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DO ROMANIAN COMPANIES FOLLOW PECKING ORDER FINANCING?

Abstract. *Capital structure represents the combination of certain types of instruments issued by a company in order to support its assets. The main aim of the paper is to check if there is support for Pecking Order theory of capital structure for Romanian companies, through the relation between debt ratio and profitability. Secondary, we need to check if this relationship is linear or non-linear. In order to test these hypotheses we have employed large database, which contains the first 2000 major and most performing Romanian companies for period 2003-2011. The results do not reject any of hypotheses. There is a non-linear and negative relation between debt ratio and profitability, which support the pecking order theory.*

Keywords: *Capital structure, pecking order theory, profitability, non linear, taxation.*

JEL classification: G32; G30; G31; H32.

1. Introduction

Capital structure represents the combination of certain types of instruments issued by a company in order to support its assets. The financial policy mosaic is one of leading decisions that a company can ever fathom, consisting in determining the optimal capital structure.

Moreover, the capital structure issue has recently gained additional weight in theoretical and empirical studies since many companies have experienced financial hardship due to the recently financial crisis.

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The rich literature on this subject indicates that the modern theory of capital structure began with the paper of Modigliani and Miller (1958) (Rajan and Zingales (1995); Harris and Raviv (1991)). Briefly, the MM evidence shows that the firm value is not dependent of its corporate financing decisions under certain restrictive conditions. The question is: in which conditions does capital structure matter?

According to Myers (2001),"there is no general theory of the debt-equity choice, and no reason to expect one." The literature suggests that the capital structure theories can be divided into two groups: the trade-off models (static), according to whom there is an optimal debt-equity ratio for each organization and the pecking-order theory, arguing that there is no defined target capital structure.

The pecking order theory (Myers and Majluf (1984)) suggests that firms prefer internal funds rather than external funds. There are conflicting points of view concerning the relationship between profitability and financial leverage. (Rajan and Zingales, 1995); Myers and Majluf (1984) find a negative relationship according to the pecking order theory while Jensen (1986) finds a positive relationship between the two variables if the market is strong and a negative relationship between profitability and leverage if the market is inefficient.

The main aim of the paper is to check if there is support for Pecking Order theory of capital structure for Romanian companies, through the relation between debt ratio and profitability. Secondary, we need to check if this relationship is linear or non-linear, by using both polynomial model and quantile regression approaches. In order to test these hypotheses we have employed a large database, which contains the first 2000 major and most performing Romanian companies for the period 2003-2011. To our knowledge, this is the largest sample used to test pecking order theory for Romanian companies. The results do not reject any of hypotheses. There is a non-linear and negative relationship between debt ratio and profitability, which supports the pecking order theory. Furthermore, we found that larger firms rather use internal sources and do not benefit from tax advantage of debt.

The paper is organized as follows. Section 2 highlights theoretical considerations regarding the main capital structure theories and determinants. Section 3 briefly describes data collection, variables used in the empirical model and methodological framework. Summary statistics and empirical results are reported in section 4 and section 5. Section 6 summarizes the conclusions of the paper.

2. Literature review

According to Harris and Raviv (1991), the balance is when the financial leverage increases with fixed assets, tax shields, investment opportunities, and firm size, and decreases with expenses, volatility, advertising the bankruptcy probability, profitability, and uniqueness." Titman and Wessels (1988) investigate determinants such as asset structure, growth, tax shields, uniqueness, industry

classification, size, earnings volatility and profitability, and they find that these factors can affect leverage according to the main capital structure theories.

Regarding the small and medium sized enterprises (SMEs), Michaelas et. al. (1999) state that the investigated determinants of capital structure (size, profitability, growth etc.) are relevant for both short and long-term debt ratios.

Based on a cross-sectional analysis of leverage in UK companies, Bevan and Danbolt (2000) find differences in the determinants of different forms of debt, short and long-term.

Recently, there are a growing number of studies that provide evidence regarding the capital structure determinants of companies from the emerging markets. The research being concerned with predicting pecking order theory for companies` capital structure in Romania, which is considered an emerging market, we will largely highlight the results of other empirical studies on emerging economies.

Patrik Bauer (2004) examines some selected determinants of capital structure of listed companies in the Czech Republic during the period 2000 to 2001: size, profitability, tangibility, growth opportunities, tax, non-debt tax shields, volatility, and industry classification. Czech listed firms` financial leverage depends on the valuation method; respectively it has a low value if it is measured in book value and has a greater value if measured in market value. The author`s results suggest that the financial leverage is positively correlated with its size and negatively correlated with its profitability and tangibility. Also, the author finds a negative correlation between leverage at market value and development opportunities. On the other hand, leverage is positively correlated with tax and negatively correlated with tax shields.

Fakher Buferna, Kenbata Bangassa and Lynn Hodgkinson (2008) investigate the conduct towards the financial policy of Libyan companies. The authors` intention is to explore the best based capital structure theory for Libyan companies. This intention is tested by investigating the correlation between different types of debt and four chosen capital hypotheses, based on comparing the relationships between long and short term debt and four explanatory variables that represent profitability, growth, tangibility and size. The methodology was developed to assess which capital structure theories best explained Libyan companies' capital structure. The authors` results show that the relevant theories to Libyan companies are the static trade-off theory and the agency cost theory.

A. Shahjahanpour, H. Ghalambor, A. Aflatooni (2010) intend to determine a number of factors that affect the capital structure of companies, using a cross sectional analysis, also investigating the applicability of two main capital structure theories for the data set, deriving from the financial statements of Iranian listed companies. The dependent variables include long and short-term debt while the independent variables refer to: liquidity, tax rate, payout ratio, tax shield and uniqueness. The results show that, in the case of the Iranian listed companies, the capital structure decisions are mostly matching the pecking order theory (60%) while the other 40% are consistent with the static trade off theory.

Nejla Ould Daoud Ellili, Nejla Ould Daoud Ellili (2011) investigate the capital structure determinants of Abu Dhabi Stock Exchange traded companies, using a panel data set for the time 2008- 2009, including 33 different companies. The authors choose nine possible capital structure determinants: asset structure, profitability, size of the company, expected growth rate, uniqueness, operating risk, industry, managerial ownership, age of the company. The results show that the structure of the assets structure is positively correlated with the long term debt, but negative to the short term debt, demonstrating that the companies use the general principle of financial balance in order to fund their assets, fixed by the long term liabilities and the current assets by the short term liabilities. The article also demonstrates empirically that the profitability is negatively correlated with the long term financial leverage and positively correlated to the short term one, meaning that successful and profitable firms finance their investments primarily by their internal funds and choose to fund their operating activities using short term external resources. The size of the company is positively correlated with the leverage ratios, confirming that powerful companies can have higher debt ratios. The growth rate is positively correlated with the long term leverage and vice-versa with the short term one, proving that firms finance their investments that will promote growth using long term external resources and not short term ones. The uniqueness and operating risk are positively correlated to the leverage ratios. As expected, the correlation of the industry is different from one industry to the other while the age of the company has an insignificant correlation with the financial leverage, results that are not consistent with the results of Peterson and Rajan (1994) that, in general, companies are able to have easier access to external resources due to their reputation, experience and ethical practices.

In the case of Romanian companies, the previous study of Dragotă Ingrid-Mihaela, Dragotă Victor, Obreja Braşoveanu Laura, Semenescu Andreea (2008) analyses the determinants of capital structure, using an OLS regression. The authors include four independent variables in the regression: tangible assets, size, profitability and market-to-book ratio, for which they empirically prove their significance.

Also, Florinița Duca (2012) examines 100 listed Romanian firms, in order to assess the factors that affect the capital structure decisions. The author finds strong correlations between leverage and tangibility of assets, firm size, liquidity and profitability. The results show that liquidity and tangibility of assets has a negative correlation with the financial leverage and profitability and size have a positive correlation with the leverage.

Table 1 summarizes the implications and empirical evidences of the main capital structure theories (Pecking Order and Trade Off) on the determinants that could affect debt ratio.

Table 1: Summary of Determinants of Capital Structure

Determinants	Definition	Theoretical Predicted Signs	Empirical Results
Profitability	EBIT divided by total assets	- (Pecking Order)	-
		+ (Trade Off)	+
Size	Natural Logarithm of Sales	- (Pecking Order)	-
		+ (Trade Off)	+
Tangibility	Fixed Assets divided by total Assets	+ (Pecking Order)	+
		+ (Trade Off)	+
Tax	Taxes Paid divided by Taxable Income		
		+ (Trade Off)	+
Non-Debt Tax Shields	Depreciation divided by total assets	-	-
Growth opportunities	Sales growth rate	± (Pecking Order)	±
		- (Trade Off)	-
Volatility	Standard deviation of EBIT	±	-
Managerial Equity Ownership	% of directors and top managers	+	+

Source: Authors` processing

3. Data and Methodology

The estimation sample consists of an unbalanced panel data of 2000 Romanian firms for the 2003-2011 period drawn from Orbis database provided by Bureau van Dijk (BvD), version 127. Several sample selection criteria were applied which worth to be noticed. First, we have focused our empirical work on the first 2000 leading companies from Romania, according to turnover criteria. Second, we have take in account only industrial firms and exclude financials and utilities. Thus, the final data set contains 14599 firm-year observations for 2000 firms with complete data for all variables used in the model.

The variables used in the model were computed based on information extracted from annual financial statements as at 31 December. According to the aim of the paper, we test if there is support for pecking order theory of capital structure for Romanian companies. In this respect, we investigate the relationship between capital structure and profitability.

There are two significant measures of capital structure used in empirical works, financial leverage and debt ratio respectively. Following other researchers, we have used debt ratio (DR) as a proxy for the capital structure and is expressed as total debts divided by total assets. Net margin (NM) was used as a proxy for profitability and is expressed as net income to total sales ratio. Pecking order theory suggests a negative relation between capital structure and profitability. This means that more profitable firms tend to use debt only when internal sources are insufficient.

In order to improve the model and to test if the sign of profitability remains unchanged, traditional control variables were added. Thus, sales-to-assets ratio was used as a proxy for size (SIZE) and effective tax rate was used as a proxy for tax shields (TR). Size is one of the most significant determinants for the capital structure and at the same time, one of the most tested explanatory variables in several models. It was found that the relation between size and capital structure could be either positive or negative, according to capital structure theory. However, larger firms with less asymmetric information issues are more diversified and generate more cash flow. This means that larger firms should tend to use more equity than debt and thus record lower leverage. Therefore, a negative relation between size and capital structure is expected.

Tax policy objectives influence the effects of taxation on capital structure, either favorable or unfavorable. For instance, the Romanian tax system favors retention against payout, encouraging internal sources. Accordingly, firms with higher level of effective tax rate will have a lower level of debt ratio. To avoid undue influence of outliers, debt ratio, profitability, size and tax rate are both winsorized at the 1st and 99th percentile.

Because listed companies want to offer attractive shares and are motivated to report fair profit in comparison with private companies, the reliability of financial statements could represent a significant issue in using financial data. In this respect, we include a dummy in the model (PUBLIC) that takes 1 if the company is listed at Bucharest Stock Exchange (BSE) and 0 otherwise. Given the listed requirements at BSE, listed companies use more equity than debt and, therefore, we expect a negative sign. It is worth to be noticed that both size through sales-to-assets ratio and public variables are fundamental elements of corporate governance.

Another factor that affects capital structure is related to the conflict between shareholders and managers. To deal with this, we introduce a dummy (INDEP) based on Independence indicator created by BvD, which characterize the degree of independence of a company with regard to its shareholders. The BvD Independence Indicators are noted as A, B, C, D and U, with further qualifications, where A companies are called “Independent companies” (Orbis – user guide). In this respect, our dummy variable INDEP take value 1 if BvD Independence Indicator is A and 0 otherwise. An independent company is more flexible in terms of financing and thus we expect a negative association with capital structure.

Finally, to account for debt financing condition we introduce a time-invariant variable in the model, i.e. fixed interest rate (RD), for which we collect data from National Bank of Romania. When fixed interest rate increase companies are likely to use less debt and a negative association is expected. However, this relation is influenced by the structure of the financial system.

In terms of methodology, panel data method is employed since the sample contains data across firms and over time. Panel data has the main advantage that it accounts for individual heterogeneity, i.e. it allows controlling for variables one cannot observe or measure like cultural factors or difference in business practices across companies.

The estimation procedure follows several steps. First, we have started with an OLS model and include only NM as independent variable. Then, we have included the controls in order to test if the size remains unchanged. In the following models we have attempted nonlinearity issue, whether polynomial terms for profitability are needed, such as second-order or third-order (Arce et al., 2009). In order to control for an individual firm heterogeneity we have employed both fixed effects and random models and have tested to select which is more suitable. According to results for classical hypotheses, two correction methods were employed, cluster approach with robust standard errors and autoregressive option. Finally, as a robustness check for nonlinearity relation and since there is high variation in DR (ranging from 0.057 to 1.857) we perform quantile regressions from 10% to 90% quantiles (Fattouh et al., 2008).

Based on the methodology aforementioned, the specific empirical model is:

$$DR_{i,t} = \alpha + \beta_1 * NM_{i,t} + \nu_{i,t} \quad (1)$$

and the general empirical model is:

$$\begin{aligned} DR_{i,t} = \alpha + \beta_1 * NM_{i,t} + \beta_2 * NM_{i,t}^2 + \beta_3 * SIZE_{i,t} + \beta_4 * TR_{i,t} + \\ \beta_5 * PUBLIC + \beta_6 * INDEP + \beta_7 * RD + \mu_{i,t} + \nu_{i,t} \end{aligned} \quad (2)$$

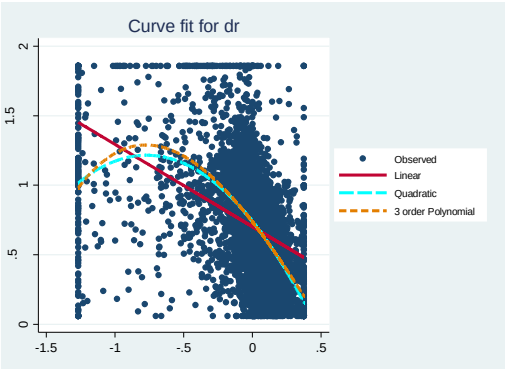
where μ_i denotes the unobservable firm effect to allow for unobserved influences on the profitability for each firm and $\nu_{i,t}$ is the idiosyncratic error component.

4. Results

Descriptive statistics for the variables used in the model is presented in Table 1. One can observe that, for period 2003-2011, Romanian companies use debt and record a poor performance since the average DR for our sample is about 69.8%, and NM is about 0.8%. Furthermore, except DR, all variables present volatility. From the correlation matrix, it can be outlined that all independent variables appears to be negatively correlated with DR and all pairs have a low correlation, suggesting no multi colinearity issues (see Table 2).

Next, an informal exploratory analysis was performed in which the relationship between capital structure and profitability is checked for linearity or nonlinearity. Figure 1 highlights this relationship and includes linear model, quadratic model and cubic model.

Figure 1. Curve estimation regression models between debt ratio and net margin



Source: Authors` calculation

The scatter plot suggests that the association between variables, DR and NM is not linear, and record a quadratic inverted U-shape. As the chart illustrates, the lowest debt ratio is associated with either negative or positive firm performance. However, in depth analysis is required in order to set what model is suitable, i.e. quadratic or cubic.

The nonlinear hypothesis is tested in depth using several econometric techniques. As a baseline, we start our estimations with the linear model, both specific and general. Following the procedure from the literature (Arce et al., 2008) we have tested the nonlinearity issue by using incremental F tests. First, we have compared the general model with the cube and square model and the results shows that at least one polynomial term should be included in the model (548.25 vs. 713.73). As a consequence, we have again compared the general model with the square model only and the results support the inclusion the squared term (548.25 vs. 1393.45). Finally, the comparison between the square model and the cube and square model suggest that the square model is most suitable (713.84 vs. 31.13 – column 4 from Table 3).

The results from specific model confirm the negative relation between DR and NM and, implicitly confirm the pecking order theory of capital structure for our sample. The results reject the hypothesis that the regression is linear and suggest that the square model is tailored. Thus, we have added the square of profitability in model 2, with control variables size, tax rate, public, independent and interest rate.

Results from model 2 suggest that all independent variables are significant and have the expected sign. Furthermore, NM sign remain unchanged from model 1 to model 2 while the square of NM is still negatively related with DR. These results suggest that the relation between capital structure and profitability is negative and concave downward.

Columns 2 and 3 from table 4 report the results for fixed effects (FE) and random effects models (RE), since Breusch-Pagan LM test suggests the presence of unobservable firm effects. The Chi-square statistic is reported in the bottom row of table 3 and is equal to 14635.36 with 0.000 p-value. In order to select the most suitable model an additional test was performed. Hausman test suggest that firm effects are not correlated with regressors, with a Chi-square equal to 431.71 and 0.000 p-value. These results lead to the conclusion that fixed effects model is more suitable than both OLS and random effects model.

Next, additional tests were performed in order to test if classical hypotheses are violated or not. The results suggest evidence of heteroskedasticity and autocorrelation in our models. We have addressed these issues with cluster approach with robust standard errors (FEM) and autoregressive option (FEM with AR), the results being reported in table 4.

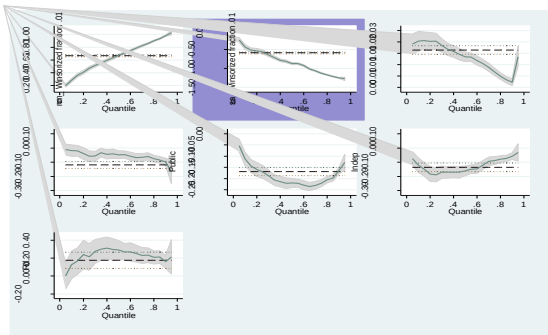
In terms of coefficient signs, the results from both estimation methods are consistent with previous models, i.e. except interest rate all independent variables are negatively related with DR. The difference than FE Model is related to the magnitude of coefficients and standard errors which seems to be lower in FEM Model and FEM with AR Model.

Robustness check

Next, we want to test whether our nonlinear relation is driven by methodology. In this respect, we employ the second approach from literature, the use of quantile regressions (Fattouh et al., 2008). In addition, our robustness check is motivated by the presence of heteroskedasticity in the initial polynomial model, which justify the use of quantile regressions. Table 5 provides regression results when the general nonlinear model was estimated.

The quantile coefficients for profitability are significantly different from the OLS coefficients. Moreover, this is confirmed in figure 2. The figure illustrates coefficient estimates for all independent variables with 95% confidence levels.

Figure 2.Quantile regression estimates



Source: Authors` calculation

The signs of the profitability variable were compatible with the claims of the pecking order theory for all selected quantiles. This supports evidence that more profitable firms tend to depend more on internally generated funds than on outside financing such as debt. When the changing pattern of estimated coefficients is examined, the absolute values of negative coefficients increase as the quantile increases. For instance, as quantiles increase from 0.10 to 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, and 0.90, the estimates change from -0.432, to 0.532, -0.638, -0.783, -0.870, -0.923, -1.064, -1.167 and -1.246, correspondingly, when the general nonlinear model was estimated. This implies that effect of profitability decreases for firms with higher debt ratio.

Looking beyond these significant statistical results, the negative relation between NM and DR support the pecking order theory of capital structure. Furthermore, for our sample this relation is nonlinear. Larger firms rather use internal sources and do not benefit from tax advantage of debt.

Overall, our empirical results both are consistent and complement the findings from capital structure topic. Like Nivorozhkin (2005), capital structure is negatively related with profitability and like Chen (2004), capital structure is negatively related with size. The main different result that contradicts other empirical works are related to negative association between capital structure and tax rate.

5. Conclusions

The main aim of our paper is to test the relation between debt ratio and profitability for most performance Romanian companies. Secondary, we want to check if this relation is linear or nonlinear and if it remains unchanged after adding size and tax rate as control variables.

Using fixed effects model, the results support pecking order theory of capital structure. This means that more profitable firms tend to use debt only when internal sources are insufficient, larger firms rather use internal sources and do not

benefit from tax advantage of debt. Moreover, the effect of profitability decreases for firms with higher debt ratio.

To sum up, the methodology employed in our empirical work provides statistical significant results which confirm the hypotheses from Pecking Order theory for the case of Romanian companies.

REFERENCES

[1] **Antoniou A., Guney Y., Paudyal K. (2008),** ***The Determinants of Capital Structure: Capital Market-Oriented versus Bank-Oriented Institutions*** *; Journal of Financial and Quantitative Analysis*, vol. 43, no. 1, 59-92.

[2] **Arce, D., Cook D., Kieschnick R. (2009),** ***On the Evolution of Capital Structures*** ;Available at SSRN id1359313;

[3] **Bauer Patrik (2004),*****Determinants of Capital Structure: Empirical Evidence from the Czech Republic***. *Czech Journal of Economics and Finance (Finance a uver)*, vol. 54, issue 1-2, 2-21;

[4] **Bevan, A. A., Danbolt, J., (2000),** ***Capital Structure and Its Determinants in the United Kingdom: A Decompositional Analysis*** ; *Applied Financial Economics*, 12, 159-170;

[5] **Chen J. (2004*****), Determinants of Capital Structure of Chinese-listed Companies***. *Journal of Business Research*, 57, 1341-1351;

[6] **Duca Florinița (2012),** ***What Determines the Capital Structure of Listed Firms in Romania*** . *CES Working Papers*, vol. 4, issue 3a, 523-531, Available at: http://www.ceeol.com/aspx/issuedetails.aspx?issueid=a87847b6-64f1-4907-8875-de120bef2c93&articleId=d20a73ee-5a5f-4344-b457-12867290c3ee;

[7] **Dragotă, Ingrid-Mihaela, Dragotă, Victor, Obreja Braşoveanu Laura, Semenescu Andreea (2008),** ***Capital Structure Determinants: A Sectorial Analysis For The Romanian Listed Companies*** ; *Economic Computation and Economic Cybernetics Studies and Research*, Vol. 42, No. 1-2, 155-172;

[8] **Fakher Buferna, Kenbata Bangassa and Lynn Hodgkinson (2008),** ***Determinants of Capital Structure Evidence from Libya***; *University of Liverpool Research Paper Series*, No. 2005, ISSN 1744-0718, Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.136.5311&rep=rep1&type=pdf;

[9] **Fattouh, B, Scaramozzino P, Harris L (2008),** ***Non-linearity in the Determinants of Capital structure: Evidence from UK Firms*** ; *Empirical Economics*, 34(3), 417-438;

[10] **Harris, M., Raviv, A. (1991),** ***The Theory of Capital Structure*** **.** *Journal of Finance*, 46 (1), 297-355;

[11] **Jensen Michael C. (1986),** ***Agency Cost of Free Cash Flow, Corporate Finance and Takeovers***. *American Economic Review*, Vol. 76, No. 2, 323-329;

[12] **Michaelas, N., Chittenden, F. and Poutziouris, P. (1999),** ***Financial Policy and Capital Structure Choice in U.K. SMEs: Empirical Evidence from Company Panel Data*** **.** *Small Business Economics*, 12, 113 – 130;
[13] **Modigliani F., Miller M. (1958),** ***The Cost of Capital, Corporation Finance and the Theory of Investment*** . *The American Economic Review*, Vol. 48, No. 3, 261-297;
[14] **Myers, S. C. (2001),** ***Capital Structure*** . *Journal of Economic Perspectives*, vol. 15, 81–102;
[15] **Myers, S. C., Majluf, N. S. (1984),** ***Corporate Financing and Investment Decisions when Firms Have Information the Investors Do not Have*** . *Journal of Financial Economics*, vol. 13, 187–221;
[16] **Nejla Ould Daoud Ellili, Nejla Ould Daoud Ellili (2011),** ***Examining the Capital Structure Determinants: Empirical Analysis of Companies Traded on Abu Dhabi Stock Exchange*** ; *International Research Journal of Finance and Economics*, Issue 67, 82-96;
[17] **Nivorozhkin E. (2005),** ***Financing Choices of Firms in EU Accession Countries*** . *Emerging Markets Review*, vol. 6, 138-169;
[18] **Rajan, R. G., Zingales L. (1995),** ***What Do We Know about Capital Structure? Some Evidence from International Data*** **.** *Journal of Finance*, 50, 1421-1460;
[19] **Shahjahanpour A., Ghalambor H., Aflatooni A. (2010),** ***The Determinants of Capital Structure Choice in the Iranian Companies*** *; International Research Journal of Finance and Economics*, Issue 5, 167-178;
[20] **Titman, S., Wessels, R. (1988),** ***The Determinants of Capital Structure Choice****; Journal of Finance*, 43, 1, 1-19.

APPENDIX

Table 2 Descriptive statistics

STATISTICS	DR	NM	SIZE	TR	PUBLIC	INDEP	RD
Mean	0.698	0.008	2.283	0.167	0.056	0.019	0.178
50th Percentile	0.710	0.021	1.617	0.161	0	0	0.151
Standard deviation	0.305	0.185	2.356	0.181	0.230	0.135	0.050
Maximum	1.857	0.374	15.687	0.933	1	1	0.262
Minimum	0.057	-1.268	0.018	-0.350	0	0	0.121

Source: Author's calculation

Table 3 Regression analysis using linear vs. nonlinear models

VARIABLES	MODELS			
	OLS	OLS	OLS	OLS
NM	-0.592***	-0.585***	-1.226***	-1.253***
	(0.026)	(0.026)	(0.030)	(0.033)
NM^2			-0.795***	-0.445***
			(0.035)	(0.110)
NM^3				0.308**
				(0.098)
SIZE		0.016***	0.012***	0.012***
		(0.001)	(0.001)	(0.001)
TR		-0.118***	-0.116***	-0.105***
		(0.014)	(0.013)	(0.013)
PUBLIC		-0.169***	-0.188***	-0.188***
		(0.009)	(0.009)	(0.009)
INDEP		-0.136***	-0.123***	-0.123***
		(0.016)	(0.015)	(0.015)
RD		0.176***	0.311***	0.302***
		(0.048)	(0.046)	(0.046)
CONSTANT	0.701***	0.667***	0.688***	0.683***
	(0.002)	(0.009)	(0.008)	(0.008)
R-Squared	0.134	0.184	0.255	0.257
RMSE	0.278	0.270	0.258	0.258
# Firms				
# Observations	14610	14599	14599	14599
Incremental F test (linear vs. nonlinear)		548.25***		713.73***
Incremental F test (square only)		548.25***	1393.45***	
Incremental F test (square and cube)			713.84***	31.13***
BPLM test[a] (p-value)			$Chi^2(1)$ =14635.36***	

Robust Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$;
[a] Breusch and Pagan Lagrangian multiplier test for random effects
Source: Author's calculation

Table 4. Regression analysis using effects models

VARIABLES	MODELS			
	FE	**RE**	**FEM**	**FEM with AR**
NM	-0.778***	-0.855***	-0.778***	-0.666***
	(0.018)	(0.018)	(0.038)	(0.017)
NM^2	-0.519***	-0.562***	-0.519***	-0.472***
	(0.018)	(0.017)	(0.038)	(0.017)
SIZE	-0.005***	0.001	-0.005*	-0.004***
	(0.001)	(0.001)	(0.002)	(0.001)
TR	-0.068***	-0.077***	-0.068***	-0.023**
	(0.009)	(0.009)	(0.011)	(0.008)
PUBLIC		-0.213***		
		(0.020)		
INDEP		-0.149***		
		(0.034)		
RD	0.495***	0.454***	0.495***	0.123*
	(0.030)	(0.030)	(0.047)	(0.051)
CONSTANT	0.658***	0.690***	0.658***	0.701***
	(0.006)	(0.007)	(0.009)	(0.004)
R-Squared	0.154		0.154	
RMSE	0.165	0.167	0.153	0.126
# Firms	2000	2000	2000	2000
# Observations	14599	14599	14599	12599
Hausman test (p-value)	$Chi^2(5) = 431.71^{***}$			
Modified Wald[b] (p-value)	$Chi^2(2000) = 2.7e+35^{***}$			
Wooldridge[c] (p-value)	$F(1,1845) = 740.32^{***}$			

Heteroskedastic-Robust Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[b] Modified Wald test for heteroskedasticity;

[c] Wooldridge test for autocorrelation

Source: Author's calculation

Table 5 Robustness check - Coefficient estimates from quantile regressions

VARIABLES	MODELS									
	OLS	**Q10**	**Q20**	**Q30**	**Q40**	**Q50**	**Q60**	**Q70**	**Q80**	**Q90**
wnm	-0.585***	-0.432***	-0.532***	-0.638***	-0.783***	-0.870***	-0.923***	-1.064***	-1.167***	-1.246***
	(0.012)	(0.032)	(0.030)	(0.022)	(0.018)	(0.014)	(0.012)	(0.010)	(0.007)	(0.008)
wsa	0.016***	0.020***	0.020***	0.018***	0.016***	0.013***	0.012***	0.009***	0.005***	0.002**
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
wtr	-0.118***	-0.019	-0.038	-0.057**	-0.045**	-0.048***	-0.057***	-0.066***	-0.074***	-0.097***
	(0.013)	(0.021)	(0.021)	(0.017)	(0.016)	(0.014)	(0.015)	(0.014)	(0.012)	(0.014)
public	-0.169***	-0.112***	-0.159***	-0.187***	-0.213***	-0.219***	-0.229***	-0.230***	-0.205***	-0.164***
	(0.009)	(0.016)	(0.016)	(0.013)	(0.012)	(0.010)	(0.010)	(0.009)	(0.007)	(0.007)
indep	-0.136***	-0.121***	-0.182***	-0.170***	-0.169***	-0.161***	-0.146***	-0.094***	-0.079***	-0.057***
	(0.016)	(0.026)	(0.027)	(0.022)	(0.021)	(0.018)	(0.017)	(0.015)	(0.012)	(0.012)
rd	0.176***	0.126	0.239**	0.276***	0.313***	0.291***	0.269***	0.229***	0.208***	0.160***
	(0.047)	(0.080)	(0.081)	(0.067)	(0.062)	(0.053)	(0.052)	(0.046)	(0.038)	(0.037)
_cons	0.667***	0.284***	0.409***	0.514***	0.594***	0.674***	0.746***	0.825***	0.900***	0.980***
	(0.009)	(0.015)	(0.015)	(0.013)	(0.012)	(0.010)	(0.010)	(0.008)	(0.007)	(0.007)
R-Squared	0.184									
Pseudo R-Squared		0.062	0.079	0.089	0.100	0.110	0.122	0.134	0.152	0.192

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$