

| *Piotr Cirin*

# The Relationship between Debt Capacity Base and Structural Risk: Evidence from the Warsaw Stock Exchange

## Abstract

*Objective:* The objective of this paper is to verify the hypothesis that there is a statistically significant correlation between the risk level determined on the basis of structural models and the value of the debt capacity base, and that the value of a company's debt capacity is determined primarily by the type and properties of its financing.

*Research Design & Methods:* The methodology was based on the analysis of the determination of the linear regression function using the least squares method and study of the correlation between the values of the debt capacity base and the net value of enterprises (determined on the basis of the approach used in structural risk models) based on accounting data of 511 companies listed on the Warsaw Stock Exchange in 2018–2019. This includes an analysis of the level of debt capacity in the context of selected forms of financing.

*Findings:* There is a strong and statistically significant correlation between the debt capacity base determined on the basis of book values and the determined net value of enterprises, representing the level of structural risk (constituting the difference between

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the value of assets and liabilities). A USD 1 bn change in the average debt capacity base leads to a USD 0.49 bn change in the average net worth of enterprises.

*Implications/Recommendations:* The designated regression function enables forecasting, within the scope of banking practice, the value of the structural risk and the debt capacity base in terms of granting short- and long-term liabilities.

*Contribution:* The study confirms the thesis that there is a statistically significant correlation between structural risk and the debt capacity base. It presents an approach that enables the determination of the debt capacity base, the value of structural risk, and the value of debt capacity for selected forms of financing.

**Keywords:** debt capacity, working capital, creditworthiness, optimal capital structure, structural risk models, free cash flow.

**JEL Classification:** G10, G21, G17, G41.

## 1. Introduction

The term “debt capacity” was first defined by S. Myers as the point at which an increase in debt utilisation reduces the total market value of a company’s debt (Myers 1977). Under the assumption of perfect capital markets, debt capacity is further defined as the amount of debt above which the company will not obtain additional loans despite being offered a greater repayment capacity (Dias & Ioannou 1995, Kim 1978, Turnbull 1979). Debt capacity has also been considered the point at which an acceptable level is exceeded in respect of the risk of bankruptcy (Donaldson 1978) and the amount of leverage an enterprise can obtain from its creditors (Leibowitz, Kogelman & Lindenberg 1990). Debt capacity refers to the “sufficiently high” debt ratios within which the financial costs incurred prevent further debt issuance (Chirinko & Singha 2000, Myers 1984, Shyam-Sunder & Myers 1999). It also relates to the rational level of debt used by the enterprise, assuming a certain amount and volatility of the expected cash resources, taking into account the conditions of the economic environment (Rizzi 1993, p. 25). Debt capacity is closely related to the company’s ability to service a certain level of debt and to set its target, maximising the amount of debt (optimal level of capital structure) (Daszyńska-Żygadło & Marszałek 2012).

Theories related to enterprise debt capacity that take into account the costs of bankruptcy as a restriction on the use of foreign capital include:

- 1) the theory of A. Robichek and S. Meyers, which points out that the debt mix under various forms of financing does not affect goodwill (Robichek & Myers 1966);

- 2) the theory of A. Kraus and R. Litzenberger, which presents a preferential optimal financial leverage model (Kraus & Litzenberger 1973);

3) the theory of J. H. Scott, which presents a multi-component model of debt, equity, and company valuation, demonstrating that the optimal level of debt (measured by interest payments for a given period) is a growing function of the liquidation value of company assets, corporate tax rate, and company size (Scott 1976);

4) the theory of E. Kim on the average variance of the optimal capital structure and corporate debt capacity (Kim 1978).

Other models for determining the debt capacity include:

1) M. Leibowitz, S. Kogelman and E. Lindenberg's model – referred to in the literature as the “LKL model” (Leibowitz *et al.* 1990) – research on which has revealed to have a low level of suitability for sector analysis of the enterprise debt capacity;

2) H. Hong and A. Rappaport's model (Hong & Rappaport 1978) (based on the Miller-Modigliani model including corporate income tax (Modigliani & Miller 1963), where the enterprise value is the highest when the enterprise uses only external capital;

3) J. V. Rizzi's six models (Rizzi 1993), which determine five static models based on the target value of the debt ratio and one dynamic.

As part of the enterprise's debt capacity, its unused capacity can be identified, constituting a safety buffer and enabling a stronger negotiating position in negotiations with creditors. Enterprises that display financial flexibility (the ability to respond in a timely manner to changes in the environment by providing cost-effective sources of financing for operational and investment activities) are larger and more profitable than enterprises that do not exhibit debt reserve flexibility (Gryko 2017). During times of crisis, companies with lower asset values increase their debt capacity, while companies with high asset values migrate to the secured debt market (to protect unsecured creditors against adverse cash flows and asset value shocks) (Giambona, Mello & Riddiough 2016). Improving one's debt service ability gradually increases the value of the acquirers, which is reflected in long-term returns on the stock market, both 12 and 24 months after an acquisition is announced (Ang, Daher & Ismail 2019).

Expanding its sources of financing attests to a company's greater creativity in raising capital and also leads to the diversification of its capital structure, reducing financial risk (Filip & Kata 2017). It is generally accepted that financing with external capital (cost of external capital) is, as a rule, cheaper than financing with equity (cost of equity). In banking practice, debt capacity is inversely related to the enterprise risk level (the higher the debt capacity, the lower the risk level). Furthermore, methods based on the analysis of cash flows during the financing periods are the dominant approach to determining the enterprise's debt capacity.

According to K. Rudnicki, estimating the maximum level of debt an enterprise can handle is a complex issue because it is associated with such difficulties as

determining the costs of bankruptcy, determining the shape of the function of these costs in relation to financial leverage, and indicating the probability of bankruptcy (Rudnicki 2017). Debt capacity theories have features of both the perfect market theory, where debt capacity can be analysed in the conditions of a perfect capital market (Kim 1978), and the imperfect market theory, which proposes that an enterprise's debt capacity is based on risk, not on the target debt ratio (Myers & Pogue 1974). This enables them to be described as a link between these two groups of theories. However, due to this dichotomy they cannot be included in the static theories of capital structure (Barowicz 2014, p. 72).

According to M. Barowicz, debt capacity is related to the probability of bankruptcy and the issue of the entity's solvency, while the issue of maximum debt capacity should be resolved before determining the optimal capital structure (Barowicz 2014, p. 72). The costs of bankruptcy mean that the maximum level of debt a company can incur on the capital market will exclude total debt financing (Gajdka 2002, pp. 276–277). The enterprise's debt capacity related to the financing of intangible assets is lower than its debt capacity related to the financing of property, plants and equipment, because intangible assets have lower collateral value of debt, and thus constitute a reason for underinvestment (Barclay, Smith & Morellec 2006). Companies managed by overconfident managers have lower debt capacity, while using a higher debt ratio than their debt capacity allows (Wrońska-Bukalska 2018). More liquidity and spare borrowing capacity buttress the firm's future compensation promises and allow the firm to retain talent in a more cost-efficient way (Bolton, Wang & Yang 2019). Volatility with asset risk and debt capacity influences the tax wedge between public and private sector discount rates (Brealey, Cooper & Habib 2020). Firms with a higher need to maintain debt capacity are less likely to lease (Rahman, Sankaran & Chowdhury 2020). An analysis of the debt maturity structure (DMS) in China in relation to the company's life cycle shows that the DMS in the period of introduction and recession is relatively low, while growth companies are characterised by a high ratio of long-term debt (Zhang & Xu 2020). As part of their debt capacity, firms can roll over the debt under the dynamic debt rollover model, which enables an analysis of the evolution of creditors' dispersion, and firms optimally increase the dispersion of creditors after a period of poor performance (Zhong 2018).

In banking practice, debt capacity is closely correlated with the level of risk, which is confirmed by, among other factors, assumptions of structural risk models in which where credit risk is higher, the value of the net asset (i.e. assets less liabilities) is closer to zero (Jajuga 2007, p. 149). The basis for structural risk models is the comparison of a company's value to its liabilities (Noetzel 2011). In the structural models approach, default occurs when goodwill reaches a critical, defined level and the company's equity is viewed as an option on its assets,

with a strike price equal to the level of liabilities (Langner 2005). Structural risk models provide fairly accurate forecasts of the sensitivity of corporate bond returns to changes in equity (Schaefer & Strebulaev 2008). Structural risk models have a wide range of applications. For instance, corporate social performance is positively associated with the probability of default by large companies (Suto & Takehara 2018) and can be used to test the relationship between the probability of default and the recovery rate (Derbali & Jamel 2019). The development of theoretical studies on structural risk was significantly influenced by the groundbreaking work in the field of corporate bond valuation by F. Black and M. Scholes (Black & Scholes 1973).

The idea of structural risk models was introduced by R. Merton in 1974 (Merton 1974), though K. Jajuga indicates that these models appeared as early as 1970 as part of an unpublished article, which subsequently found practical application in the KMV model (Jajuga 2007, p. 150). The KMV model considers a company's financial structure, assets and liabilities, where liabilities are divided into liabilities and equity and form the following two relationships (Jajuga 2007, p. 150):

$$A = L + E, \quad (1)$$

$$A_n = A - L = E, \quad (2)$$

where:

- $A$  – assets,
- $L$  – liabilities,
- $E$  – equity,
- $A_n$  – net assets.

The research problem focuses on an attempt to confirm the thesis predicting a correlation between risk and debt capacity on the assumption that the level of risk may be reflected by the value of  $A_n$ , which is a predictor of net worth (NW) within the foundations of structural risk theory. Another important research issue is the verification of the basis for determining the value of the debt capacity under various forms of external financing. Can the characteristics of the debt capacity base and the type of a given liability determine the potential amount of debt *ceteris paribus*? In discussing these issues, this paper adopts the deductive-inductive paradigm, using the experience of banking practice in corporate and investment banking.

The research addresses the following areas:

- 1) a detailed presentation of the full process of determining the value of debt capacity,
- 2) the lack of a clear distinction between the concept of “base of debt capacity” and the concept of “debt capacity”,

3) relatively narrow definitions in the scientific literature of the concept of debt capacity,

4) no examples of research on the relationship between the base of debt capacity and structural risk models,

5) a disproportionate relationship between theory and practice – practically every loan granted, in the financial sector, is associated with a model for determining the maximum debt capacity,

6) strategies for determining the debt capacity (internal policies, rules, etc.) are often highly guarded business secrets.

The aim of the study is to verify, on the basis of the presented empirical evidence, the hypothesis that there is a strong positive, statistically significant correlation between the risk level, determined on the basis of the foundation of structural models, and debt capacity; and that the value of a company's debt capacity is strongly determined by the type of financing it has used and its properties (due to the structure of the components of a given type of liability, financial and non-financial parameters, and the debt capacity base adopted for the calculation).

## **2. Determinants of the Base of Debt Capacity as a Hypothetical Category**

In order to verify the hypothesis, it is necessary to define assumptions regarding the theoretical base of debt capacity, which have their sources in the data contained in the financial statements of enterprises. In banking practice, one of the basic approaches to calculating capacity is to determine the base of debt capacity, which consists of: 1) non-leveraged free cash flows (FCFs) – representing free cash flow for capital owners and creditors, being a surplus or shortage of cash that may arise as a result of the company's operating, financial and investment activities after settling its liabilities to capital providers, and 2) the value of working capital (WC). The concept of FCFs is not clearly defined in the literature and they can be calculated using various formulas (Pomykalski & Pomykalska 2017, p. 86). In investment and corporate banking, the term “free cash flow” is often referred to as “free cash flow to firm” (FCFF).

FCF allows one to visualise the value of cash that can be withdrawn from a company without generating problems in its business. FCF is the sum of cash flows from operating and investing activities (Pomykalski & Pomykalska 2017, p. 86). The value of FCF can be calculated in different ways depending on the recipients and the data available. Depending on the audience, we can also make a number of refinements and adjustments to try to eliminate distortions. In practice, three basic approaches are used to determine FCF, based on:

1) EBIT:

$$FCF = EBIT \cdot (1 - T) + D\&A - \Delta WC - Capex, \quad (3)$$

2) the net income approach:

$$FCF = NI + D\&A + Interest(1 - T) + \Delta WC - Capex, \quad (4)$$

3) EBITDA:

$$FCF = EBITDA \cdot (1 - T) + D\&A \cdot T + \Delta WC - Capex, \quad (5)$$

where:

*FCF* – free cash flow,

*EBIT* – earnings before interest and taxes,

*T* – the corporate tax rate,

*D&A* – depreciation and amortization,

$\Delta WC$  – the change in working capital,

*Capex* – the capital expenditure,

*NI* – the firm's net income,

*Interest* – interest expense,

*EBITDA* – earnings before interest, taxes, depreciation and amortisation.

One of the main divisions of external forms of financing enterprises is the division into short-term debt (granted up to one year) and long-term debt (granted for a period of more than one year). In banking practice, for risk assessment purposes, it is assumed that the financing of the shortfall in working capital corresponding to the value of WC should be performed with the use of short-term working capital loans or other short-term forms of financing (e.g. factoring). On the other hand, investment needs or other long-term liabilities are financed with long-term debt, for which the source of repayment is the FCF value generated (e.g. leasing or investment loan).

FCF is the cash flow available to the suppliers of capital after all operating expenses (including taxes) are paid and working and fixed capital investments are made. In the literature, one finds the same understanding of the concept of working capital (WC) and net working capital (NWC) (Pomykalski & Pomykalska 2017, p. 95). NWC is the difference between current assets and short-term liabilities and is an indication of whether the company has sufficient liquidity to meet its short-term liabilities. One of the goals of cash management is to minimise surplus or unnecessary NWC, thereby reducing the cost of owning inactive assets (Finnerty 2006). The analyses carried out confirm the important role working capital management plays in value generation in small and medium-sized firms, for which current liabilities are a main source of external financing (García-Teruel & Martínez-Solano 2007). The increase in WC creates a liquidity gap that can be covered by a short-term working capital loan that can be repaid with funds that

will arise as the difference between current assets and existing liabilities. Thus, in the context of capacity, creditors are willing to finance the resulting liquidity gap, which should be expressed as follows:

$$WC = Stocks + Debtors - Creditors, \quad (6)$$

where:

*WC* – working capital<sup>1</sup> (formula adopted in line with the definitions for the Orbis database),

*Stocks* – inventory,

*Debtors* – accounts receivable,

*Creditors* – accounts payable.

For the purposes of this study, this WC formula is sufficient, though it may be subject to modifications depending on the recipient and available data. Finally, the basis of debt capacity ( $DC_B$ ) is the sum of FCF and WC, which can be expressed by the formula:

$$DC_B = FCF + WC. \quad (7)$$

Based on the established values constituting the source of repayment, knowing the parameters of a given form of financing (price and non-price parameters), and further based on “reverse” algorithms for servicing a given liability, the maximum debt capacity can be determined (prospective perspective). Debt capacity: 1) is a potential value, which is a theoretical category in the form of a hypothesis, 2) is not shown in the balance sheet, 3) is not be found in other of the company’s financial statements, 4) does not activate the tax shield, 5) cannot be the basis for any obligations on the part of either the creditor or the debtor, 6) is a possible or expected value, 7) is a benchmark for the value of possible debt, 8) is an alternative category to the concept of the financial gap, and 9) may have a weighted average cost of use as a function of prices on the capital market.

The cost of using debt capacity can be considered in terms of average or marginal cost. In the event of a positive financial leverage effect, it should be considered as the required debt value that maximises the value of the enterprise. Its determination is necessary in the process preceding the implementation of investment projects, and ensures a positive rate of return on investment. For the owners of an enterprise, the debt capacity determines the value of a potential investment based on individual cost and risk. In terms of the terminology used in the context of describing the phenomenon of debt capacity, it is advisable to separate the concept of “debt capacity base” from that of “debt capacity”. The primary

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<sup>1</sup> *Orbis Internet User Guide*, Bureau Van Dijk, A Moody’s Analytics Company, <https://www.bib.uni-mannheim.de/fileadmin/ub/pdf/Fachref/BWL/OrbisInternetUserGuide.pdf>, p. 19 (accessed: 27.09.2020).



category is “debt capacity base”, while “debt capacity” is a secondary category, determined on a fixed basis.

### 3. Research Methodology

The analysis was based on data from the Orbis database for selected companies listed on the Warsaw Stock Exchange, based on the global standard of financial data (companies operating in the financial and insurance industry were excluded from the study)<sup>2</sup>.

On the basis of the data collected, 511 enterprises qualified for the study. Based on the financial data for the most recent available year (2019) and the previous year (2018), the following values were determined for the enterprises: the level of structural risk, net worth (NW; the difference between the value of total assets and the value of total liabilities), and the debt capacity base in the form of FCF and WC. A matrix of mutual correlations between the tested values was then determined. Next, an analysis of the linear regression function was performed, using the linear least squares method for the relation between the NW value and the FCF and WC values separately, and between the NW value and the sum of FCF and WC values (FCF&WC). Then, a test of the statistical significance of the determined regression function of NW value and debt capacity base (sum of FCF&WC) was performed. The hypothesis on the differentiation of the debt capacity was determined in the following manner. Depending on the type of liability and its properties based on the obtained values of the debt capacity base for the entire group, the debt capacity was determined for selected forms of financing, namely: 1) long-term loan repaid in annuity installments, 2) long-term loan repaid in the last installment, assuming current interest repayment, 3) short-term working capital loan. For this purpose, formulas for these types of financing were worked out.

In order to determine the debt capacity for a long-term loan repaid in annuity installments (equal principal and interest installments), the annuity formula was used as a starting point. An installment with an  $R$  value, given by the formula below, is called an annuity installment or a fixed installment, payable in arrears (Podgórska & Klimkowska 2013, p. 198):

$$R = L_0 \frac{i(1+i)^n}{(1+i)^n - 1}, \quad (8)$$

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<sup>2</sup> The criteria used: Orbis database – a solution of Bureau Van Dijk, A Moody’s Analytics Company; data from Warsaw Stock Exchange [XWAR], all activities and industries according to NACE Rev. 2, excluding the industry “K – Financial and insurance activities”, Financials – Global Standard Format.

where:

$L_0$  – initial loan value,

$i$  – base period interest rate, if the annual interest rate is  $r$ , then  $i = \frac{r}{12}$ ,

$n$  – number of monthly installments.

If we assume that the enterprise generates free cash flow annually in the value of FCF, and the sum of the principal and interest installments (repayment of principal and interest in annuity installments) corresponds to the value of FCF, then the value of FCF is the value of the debt capacity. Every year, the enterprise is able to spend to repaying the loan a maximum of the value of money which is equal to the FCF value (repayment of principal and interest in annuity installments and other factors unchanged). Consequently, if we assume that in annual terms  $R = FCF$ , we obtain the following formula after transformation:

$$L_0 = \frac{\frac{FCFn}{n}}{\frac{i(1+i)^n}{(1+n)^{n-1}}}, \quad (9)$$

Hence, the maximum loan amount  $L_0$  repaid in annuity installments (A) will be directly dependent on FCF,  $i$  and  $n$ . If  $L_0$  is the starting amount of the long-term loan with FCF,  $i$  – the monthly interest rate of the base period, and  $n$  – the number of monthly periods, then  $L_0 = DC_0^A$ . Hence, the formula for the debt capacity in the case of a long-term loan repaid in annuity installments is:

$$DC_0^A = \frac{\frac{FCFn}{n}}{\frac{i(1+i)^n}{(1+n)^{n-1}}}, \quad (10)$$

If the debt capacity is to be tested for annual periods, then  $DC_0^A$  should be determined for particular base periods corresponding to the 12-month annual  $n = 12, n = 24, n = 36, n = \dots, n = 12n$ . Obviously, the above formula applies to calculations for every  $n \geq 1$ .

In order to present an alternative to a long-term loan repaid in annuity installments, calculations of the debt capacity for a long-term loan are presented, where the principal is paid in the final installment and interest is paid monthly on an ongoing basis. For this form of financing, we can observe that the principal in each repayment period  $n$  is equal to  $L_0$  and is repaid at the end, in arrears, in the final installment, while the value of interest in each base period  $n$  is the product of  $L_0$  and the rate  $i$  (monthly loan interest rate). In each  $L_{n-1}$  base period, capital corresponds to  $L_0$ . Therefore, we must first multiply the monthly interest rate by the number of installments  $n$ , adding 1, which corresponds to the final principal payment and is presented as the coefficient ( $W$ ):

$$W = ni + 1. \quad (11)$$

The factor  $W$  is the necessary denominator. When combined with the numerator in the form of FCF multiplied by  $n$ , it will give us the value of  $L_0$ .

$$L_0 = \frac{FCFn}{ni + 1}. \quad (12)$$

Finally, the above formula makes it possible to determine the value of the debt capacity  $DC_0^{CLICI}$  for repayment in the formula of the current interest repayment and the return of capital in the final installment (the capital in the final installment, current interest) (CLICI), which is also the initial value of the loan  $L_0$ . Then the overall formula for  $DC_0^{CLICI}$ , based solely on the FCF values  $i$  and  $n$ , takes the form:

$$DC_0^{CLICI} = \frac{FCFn}{ni + 1} = L_0. \quad (13)$$

If we want to test the debt capacity for annual periods, then  $DC_0^{CLICI}$  should be determined for individual  $n$  periods corresponding to 12-month annual  $n = 12$ ,  $n = 24$ ,  $n = 36$ ,  $n = \dots$ ,  $n = 12n$ . Of course, the above formula applies to computations for every  $n > 0$ .

In terms of working capital financing, the most popular loan among enterprises is an overdraft loan, which is granted for one year and is repaid at the end of the loan period. Interest is paid monthly, which makes it possible to apply formula (13). Consequently, the formula for debt capacity  $DC_0^{OD}$  for financing in the form of an overdraft takes this form:

$$DC_0^{OD} = \frac{FCFn}{ni + 1} = L_0. \quad (14)$$

The strong correlation between the base of debt capacity and structural risk provides a quick and easy-to-use method to identify potential opportunities to grant (creditor) or incur (debtor), which can lower transaction costs for both parties. Significant deviations in the level of the correlation under study may signal a disproportionate level of risk or attractive investment opportunities. The selected companies listed on the Warsaw Stock Exchange constitute a relatively representative group for all enterprises.

Popularising knowledge and awareness of debt capacity has a high social value: it allows entities to maximise the benefits of the financial leverage effect and awareness of their own abilities, reduces the asymmetry of information between donors (most often professional entities from the financial sector) and recipients of capital, and misunderstandings in relations with other entities, e.g. related to ensuring an appropriate level of financing for investment projects.

## 4. Results

The NW value, representing the risk level, reaches the highest level of Pearson's  $r$  correlation in relation to the sum of FCF&WC (0.92) (data in Table 1), while it is slightly less correlated with the FCF (0.85) and WC (0.83). These correlation levels indicate that NW is strongly correlated with the debt capacity base in the form of FCF and WC, at the level of each separately, as well as at the level of their sum. This is confirmed by the strong correlation of debt capacity with the level of risk defined in structural models based on accounting data. Note the value of the correlation of long-term and short-term loans with FCF and WC – the Pearson's  $r$  correlation value for the sum of FCF&WC and the sum of long-term and short-term loans is 0,81, for FCF – long-term loans, 0.83, and for short-term loans and WC, 0.48. This means that in terms of the financing used, there is a stronger correlation between the debt capacity base for long-term loans (i.e. FCF) than the capacity base for short-term loans (i.e. WC). This in turn indicates that the debt capacity base in the analysed group is better used for long-term than for short-term financing.

Table 1. Pearson's  $r$  Correlation Table for the Examined Items

Correlation Matrix	Net Worth	FCF	Working Capital	FCF&Working Capital
Net Worth	1	–	–	–
FCFF	0.85	1	–	–
Working Capital	0.83	0.68	1	–
FCF&Working Capital	0.92	0.94	0.89	1

Source: the author's own study based on Orbis database, Global Standard Format data.

As a result of the comparison of the NW values and the FCF and WC positions, two linear regression functions were obtained, based on the linear least squares method with a high level  $R^2$ , respectively for the relationship FCF with NW –  $R^2 = 0.74$ , and WC with NW  $R^2 = 0.69$ .

To verify the assumed hypothesis, the value of the FCF&WC sum was compared with the value of NW, as the values with the highest correlation. This yielded a linear regression function based on the linear least squares method, where the  $R^2$  values were 0.85 (Figure 1).

To confirm the significance of the established linear regression function (Figure 1), significance studies were performed using the Student's  $t$ -test. In terms of data on NW – explanatory variables  $x$ , and the value of the sum of FCF&WC, corresponding to the value of the base of debt capacity  $D_{CB}$  – dependent variables  $y$ , the null hypothesis  $H_0: \rho = 0$ , indicating no correlation between the tested

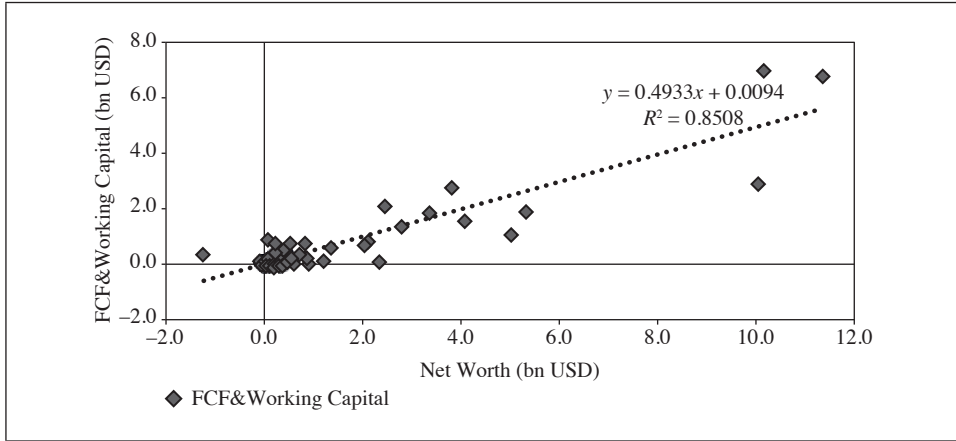


Fig. 1. Regression Function Indicating the Relationship between the Sum of FCF&WC and the NW Values

Source: the author’s own study based on Orbis database, Global Standard Format data.

values, and the alternative hypothesis  $H_1: \rho \neq 0$ , indicating that the value streams are not correlated. The value of the  $t_{obl}$  statistics is 53.87. For the selected significance level  $\alpha = 0.05$  and the number of degrees of freedom  $\nu = 509$ , the critical  $t_{\alpha, \nu}$  (obtained from the Student’s  $t$ -statistics distribution tables) was determined. Regression statistics are presented in Table 2.

Since  $t = 53.87 > t_{\alpha, \nu} = 1.96$ , the correlation is significant. Therefore, hypothesis  $H_0$  should be rejected at the significance level  $\alpha = 0.05$  in favour of the alternative hypothesis,  $H_1$ . The designated form of the regression function:  $\hat{y} = 0.4933x + 0.0094$  can be used to describe the relationship between the examined features. A USD 1 bn change in the average level of the debt capacity base  $DC_B$  ( $y$ ) leads to a change in the average NW ( $x$ ) increase by USD 0.49 bn. The intercept  $b_y = 0.0094$  (regressing  $y$  against  $x$ ) marks the intersection with the ordinate (vertical) axis and is not statistically significant. However, if we were to assume that the intercept is statistically significant, then we would conclude that if all  $x$  (NW) explanatory variables are set to zero then the response variable (FCF&WC) will be on average around 0.0094. This means that we could assume that firms with a net worth of 0 might still have a low base of debt capacity (a lack of capital does not ultimately make it impossible to obtain debt). The measure of the fit of the regression line to the observed variables  $x$  and  $y$  is the coefficient of determination equal to the square of the correlation coefficient and expressed as a percentage ( $R^2 \times 100\%$ ). The calculated coefficient of determination is equal to 85.08%, which indicates that part of the variability of the feature  $y$  ( $DC_B$ ) is caused by the linear influence of the feature  $x$  (NW).

Table 2. Regression Statistics

Regression Statistics								
Multiple R	0.92							
R <sup>2</sup>	0.85							
Matched R <sup>2</sup>	0.85							
Standard error	0.19							
Observations	511							
Analysis of Variations								
			<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	Significance <i>F</i>	
Regression			1	110.43	110.43	2,902.15	2.09	
Residual			509	19.37	0.04			
Together/in total			510	129.80				
	Coeffi- cients	Standard Error	<i>t</i> Stat	<i>p</i> -value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intersection	0.01	0.01	1.07	0.29	-0.01	0.03	-0.01	0.03
Variable <i>x</i> (NW)	0.49	0.01	53.87	0.00	0.48	0.51	0.48	0.51
Significance level $\alpha$	0.05							
The number of degrees of freedom $\nu$	509							
$t_{\alpha, \nu}$ (reading from Student's <i>t</i> -distribution tables)	1.96							
Coefficient of determination ( $R^2 \times 100\%$ )	85.08%							

Source: the author's own study based on Orbis database, Global Standard Format data.

The debt capacity for individual forms of financing for the group studied is presented in Figure 2, where two alternative combinations are presented: 1) on the left,  $DC_0^A$  (where the base is FCF) and  $DC_0^{OD}$  (where the base is WC), and 2) on the right,  $DC_0^{CLICI}$  (where the base is FCF) and  $DC_0^{OD}$  (where the base is WC). The interest rate was calculated on the basis of the value of interest paid ( $I$ ) from the Orbis database (for 2019 –  $t_0$  and 2018 –  $t_{-1}$ ), while the calculations were based on an average interest rate of 4.41%, determined as the quotient of the average interest  $\frac{I_{t_0} + I_{t_{-1}}}{2}$ , and the average sum of long-term ( $LT$ ) and short-term ( $LST$ ) loans according to the formula  $\frac{LS_{t_0} + LS_{t_{-1}} + LT_{t_0} + LT_{t_{-1}}}{2}$ . The capacity for the overdraft form of financing is set for a period of 12 months (in banking practice, such loans are granted for a year and subsequently extended for further periods, subject to a capacity assessment), and for other forms of financing for up to 120 months. The decision whether to use alternative values of the debt capacity is left to the enterprise.

Figure 2 presents two alternative possibilities of using the debt capacity for the group of enterprises. The first shows the difference between the maximum value of  $DC_0^A$  (for a 10-year period) and  $DC_0^{OD}$  (for a one-year period), while the second shows that the maximum value of  $DC_0^{CLICI}$  (for a 10-year period) and  $DC_0^{OD}$

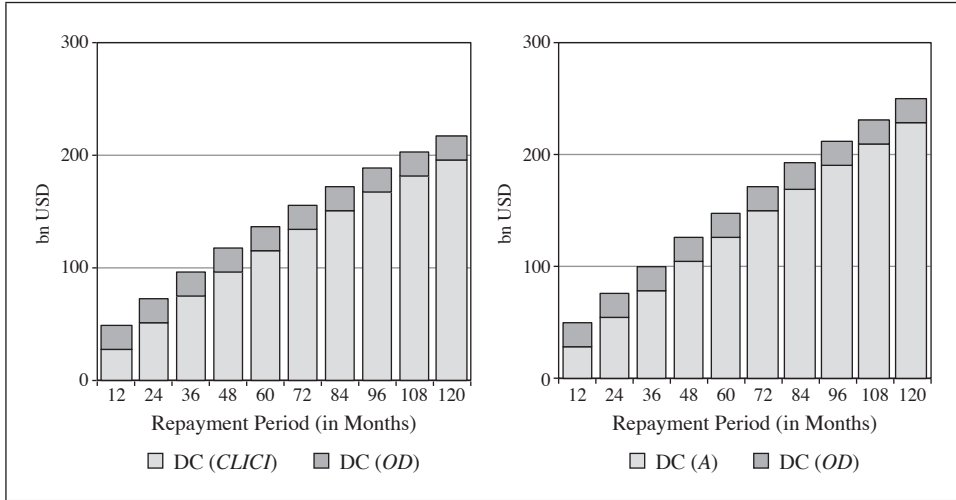


Fig. 2. DC for Individual Forms of Financing:  $DC_0^A, DC_0^{CLICI}, DC_0^{OD}$

Source: the author’s own study based on Orbis database, Global Standard Format data.

(for the one-year period) is 63.3%. This indicates a very high differentiation in the debt capacity due to the form of financing and its properties, even with the same interest rate and utilisation period.

### 5. Discussion of Results and Directions for Further Research

The analysis presented in this paper does not contain the value of the default component of the correlation analysis, which should be taken into account in further research. The application of structural risk models encounters numerous difficulties in the scope of estimating the parameters of a company’s asset valuation process (Elizalde 2006, p. 60). Empirical results for a panel dataset of European listed companies in 2002–2012 – based on a multi-criteria approach that combined accounting data with a structured prediction model – demonstrated that the distance-to-default measure obtained from the structured model provides significant information compared to popular financial indicators, while the market capitalisation values weaken the model’s strength (Douplos *et al.* 2015). Other research indicates that the combination of accounting variables and the structural model is more effective in explaining CDS spreads than using its main components independently – both accounting and market information sources complement each other (Das, Hanouna & Sarin 2009). Because there is a strong and statistically significant correlation between the debt capacity and NW value, the

book value of the difference between assets and liabilities can be an effective predictor not only of risk but also of debt capacity (Łach 2020).

## 6. Summary and Conclusions

For this paper, the base of debt capacity is the sum of the value of FCF and WC, determined on the base of book values derived from the reports of 511 companies listed on the Warsaw Stock Exchange selected for audit for 2019 and 2018. It is strongly and significantly statistically correlated with the determined NW value, representing the level of structural risk (representing the difference between the value of assets and liabilities).

A change of USD 1 bn in the average level of debt capacity base leads to an increase of USD 0.49 bn in the average NW. The determined value of the coefficient of determination causes 85.08% of the variability of the debt capacity base to be caused by the linear influence of the NW value.

The analysis of the FCF and NW as well as WC and NW relations also made it possible to obtain statistically significant regression functions, where a higher level of statistical significance was obtained for the FCF and NW relations than for WC and NW. A change in the average FCF level by USD 1 bn results in a change in the mean NW value by USD 0.28 bn ( $R^2 = 0.86$ , and the regression parameters of FCF ( $y$ ) against NW ( $x$ ) were statistically significant  $t = 37.76 > t_{\alpha, \nu} = 1.96$ , where  $\alpha = 0.05$  and  $\nu = 509$ ) while a change in the mean value of WC by USD 1 bn causes a change of USD 0.21 bn in the mean value of NW ( $R^2 = 0.83$ . The regression parameters FCF ( $y$ ) versus NW ( $x$ ) were also statistically significant  $t = 33.83 > t_{\alpha, \nu} = 1.96$ , where  $\alpha = 0.05$  and  $\nu = 509$ ).

The value of the undrawn capacity base (assuming that the base of the debt capacity for short-term loans is the value of WC, and the base of the debt capacity for long-term loans is the value of FCF) is higher in the case of WC, as evidenced by the low ratio of short-term loans to working capital of 36% than in the case of FCF, as evidenced by the low ratio of long-term loans to FCF – 135%. The value of long-term loans is 4.6 times higher than that of short-term loans. On average, half of the financing of the surveyed companies is constituted of equity. The high level of unused debt capacity and the high level of financing by equity indicate a significant dysfunction of the credit market for enterprises, which is a significant challenge for the banking sector and for enterprises themselves.

This research contributes to the existing knowledge in several ways. First, it indicates the characteristics of debt capacity, clearly distinguishing between the terms “base of debt capacity” and “debt capacity”. It also presents a detailed process of determining the value of debt capacity, confirms the thesis on the exist-



ence of a statistically significant correlation of structural risk and the base of debt capacity, and puts the determined regression function into practice.

The main limitations of the study and results obtained are the following. Firstly, the group of enterprises studied was mainly large and medium-sized enterprises (according to the EU classification), so overall representativeness is an issue. In the case of micro and small enterprises, due to the limitations resulting from the reporting, determining the FCF&WC or NW may be subject to numerous disturbances, including obtaining income from various sources, mixing different types of assets and liabilities, etc. Secondly, FCF&WC or NW positions are volatile over time – past results (*ex post*) are not guaranteed to be reproduced in the future (*ex ante*). Finally, the quality of accounting data is also at issue. Financial data based on legal standards (*de iure*) may not provide the full actual picture of FCF&WC or NW and may be distorted (*de facto*).

It is not possible to determine debt capacity without knowing the basic parameters (price and non-price elements) of the form of the debt obligation (forms of financing), such as the period, interest rate, repayment formula, or tax consequences of a given form of debt (affecting the level of the tax shield) and many other factors. Thus, the value of the debt capacity is determined by the value of the debt capacity base, the characteristics of the type of liability, and the level of structural risk.

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## **Relacja pomiędzy podstawą pojemności zadłużeniowej a ryzykiem strukturalnym – analiza na podstawie danych z Giełdy Papierów Wartościowych w Warszawie**

(Streszczenie)

*Cel:* Celem artykułu jest weryfikacja hipotezy wskazującej, że pomiędzy poziomem ryzyka wyznaczonego na podstawie modeli strukturalnych a wartością podstawy pojemności zadłużeniowej występuje istotna statystycznie korelacja oraz że wartość pojemności zadłużeniowej przedsiębiorstwa jest silnie zdeterminowana rodzajem danej formy finansowania i jej właściwościami.

*Metodyka badań:* Metodologia została oparta na wyznaczeniu funkcji regresji liniowej metodą najmniejszych kwadratów oraz zbadaniu korelacji pomiędzy wartością podstawy pojemności zadłużeniowej oraz wartością netto przedsiębiorstw (ustalonej zgodnie z podejściem stosowanym w ramach strukturalnych modeli ryzyka) na podstawie danych księgowych 511 spółek notowanych na Giełdzie Papierów Wartościowych w Warszawie za lata 2018–2019.

*Wyniki badań:* Podstawa pojemności zadłużeniowej ustalona na podstawie wartości księgowych jest silnie i istotnie statystycznie skorelowana z wyznaczoną wartością netto przedsiębiorstw, reprezentującą poziom ryzyka strukturalnego (stanowiącą różnicę pomiędzy wartością aktywów i zobowiązań). Zmiana przeciętnego poziomu podstawy pojemności zadłużeniowej o 1 mld USD prowadzi do zmiany przeciętnego wzrostu wartości netto przedsiębiorstw o 0,49 mld USD.

*Wnioski:* Wartość pojemności zadłużeniowej jest zdeterminowana wartością podstawy pojemności zadłużeniowej, właściwościami rodzaju zobowiązania oraz poziomem ryzyka strukturalnego. Wyznaczona funkcja regresji umożliwia prognozowanie, w ramach praktyki bankowej, wartości ryzyka strukturalnego oraz podstawy pojemności zadłużeniowej w zakresie udzielania zobowiązań krótko- i długoterminowych. Wskazane metody kalkulacji pozwalają na ustalenie pojemności zadłużeniowej dla wybranych form finansowania.

*Wkład w rozwój dyscypliny:* Potwierdzenie tezy o występowaniu istotnej statystycznie korelacji ryzyka strukturalnego i podstawy pojemności zadłużeniowej, a także przedstawienie podejścia umożliwiającego wyznaczenie podstawy pojemności zadłużeniowej, wartości ryzyka strukturalnego oraz samej wartości pojemności zadłużeniowej dla wybranych form finansowania.

**Słowa kluczowe:** pojemność zadłużeniowa, kapitał pracujący, zdolność kredytowa, optymalna struktura kapitałowa, modele ryzyka strukturalnego, wolne przepływy pieniężne.