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To cite this article: Oksana Pirogova *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **497** 012129

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Optimizing trading company capital structure on the basis of using bankruptcy logistic models under conditions of economy digitalization

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Abstract. The publication gives consideration to the directions of using logistic models of bankruptcy of the companies in the algorithms of determining optimal capital structure on the basis of trade-off approach. A variant of determining company's financial distress costs has been offered proceeding from the bankruptcy risk assessment. The bankruptcy risk can be calculated on the basis of logistic regression models. Unlike the more widespread discriminate bankruptcy risk models, the bankruptcy risk models based on the logistic regression assess a probability of the bankruptcy risk occurrence. An algorithm of calculating the cost of financial distress has been offered proceeding from the risk level assessment. It will be possible to calculate the optimal level of company's debt burden on the basis of calculating this indicator in future. The suggested approach helps to take into account quite a great number of factors affecting the bankruptcy risk and use these data in the summarized form to determine the optimal level of the of company's debt burden.

1. Introduction

A rapid development of the network and digital technologies brings about a considerable business environment transformation. In line with the emergence of virtual companies digitalization influences more and more the companies of a traditional order. So, according to the authors of publication [1] the companies of a traditional order change to an active use of the latest technologies as the infrastructural basis of their activity. These include the equipment with a possibility of connection to the shared network, communication systems and software products of wide spectrum. They use all these to accelerate information exchange both inside the company and with the external world, taxation and state authorities, public organizations and individual persons concerned [2].

The digitalization of activity became one of the most important factors of competitiveness for traditional companies. A possibility of generating new online knowledge emerges with the companies' management due to increasing flexibility in processing data arrays of significant volume and expanding access to information. All these factors contribute to the growth of management efficiency in the company [3].

The depth and quality of analysis of already passed stages of activity increase, as well as the capabilities of current and advanced planning and forecasting the company's activity expand on the



basis of digitalization. The new knowledge and new models of its acquisition and utilization help shorten a period of time for analyzing and taking decisions, provide consideration of a great number of factors and enhance a probability of revealing future problems and challenges concerning efficient development of economical systems [4].

It should be noted that the present-day models of financial management at the enterprise, which main purpose is to answer two questions: ‘Where to take monetary funds for providing growth and development of a company and how to adequately invest these funds’, is based on rather extensive statistical external and internal information. The peculiarity of modern digital infrastructure of the economy consists in extending access of the companies to information on the activity of various economic operators and institutes. This information is presented both in the original form and in processed aggregative form. The processing and analysis of this information enables an enterprise to more accurately regulate the aspects of its activity. The purpose of providing an optimal level of financial leverage, which ensures a maximum growth of the company’s cost, also belongs to such aspects.

2. Problems of determining optimal capital structure at the enterprise under present-day conditions

The problem of providing an optimal capital structure is presently one of central problems in financial and economical science. At the present time the enterprise (form or company) may choose different sources of financing its activity. According to the modern concept of “Value Based Management” or VBM any capital element used by the enterprise has its value reflecting the risk of capital mobilization for financing activity of the enterprise [5–7]. The risk level in its turn is the basis for determining discount rates, which make it possible to get the cost estimate of the enterprise. In case of changing the capital structure the risk levels of its individual elements change, which brings about a change of the rate of weighed average capital cost — WACC.

The analysis of equity and debt capital ratio is seen for the moment as one of the most important VBM problems, since it helps implement the enterprise cost management at the operational level [8]. Moreover, the models of accessing cost and optimization of capital structure by this time do not fully reflect the interrelations between cost, risk and price of capital arising in the process of enterprise activity.

The analysis of models used for selection of the optimal capital structure shows that two big groups of models - financial (sustainable) and models of asymmetric information, which are generally represented by pilot models have taken shape for the moment [9].

The models of asymmetric information or pilot models include:

- theories of market tracking;
- theory of autonomy of managers’ investments;
- theory of information cascades.

The main point of these models consists in the fact that the managers, owners and investors possess various information with respect to market behavior and methods of company’s response to these changes, in this case the main role in adopting decision is played by the managers attempting to optimize the capital structure with the aim of maximizing cost, but the cost in terms of market-value appraisal, and not the fundamental cost.

The following factors can be referred to as a disadvantage of the above models:

- in spite of the sufficient empirical substantiation these models are difficult to get formalized, they help assess some trends, but it is difficult to obtain particular quantitative appraisals by means of these models;
- these models have been tested basically on the accountancy of big companies, at the same time, smaller companies have fewer capabilities for implementing the above approaches, while an issue of empirical confirmation of the above approaches for medium and small enterprises remains to be open so far;

— an important peculiarity is the fact that according to pilot models the capital structure gets optimized for maximizing the market cost, as one of the private types of cost, i.e. the cost for the participants of stock market, moreover, the issues of optimization for the sake of maximizing the fundamental cost remain to be controversial.

The financial or sustainable models of selecting capital structure include the following models [9]:

- classic model,
- Miller-Modigliani models in different modifications,
- frictionless model.

All financial models are based on the modern theory of Capital Asset Pricing Model (CAPM). This theory states that the capital cost is determined by the risk of investing it, at that, the risk of investing it is determined as the sum of two types of systematic (non-diversified) and non-systematic (diversified) risks.

The above cost models are based on the fundamental concepts of risk and cost ratio, i.e. the cost of engaging this or the other source of capital is the function of risk level, which is generated by this or the other investment variant, in this case, a necessity of profitability and risk ratio is not below the mid-market investments for substantiation of practicability of investments is an evident restricting condition. The advantage of the financial models consists in the fact that they are aimed at getting an answer — an optimal relation of loan and equity capital. At the same time, there is a number of points at issue in these models, which embarrass the practical application thereof as a matter of practice.

3. Integrating models of assessing bankruptcy risk with the models of determining optimal level of financial leverage of an enterprise

The investigation of opportunities of financial models application continues at the present time, however, a necessity of building or using a number of sub models are the general provisions in the course of investigating thereof [9–11]:

- model of cost of the capital of the levered enterprise (firm), i.e. a firm that uses the debt financing;
- model of cost of debt capital involvement;
- model of cost of owner's capital involvement.

The optimal capital structure is determined according to classical approach proceeding from the condition of minimizing the average weighted rate for capital, in this case only it is possible to attain the cost maximization in accordance with classical VBM provisions. It can be demonstrated by the example of Gordon formula, when the cost of an enterprise is determined on the basis of discounting Free Cash Flow (FCF).

The works of Miller and Modigliani have contributed greatly to understanding a mechanism of optimizing the capital cost [10]. The main credit thereof consists in proving the fact that the total risk of the levered enterprise is divided between a creditor and an owner. This provision is a basic one practically in all present-day optimization models. In case of a number of assumptions and perfect markets it brings about a fairly disputable conclusion – the cost of firm does not depend on the capital structure, which, as a matter of fact, contradicts to what we see in the economy and finances of enterprises. One of the main disadvantages of Miller-Modigliani approach consists in the fact that it takes into account the risks of receiving the free cash flow only, ignoring the risks of liquidity, loss of solvency and bankruptcy.

The frictionless model seems the most promising now [9]. It is supposed in this model that the optimal capital structure is influenced not only by the relation of tax shield advantages (possibility of including payment for the loan capital into prime cost), but by the losses (expenses) of possible bankruptcy too, which adversely influences the company's cost. The analysis of works, which offer different modifications of the frictionless model shows that they do not give consideration to one of the most important aspects: who bears the risks and how they are distributed. Indeed, the accentuation of possible bankruptcy expenses explains to some extent the optimal ration of the loan and equity

capital will take up an absolutely different meaning value, than that obtained according to Miller and Modigliani model, however, it does not answer a number of important questions:

1. How does the cumulative risk of the levered (using debt financing) enterprise change depending on the debt level.

2. How does the creditor's risk change depending on the debt level?

3. How does the owner's risk change depending on the debt level?

Obviously, the creditor's and the owner's risk will be determined as before by the cumulative risk of the levered enterprise, but an issue of dividing risks remains open.

A number of works offers variants of assessing expenses of possible bankruptcy for the frictionless model.

So, for instance, work [11] offers the formula for determining bankruptcy expenses:

$$V_{BE} = \alpha \cdot w_{LC}^2 + \beta \cdot w_{LC}, \quad (1)$$

where, w_{LC} — debt share in the structure of enterprise's capital; α , β — coefficients of a model of dependence of the amount of losses on possible bankruptcy; it is invited to determine these losses on the basis of historical data (past periods data). At the same time, no particular recommendations on determining the value of these coefficients are given in work [11]. The very possibility of assessing possible financial difficulties on the basis of historical data, if the enterprise features operational stability, poses a challenge.

Apparently, that if the issue is associated with bankruptcy, the assessment of bankruptcy expenses can be performed only on the basis of review data of the group of enterprises, including the bankrupt enterprises.

A similar approach is used for building models of bankruptcy of enterprises. The bankruptcy models built on the basis of multiple discriminate factor analysis (MDA) have come presently into widespread acceptance [12]. The models of Altman, Taffler, Beaver, Springate are considered the best known, but by no means the most precise, there are also domestic analogs — the models of Sayfullin and Kadykov, Zaitseva, Belikova-Davydova, etc. The peculiarity of these models consists in the fact that they are used to determine Z-account indicator (according to Altman), on which basis the enterprise bankruptcy risk is assessed.

The second direction of bankruptcy statistical analysis is the use of the logistic regression method (logit-model) [13]. This model has been proposed by J.A. Ohlson for the first time. According to this model the probability of enterprise bankruptcy is determined on the basis of the ratio:

$$p = \frac{1}{1 + e^{-Y}} \quad (2)$$

where: p — probability of enterprise bankruptcy; e — Euler number; Y — logistic regression indicator.

Generically, the logistic regression indicator will be calculated on the basis of the expression:

$$Y = A - B_1 X_1 - B_2 X_2 - \dots - B_n X_n, \quad (3)$$

where, A , B_i — model coefficients; X_i — model factors; n — number of model factors.

So, Ohlson has obtained the nine-factor model, including nine different financial indicators, sometimes exotic, which are not practically encountered in the domestic financial and economic analysis, e.g., the ratio between total assets and deflator index of the gross national product.

In our country V. Zhdanov has built a five-factor logistic model of assessing probability of bankruptcy of enterprises of aviation industrial complex. It is important to note particularly the ten-factor model suggested by A. Khaidarshina, where the coefficients for enterprises of different industries have been offered [14].

Unlike MDA model the logit model allows for the conclusion not only regarding appurtenance of an enterprise to a group of bankrupts (that the interpretation of MDA models confines itself to), but for

an assessment of probability of occurrence of bankruptcy risk for an enterprise, as well as for description of non-linear dependences between variables in the model.

The authors of work [13] distinguish the following advantages of logit models:

- possibility of determining probability of enterprise bankruptcy risk.
- amply high accuracy of results.
- possibility of taking into account industry-specific peculiarities of activity of enterprises.
- smooth requirements to the normality of incoming data as compared with MDA models.
- simplicity of interpreting results for enterprise management.

Generally, the above models include indicators reflecting capital structure, e.g., Zhdanov model includes coefficient of internal financing, while Ohlson model includes a ratio between aggregate liability and aggregate assets.

4. Algorithm of calculating the cost of capital of the levered enterprise taking into account bankruptcy risk

A chance appears on the basis of logit model to investigate variation of bankruptcy risk probability depending on capital structure. Hence, if we can assess expenses (damages) of creditors and owners as a result of bankruptcy, in such case it is possible to assess the expenses of possible bankruptcy too using a formula traditional for risk management for the risk level [12]:

$$V_{BC}(w_D) = Y_R = p(w_D) \times (PD_C + PD_E), \quad (4)$$

where: V_{BC} — possible (expected) bankruptcy expenses depending on the structure of enterprise capital; Y_R — risk level; $p(w_D)$ — probability of enterprise bankruptcy depending on capital structure; PD_C — possible damage for a creditor in case of enterprise bankruptcy, rub; PD_E — possible damage for an owner in case of enterprise bankruptcy, rub.

A positive specific feature of such approach also consists in the fact that it does not give consideration to the amount of consolidated damages in excess of the amounts of total enterprise's capital; hence, the maximum value of bankruptcy expenses will not exceed the value of total enterprise's capital.

Given below is the algorithm of calculating capital cost of the levered enterprise taking into account the bankruptcy risks and the value of possible losses.

1. An extent of possible losses incurred by the owners and creditors in case of enterprise bankruptcy is determined on the basis of analyzing the balance of an enterprise as well as suchlike similar enterprises. The extent of possible losses can be determined also on the basis of capital structure.

2. A dependence of probability of enterprise bankruptcy on the parameter reflecting capital structure for the range of values of the loan capital share is built on the basis of logit model of bankruptcy risk.

3. An amount of possible bankruptcy expenses for every value of the loan capital share is determined on the basis of calculations.

4. A current cost of the levered currency flow of an enterprise is corrected according to formula:

$$r_l = r_n \frac{V}{V - V_{BC}}, \quad (5)$$

where: V — cost of non-levered enterprise; r_n — current cost of non-levered currency flow of an enterprise.

Formula (5) has been obtained from the condition of equality of free currency flow for non-levered and levered enterprises, accordingly, which has been included as a basis for calculating the enterprise cost.

5. Conclusions

Thus, the offered approach gives a possibility in addition to a tax shield to take into account the influence of bankruptcy expenses in the form of changing current cost of the levered currency flow of an enterprise. It will help the enterprise reduce the bankruptcy risk and the amount of possible losses and competently shape the capital structure.

The offered model is based on using a great volume of statistical and aggregated economical data, which can be updated in the process of activity of the enterprise proper and change of the economic situation in the industry and in the economy as a whole. The economy digitalization, development of its information infrastructure extends the capabilities of enterprises in accounting the factors of economic reality in the applicable models related to taking decisions and optimization of enterprise's activity.

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