t^2$ turn out to be negative, they are set to some small positive number. Once convergence is reached, standard errors for $\hat{\boldsymbol{\beta}}$ can be obtained for instance by the BHHH algorithm.

A. Specification Tests

a. UNCENSORED DATA

Besides the Kim-Maddala estimator, we also compute the conventional random- and fixed-effects models from the specification

$$y_{it} = \boldsymbol{\beta}'\mathbf{x}_{it} + \alpha_i + \nu_{it} \tag{11}$$

where $\alpha_i = \mathbf{z}_i'\alpha$ for the fixed-effects model, and $\alpha_i = \alpha + \mu_i$, for the random-effects model.

An asymptotically equivalent way of carrying out Hausman's specification test of random versus fixed effects is by using the following augmented regression (see Baltagi, 2001, chapter 4):

$$\mathbf{y}^* = \mathbf{X}^*\boldsymbol{\beta} + \tilde{\mathbf{X}}\boldsymbol{\gamma} + \boldsymbol{\omega} \tag{12}$$

where

$$\mathbf{y}^* = \begin{pmatrix} \mathbf{y}_1^* \\ \mathbf{y}_2^* \\ \dots \\ \mathbf{y}_N^* \end{pmatrix},\ \mathbf{y}_i^* = \begin{pmatrix} y_{i1} - \phi\bar{y}_{i.} \\ y_{i2} - \phi\bar{y}_{i.} \\ \dots \\ y_{iT} - \phi\bar{y}_{i.} \end{pmatrix},\ \mathbf{X}^* = \begin{pmatrix} \mathbf{x}_1^{*(1)} & \mathbf{x}_1^{*(2)} & \dots & \mathbf{x}_1^{*(k)} \\ \mathbf{x}_2^{*(1)} & \mathbf{x}_2^{*(2)} & \dots & \mathbf{x}_2^{*(k)} \\ \dots & \dots & \dots & \dots \\ \mathbf{x}_N^{*(1)} & \mathbf{x}_N^{*(2)} & \dots & \mathbf{x}_N^{*(k)} \end{pmatrix},$$

$$\mathbf{x}_i^{*(j)} = \begin{pmatrix} x_{i1}^{(j)} - \phi\bar{x}_{i.}^{(j)} \\ x_{i2}^{(j)} - \phi\bar{x}_{i.}^{(j)} \\ \dots \\ x_{iT}^{(j)} - \phi\bar{x}_{i.}^{(j)} \end{pmatrix},$$

$$\phi = 1 - \frac{\sigma_\nu}{\sqrt{\sigma_\nu^2 + T\sigma_\mu^2}},\ \sigma_\nu^2 = E(\nu_{it}^2),\ \sigma_\mu^2 = E(\mu_i^2),$$

$$\tilde{\mathbf{X}} = \begin{pmatrix} \tilde{\mathbf{x}}_1^{(1)} & \tilde{\mathbf{x}}_1^{(2)} & \dots & \tilde{\mathbf{x}}_1^{(k)} \\ \tilde{\mathbf{x}}_2^{(1)} & \tilde{\mathbf{x}}_2^{(2)} & \dots & \tilde{\mathbf{x}}_2^{(k)} \\ \dots & \dots & \dots & \dots \\ \tilde{\mathbf{x}}_N^{(1)} & \tilde{\mathbf{x}}_N^{(2)} & \dots & \tilde{\mathbf{x}}_N^{(k)} \end{pmatrix},\ \tilde{\mathbf{x}}_i^{(j)} = \begin{pmatrix} x_{i1}^{(j)} - \bar{x}_{i.}^{(j)} \\ x_{i2}^{(j)} - \bar{x}_{i.}^{(j)} \\ \dots \\ x_{iT}^{(j)} - \bar{x}_{i.}^{(j)} \end{pmatrix} \text{ i=1,…, N; j=1,…, k,}$$

The notation $x_i^{*(j)}$ indicates regressor "j", j=1,..,k, for unit "i", i=1,…, N. There are T observations for each regressor, within each unit. Similarly for $\tilde{\mathbf{x}}_i^{(j)}$.

Under the null hypothesis of random effects, $\gamma=\mathbf{0}$. The advantage of this formulation is that one circumvents the problem that $\hat{\boldsymbol{\psi}} \equiv \widehat{\mathrm{Var}}(\hat{\boldsymbol{\beta}}_{FE}) - \widehat{\mathrm{Var}}(\hat{\boldsymbol{\beta}}_{RE})$ has usually rank less than k in the Wald criterion, $(\hat{\boldsymbol{\beta}}_{FE} - \hat{\boldsymbol{\beta}}_{RE})\hat{\boldsymbol{\psi}}^{-1}(\hat{\boldsymbol{\beta}}_{FE} - \hat{\boldsymbol{\beta}}_{RE}) \xrightarrow{d} \chi^2(k)$, where k is the number of slopes, FE stands for fixed effects and RE, for random effects.

The conventional random-effects and the Kim-Maddala models are non-nested. Therefore, in order to compare them, we use both Davidson-Mackinnon (1981, 1982)'s J test and Cox (1962)'s test. Let us first consider the J test when the null hypothesis is Kim-Maddala's specification:

H_0: $\mathbf{y}=\mathbf{X}\beta+\varepsilon$

where

$$E(\boldsymbol{\varepsilon\varepsilon}') = \begin{pmatrix} \boldsymbol{\Sigma}_{11} & \mathbf{0} & \dots & \mathbf{0} \\ \mathbf{0} & \boldsymbol{\Sigma}_{22} & \dots & \mathbf{0} \\ & & \vdots & \\ \mathbf{0} & \mathbf{0} & \dots & \boldsymbol{\Sigma}_{NN} \end{pmatrix},$$

$$\boldsymbol{\Sigma}_{ii} = \begin{pmatrix} \sigma_i^2 + \theta_1^2 & 0 & \dots & 0 \\ 0 & \sigma_i^2 + \theta_2^2 & \cdots & 0 \\ \dots & \dots & \ddots & \dots \\ 0 & 0 & \dots & \sigma_i^2 + \theta_T^2 \end{pmatrix}, \ i = 1, \dots, N.$$

H_1: $\mathbf{y}=\mathbf{X}\beta+\eta$

where

$$\eta_{it}=\mu_i+\nu_{it},\ E(\nu_{it}^2) = \sigma_\nu^2,\ E(\mu_i^2) = \sigma_\mu^2,\ i=1,..,N;\ t=1,...,T.$$

$$\mathrm{E}(\boldsymbol{\eta\eta}') = \begin{pmatrix} \boldsymbol{\Sigma} & \mathbf{0} & \dots & \mathbf{0} \\ \mathbf{0} & \boldsymbol{\Sigma} & \dots & \mathbf{0} \\ & & \vdots & \\ \mathbf{0} & \mathbf{0} & \dots & \boldsymbol{\Sigma} \end{pmatrix} = \mathbf{I}_N \otimes \boldsymbol{\Sigma},$$

$$\boldsymbol{\Sigma} = \begin{pmatrix} \sigma_\nu^2 + \sigma_\mu^2 & \sigma_\mu^2 & \cdots & \sigma_\mu^2 \\ \sigma_\mu^2 & \sigma_\nu^2 + \sigma_\mu^2 & \cdots & \sigma_\mu^2 \\ \cdots & \cdots & \ddots & \cdots \\ \sigma_\mu^2 & \sigma_\mu^2 & \cdots & \sigma_\nu^2 + \sigma_\mu^2 \end{pmatrix}.$$

We test whether $\lambda=0$ in the following compound model:

$$\tilde{\tilde{\mathbf{y}}} = (1-\lambda)\tilde{\tilde{\mathbf{X}}}\boldsymbol{\beta} + \lambda\hat{\mathbf{y}}^* + \boldsymbol{\xi} \qquad (13)$$

where

$$\tilde{\tilde{\mathbf{y}}} = \begin{pmatrix} \tilde{\tilde{\mathbf{y}}}_1 \\ \tilde{\tilde{\mathbf{y}}}_2 \\ \dots \\ \tilde{\tilde{\mathbf{y}}}_N \end{pmatrix}, \ \tilde{\tilde{\mathbf{y}}}_i = \begin{pmatrix} y_{i1} \Big/ \sqrt{\sigma_i^2 + \theta_1^2} \\ y_{i2} \Big/ \sqrt{\sigma_i^2 + \theta_2^2} \\ \dots \\ y_{iT} \Big/ \sqrt{\sigma_i^2 + \theta_T^2} \end{pmatrix}, \ \tilde{\tilde{\mathbf{X}}} = \begin{pmatrix} \tilde{\tilde{\mathbf{x}}}_1^{(1)} & \tilde{\tilde{\mathbf{x}}}_1^{(2)} & \dots & \tilde{\tilde{\mathbf{x}}}_1^{(k)} \\ \tilde{\tilde{\mathbf{x}}}_2^{(1)} & \tilde{\tilde{\mathbf{x}}}_2^{(2)} & \dots & \tilde{\tilde{\mathbf{x}}}_2^{(k)} \\ \dots & \dots\dots & \dots & \dots \\ \tilde{\tilde{\mathbf{x}}}_N^{(1)} & \tilde{\tilde{\mathbf{x}}}_N^{(2)} & \dots & \tilde{\tilde{\mathbf{x}}}_N^{(k)} \end{pmatrix},$$

$$\tilde{\tilde{\mathbf{x}}}_i^{(j)} = \begin{pmatrix} x_{i1}^{(j)} \Big/ \sqrt{\sigma_i^2 + \theta_1^2} \\ x_{i2}^{(j)} \Big/ \sqrt{\sigma_i^2 + \theta_2^2} \\ \dots \\ x_{iT}^{(j)} \Big/ \sqrt{\sigma_i^2 + \theta_T^2} \end{pmatrix}$$

$$\hat{\mathbf{y}}^* = \begin{pmatrix} \hat{\mathbf{y}}_1^* \\ \hat{\mathbf{y}}_2^* \\ \cdots \\ \hat{\mathbf{y}}_N^* \end{pmatrix},\ \hat{\mathbf{y}}_i^* = \begin{pmatrix} y_{i1} - \hat{\phi}\bar{y}_{i.} \\ y_{i2} - \hat{\phi}\bar{y}_{i.} \\ \cdots \\ y_{iT} - \hat{\phi}\bar{y}_{i.} \end{pmatrix},\ \hat{\phi} = 1 - \frac{\hat{\sigma}_\nu}{\sqrt{\hat{\sigma}_\nu^2 + T\hat{\sigma}_\mu^2}},\ i = 1,\ldots, N.$$

Given that σ_i^2 and θ_t^2 are unknown, we plug in their maximum-likelihood estimates. In order to test the random-effects model against Kim-Maddala's specification, we just reverse the roles of H_0 and H_1.

In order to obtain the functional form of the Cox test for this particular case, we follow Pesaran (1974)'s line of reasoning (pages 156-158)[6]. Under the null hypothesis that the Kim-Maddala model is true

$$\frac{c_0}{\sqrt{\hat{V}(c_0)}} \xrightarrow{d} N(0,1) \tag{14}$$

where

$$c_0 = \frac{NT}{2}\ln\left(\frac{\hat{\sigma}^2_{\mathbf{X}^*}}{\hat{\sigma}^2_{\tilde{\tilde{x}}} + \frac{1}{NT}\hat{\boldsymbol{\beta}}_0'\tilde{\tilde{\mathbf{X}}}'\mathbf{M}_{\mathbf{X}^*}\tilde{\tilde{\mathbf{X}}}\hat{\boldsymbol{\beta}}_0}\right) = \frac{NT}{2}\ln\left(\frac{\hat{\sigma}^2_{\mathbf{X}^*}}{\hat{\sigma}^2_{\mathbf{X}^*\tilde{\tilde{\mathbf{X}}}}}\right)$$

$$\hat{V}(c_0) = \frac{\hat{\sigma}^2_{\mathbf{X}^*}}{\hat{\sigma}^4_{\mathbf{X}^*\tilde{\tilde{\mathbf{X}}}}}\hat{\boldsymbol{\beta}}_0'\tilde{\tilde{\mathbf{X}}}'\mathbf{M}_{\mathbf{X}^*}\mathbf{M}_{\tilde{\tilde{x}}}\mathbf{M}_{\mathbf{X}^*}\tilde{\tilde{\mathbf{X}}}\hat{\boldsymbol{\beta}}_0$$

[6]The functional form of the Cox test for a linear regression model is reproduced in Greene (2003), chapter 8.

$$\mathbf{M}_{\mathbf{X}^*} = \mathbf{I} - \mathbf{X}^*(\mathbf{X}^{*\prime}\mathbf{X}^*)^{-1}\mathbf{X}^{*\prime} \qquad \mathbf{M}_{\tilde{\tilde{\mathbf{X}}}} = \mathbf{I} - \tilde{\tilde{\mathbf{X}}}(\tilde{\tilde{\mathbf{X}}}'\tilde{\tilde{\mathbf{X}}})^{-1}\tilde{\tilde{\mathbf{X}}}'$$

$$\hat{\boldsymbol{\beta}}_0 = (\tilde{\tilde{\mathbf{X}}}'\tilde{\tilde{\mathbf{X}}})^{-1}\tilde{\tilde{\mathbf{X}}}'\tilde{\tilde{\mathbf{y}}}$$

$\hat{\sigma}^2_{x^*} = \dfrac{\mathbf{e}_{\mathbf{X}^*}'\mathbf{e}_{\mathbf{X}^*}}{NT}$. Mean-squared residual in the regression of $\tilde{\tilde{\mathbf{y}}}$ on $\mathbf{X}^*$

$\hat{\sigma}^2_{\tilde{\tilde{x}}} = \dfrac{\mathbf{e}_{\tilde{\tilde{x}}}'\mathbf{e}_{\tilde{\tilde{x}}}}{NT}$. Mean-squared residual in the regression of $\tilde{\tilde{\mathbf{y}}}$ on $\tilde{\tilde{\mathbf{X}}}$.

$$\hat{\sigma}^2_{x^*\tilde{\tilde{x}}} = \hat{\sigma}^2_{\tilde{\tilde{x}}} + \frac{\hat{\boldsymbol{\beta}}_0'\tilde{\tilde{\mathbf{X}}}'\mathbf{M}_{\mathbf{X}^*}\tilde{\tilde{\mathbf{X}}}\hat{\boldsymbol{\beta}}_0}{NT}$$

$\tilde{\tilde{\mathbf{y}}}$, $\mathbf{X}^*$, and $\tilde{\tilde{\mathbf{X}}}$ are as previously defined in expressions (12) and (13).

Similarly to the J test, for testing the random-effects model against Kim-Maddala's specification, we reverse the roles of H_0 and H_1.

An additional diagnostic test we use to discriminate between models is Pesaran (2004)'s test of cross-section dependence. Pesaran points out that Breusch and Pagan (1980)'s Lagrange multiplier (LM) statistic for testing cross-equation error correlation is likely to present considerable size distortions for N large and T small—which is usually the case in panels. Therefore, he proposes the following alternative LM statistic

$$\sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right) \xrightarrow{d} N(0,1) \qquad (15)$$

where

$$\hat{\rho}_{ij} = \hat{\rho}_{ji} = \frac{\sum_{t=1}^{T} e_{it} e_{jt}}{\left(\sum_{t=1}^{T} e_{it}^2\right)^{1/2} \left(\sum_{t=1}^{T} e_{jt}^2\right)^{1/2}}$$

is the sample pair-wise correlation of residuals.

b. CENSORED DATA

Let us consider the model of equation (1) when the dependent variable is censored at zero:

$$y_{it}^{*}=\beta' \mathbf{x}_{it}+\varepsilon_{it}; \quad y_{it}=y_{it}^{*} \text{ if } y_{it}^{*}>0 \qquad (16)$$

where

$$\varepsilon_{it} \sim IN(0,\ \sigma_t^2),\ \sigma_t^2 = \sigma_i^2 + \theta_t^2 .$$

Anderson (1986) develops a test for within unit non-zero error covariances. That is, H_0: $E(\varepsilon_{it}\varepsilon_{is})=0$, $t \neq s$, against H_1: $E(\varepsilon_{it}\varepsilon_{is}) \neq 0$. Under Kim-Maddala's specification, Anderson's statistic becomes

$$\sum_{i \in N_1} \psi_i^2 \xrightarrow{d} \chi^2(N_{11}) \qquad (17)$$

where

$$\psi_i = \frac{1}{K_i} \sum_{\substack{t \in S \\ s \in S \\ s<t}} \frac{\hat{c}_{its}}{\sqrt{\hat{v}_{its}}} \xrightarrow{d} N(0,1) \qquad \text{Independent over all i}$$

$$\hat{c}_{its} = (\hat{\varepsilon}_{it} - M_{it})(\hat{\varepsilon}_{is} - M_{is})$$

$$M_{it} = E(\varepsilon_{it} \mid \varepsilon_{it} > -\boldsymbol{\beta}'\mathbf{x}_{it}) = \frac{\phi\left(-\boldsymbol{\beta}'\mathbf{x}_{it} \Big/ \sqrt{\sigma_i^2 + \theta_t^2}\right)}{1 - \Phi\left(-\boldsymbol{\beta}'\mathbf{x}_{it} \Big/ \sqrt{\sigma_i^2 + \theta_t^2}\right)}$$

$$\hat{v}_{its} = \left(1 - M_{it}\left(M_{it} + \boldsymbol{\beta}'\mathbf{x}_{it} \Big/ \sqrt{\sigma_i^2 + \theta_t^2}\right)\right)\left(1 - M_{is}\left(M_{is} + \boldsymbol{\beta}'\mathbf{x}_{is} \Big/ \sqrt{\sigma_i^2 + \theta_s^2}\right)\right)$$

.

- $K_i = \frac{I(I-1)}{2}$ is the number of covariance terms for firm i, where I is the number of non-zero observations for firm i.

- S is the set of non-zero observations for firm i.

- N_1 represents the set of firms for which ψ_i exists, and N_{11} is the number of elements in this set.

Based on this test, we would choose the specification that exhibits comparatively less serial correlation within units.

Unlike the models for uncensored data we discussed in the previous sub-section, the pooled Tobit model is a special case of Kim-Maddala's model. Therefore, we can use a likelihood-ratio test to choose between the two. Indeed, the pooled Tobit is given by

$y_{it}^* = \boldsymbol{\beta}'\mathbf{x}_{it} + \varepsilon_{it}$; $y_{it} = y_{it}^*$ if $y_{it}^* > 0$
(17)

where

$\varepsilon_{it} \sim IN(0, \sigma^2)$.

Therefore, under the null hypothesis of a pooled Tobit model, $\sigma_i^2 = \sigma^2 \;\; \forall$ i=1,..,N, and $\theta_t^2 = 0$, $\forall$ t=1,..,T. Therefore, under the null, there are N+T restrictions. A likelihood-ratio test will be asymptotically distributed as chi-square (χ^2) with (N+T) degrees of freedom. For (N+T)≥100, $\sqrt{2\chi^2}$ is approximately $N(\sqrt{2(N+t)-1}, 1)$ - see Abramowitz and Stegun (1964), page 941. Consequently, we refer to the critical values of the standard normal distribution.

3 Data and estimation results

A. Description of the data

Our sample was taken from quarterly balance-sheet data gathered by the Chile Superintendency of Securities and Insurance (SVS) in the Uniformly Coded Statistical Record (*FECU*). We only considered firms with complete information for the whole sample period of 1990-2002. Given the characteristics of our panel-data model, working with a balanced panel facilitated computations considerably. Consequently, we ended up with 64 firms (i.e., 3,328 observations altogether), most of which were exchange-traded along the sample period. As usual, financial services firms were excluded.

Table 1 presents descriptive statistics for the firms in the sample. We observe an average operational profitability of 16 percent per year, and relatively high liquidity, measured by an average quick ratio (or acid test) of 1.82, and an average cash ratio of 3.5 percent. Some distinctive patterns arise from the average figures. First, firms use more equity than debt, as a proportion of total assets (61.2 versus 30.1 percent). Second, firms rely much more on bank debt than on bond issues (14.6 versus 4.1 percent of total assets), and use trade credit to some degree (accounts payable/assets averaged 3.4 percent). Third, tangibility is relatively high (55.2 percent of total assets).

It is worth pointing out that the firms in our sample -and, in general, all of those in the records of the Superintendency of Securities and Insurance- correspond essentially with large firms. Indeed, according to the Chile Ministry of Economic Affairs, firms with annual sales equal to or larger than US$2.4 million (using the average Chilean peso/US dollar exchange rate of December 2002) are classified as large. Indeed, for the whole sample, firms in the first quartile had annual sales of US$10.4 million whereas those in the third quartile, US$94.9 million, on average.

Table 1

Descriptive statistics (1990-2002) for the whole sample of firms

VARIABLE	MEAN	STD. DEV.	MEDIAN	Q1	Q3
Cash ratio	0.035	0.061	0.014	0.004	0.038
Debt/Equity	0.612	2.477	0.424	0.164	0.751
Debt/Assets	0.301	0.238	0.285	0.138	0.414
Tangibility	0.552	0.247	0.575	0.385	0.751
Profitability	0.160	0.167	0.145	0.065	0.249
Quick ratio	1.820	4.282	1.114	0.747	1.702
Non-current assets/Assets	0.730	0.195	0.790	0.600	0.884
Equity/Assets	0.637	0.275	0.653	0.529	0.796
Payables/Assets	0.034	0.042	0.019	0.008	0.044
Bank debt/Assets	0.146	0.156	0.102	0.020	0.225
Bond debt/Assets	0.041	0.083	0.000	0.000	0.033
Long-term debt/Assets	0.109	0.126	0.063	0.000	0.175
Total debt (mill. US$)	104.2	294.3	12.7	4.6	64.6
Total equity (mill US$)	192.4	356.9	37.4	11.1	231.3
Total current assets (mill US$)	47.7	88.6	14.2	4.6	46.9
Total assets (mill US$)	308.2	636.9	64.4	19.8	301.8
Annual sales (mill US$)	79.1	126.1	27.0	10.4	94.9
Number of firms			64		

NOTES: (1) Figures are computed using balance-sheet data as of December of each year obtained from the Superintendency of Securities and Insurance. (2)The total number of observations per firm is 13. (3) The variables in levels are expressed in US dollars of December 2002. (4) Q1 and Q3 stand for first and third quartile, respectively.

B. Estimation results

Leverage equations usually include the market-to-book ratio as an approximation of firm growth opportunities. Unfortunately, we have information on the amount of shares outstanding for exchange-traded firms only for December of each year, and for 1990-1996.[7] Therefore, we do not control for this variable in the leverage equations of this section, but we do when contrasting the trade-off and pecking-order hypothesis in section 3.3.8 Instead, we consider other factors that are usually neglected in the literature: the spread of interest rates and economic growth.

We disaggregate firm liabilities for the whole sample and by economic sector. We focus on the determinants of trade credit, bank, long-maturity, and bond debt. Trade credit is a short-term loan that a supplier provides to a given firm, upon a purchase of his/her product. The existing literature states that credit-constrained firms are those most likely to use trade credit as a substitute for other funding sources - e.g., bank loans and bond issues (see, for instance, Peterson and Rajan (1995) and Nilsen (2002)).

All firms hold accounts payable, so we estimate the trade-credit equations with the same machinery utilized to fit the leverage equations reported above. By contrast, given that at some points in time firms do not necessarily hold bank, long-maturity or bond debt, we use the econometric techniques for censored data described in Section 2. Table 2, Panels (a) through (d), shows our estimation results.

[7]The electronic FECUS, which are currently available from the SVS, contain information on firm cash flows only from March 2001 onwards. We had access to an older version of the SVS's electronic tapes, which contained records on cash flows for 1990-1996.

[8]At least for the computations reported in Section 3.3, the book-to-market ratio is statistically significant only in the margin.

Table 2

Composition of liabilities
(a) Whole sample

TRADE CREDIT

	FIXED EFFECTS (FE)			RANDOM EFFECTS (RE)			KIM-MADDALA (KM)		
REGRESSOR	COEF	T-TEST	P-VALUE	COEF	T-TEST	P-VALUE	COEF	T-TEST	P-VALUE
Exchange-traded	–0.002	–0.56	0.577	–0.003	–0.95	0.343	0.002	1.93	0.054
Tangibility	0.008	2.17	0.030	0.007	1.76	0.078	0.002	1.45	0.147
Bank debt	–0.025	–4.27	0.000	–0.025	–5.41	0.000	–0.017	–4.84	0.000
Size	–0.002	–1.78	0.076	–0.003	–3.13	0.002	–0.005	–21.02	0.000
Profitability	0.114	4.96	0.000	0.115	6.25	0.000	0.123	8.66	0.000
Equity	–0.024	–5.72	0.000	–0.024	–9.92	0.000	–0.025	–11.93	0.000
Economic growth	0.029	2.84	0.005	0.028	2.80	0.005	0.019	1.85	0.065
Spread 1	–0.008	–0.42	0.677	–0.008	–0.46	0.646	–0.018	–-1.00	0.320
Adjusted R^2		0.716			0.134			0.181	
Observations		3,328			3,328			3,328	
Cross-correlation test	–8.367	p-value	0.000	–9.042	p-value	0.000	–7.039	p-value	0.000
H_0: RE H_1: FE				1.120	p-value	0.997			
J test									
H_0: KM H_1: RE							6.822	p-value	0.000
H_0: RE H_1: KM							2.396	p-value	0.017
Cox test									
H_0: KM H_1: RE							–5.208	p-value	0.000
H_0: RE H_1: KM							–3.751	p-value	0.000

BANK DEBT

	POOLED TOBIT (PT)			KIM-MADDALA (KM)		
REGRESSOR	COEF	T-TEST	P-VALUE	COEF	T-TEST	P-VALUE
Constant	0.315	11.38	0.000	0.201	6.78	0.000
Exchange-traded	–0.056	–9.91	0.000	–0.029	–6.14	0.000
Non-debt tax shields	–0.010	–1.39	0.163	–0.076	–7.81	0.000
Cash ratio	–0.426	–10.28	0.000	–0.302	–10.41	0.000
Tangibility	0.074	6.98	0.000	0.063	7.09	0.000
Size	0.002	1.61	0.107	0.005	4.37	0.000
Profitability	0.842	10.51	0.000	0.939	9.68	0.000
Equity	–0.334	–31.13	0.000	–0.267	–10.17	0.000
Economic growth	–0.073	–1.26	0.207	–0.129	–2.79	0.005
Spread 2	–0.333	–2.15	0.032	–0.209	–1.64	0.101
R^2		0.320			0.251	
Observations		3,328			3,328	
Positive observations		2,923			2,923	
Fitted Prob(y*>0)		0.797			0.771	
Serial-correlation test	18.36	p-value	1.000	27.79	p-value	0.999
H_0: PT H_1: KM	22.10	p-value	0.000			

(Continue)

LONG-MATURITY DEBT						
	POOLED TOBIT (PT)			KIM-MADDALA (KM)		
REGRESSOR	COEF	T-TEST	P-VALUE	COEF	T-TEST	P-VALUE
Constant	–0.449	–16.56	0.000	–0.402	–14.89	0.000
Exchange-traded	0.023	4.15	0.000	0.025	5.56	0.000
Non-debt tax shields	–0.068	–9.58	0.000	–0.107	–11.17	0.000
Tangibility	0.116	11.38	0.000	0.096	9.50	0.000
Size	0.029	18.83	0.000	0.027	21.31	0.000
Profitability	0.984	11.84	0.000	1.065	11.38	0.000
Non-current assets	0.196	14.14	0.000	0.144	12.47	0.000
Equity	–0.334	–30.93	0.000	–0.259	–9.70	0.000
Economic growth	–0.002	–0.03	0.975	–0.051	–1.08	0.279
Spread 2	–0.035	–0.24	0.814	–0.002	–0.02	0.984
R^2		0.337			0.313	
Observations		3,328			3,328	
Positive observations		2,375			2,375	
Fitted Prob(y*>0)		0.681			0.664	
Serial-correlation test	179.25	p-value	0.000	91.89	p-value	0.004
H_0: PT H_1: KM	18.87	p-value	0.000			

BOND DEBT						
	POOLED TOBIT (PT)			KIM-MADDALA (KM)		
REGRESSOR	COEF	T-TEST	P-VALUE	COEF	T-TEST	P-VALUE
Constant	–1.122	–22.58	0.000	–1.097	–26.29	0.000
Exchange-traded	0.078	7.95	0.000	0.063	8.37	0.000
Non-debt tax shields	–0.250	–11.89	0.000	–0.223	–14.63	0.000
Tangibility	0.068	4.30	0.000	0.054	4.53	0.000
Bank debt	–0.562	–15.74	0.000	–0.433	–14.36	0.000
Size	0.071	26.62	0.000	0.066	31.22	0.000
Profitability	1.675	11.26	0.000	1.301	9.77	0.000
Equity	–0.394	–21.57	0.000	–0.292	–14.67	0.000
Economic growth	0.391	4.65	0.000	0.330	5.06	0.000
Spread 2	–0.003	–0.01	0.989	–0.077	–0.46	0.642
R^2		0.319			0.320	
Observations		3,328			3,328	
Positive observations		996			996	
Fitted Prob(y*>0)		0.294			0.268	
Serial-correlation test	300.008	p-value	0.000	84.895	p-value	0.000
H_0: PT H_1: KM	24.93	p-value	0.000			

NOTES: The likelihood-ratio statistic for testing H_0: Polled Tobit against H_1: Kim-Maddala is asymptotically normal in this case.

(b) Manufacturing

	TRADE CREDIT								
	FIXED EFFECTS (FE)			RANDOM EFFECTS (RE)			KIM-MADDALA (KM)		
REGRESSOR	COEF	T-TEST	P-VALUE	COEF	T-TEST	P-VALUE	COEF	T-TEST	P-VALUE
Exchange-traded	–0.008	–1.58	0.115	–0.007	–1.17	0.241	–0.003	–1.78	0.076
Tangibility	0.021	4.06	0.000	0.024	4.23	0.000	0.045	15.52	0.000
Bank debt	–0.068	–6.37	0.000	–0.069	–8.55	0.000	–0.041	–5.95	0.000
Size	–0.005	–3.01	0.003	–0.005	–3.90	0.000	–0.004	–9.99	0.000
Profitability	0.064	2.25	0.024	0.059	2.41	0.016	0.043	2.21	0.027
Equity	–0.076	–9.17	0.000	–0.077	–11.76	0.000	–0.046	–9.54	0.000
Economic growth	0.001	0.09	0.931	–0.001	–0.05	0.961	0.007	0.65	0.518
Spread 1	–0.072	–3.29	0.001	–0.073	–3.63	0.000	–0.052	–2.51	0.012
Adjusted R^2		0.726			0.393			0.397	
Observations		1,300			1,300			1,300	
Cross-correlation test	–8.104	p-value	0.000	–8.748	p-value	0.000	–10.942	p-value	0.000
H_0: RE H_1: FE				1.000	p-value	0.998			
J test									
H_0: KM H_1: RE							11.658	p-value	0.000
H_0: RE H_1: KM							2.529	p-value	0.011
Cox test									
H_0: KM H_1: RE							–7.792	p-value	0.000
H_0: RE H_1: KM							1.164	p-value	0.244

	Bank debt					
	Pooled Tobit (PT)			Kim-Maddala (KM)		
Regressor	Coef	t-test	p-value	Coef	t-test	p-value
Constant	0.363	10.62	0.000	0.378	12.34	0.000
Exchange-traded	–0.007	–1.02	0.306	–0.013	–2.19	0.029
Non-debt tax shields	–0.044	–2.72	0.007	–0.048	–3.21	0.001
Cash ratio	–0.090	–3.00	0.003	–0.123	–4.45	0.000
Tangibility	0.136	9.05	0.000	0.083	4.73	0.000
Size	0.008	4.39	0.000	0.004	2.93	0.003
Profitability	–0.086	–0.94	0.347	0.085	0.86	0.390
Equity	–0.591	–39.63	0.000	–0.507	–25.62	0.000
Economic growth	–0.077	–1.47	0.142	–0.110	–2.12	0.034
Spread 2	–0.302	–2.15	0.032	–0.207	–1.53	0.127
R^2		0.687			0.681	
Observations		1,300			1,300	
Positive observations		1,192			1,192	
Fitted Prob(y*>0)		0.818			0.811	
Serial-correlation test	20.639	p-value	0.727	12.616	p-value	0.981
H_0: PT H_1: KM	196.03	p-value	0.000			

(Continue)

Long-maturity debt

	Pooled Tobit (PT)			Kim-Maddala (KM)		
Regressor	Coef	t-test	p-value	Coef	t-test	p-value
Constant	0.005	0.15	0.884	–0.022	–0.80	0.422
Exchange-traded	0.034	4.46	0.000	0.029	5.30	0.000
Non-debt tax shields	–0.099	–5.59	0.000	–0.111	–7.47	0.000
Tangibility	0.033	2.01	0.044	0.038	2.57	0.010
Size	0.016	7.77	0.000	0.014	8.91	0.000
Profitability	0.380	3.78	0.000	0.232	2.58	0.010
Non-current assets	0.169	9.10	0.000	0.157	9.39	0.000
Equity	–0.544	–31.33	0.000	–0.437	–24.26	0.000
Economic growth	0.155	2.73	0.006	0.187	4.18	0.000
Spread 2	–0.305	–2.02	0.043	–0.306	–2.66	0.008
R^2		0.510			0.499	
Observations		1,300			1,300	
Positive observations		961			961	
Fitted Prob(y*>0)		0.678			0.698	
Serial-correlation test	9.221	p-value	0.997	8.021	p-value	0.999
H_0: PT H_1: KM	163.42	p-value	0.000			

Bond debt

	Pooled Tobit (PT)			Kim-Maddala (KM)		
Regressor	Coef	t-test	p-value	Coef	t-test	p-value
Constant	–0.586	–7.08	0.000	–0.537	–7.07	0.000
Non-debt tax shields	–0.378	–9.24	0.000	–0.348	–10.24	0.000
Tangibility	0.049	1.92	0.055	0.062	3.62	0.000
Bank debt	–0.739	–13.45	0.000	–0.714	–14.23	0.000
Size	0.059	14.18	0.000	0.053	16.11	0.000
Profitability	0.269	1.49	0.136	0.255	1.87	0.062
Equity	–0.609	–17.59	0.000	–0.538	–15.19	0.000
Economic growth	0.631	6.65	0.000	0.388	6.10	0.000
Spread 2	–0.816	–3.42	0.001	–0.446	–3.24	0.001
R^2		0.442			0.412	
Observations		1,300			1,300	
Positive observations		386			386	
Fitted Prob(y*>0)		0.289			0.264	
Serial-correlation test	77.615	p-value	0.000	27.669	p-value	0.001
H_0: PT H_1: KM	364.43	p-value	0.000			

NOTES: All firms holding bond debt in the sample were exchange-traded.

(c) Electricity, Gas, and Water

TRADE CREDIT

	FIXED EFFECTS (FE)			RANDOM EFFECTS (RE)			KIM-MADDALA (KM)		
REGRESSOR	COEF	T-TEST	P-VALUE	COEF	T-TEST	P-VALUE	COEF	T-TEST	P-VALUE
Exchange-traded	0.016	6.26	0.000	0.019	5.885	0.000	0.032	20.08	0.000
Tangibility	–0.014	–2.82	0.005	4.32E-04	0.103	0.918	–0.019	–10.45	0.000
Bank debt	–0.017	–2.61	0.009	–0.020	–3.672	0.000	0.004	0.74	0.462
Size	–0.029	–10.60	0.000	–0.018	–13.703	0.000	–0.009	–27.04	0.000
Profitability	–0.118	–2.41	0.016	–0.198	–4.819	0.000	–0.249	–6.31	0.000
Equity	–0.031	–5.36	0.000	–0.014	–2.988	0.003	0.006	1.77	0.077
Economic growth	–0.024	–2.21	0.027	–0.010	–1.034	0.301	0.021	1.86	0.064
Spread 1	–0.005	–0.30	0.762	–0.003	–0.197	0.844	0.007	0.36	0.717
Adjusted R^2		0.784			0.388			0.492	
Observations		884			884			884	
Cross-correlation test	–7.909	p-value	0.000	–12.353	p-value	0.000	26.835	p-value	0.000
H_0: RE H_1: FE				8.511	p-value	0.385			
J test									
H_0: KM H_1: RE							–13.481	p-value	0.000
H_0: RE H_1: KM							–4.630	p-value	0.000
Cox test									
H_0: KM H_1: RE							4.753	p-value	0.000
H_0: RE H_1: KM							–2.899	p-value	0.004

BANK DEBT

	POOLED TOBIT (PT)			KIM-MADDALA (KM)		
REGRESSOR	COEF	T-TEST	P-VALUE	COEF	T-TEST	P-VALUE
Constant	0.086	1.44	0.149	–0.093	–2.20	0.027
Exchange-traded	0.064	4.31	0.000	–0.007	–0.78	0.438
Non-debt tax shields	–0.097	–5.41	0.000	–0.049	–3.47	0.001
Cash ratio	–0.322	–3.31	0.001	–0.122	–2.18	0.030
Tangibility	0.144	8.54	0.000	0.095	7.73	0.000
Size	0.005	1.68	0.094	0.013	7.45	0.000
Profitability	–0.277	–0.86	0.390	0.404	1.80	0.072
Equity	–0.238	–8.07	0.000	–0.182	–7.36	0.000
Economic growth	–0.187	–2.03	0.042	–0.054	–0.82	0.414
Spread 2	–0.255	–1.07	0.283	–0.213	–1.11	0.268
R^2		0.397			0.329	
Observations		884			884	
Positive observations		704			704	
Fitted Prob(y*>0)		0.711			0.691	
Serial-correlation test	80.356	p-value	0.000	29.990	p-value	0.026
H_0: PT H_1: KM	198.63	p-value	0.000			

(Continue)

Long-maturity debt

	Pooled Tobit (PT)			Kim-Maddala (KM)		
Regressor	Coef	t-test	p-value	Coef	t-test	p-value
Constant	–0.524	–7.24	0.000	–0.365	–5.01	0.000
Exchange-traded	0.182	9.31	0.000	0.170	10.04	0.000
Non-debt tax shields	–0.027	–1.42	0.156	–0.032	–2.57	0.010
Tangibility	0.076	4.26	0.000	0.048	2.70	0.007
Size	0.009	2.74	0.006	0.001	0.51	0.610
Profitability	–1.404	–4.18	0.000	–0.787	–2.58	0.010
Non-current assets	0.735	11.35	0.000	0.608	9.68	0.000
Equity	–0.506	–16.33	0.000	–0.370	–10.95	0.000
Economic growth	–0.050	–0.51	0.608	–0.014	–0.15	0.878
Spread 2	–0.427	–1.76	0.079	–0.101	–0.43	0.668
R^2		0.658			0.648	
Observations		884			884	
Positive observations		568			568	
Fitted Prob(y*>0)		0.632			0.664	
Serial-correlation test	35.313	p-value	0.002	11.056	p-value	0.749
H_0: PT H_1: KM	60.57	p-value	0.756			

Bond debt

	Pooled Tobit (PT)			Kim-Maddala (KM)		
Regressor	Coef	t-test	p-value	Coef	t-test	p-value
Constant	–0.562	–5.55	0.000	–0.787	–9.54	0.000
Non-debt tax shields	0.017	0.47	0.638	–0.017	–0.76	0.449
Tangibility	–0.012	–0.42	0.674	0.045	1.98	0.047
Bank debt	–0.694	–9.76	0.000	–0.493	–9.47	0.000
Size	0.054	11.30	0.000	0.055	14.63	0.000
Profitability	–2.195	–4.03	0.000	–0.872	–2.04	0.042
Equity	–0.623	–13.83	0.000	–0.397	–8.62	0.000
Economic growth	0.500	3.26	0.001	0.352	2.71	0.007
Spread 2	–0.056	–0.14	0.888	0.152	0.41	0.681
R^2		0.431			0.415	
Observations		884			884	
Positive observations		292			292	
Fitted Prob(y*>0)		0.330			0.313	
Serial-correlation test	94.352	p-value	0.000	73.346	p-value	0.000
H_0: PT H_1: KM	137.42	p-value	0.000			

NOTES: All firms holding bond debt in the sample were exchange-traded.

(d) Agriculture, Fishing, Forestry, and Mining

	Trade credit								
	Fixed effects (FE)			Random effects (RE)			Kim-Maddala (KM)		
Regressor	Coef	t-test	p-value	Coef	t-test	p-value	Coef	t-test	p-value
Exchange-traded	–0.004	–0.83	0.409	–0.015	–1.34	0.180	–0.027	–8.04	0.000
Tangibility	–0.032	–2.97	0.003	–0.036	–2.78	0.005	–0.044	–5.37	0.000
Bank debt	–0.058	–2.61	0.009	–0.059	–3.53	0.000	–0.034	–4.08	0.000
Size	0.020	2.86	0.004	0.005	1.14	0.256	–0.017	–14.32	0.000
Profitability	0.183	3.65	0.000	0.208	4.02	0.000	0.154	4.20	0.000
Equity	–0.037	–3.97	0.000	–0.031	–5.30	0.000	–0.015	–3.31	0.001
Economic growth	0.097	2.30	0.022	0.101	2.25	0.025	0.036	1.20	0.229
Spread 1	0.070	0.94	0.349	0.079	1.05	0.294	0.034	0.57	0.566
Adjusted R^2		0.572			0.177			0.376	
Observations		520			520			520	
Cross-correlation test	–11.434	p-value	0.000	–11.995	p-value	0.000	–9.888	p-value	0.000
H_0: RE H_1: FE				3.306	p-value	0.914			
J-test									
H_0: KM H_1: RE							–1.995	p-value	0.046
H_0: RE H_1: KM							4.459	p-value	0.000
Cox test									
H_0: KM H_1: RE							5.508	p-value	0.000
H_0: RE H_1: KM							–7.657	p-value	0.000

	Bank debt					
	Pooled Tobit (PT)			Kim-Maddala (KM)		
Regressor	Coef	t-test	p-value	Coef	t-test	p-value
Constant	–0.378	–3.79	0.000	–0.073	–0.83	0.406
Exchange-traded	–0.011	–0.63	0.529	–0.081	–5.52	0.000
Non-debt tax shields	0.154	12.80	0.000	0.167	6.30	0.000
Cash ratio	–1.719	–8.36	0.000	–0.074	–0.48	0.634
Tangibility	–0.125	–3.27	0.001	–0.163	–4.33	0.000
Size	0.040	6.40	0.000	0.018	2.60	0.009
Profitability	2.045	9.74	0.000	1.429	7.51	0.000
Equity	–0.121	–5.10	0.000	–0.066	–1.57	0.117
Economic growth	0.186	1.15	0.248	0.637	2.44	0.015
Spread 2	–1.532	–3.57	0.000	–1.536	–5.14	0.000
R^2		0.565			0.399	
Observations		520			520	
Positive observations		422			422	
Fitted Prob(y*>0)		0.785			0.743	
Serial-correlation test	4.614	p-value	0.915	4.233	p-value	0.936
H_0: PT H_1: KM	72.32	p-value	0.174			

(Continue)

	Long-maturity debt					
	Pooled Tobit (PT)			Kim-Maddala (KM)		
Regressor	Coef	t-test	p-value	Coef	t-test	p-value
Constant	–0.900	–7.23	0.000	–0.402	–4.95	0.000
Exchange-traded	0.005	0.27	0.785	–0.040	–3.03	0.002
Non-debt tax shields	0.072	5.21	0.000	0.119	4.78	0.000
Tangibility	0.001	0.02	0.984	–0.077	–2.94	0.003
Size	0.047	5.85	0.000	0.025	5.00	0.000
Profitability	1.517	5.87	0.000	1.221	6.25	0.000
Non-current assets	0.270	6.30	0.000	0.097	4.18	0.000
Equity	–0.144	–5.18	0.000	–0.050	–2.05	0.040
Economic growth	0.284	1.49	0.136	–0.125	–0.88	0.380
Spread 2	–1.025	–2.11	0.035	–0.398	–1.26	0.209
R^2		0.389			0.231	
Observations		520			520	
Positive observations		290			290	
Fitted Prob(y*>0)		0.543			0.532	
Serial-correlation test	133.305	p-value	0.000	32.118	p-value	0.000
H_0: PT H_1: KM	83.05	p-value	0.038			

NOTES: Too few observations for bond debt were available for Agriculture, Fishing, Forestry, and Mining.

For the trade-credit equation of the whole sample, the Hausman test gives more support to random than to fixed effects, and the J test tells us that we should prefer the random-effects model to Kim-Maddala's, at least at the 1-percent significance level. (The Cox test is inconclusive in this case). The regression output shows that there is an inverse relationship between trade credit and availability of bank loans, equity funding, and firm size. In addition, trade credit would be procyclical, and it would exhibit a positive association with firm profitability.

For manufacturing, we also find that the random-effects model is best. In this case, factors relevant to the use of trade credit, other than bank loans, equity funding, and firm size, are tangibility and the short-term spread of interest rates. (Economic growth is statistically insignificant in this case). In particular, firms with a greater proportion of collateralizeable assets would be more credit worthy from their suppliers' viewpoint. On the other hand, a tighter monetary policy -that is, an increase of the short-maturity vis-à-vis the long-maturity interest rate- would lead firms to use trade credit more intensively. A similar conclusion is reached by Nilsen (2002).[9]

Firms in the electricity, gas, and water, and the agriculture, fishing, forestry and mining sectors exhibit a slightly different pattern of trade-credit usage. In particular, more profitable utility firms would resort to less supplier's credit, and firms with fewer tangible assets would use less trade credit in the agriculture, fishing, forestry and mining sector. In neither case, is the spread of interest rates relevant. (For electricity, gas, and water utilities, the cross-correlation and Hausman tests give more support to the random-effects model, whereas the Cox and J tests are inconclusive. For the agriculture, fishing, forestry and mining sector in turn the J test favors Kim-Maddala's specification).

For the average firm in the sample, the estimation results show that there exists an inverse relationship between the bank-loans ratio and non-debt tax shields, firm liquidity (measured by the cash ratio), the equity ratio, economic growth, and being exchange-traded. On the other hand, firm size, tangibility, and profitability affect positively the extent of bank financing. The regression output also suggests that as the long interest rate (8-year rate) becomes larger relative to the short rate (90-day rate), firms reduce their leverage. In this case, a likelihood-ratio test gives more support to Kim-Maddala's model than to a pooled Tobit model. The estimation yields that the likelihood of holding bank loans for an average firm was about 77 percent over the sample period.

We should notice that the marginal effects in the censored regression are the coefficients on the regressors times the probability of holding bank debt (see, for instance, Greene, 1999), in this case. For example, a 1-percent increase in the economic growth rate would lead to a decrease of 0.099 in bank loans to total assets.

[9] Nilsen defines the spread as the difference between the Fed funds and the long-term Treasury bond rates. (His definition has the sign opposite to ours). We also tried the Spread 2 variable -a definition more in line with Nilsen's- in the model specification, but it had a lower statistical significance than the Spread 1 variable.

For the manufacturing and electricity, gas, and water sectors, we find similar evidence to that for the whole sample. In these two cases, the likelihood-ratio test also favors the Kim-Maddala model. However, profitability and the interest rate spread are not as strongly associated to bank loans as before. In particular, the former is only statistically significant for utility firms (at the 10-percent level), and the latter is marginally significant for manufacturing.

For the agriculture, fishing, forestry and mining sector in turn, we cannot reject the null hypothesis of a pooled Tobit model. In this case, all the regressors, except for the exchange-traded dummy and economic growth, are statistically significant. Both tangibility and the non-debt tax shields variable have, however, unexpected signs. Like in the trade credit regression for this sector, financial leverage is inversely associated to tangibility. Booth, Aivazian, Demirgue-Kunt, and Maksimovic (2001) find a similar pattern for various countries of their sample of emerging economies. The positive sign on non-debt tax shields seems counter-intuitive, but it is also reported by Bradley, Jarrel, and Kim (1984). The authors argue that this finding is consistent with Scott (1977)'s secured debt hypothesis: firms can borrow at lower interest rates if their debt is shielded with tangible assets. (They generate relatively high levels of depreciation by investing heavily on tangible assets).

Regarding long-maturity debt, the regression results for the whole sample show that this is inversely associated with non-debt tax shields and the equity ratio, and it is positively associated with size, tangibility, profitability, and the non-current assets ratio. The term spread and economic growth do not turn out to be statistically significant. Both the likelihood-ratio test and Anderson's serial correlation test give more support to the Kim-Maddala model.

For manufacturing, we find some similar results, except that in this case both the term spread and economic growth are statistically significant. In particular, long-maturity debt is negatively associated with the term spread, and it shows a procyclical behavior. (Again, the Kim-Maddala specification is preferred). For the electricity, gas, and water sector, the pooled

Tobit and Kim-Maddala's estimates suggests that more profitable utility companies utilize less long-term funding. (In this case, we cannot reject the null hypothesis of a pooled Tobit, but Anderson's test favors the Kim-Maddala specification). Finally, for the agriculture, fishing, forestry, and mining sector, we again report a positive association between leverage and non-tax shields. Both economic growth and the term spread are statistically insignificant for the latter two sectors.

Finally, we analyze the determinants of bond-debt holding. The estimation results for the whole sample show that tangibility, size, profitability, economic growth, and being an exchange-traded firm are positively associated with bond issues. By contrast, firms that rely more heavily on bank loans and equity, and that have more non-debt tax shields tend to use this source of funding to a lesser extent. On average, however, firms issued a very limited amount of bonds over the sample period. Indeed, the likelihood of holding bond debt for an average firm reached only 27 percent over 1990-2002 (based on Kim-Maddala's specification).

For manufacturing, we reach the same conclusions, except for the fact that the term spread is statistically significant—the same regularity we found for bank and long-maturity debt in this economic sector. For utilities, we again conclude that profitability is inversely related with leverage. Moreover, the regression output shows that utilities on average had a slightly higher probability of issuing bonds than manufacturing firms (31 percent, based on Kim-Maddala's model). Bonds issues in the agriculture, fishing, forestry, and mining sector were almost non-existing. So we did not have enough data to fit a model in this case.

In sum, we find evidence in favor of the trade-off theory: more profitable firms issue more debt and debt is inversely associated with non-debt tax shields. An exception is the exchange-traded dummy, whose coefficient is both positive and statistically significant in a few cases. This result is more in line with the pecking-order theory: exchange-traded firms use preferably debt, and occasionally resort to equity issues.

C. Further evidence on support of the trade-off theory

Direct testing of the pecking-order theory involves a dynamic structure, in which we focus on firm cash flows. Based on Frank and Goyal (2003)'s approach and our estimation methods described earlier, we analyze which competing theory gets more support from the data.

As discussed in the introduction, the implications of the pecking-order theory are that firms prefer internal financing in the first place. They adapt their target dividend payout ratios to their investment opportunities, so that to avoid sudden changes in dividends. In case the uses exceed the sources of funds, firms issue the safest security first (i.e., debt), then bonds, and use equity issues as the last resort. Conversely, if the sources exceed the uses of funds, firms pay off debt, invest on marketable securities or repurchase equity.

Frank and Goyal (2003) use the following accounting cash-flow identity for the financing deficit:

$$DEF_t = DIV_t + I_t + \Delta W_t - C_t = \Delta D_t + \Delta E_t \qquad (18)$$

Where DEF_t is the financing deficit in year t; DIV_t is the cash dividends in year t; I_t is the net investment in year t; ΔW_t is the change in working capital in year t, and C_t is the cash flow after interest and taxes in year t. The gap between the uses and sources of funds is filled by net debt issues (ΔD_t) and/or net equity issues (ΔE_t).

Table 3 shows average figures for each year of the period 1990-1996, on the items in identity (18). All figures are scaled by net assets (total assets minus current liabilities). For the sample period, the financial deficit averaged 3.7 percent of total assets, and was covered primarily by net equity issues (3.1 percent of total assets). This evidence questions already the validity of the pecking-order theory.

Table 3

Average cash flows and financing: 1990-1996

	1990	1991	1992	1993	1994	1995	1996
Cash dividends[(1)]	0.077	0.080	0.083	0.076	0.073	0.069	0.064
Net Investment[(2)]	0.121	0.086	0.117	0.121	0.116	0.098	0.108
Δ Working capital[(3)]	0.000	0.016	–0.026	0.027	0.017	–0.018	0.004
Internal cash flow[(4)]	0.177	0.174	0.144	0.160	0.147	0.129	0.119
Financing deficit[(1)+(2)+(3)–(4)]	0.022	0.008	0.030	0.063	0.058	0.020	0.058
Net debt issues	0.003	–0.005	–0.004	0.024	0.009	0.005	0.010
Net equity issues	0.018	0.013	0.034	0.039	0.049	0.015	0.048
Net external financing	0.022	0.008	0.030	0.063	0.058	0.020	0.058

NOTES**:** (1) All variables are scaled by net assets (total assets minus current liabilities).
(2) Figures are averages of December of each year for the whole sample of 64 firms.

Table 4 (a) shows a leverage regression in first differences, in which the financing deficit is an additional explanatory variable. The dependent variable in this case is the change in the leverage ratio, defined as total interest-bearing liabilities to net assets. First differences are used given the dynamic content of the pecking-order theory. If the latter were true, the financing deficit would wipe out all the explanatory power of the other variables used in conventional leverage regressions. But this is not the case. In fact, the (lagged) financing deficit has explanatory power in the fixed-effects and random-effects regression models, but not under Kim-Maddala's specification - which, according to the cross-correlation test, would get more support than the random-effects model.10

[10] The lagged financing deficit gives a better fit than its current value.

Table 4

Change in the leverage ratio and financing deficit
(a) Without lagged Δ leverage ratio as a regressor

	Δ Leverage ratio								
	Fixed effects			Random effects			Kim-Maddala		
Regressor	Coef	t-test	p-value	Coef	t-test	p-value	Coef	t-test	p-value
Δ Tangibility	0.913	14.41	0.000	0.906	22.73	0.000	0.816	24.71	0.000
Δ Non-debt tax shields	–0.250	–1.62	0.106	–0.243	–2.48	0.013	–0.155	–2.24	0.026
Δ Equity ratio	–0.292	–2.68	0.008	–0.275	–3.83	0.000	–0.290	–5.10	0.000
Δ Market-to-book	0.002	1.08	0.280	0.002	0.82	0.412	0.001	1.00	0.318
Δ Profitability	–0.337	–1.67	0.097	–0.328	–2.41	0.016	–0.205	–2.04	0.042
Δ Size	0.239	2.93	0.004	0.203	5.00	0.000	0.123	4.12	0.000
Lagged financing deficit	0.188	2.59	0.010	0.126	2.58	0.010	0.056	1.44	0.150
Adjusted R^2		0.633			0.664			0.724	
Observations		320			320			320	
Cross-correlation test	2.566	p-value	0.010	2.060	p-value	0.039	0.413	p-value	0.680
H_0: RE H_1: FE				9.825	p-value	0.199			
J test									
H_0: KM H_1: RE							4.145	p-value	0.000
H_0: RE H_1: KM							–2.319	p-value	0.020
Cox test									
H_0: KM H_1: RE							–6.882	p-value	0.000
H_0: RE H_1: KM							9.566	p-value	0.000

Table 4(b) reports a leverage regression, in first differences, where the lagged change in leverage is an additional regressor. The fixed- and random-effects models are shown just for illustrative purposes, given that they yield biased estimates. The lagged financing deficit has no explanatory power in Kim-Maddala's model, whereas the lagged difference in leverage does. The first differences in non-debt tax shields, the equity ratio, and size are all highly significant.

Table 4

(b) With lagged Δ leverage ratio as a regressor

	Δ Leverage ratio								
	Fixed effects			Random effects			Kim-Maddala		
Regressor	Coef	t-test	p-value	Coef	t-test	p-value	Coef	t-test	p-value
Δ Tangibility	0.795	10.63	0.000	0.797	18.23	0.000	0.801	21.51	0.000
Δ Non-debt tax shields	–0.314	–1.88	0.061	–0.291	–3.19	0.001	–0.194	–2.92	0.004
Δ Equity ratio	–0.250	–2.70	0.008	–0.269	–4.13	0.000	–0.281	–5.01	0.000
Δ Market-to–book	0.005	0.99	0.322	0.009	1.46	0.145	0.011	2.18	0.030
Δ Profitability	–0.189	–0.94	0.350	–0.255	–1.73	0.083	–0.181	–1.45	0.148
Δ Size	0.169	3.30	0.001	0.179	4.79	0.000	0.134	4.76	0.000
Lagged financing deficit	–0.050	–0.67	0.503	–0.027	–0.57	0.567	–0.007	–0.19	0.849
Lagged Δ Leverage ratio	–0.258	–3.37	0.001	–0.240	–7.46	0.000	–0.189	–5.60	0.000
Adjusted R^2		0.726			0.780			0.780	
Observations		256			256			256	
Cross-correlation test	0.026	p-value	0.979	1.998	p-value	0.046	2.129	p-value	0.033

4 Conclusions

This article analyzes the driving forces of capital structure in Chile for the period 1990-2002. We study interest-bearing liabilities for firms classified by economic sector. Our findings are more congruent with the trade-off theory than with the pecking-order hypothesis. In particular, more profitable firms issue more debt and debt is inversely associated with non-debt tax shields.

The contribution of this article is two-fold. First, the literature on capital structure has focused primarily on developed economies. Some exceptions are international comparisons that include emerging economies. But their data bases usually cover short time-spans. Second, we expand Anderson (1986)-Kim-Maddala (1992)'s work to panel data models for uncensored data, and devise specification tests for non-nested random-effect models. Most literature on capital structure focuses on the cross-section variation of the data by averaging observations over time.

Appendix 1

Variables definition

Variable	Description
Bank debt	(Short-term debt+Long-term debt+Long-term debt with a short-term portion)/Total assets
Bond debt	(Short- and long-maturity bonds)/Total assets
Cash ratio	(Cash and equivalents)/Total assets
Economic growth	Annualized growth rate of the Monthly Index of Economic Activity (IMACEC)
Equity	Equity/Total assets
Exchange-traded	=1 if stock was exchange-traded in that quarter; =0 otherwise
Leverage	(Bank loans+ Affiliated firms loans+ Bond and debt notes)/Total assets
Non-current assets	(Total assets–Current assets)/Total assets
Non-debt tax shields	Depreciation/Total assets
Quick ratio	(Current assets–Inventories)/Current liabilities
Profitability	Net operating income/Total assets
Size	Log(total assets)
Spread 1	90-day interest rate minus 30-day interest rate
Spread 2	8-year interest rate minus 90-day interest rate
Tangibility	(Total fixed assets+ Inventories)/Total assets
Trade credit	Accounts payable/Total assets

Appendix 2

Firms included in the estimation process

	Sampled firm	Economic sector	Listed
1	AES GENER S.A.	Electricity, Gas and Steam	Yes
2	AGRICOLA NACIONAL S.A.C. E I.	Agriculture and livestock production	Yes
3	AGUAS ANDINAS S.A.	Water Works and Supply	Yes
4	BODEGAS Y VIÑEDOS STA. EMILIANA S.A.	Beverage industries	Yes
5	C.T.I. COMPAÑIA TECNO INDUSTRIAL S.A.	Manufacture of fabricated metal products, except machinery and equipme	Yes
6	CARBONIFERA VICTORIA DE LEBU S.A.	Coal Mining	No
7	CEM S.A.	Manufacture of fabricated metal products, except machinery and equipme	Yes
8	CEMENTO POLPAICO S.A.	Manufacture of other non-metallic mineral products	Yes
9	CHILECTRA S .A.	Electricity, Gas and Steam	Yes
10	CHILESAT CORP S.A.	Communication	No
11	CIA CERVECERIAS UNIDAS S.A.	Beverage industries	Yes
12	CIA CHILENA DE FOSFOROS S.A.	Other Manufacturing Industries	Yes
13	CIA DE TELECOMUNICACIONES DE CHILE S.A.	Communication	Yes
14	CIA DE TELEFONOS DE COYHAIQUE S.A.	Communication	No
15	CIA ELECTRICA DEL LITORAL S.A.	Electricity, Gas and Steam	No
16	CIA ELECTRICA DEL RIO MAIPO S.A.	Electricity, Gas and Steam	Yes
17	CIA ELECTRO METALURGICA S.A.	Manufacture of fabricated metal products, except machinery and equipme	Yes
18	CIA GENERAL DE ELECTRICIDAD S.A.	Electricity, Gas and Steam	Yes
19	CIA INDUSTRIAL EL VOLCAN S.A.	Other Manufacturing Industries	No
20	COBRE CERRILLOS S.A.	Manufacture of fabricated metal products, except machinery and equipme	No
21	COLBUN S.A.	Electricity, Gas and Steam	Yes
22	COMPAÑIA NACIONAL DE TELEFONOS, TELEFONICA DE	Communication	Yes
23	COMPAÑIAS CIC S.A.	Manufacture of furniture and fixtures, except primarily of metal	Yes
24	CRISTALERIAS DE CHILE S.A.	Manufacture of glass and glass products	Yes
25	EMBOTELLADORA ANDINA S.A.	Beverage industries	Yes
26	EMPRESA DE LOS FERROCARRILES DEL ESTADO	Land transport	No
27	EMPRESA DE OBRAS SANITARIAS DE VALPARAISO S.A.	Water Works and Supply	No
28	EMPRESA ELECTRICA ATACAMA S.A.	Electricity, Gas and Steam	Yes
29	EMPRESA ELECTRICA DE ANTOFAGASTA S.A.	Electricity, Gas and Steam	Yes
30	EMPRESA ELECTRICA DE ARICA S.A.	Electricity, Gas and Steam	Yes
31	EMPRESA ELECTRICA DE IQUIQUE S.A.	Electricity, Gas and Steam	Yes
32	EMPRESA ELECTRICA DE MAGALLANES S.A.	Electricity, Gas and Steam	No
33	EMPRESA ELECTRICA DEL NORTE GRANDE S.A.	Electricity, Gas and Steam	Yes
34	EMPRESA NACIONAL DE ELECTRICIDAD S.A.	Electricity, Gas and Steam	Yes
35	EMPRESA NACIONAL DE TELECOMUNICACIONES S.A.	Communication	Yes
36	EMPRESA NACIONAL DEL CARBON S.A.	Coal Mining	Yes
37	EMPRESAS CABO DE HORNOS S.A.	Hotels, rooming houses, camps and other lodging places	No
38	EMPRESAS IANSA S.A.	Food manufacturing	Yes
39	EMPRESAS LUCCHETTI S A	Food manufacturing	Yes
40	EMPRESAS MELON S.A.	Manufacture of other non-metallic mineral products	Yes
41	FCA VICTORIA DE PUENTE ALTO S.A. TEXTIL	Manufacture of textiles	No
42	FERIA DE OSORNO S.A.	Agricultural services	No
43	FORESTAL CHOLGUAN S.A.	Logging	Yes
44	FRUTICOLA VICONTO S.A.	Agriculture and livestock production	Yes
45	GASCO S.A.	Electricity, Gas and Steam	Yes
46	GENERAL ELECTRIC DE CHILE S.A.	Manufacture of glass and glass products	No
47	HOTELES CARRERA S. A.	Hotels, rooming houses, camps and other lodging places	No
48	INDUSTRIAS FORESTALES S.A.	Manufacture of paper and paper products	Yes
49	INDUSTRIAS PRODUCTOS ALIMENTICIOS S.A.	Food manufacturing	No
50	INSTITUTO SANITAS S.A.	Manufacture of other chemical products	No
51	MADECO S.A.	Manufacture of fabricated metal products, except machinery and equipme	Yes
52	MASISA S.A.	Manufacture of wood and wood and cork products, except furniture	Yes
53	MINERA VALPARAISO S.A.	Electricity, Gas and Steam	No
54	MUELLES DE PENCO S.A.	Water transport	No
55	PESQUERA IQUIQUE - GUANAYE S.A.	Fishing	No
56	S. A. FERIA DE LOS AGRICULTORES	Agricultural services	No
57	SOC ABASTECEDORA DE LA INDUSTRIA METALURGICA	Wholesale Trade	No
58	SOC AGRICOLA LA ROSA SOFRUCO S.A.	Agriculture and livestock production	Yes
59	SODIMAC S.A.	Wholesale Trade	No
60	SOMELA S.A.	Other Manufacturing Industries	No
61	SOPROCAL CALERIAS E INDUSTRIAS S.A.	Other Mining	No
62	TERMAS Y AGUA DE PANIMAVIDA S.A.	Hotels, rooming houses, camps and other lodging places	No
63	VIÑA CONCHA Y TORO S.A.	Beverage industries	Yes
64	VIÑA UNDURRAGA S.A.	Beverage industries	Yes

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