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DETERMINANTS OF CAPITAL STRUCTURE: EVIDENCE FROM THE CZECH AUTOMOTIVE INDUSTRY

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Abstract

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The objective of the paper is to identify the determinants influencing the capital structure of large and medium-sized enterprises of the automotive industry in the Czech Republic. The sample consists of 100 companies belonging to NACE division 29. The data come from financial statements of selected companies and cover a period from 2006 to 2010. For the purpose of the paper quantitative research is used. The selection of appropriate dependent and independent is realized on the basis of secondary research on studies of capital structure. The analysis of variance, correlation and regression analyses have been performed to see the nature of relationship between variables. Size, tangibility, profitability and liquidity appear to be relevant determinants of capital structure. Growth is not a statistically significant determinant of leverage. It has been observed that the maturity of debt has to be considered, since the investigation of total debt only does not provide precious results. The findings do not unequivocally support either the static trade-off theory or the pecking order theory.

capital structure, determinants of capital structure, leverage, automotive industry, pecking order theory, trade-off theory

One of the most frequently discussed issues of financial management is the question of capital structure choice. The original propositions of Modigliani and Miller (1958) have been developed, as Kislingerová *et al.* (2010) state, into two main schools of thought. The static trade off theory believes in the existence of a target debt ratio, in which the benefits of debt trade-off the costs of potential financial distress. In contrast, the pecking order theory denies the existence of optimal capital structure and claims that the enterprises prefer internal to external financial sources.

The vast majority of foreign studies concern the capital structure of large sized enterprises in developed countries (e.g. Titman and Wessels, 1988; Bevan and Danbolt, 2002). Recently, the studies on small and medium sized enterprises (e.g. Hall, Hutchinson and Michaelas, 2004; Degryse, de Goeij and Kappert; 2012) or on enterprises in developing countries (e.g. Gurcharan, 2010; Afza and Hussain, 2011) have appeared.

There are only a limited number of papers examining the capital structure choice among Czech enterprises. Above all, it is worthy to mention the study by Krauseová (1995) or the study by Bauer (2004), which is focused on listed companies in Visegrad countries.

Generally, the corporate capital structure is determined by various external and internal factors. External factors are macroeconomic variables, such as tax policy, inflation rate or capital market conditions. Internal micro-factors are related to individual firm characteristics. The capital structure theories have identified a wide range of internal factors potentially influencing capital structure choice. Mazur (2007) notifies that these factors and their impact on capital structure can be sorted according to theories, they refer to. Landa and Martinovičová (2010) classify the factors into two categories. The first category is related to the costs of capital. The second category concerns the assets

structure and profitability, and is primarily the subject of interest of present study.

Moreover, it seems that the relationship between potential determinants and capital structure differs with respect to country specifics (see for example Wald, 1999; Psillaki and Daskalakis, 2009). Some authors also emphasize the existence of industry specifics (see Hall, Hutchinson and Michaelas, 2000; Degryse, de Goeij and Kappert, 2012). As a consequence of these facts, the findings of existing studies cannot be generally applicable to the conditions in the Czech Republic.

METHODS AND RESOURCES

The objective of the paper is to identify the determinants influencing the capital structure of large and medium-sized enterprises of the automotive industry in the Czech Republic.

First, the selection of appropriate dependent and independent (explanatory) variables is made on the basis of secondary research on studies of capital structure. Next, several statistical methods are performed. The analysis of variance is applied to distinguish significant differences between statistical groups of medium and large sized-enterprises. Then, the paper follows the methodology presented in Heyman, Deloof and Ooghe (2008). The Pearson correlation is used to test the relationship among the variables and to define the significant determinants of corporate capital structure and the multiple regression analysis is run to see the impact of explanatory variables on dependent capital structure variables. Lastly, the findings are compared with the results of previous works on the same subject.

The paper uses the data collected from the balance sheets and income statements of companies manufacturing the motor vehicles, trailers and semi-trailers (NACE division 29). These data are obtained from the Amadeus database. The sampling period covers a time frame of five years from 2006 to 2010.

The companies in the population have to meet the following criteria:

- be in the legal form of private limited company or public limited company,
- be medium or large sized enterprise, according to the European Commission Recommendation of 6 May 2003 (2003/361/EC),
- submit its financial statements in every year of the sampling period.

From this population of 238 subjects, a random sample of 50 medium-sized enterprises and 50 large-sized enterprises is drawn. In total, the panel data comprises 500 observations.

Selection of dependent variables

The most common definition of capital structure is the amount of equity and long-term debt used to finance a company (Pratt, Reilly and Schweis, 1996; Brigham and Houston, 2009). Nevertheless, there also exists a variant approach, in which capital structure refers to a mix of equity and total debt financing (Bierman, 2001).

Because of the fact that short-term debt constitutes a relatively high proportion of total debt in funding of enterprises in the Czech automotive industry, the second approach is respected and the analysis of determinants of capital structure is based on the analysis of total debt. However, both long-term and short-term debt ratios also have to be considered separately, because, as Hutchinson (2003) argues, the use of total debt may hide their potential opposite effects.

Hence, the study employs three measures of financial leverage. These are:

- Total debt ratio (TD) = total liabilities to total assets.
- Long-term debt ratio (LTD) = non-current liabilities to total assets.
- Short-term debt ratio (STD) = current liabilities to total assets.

Due to data limitations, all of the measures are based on book values.

Selection of independent variables

The theories of corporate capital structure suggest a number of its potential determinants. The overview of the major determinants, based on the findings of theoretical and empirical studies, follows.

Size

The influence of size on financial leverage seems to be ambiguous. It is claimed that large companies are more diversified; hence they have less chance of going bankrupt (Rajan and Zingales, 1995). From this point of view, the size serves as an inverse proxy for the probability of bankruptcy and has positive impact on debt ratios. The positive relationship is also supported by the information asymmetry theory (Myers and Majluf, 1984). Outside investors have more information about large firms than small ones. Therefore, it is easier for large companies to issue debt. In contrast, Rajan and Zingales (1995) have argued that large companies would prefer equity to debt financing to avoid providing more information to outsiders. Consequently, their leverage is expected to be lower.

Empirical studies do not show clear findings. Rajan and Zingales (1995) confirm a positive impact on debt ratios. On the contrary, Titman and Wessels (1988) observe a negative relation. Bevan and Danbolt (2002) reveal that the nature of relationship is dependent on the nature of debt. In case of long-term debt, the association is expected to be positive; in case of short-term debt the association is expected to be negative.

Tangibility

Tangibility is a widely accepted determinant of capital structure. Fixed assets serve as collateral which protects the lenders against losses resulting from the conflicts between lenders and

shareholders, or against losses resulting from the lack of information. From this aspect, due to agency cots (Jensen and Meckling, 1976) and information asymmetry costs (Myers and Majluf, 1984), the trade-off theory expects a positive relationship between tangibility and leverage. Companies with a high proportion of tangible assets will use more debt than companies with a high proportion of intangible assets. To the contrary, the pecking order theory believes that companies with higher level of tangible assets tend not to face asymmetric information problems and are less likely to employ debt finance. From this point of view, a negative relationship is anticipated.

Empirical studies do not provide clear evidence. Titman and Wessels (1988) and Rajan and Zingales (1995) support a positive relationship between tangibility and gearing. On the contrary, Huang and Song (2006) observe a negative relationship. Many authors (see Bevan and Danbolt, 2002; Song, 2005) find that tangibility is positively associated with total debt ratio and long-term debt ratio, but it is negatively associated with short-term debt ratio. According to Bevan and Danbolt (2002), this result is in agreement with the maturity matching principle which suggests that long-term assets should be financed with long-term debt and short-term assets should be financed with short-term debt.

Profitability

The pecking order theory (Myers and Majluf, 1984) predicts a negative relationship between profitability and leverage since highly profitable firms would prefer internal sources to external sources. On the other hand, the trade-off theory claims that enterprises with higher profitability will acquire more debt to reduce its tax burden. A positive relationship is also supported from the perspective of the free cash flow theory (Jensen, 1986). More profitable enterprises will use more debt financing to prevent managers from investment into risky projects. However, the majority of existing studies confirm the findings of pecking order theory (see Titman and Wessels, 1988; Rajan and Zingales, 1995; Bevan and Danbolt, 2002; Mazur, 2007).

Liquidity

Liquidity together with profitability belongs to indicators of a company's financial position. With respect to this fact, the relation between liquidity and leverage is expected to be analogous, based on the same assumptions. Mazur (2007) and Lipson and Mortal (2009) find negative effect of liquidity on corporate capital structure, which would mean that companies with more liquid assets have lower leverage and prefer equity financing when increasing capital.

Growth

The pecking order theory assumes a positive relationship between growth and leverage since a high growth implies increased needs for financial sources and a greater dependence on external financial sources. On the other hand, Myers (1977) predicts a negative impact on leverage as a consequence of higher opportunities to invest in risky projects, which leads to the increase in the cost of debt. These agency costs can be reduced by the substitution of short-term debt for long-term debt. In this case, growth is predicted to have a positive effect on a short-term leverage. Yet, the empirical evidence is ambiguous. A negative relationship is confirmed by Titman and Wessels (1988) or Rajan and Zingales (1995). On the contrary, Bevan and Danbolt (2002) report a positive correlation.

The final set of five explanatory variables has been selected for the purpose of the paper. These determinants, together with their measure and expected impact, are reported in Table I. The choice of measures is based on studies of similar focus, for example, Bauer (2004), Hall *et al.* (2004), Song (2005) or Mazur (2007).

RESULTS AND DISCUSSION

The average leverage ratios for different level of debt of medium and large-sized companies are shown in Tab. II. In the case of medium-sized enterprises, the average long-term debt ratios oscillate approximately around the same level. To the contrary, a steep fall of short-term debt between years 2007 and 2008 can be detected. The debt ratios of large-sized enterprises seem to be more stable and a mild decrease is evinced.

Analysis of variance was performed to test the statistical significance of the differences between the statistical groups of medium and large sized companies. On the significance level of 0.05, the results show that the differences are not statistically significant. With regard to this finding, the study further works with one common statistical group.

I: *Potential determinants of capital structure, their measures and expected effect on leverage*

Determinant	Measure	Expected effect	
		Trade-off theory	Pecking order theory
Size (SZ)	Log of total assets	+	–
Tangibility (TANG)	Fixed assets / Total assets	+	–
Profitability (PROF)	EBIT / Total assets	+	–
Liquidity (LIQ)	Current assets / Current liabilities	+	–
Growth (GRW)	Percentage change in sales turnover	–	+

Tab. III illustrates the descriptive statistics of the leverage ratios. The sample means, medians, minimums, maximums and standard deviations are presented with regard to time period and debt maturity. It is evident that both long-term and short-term debt ratios gradually decrease during observed period, with exception of year 2007. The total debt of companies in automotive industry has mainly short-term character and there even exist companies that do not use long-term debt funding. Tab. IV shows the summary of descriptive statistics of different explanatory variables.

The correlation matrix of dependent and independent variables is presented in Tab. V. The table reports the value of Pearson correlation coefficient and the results of the significance test of these coefficients. The test was performed at the 0.05 level of significance.

The results derived from regression analysis are summarized in Tab. VI. The value of coefficient of determination of TD model (R^2 = 0.6486) indicates that 65% of the variation in capital structure is caused by the variation in size, tangibility, profitability, liquidity and growth. Similarly, the coefficient of determination of STD model has the value of 0.6425. The LTD model achieves the determination coefficient of only 0.3530. In comparison with other studies (see Huang and Song, 2006; Hall, Hutchinson and Michaelas, 2004), these results seem to be sufficient.

Size is positively correlated with long-term debt ratio, but it is negatively correlated with short-term debt ratio. This finding, consistent with those reported by Bevan and Danbolt (2002), reveals that larger firms in the sample tend to use more long-term debt finance than short-term debt finance. Yet, the slightly negative association between size and total debt document that larger firms have a lower debt ratio. These results suggest that larger firms rely more on equity finance and are more likely to acquire long-term debt than short- term debt.

Regarding the relationship between tangibility and leverage, the results show that tangibility has a positive effect on all three debt measures. This result supports the trade-off theory and signals the importance of collateral in securing debt, but it

II: *Average leverage ratios of medium and large-sized companies in automotive industry*

Debt Ratio (%)	Company Size	Year				
		2006	2007	2008	2009	2010
Long-term	Medium	12.01	11.47	11.42	9.88	9.16
	Large	14.47	10.51	12.32	11.76	9.47
Short-term	Medium	66.02	73.13	37.18	36.46	37.62
	Large	45.07	46.67	45.96	43.70	43.23

Source: Author's calculations

III: *Summary statistics of leverage ratios*

Debt Ratio (%)	Year	Mean	Median	Min.	Max.	Std. Dev.
Long-term	2006	13.24	6.53	0.00	72.69	15.89
	2007	10.99	3.88	0.00	59.28	13.96
	2008	11.87	3.31	0.00	92.59	18.01
	2009	10.82	2.24	0.00	92.48	17.27
	2010	9.31	1.36	0.00	90.21	15.59
Short-term	2006	55.55	38.54	3.84	1351.11	132.97
	2007	59.90	39.92	3.35	1660.49	163.27
	2008	41.58	39.24	2.53	115.26	24.05
	2009	40.08	33.32	0.88	171.76	29.41
	2010	40.43	33.36	2.70	202.92	30.06

Source: Author's calculations

IV: *Summary statistics of potential determinants of capital structure*

	Mean	Median	Min.	Max.	Std. Dev.
Size (millions CZK)	143.15	48.66	0.26	1 431.87	229.96
Tangibility (%)	41.74	41.03	0.18	290.30	23.05
Profitability (%)	7.98	5.93	–55.21	125.76	14.56
Liquidity (%)	273.43	145.41	–11.46	10 899.17	587.56
Growth (%)	–728.22	330.93	–269 394.00	10 000.00	12 577.28

Source: Author's calculations

V: *The correlation matrix between dependent and independent variables*

Variables	TD	LTD	STD	SZ	TANG	PROF	LIQ	GRW
SZ	–0.080 (S)	0.122 (S)	–0.103 (S)	1				
TANG	0.481 (S)	0.272 (S)	0.444 (S)	0.031 (I)	1			
PROF	0.331 (S)	–0.178 (S)	0.367 (S)	–0.082 (S)	–0.002 (I)	1		
LIQ	–0.148 (S)	–0.145 (S)	–0.126 (S)	0.090 (S)	–0.199 (S)	0.061 (I)	1	
GRW	0.007 (I)	–0.050 (I)	0.016 (I)	–0.064 (I)	–0.083 (S)	0.064 (I)	–0.037 (I)	1

Source: Author's calculations
Notes: Statistically significant values are marked by "S", statistically insignificant values are marked by "I".

VI: *Regression analysis results*

Variables	TD	LTD	STD
(Constant)	–0.291	–0.078	–0.213
SZ	–0.011	0.008*	–0.019
TANG	1.385*	0.168*	1.217*
PROF	1.925*	–0.183*	2.109*
LIQ	–0.011**	–0.003**	–0.008
GRW	0.000	–0.000	0.000

Source: Author's calculations
Notes: * Statistically significant at 1% level, ** statistically significant at 5% level.

does not confirm the proposed matching principle. Companies that maintain a large share of tangible assets in their assets structure are more prone to debt funding.

In accordance with the pecking order theory, profitability is negatively correlated with long-term debt ratio, which confirms the presumption that more profitable companies prefer the use of internal funds and only the companies with insufficient amount of own sources use more long-term debt financing. Nevertheless, the association of profitability with short-term debt ratio and total debt ratio is positive. If companies need more finance, they prefer to raise short-term debt than long-term debt. The profitability results are in line with the results reported in Michaelas *et al.* (1999) who have argued for a larger negative impact of profitability on short term debt than on long term debt.

As far as liquidity is concerned, the findings indicate a negative relationship with all measures of capital structure. This result, together with the negative relationship between profitability and long-term debt, supports the pecking order theory. The enterprises with better liquidity prefer equity financing. Only if lacking internal sources, they tend to employ more debt in their capital structure.

The obtained results do not indicate a significant relationship between growth and debt ratios. This finding is consistent with the findings of Song (2005), Mazur (2007) or Psillaki and Daskalakis (2009). Song (2005) has also provided potential explanations of the causes. The first possible explanation is contradictory effect of two key theories, which neutralize each other. The second possible explanation lies in inappropriate choice of growth measure.

CONCLUSIONS

The study has examined the determinants of capital structure of medium to large sized automotive companies in the Czech Republic. Four important factors have been identified, namely size, tangibility, profitability and liquidity. Size is negatively related to total debt and short-term debt, but positively related to long-term debt. Tangibility and leverage are positively related in all cases. Profitability and total debt as well as short-term debt are positively related, but profitability and long-term debt are negatively related. Liquidity and leverage are negatively related in all cases. The only one insignificant variable is growth.

The findings provide evidence that the nature of relationship between leverage and explanatory variables is highly dependent on the choice of financial leverage. In four cases there have been observed differences between long-term and short-term debt ratios. Hence, the use of total debt ratio conceals opposite effect of long-term and short-term debt. The results do not clearly confirm the universal validity of any of the capital structure theories. Both the pecking order and trade-off theories, under some conditions, seem to be applicable in explaining the capital structure of Czech automotive companies.

Theoretical and empirical studies denote that unique characteristics of enterprises play a significant role in forming the capital structure. Nevertheless, these factors are not the only variables that can influence financing decisions. Future research should include quantitative investigation of management's behaviour. The results also indicate that country and industry specifics affect the capital structure choice. Further survey might consider the impact of inter-industry variations on capital structure choice.

SUMMARY

The question of capital structure choice is one of the fundamental issues in the field of financial management. The original propositions of Modigliani and Miller (1958) have been developed into two main schools of thought: the static trade off theory and the pecking order theory. Also, there exist a number of potential determinants of capital structure choice. These factors and their impact on capital structure are frequently proposed from the perspective of capital structure theories. The objective of the paper is to identify the determinants influencing the capital structure of large and medium-sized enterprises of the automotive industry in the Czech Republic. The sample consists of 100 enterprises belonging to NACE division 29 (the manufacture of motor vehicles, trailers and semi-trailers). The sampling period covers a time frame of five years from 2006 to 2010. On the basis of secondary research three dependent and five independent variables have been selected. The dependent variables are total debt, long-term debt and short-term debt ratios. The independent variables are size, tangibility, profitability, liquidity and growth. The analysis of variance, correlation and regression analyses have been performed to see the nature of relationship between variables. The findings show that the determinants of capital structure proposed by theoretical studies are relevant for companies of Czech automotive industry, but the direction of relationship can be different. Total debt has been found to be related positively to tangibility and profitability and negatively to size and liquidity. Long-term debt is related positively to size and tangibility and negatively to profitability and liquidity. Short-term debt is related positively to tangibility and profitability and negatively to size and liquidity. Growth has insignificant effect on all three debt measures. The results of the study reveal that the character of relationship is highly dependent on the choice of financial leverage. Larger companies prefer equity finance and are more likely to employ long-term debt to short-term debt. Companies with more tangible assets tend to debt financing. More liquid companies prefer equity financing. More profitable companies are prone to raise equity and short-term debt. Neither the pecking order theory nor the trade-off theory has been convincingly proved.

REFERENCES

AFZA, T. and HUSSAIN, A., 2011: Determinants of Capital Structure: A Case Study of Automobile Sector of Pakistan. *Interdisciplinary Journal of Contemporary Research in Business*, 2(10), 219–230.

BAUER, P., 2004: Capital structure of listed companies in Vise-grad countries. *Prague Economic Papers*, 2, 159–175.

BEVAN, A. A. and DANBOLT, J., 2002: Capital structure and its determinants in the United Kingdom – a decompositional analysis. *Applied Financial Economics*, 12(3), 159–170.

BIERMAN, H., 2001: *Increasing shareholder value: distribution policy, a corporate finance challenge*. Springer. ISBN 9780792375173.

BRIGHAM, E. F. and HOUSTON, J. F., 2009: *Fundamentals of Financial Management*. Cengage Learning. ISBN 9780324597714.

DEGRYSE, H., DE GOEIJ, P. and KAPPERT, P., 2012: The impact of firm and industry characteristics on small firms' capital structure. *Small Business Economics*, 38 (4), 431–447.

EC, 2003: EC recommendation concerning the definition of micro, small and medium-sized enterprises. [online] Available on http://ec.europa.eu/enterprise/policies/sme/factsfigures-analysis/sme-definition/index_en.htm.

GURCHARAN, S. A., 2010: A Review of Optimal Capital Structure Determinant of Selected ASEAN Countries. *International Research Journal of Finance and Economics*, 47, 30–41.

HALL, G. C., HUTCHINSON, P. J. and MICHAELAS, N., 2000: Industry Effects on the Determinants of Unquoted SMEs Capital Structure. *International Journal of the Economics of Business*, 7(3), 297–312.

HALL, G. C., HUTCHINSON, P. J. and MICHAELAS, N., 2004: Determinants of the Capital Structures of European SMEs. *Journal of Business Finance and Accounting*, 31(5) and (6), 711–729.

HEYMAN, D., DELOOF, M. and OOGHE, H., 2008: The Financial Structure of Private Held Belgian Firms. *Small Business Economics*, 30, 301–313.

HUANG, G. and SONG, F. M., 2006: The determinants of capital structure: Evidence from China. *China Economic Review*, 17, 14–36.

HUTCHINSON, P. J., 2003: How much does growth determine SMEs capital structure? 16th Annual Conference of Small Enterprise Association of Australia and New Zealand.

JENSEN, M. C., 1986: Agency Costs of Free Cash-flow, Corporate Finance, and Takeovers. *American Economic Review*, 76, 323–329.

JENSEN, M. C. and MECKLING, W. H., 1976: Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure. *Journal of Financial Economics*, 3, 305–360.

KISLINGEROVA, E. a kol., 2010: *Manažerské finance*. Praha: C. H. Beck. 3. vyd. ISBN 978-80-7400-194-9.

KRAUSEOVÁ, J., 1995: Analýza kapitálové struktury českých firem. *Finance a úvěr*, 45(9), 481–491.

LANDA, M., MARTINOVIČOVÁ, D., 2010: Přístupy k hodnocení změn kapitálové struktury průmyslových odvětví. *Acta universitatis agriculturae et silviculturae Mendelianae Brunensis*, LVIII, No. 6, 259–268.

LIPSON, M. L. and MORTAL, S., 2009: Liquidity and capital structure. *Journal of Financial Markets*, 12, 611–644.

MAZUR, K., 2007: The Determinants of Capital Structure Choice: Evidence from Polish Companies. *International Advances in Economic Research*, 13(4), 495–514.

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(2), 113–130.

MODIGLIANI, F. and MILLER, M. H., 1958: The Cost of Capital, Corporate Finance and the Theory of Investment. *American Economic Review*, 48, 261–296.

MYERS, S. C., 1977: Determinants of Corporate Borrowing. *Journal of Financial Economics*, 5, 147–175.

MYERS, S. C. and MAJLUF, N. S., 1984: Corporate Financing and Investment Decisions when Firms have Information the Investors Do Not Have. *Journal of Financial Economics*, 13, 187–221.

PRATT, S. P., REILLY, R. F. and SCHWEIS, R. P., 1996: *Valuing a business: the analysis and appraisal of closely held companies*. Irwin Professional Pub. ISBN 9781556239717.

PSILLAKI, M. and DASKALAKIS, N., 2009: Are the determinants of capital structure country or firm specific? *Small Business Economics*, 33, 319–333.

RAJAN, R. G. and ZINGALES, L., 1995: What Do We Know about Capital Structure? Some Evidence from International Data. *Journal of Finance*, 50, 1421–1460.

SONG, H. S., 2005: Capital Structure Determinants. An Empirical Study of Swedish Companies. International PhD Workshop "Innovation, Entrepreneurship and Growth", Royal Institute of Technology Stockholm.

TITMAN, S. and WESSELS, R., 1988: The determinants of capital structure choice. *Journal of Finance*, 43(1), 1–19.

WALD, J. K., 1999: How firm characteristics affect capital structure: An international comparison. *Journal of Financial Research*, 22, 161–187.

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