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Review of the doctoral dissertation entitled „The Interdependence of Capital Structure and Business Performance - Financing Decisions among German Listed Companies" **written by Milad Zargartalebi.**

The dissertation written and submitted at Gdańsk University, the Faculty of Economics, under the scientific guidance of dr. hab. Ewelina Sokołowska, prof. UG.

Legal ground – Act of 20 July 2018 on higher education and science (Dz. U. 2022 item. 574 with subsequent amendments).

Structure of the PhD dissertation

The doctoral dissertation written by Milad Zargartalebi has 172 pages. The dissertation is divided into five chapters, including the introduction and the conclusions as well as bibliography. The introduction and the first two chapters are theoretical in character, the fourth chapter contains analyses, and the last chapter concludes the theoretical considerations and research results. The structure of the thesis is clear. The sequence of the chapters and the composition of the contents in each chapter are logical and coherent in their entirety, leading the reader to the conclusions.

Introduction (first chapter) contains the justification of the author's choice of the subject and the embedding of the research problem in the discipline of economics and finances. This chapter also clarifies the research questions and presents an outline of the methodological procedure. Moreover, the expected theoretical, practical and methodological contribution of the study to the global debate concerning the effect of capital structure on results achieved by companies is implicated. It is worth emphasizing that the author took into account not only the expected original solution of the research problem but also its applicability, which the reviewer deems as a significant aspect, namely providing managers with some guidelines regarding the mutual effects of capital structure and companies' results, so as to enable them to use this knowledge in order to optimize the value of their companies.

The second chapter contains a review of the subject literature in the scope of capital structure, making a distinction between the traditional and contemporary approaches to this research problem. The author presented neoclassical, institutional and behavioural approaches to the structure of capital in enterprises as well as the latest, 'unclassified' view on this matter. He discusses in detail the theory of the structure of capital, its choice and determinants, also implicating the practical verification of the theory of capital structure, on the basis of international studies reported in the subject literature. The chapter ends with a presentation of a review of studies on the structure of capital and financial results of companies, which together with the theoretical aspect of the considerations helped the author to identify precisely a gap in the research and to determine the course of analyses reported in the later parts of the dissertation. A careful review and classification of both the theoretical and empirical approaches to the research problem deserves special mention. The in-depth scientific discussion presented in this chapter provides the basis for correctly identified research parameters and conducted analyses.

The third chapter brings a more detailed continuation of the discussion carried out in the foreign literature (unfortunately not in Polish) on the subject of capital structure. It provides the basis for specifying the research aims: questions and hypotheses, and for determination of the research group, its division and the selection of research tools for analysis of data. It should be concluded that the research concept proposed by the author is proper from the point of view of the goal set in the dissertation. According to the reviewer, the research concept proposed by the author is also ambitious, employing various research methods and techniques, mainly of quantitative character, including an attempt to make an analysis with the help of artificial neural network (ANN) using selected data in order to verify the results obtained from fixed regression models. For better transparency of objectives and effects of the entire research process, it would be recommendable to identify more precisely the research aim, scientific and application goals, and hypotheses as well as to indicate stages of the research, selection of tools for the verification of the hypotheses and analyses.

The **fourth chapter** presents results of the quantitative analysis based on structured numerical data from financial reports of the analyzed public companies from the German market. This empirical chapter, by applying the selected quantitative methods to the specific set of data and variables, constitutes the key research contribution of this dissertation. A discussion on the limitations of the results is also presented. Noteworthy is the presentation of analyses from the ANN model. In the reviewer's opinion, the undertaken effort to analyze, search and verify the results with traditional tools from quantitative methods with the help of the newest tools, i.e. ANN, is a correct direction in the author's development as a researcher. Although the application of the neural network mostly confirmed the conclusions derived from the analyses made in the study, I highly appreciate this aspect of the research.

The fifth chapter comprises a discussion of the results of the analyses with reference to the review of the literature and the empirical part of the study. In addition, recommendations for economic practice based on the author's research results were offered. The chapter also contains the author's reflection on the contribution of his dissertation to science, and suggestions regarding future investigations.

The dissertation offers a comprehensive review of the bibliography referring to the research issues raised in the study. The critical analysis of the literature given in the introduction and the first chapter corresponds to the nature of the studied problems. The author referred to 293 foreign language publications pertaining to economics, finances and law. In most cases, the author cites the latest literature and in justified cases also refers to older literature, quoting the classics of the economic thought and finances. Despite the great number of references, a significant gap in the literature review is the absence of the Polish science thought as regards the analyzed problem. The inclusion of Polish authors would definitely have enriched the theoretical considerations. Regardless of the mentioned limitations, the scope of the bibliographical sources is rich in the context of the issues submitted to research.

The choice of the research subject, objective, hypotheses and methods

The undertaken study of capital structure and its influence on financial results of enterprises relates to the discipline of economics and finances. The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel awarded to Franco Modigliani in 1985 and to Merton Miller in 1990 for their contributions to the concept of a value of an economic enterprise not depending on the ratio of its debt to own capital and financial leverage, which does not affect the weight-averaged cost of capital, is connected to the subject matter of the reviewed dissertation and confirms the essence of the issues raised in it. Embedding the scientific theories of capital structure, and therefore the cost of capital translating into the financial results of public companies from the German market is in my opinion an original approach to the science problem, giving rise to interesting although not completely satisfying research results. As the author himself indicated in the critical review of the literature, most studies are under the influence of the mentioned Nobel Prize winners' notion of the so-called 'insignificance' (p. 2).

However, having defined the gap in empirical studies concerning the actual determinants of financial decisions and capital structure, the author fails to draw significant conclusions. As he himself observes '*it was not possible to verify the direct relationship between the structure of capital and the economic and financial effectiveness of a company. In most cases, there was lack of sufficient evidence to confirm the research hypotheses. It is therefore important to continue research in this area ... .*' Perhaps, by following the trail set by the Nobel Prize holders and expanding the research to include aspects of the cost of capital and consequently the value of a company could have yielded more precise answers to the research problem pursued in the dissertation, especially since the author used the available data of public companies.

The object of the empirical study consisted of 361 German listed companies which were included in the list of the GuruFocus financial data provider. Owing to this parameter, these companies compose a specific but homogenous statistical sample. The time period submitted to the analysis, partly dictated by the availability of data, spanned the years 2008-2919. It is worth noting that the final sample was devoid of outliers, which represented 1% of the original sample, which reduced the risk of burden on the estimates obtained.

The character of the PhD research in its essence and assumption is explorative, and not thesis-creating. Despite the thorough analysis of various theories describing capital structure in companies and the broad review of the literature regarding the empirical results of studies in this scope, the author does not specify precisely any research model, and in consequence does not put forward detailed research hypotheses. The utilitarian approach to the examined problem, according to the author, is due to the lack in the up-to-date studies of the sufficient evidence regarding the potential variables and their relationships influencing the structure of capital rather than the confirmation or negation of the previous theories describing this problem area. In line with the above, the author takes advantage of data from the financial analysis of a company and explores these data in order to show potential relationships between the managerial activity of the company (operational and investment activities), effectiveness of the management and business results versus the company's capital structure. Moreover, the dependence between the distinguished aspects of a company's activity, in particular the structure of its capital, and the other activities assumes a recursive form, that is the shape of feedback. The above assumption constitutes the primary research problem in the dissertation.

The variables determining the structure of capital were mainly, considering most of the analyses, the total debt ratio and the interest coverage ratio as the quotient of profit and total amount of interest. The other three groups of indicators included basic measures of operational management effectiveness, investment effectiveness and appraisal of the company relative to its book value or profit value.

The author used statistical and econometric methods of correlations between variables and such statistical inference tools as: the Pearson's correlation coefficient, stepwise regression method, panel regression models with fixed and random individual effects, testing hypotheses relative to the average level of a given phenomenon. The above methods were applied to different combinations of variables and to different subsets of variables, especially with respect to differences in the size of development as well as the classification of branches. An attempt was also made to create an artificial neural network, using the selected data to verify the results obtained from regression models with fixed effects. Particular analyses composed subsequent stages of an overall procedure describing relationships between capital structure and results of a company's business activity.

The preliminary empirical analysis comprised statistical characterization of the distribution of analyzed variables and an analysis of correlations between variables, supported by an analysis of the collinearity of these variables with the help of variance inflation factor (VIF) and tolerance factor (TOL). All calculations were done correctly, although some minor remarks come to mind. Firstly, no description is provided for particular statistics of distribution, not even the mean level of a variable. The results presented in the dissertation also implicate the occurrence of considerable asymmetry in the distributions of variables, which may translate to the lack of concordance of these distributions with normal distribution, and lead to certain difficulties in using tests to verify parametric hypotheses. Secondly, when presenting a matrix of correlation coefficient, a critical value at the level of significance, e.g. 0.05, should be given. However, it needs to be underlined that with such a great number of observations in the research, it would be difficult for the author to leave analyses non-significant, non-correlated data for further. Furthermore, the calculations necessary for creating a neural network were done with the use of R environment, but it would be advisable to explain which statistical software was used to perform the remaining statistical analyses.

The study of mutual relationships between the factors defining capital structure versus the other groups of indicators of companies' activity was based on an analysis of stepwise regression analysis and panel regression models. The stepwise method led to the distinction of seven and four significant factors affecting, respectively, the overall debt factor and interest coverage factor. The choice of proper variables in the stepwise method was based on the average prediction error, the Akaike information criterion and the Mallows statistics. Unfortunately, the application of these measures and their symbols were not described nor interpreted in the dissertation. Also, values of the factors themselves or factors for standardized variables, which would enable the identification of factors with the highest positive and negative impact on capital structure indicators, were not given.

The key results of the PhD research are estimates of models of panel data, according to the previously adopted specification of regression equations. The author verified positively four significant variables shaping the interest coverage ratio and only one variable significantly affecting the total debt ratio. These variables were operating margin (OM), asset turnover ratio (AT), ROE and price-to-book ratio (PB). However, the author did not explain the unexpected fact of almost opposite results of panel regression and stepwise regression for total debt ratio. Regardless of the correct application and interpretation of the chosen estimators, the presentation of data reveals some ambiguities, which should be clarified or dispelled. For example, there is no estimation of the free expression for models employing the FE estimator. Also, the F test shown in the table, which most probably serves to estimate the total significance of variables, is not explained. It would also be appropriate to give results of the Wald test for differentiation of free expressions. The absence of any explanation of what is given in brackets or the lack of values of probabilities for the Hausman test statistics is another shortage. Moreover, the author did not show in the methodology any statistical assumptions for the panel data models used, or advantages and disadvantages of that approach over other models for heterogenous samples. These questions can depreciate the validity of the model and accuracy of results.

It is worth emphasizing that despite some significant estimates of parameters, the models presented in this work explain a negligible percentage of variability of dependent variables, especially the total debt ratio. This can give rise to the question whether this research should not have been conducted on a higher level of generalization, for example considering the division of companies into ones with a safe and unsafe level of capital structure indicators using logistic regression. Another solution could involve the application of quantile regression, which could have helped to eliminate to a higher extent the impact of outlier observations or to omit assumptions regarding the distribution of a given variable. At this point, it is worth mentioning that there are dynamic adjustment models that can be used as tools to study an optimal structure of capital. These models employ as dependent variables distances between the observable and target leverage, rate of the growth of a company or the company's size[1]. Noteworthy is the fact that some of these variables were taken into consideration in the

[1] Np. Drobetz W., Wanzenried G. (2006). What determines the speed of adjustment to the target capital structure? „Applied Financial Economics", 16, s. 941–958.

reviewed dissertation and that the author is fully aware of the possibility of some dynamics in adjustment processes leading to the optimal capital structure, which he proved in many parts of the thesis.

Mutual relationships between the variables that are the subject of the research were also analyzed for different subsets of data divided according to the adopted criteria. This further stage of the research appears reasonable considering the earlier, ambiguous results and the theoretical implications described in the subject literature. Having differentiated equal in number companies relative to their size, level of increase in revenue and profitability, and the sector they belonged to, several panel models were created and estimated, illustrating the recursive impact of the indicators of capital structure and measures of effectiveness of the analyzed companies' business activity. Owing to the qualitative division of analyses, the author was able to obtain relatively more statistically significant relationships than when all companies were analyzed together. Moreover, significant differences were observed in the distinguished subgroups as regards the levels of total debt ratio, operational margin, and asset turnover ratio relative to the entire sample of companies and between variants of a given subgroup. The results were interpreted and submitted to critical discussion related to the author's own experience and literature review. However, some estimates might raise certain doubts, which would call for some explanation. For example, Table 25 (p. 101) shows that estimates of parameters of the variables OM and AT for the whole sample assume opposite signs to the assessment of these parameters estimated in subgroups. This is even more interesting in the light of the fact that such findings did not appear or appeared only sporadically for the remaining variables.

In the final part of the dissertation, the author undertakes an attempt to predict the structure of capital and to verify the results of panel regressions using artificial neural network. At this point, it is worth underlining the author's skill of creating (programming) and testing a neural network as a kind of an IT tool. Although the general conclusions support the observations derived from previous analyses contained in this dissertation, the results achieved with the help of the neural networks indicate the presence of non-linear relationships between the analyzed variables. According to the author, considerable differentiation of the analyzed indicators within the whole sample makes it significantly difficult to draw conclusions regarding relationships between capital structure and business results achieved by the analyzed companies.

In the recapitulation, the subject selected for the research seems interesting from the point of view of science and application potential. The research objective has been achieved. However, as the author indicates, the results obtained in his research coincide with the results of earlier studies, starting from those dating back to 1976, and according to the reviewer they are quite obvious. They would serve as a preliminary study rather than as material for analyses in a doctoral thesis. In the latter case, differentiation of the research sample by dividing it into branches, specific nature of business activity, size or structure of capital and the choice of appropriate (different from the different groups distinguished) indicators of the effectiveness of business activity could demonstrate some economic and financial trends followed by companies. The economic environment and the origin of companies (in this case, the German market) are also of importance. The impact of global factors on the economy of a given country and macroeconomy of a company is obvious. The economic situation, both global and domestic, status of the financial sector or non-standard events such as economic or financial crises and then quantitative easing are external factors that should also be taken into consideration because they have a substantial effect on both capital structure and a company's results. In the area covered by this research, another interesting thread would be to associate capital structure and financial results with risk, for example market risk, risk of the branch, or even risk propensity of the managerial staff. The reviewer's suggestions as to how this research could be developed arise from the multi-faceted influence of various factors on the analyzed problem. Only a broader approach to the raised research question could provide satisfying research results and reliable recommendations for economic practice.

Conclusion

The doctoral dissertation entitled „The Interdependence of Capital Structure and Business Performance - Financing Decisions among German Listed Companies" constitutes an original presentation of a research problem and a solution thereof. It attests to the author's knowledge of theory in the field of economics and finances and other disciplines connected to the analyzed issues. Despite some critical remarks, in the light of the conducted research, I conclude that the author has acquired the skills essential for performing studies as an independent researcher and the dissertation meets the requirements for a doctoral thesis. I therefore request that the PhD dissertation authored by Milad Zagartalebi to be submitted to public presentation.

Olsztyn, 5 September 2023