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Models of Structure Capital Management Based on the Lag Determinants, Including the Cost of Debt and Tax

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ABSTRACT

The question of the optimal capital structure existence has been a controversial field for scientists for more than 70 years. The development of capital structure theories has prompted scientists to analyze the factors that influence the decision-making on the equity/debt ratio. The applied methods of capital structure management depend on the goals of the company's management and may include ensuring financial stability, profit maximization or ensuring the return on invested capital. At the same time, managerial decision-making regarding the capital structure is based, as a rule, on informal assessments due to the lack of specific tools that allow for making scientifically sound decisions in this area. The **purpose** of the study is to develop a formalized approach to capital structure management by varying lag determinants. A three-factor lag model allows us to determine the corporate capital structure based on the increment of three determinants — return on sales, resource efficiency, and equity multiplier. A five-factor lag model takes into account, in addition to the above, the costs of debt and taxes. The choice of a model for capital structure is based on the availability and objectivity of information for calculation. At the same time, both three-factor and five-factor lag models produce a very similar capital structure for the metallurgical industry. As calculations have shown, the difference in modeling arises due to an increase in the return on sales (ΔROS) and an interest burden (Δlb). Moreover, if the increase in the return on sales exceeds Δlb, then the share of equity capital will rise. In order to improve the quality of management decisions regarding the capital structure, it is advisable to carry out forecasting using two models, and in practical activity the obtained results should be used as a guideline for possible changes in the total capital structure. The empirical basis of the study was the reporting and forecast data from the largest companies of the metallurgical industry in the Russian Federation over 2019–2023.

Keywords: modeling; optimization; capital structure; profitability; forecasting; lag models

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INTRODUCTION

In practice, companies independently make decisions about the structure of corporate capital. However, their logic in forming the capital structure and the factors influencing its structure remain not fully understood.

According to some scientists, the use of borrowed capital provides expanded reproduction and brings additional income to companies. This is consistent with the conclusions presented in the works of A. Khan, M.A. Qureshi and P.I. Davidsen, who argue that an increase in the share of debt in the capital structure increases the value of the company [1]. The results of the work of K. Natsir and Yu. Usbardini has shown that the size of a firm and the capital structure have a significant impact on profitability [2].

Other scientists, on the contrary, refute some previous studies. Thus, according to S.L. Nguyen, K.D. Pham, T.V. Truong, and others, there is a negative relationship between long-term debt and profit maximization [3]. Empirical studies confirming the negative relationship between leverage and profitability contradict well-known models, such as the Modigliani-Miller model with taxes, compromise theory, and hierarchical structure theories. However, the provisions of all the mentioned theories are confirmed when a certain measure of leverage is applied individually [4]. N.H. Dang, V.T.V. Tui, and T.V.H. Hoang have revealed that the capital structure is a factor that negatively affects the cost of an enterprise [5].

M.S. Kokoreva, M.S. Stepanova, K.S. Povkh have proved in the course of their research that some companies generally adhere to a policy of "zero debt", which they are driven to by managerial entrenchment motives [6].

An attempt to assess the impact of the capital structure on the key financial performance of the company was made in the works of T.N. Bay, H. Nguyen, K.T. Pham [7], N. Grinyuk, L. Dokienko, V. Levchenko, V. Tranchuk [8], P.N. Brusov, T.V. Filatova, V.L. Kulik [9]. Their research is based on determining the feasibility of attracting borrowed resources in terms of balancing financial risk and profitability. N.A. Ramli, H. Latan and G.T. Solovida have established an indirect relationship between the use of borrowed funds and the financial performance of the company [10].

Also debatable is the set of criteria that guide the company when making decisions about the structure of funding sources. The articles by E.A. Nenu, G. Vintil and S.S. Gergin, L. Kurznak, D. Schoenmaker, A. Shramadyu are devoted to this topic [11, 12].

Justifying the applied methods of modeling the capital structure, modern scientists refer to the goals of management, which may be to ensure financial stability, maximize profits by minimizing the cost of capital [13] or ensure returns on invested capital. H. Deangelo in his work "The Riddle of capital structure: what are we missing?" notes the fact that managers do not have sufficient knowledge to optimize the capital structure with any real precision [14].

Research conducted by Russian and foreign scientists in this area shows that the assessment of the cost and risks of investments in Russian companies depends not only on the debt burden and optimal capital structure from the perspective of minimizing its weighted average cost due to increased leverage, but also on other factors. Among them: variable income, frequent payments of income tax, advance payments of income tax [15], the share of profits allocated to dividends, political, sanctions risks, as well as risks associated with corporate governance, expressed in the potential withdrawal of assets by managers from the company and other abuses [16, 17].

The works of D. Schoenmaker, V. Shramade, and B. Kulwizira Lukanim are devoted to the issues of static capital structure, proposing to build some kind of integrated capital structure corresponding to a certain level of risk and ensuring the expected profitability of owners [18, 19].

There are many works devoted to the theories of capital structure, an overview of which is presented in detail in the works of S. Kruk, S.G. Makarova, I.V. Nikitushkina, B.T.T. Tao, T. D.N. Ta and other scientists

[20–22]. However, modern research indicates the uncertainty of the impact of the firm's economic policy on the firm's leverage and the rate of its adjustment [23]. In this regard, the search for the optimal capital structure, focused not only on minimizing the weighted average cost of capital, but also on maximizing profitability and compliance with established values of financial covenants, is becoming particularly relevant.

The aim of the study is to develop a systematic approach to managing a company's capital structure that will ensure a certain level of return on equity, while taking into account various factors such as the cost of debt and taxation.

The specific scientific problem addressed is *the algorithmization of how a company should form its capital structure in the present and future, based on information about past capital structures that have achieved a desired level of return on equity.*

METHODS

The modeling is based on the traditional theory of capital structure based on the criterion of return on equity (*ROE*) (maximizing or ensuring a given level) by managing the ratio of equity and borrowed capital.

In the three-factor model, the return on equity *ROE* is expressed by the dependence

$$ROE = ROS \cdot Y \cdot M, \quad (1)$$

where *ROE* is the coefficient of return on equity; ROS is the coefficient of return on sales; *Y* is the coefficient of resource efficiency; *M* is the multiplier of equity.

It is logical to assume that a change in the values of some determinants included in the *ROE* should be fully compensated by an increase or decrease in others so that the change in *ROE* is zero.

Formula (1) can be converted to the form for convenience:

$$R = x \cdot y \cdot z, \quad (2)$$

where *R* is the return on equity (*ROE*), x is the ratio of net profit to revenue (*ROS*), y is the ratio of revenue to assets (*Y*), and z is the ratio of assets to equity (*M*).By defining the increment of a function of three variables,[1] we have:

$$\Delta R = R(x+\Delta x, y+\Delta y, z+\Delta z) - R(x,y,z). \quad (3)$$

From the formula of the total increment (3) we deduce:

$$\Delta R = (xyz + \Delta xyz + \Delta x\Delta yz) - xyz + \\ + (xy + \Delta xy + x\Delta y + \Delta x\Delta y)\Delta z.$$

Now, from the condition of maintaining a given rate of return on equity ($\Delta R = 0$), we can express Δz:

$$\Delta z = \frac{z(\Delta xy + x\Delta y + \Delta x\Delta y)}{xy + \Delta xy + x\Delta y + \Delta x\Delta y},$$

where

$$\frac{z+\Delta z}{z} = \frac{xy}{(x+\Delta x)\cdot(y+\Delta y)}, \text{ then } \frac{\Delta z}{z} = \frac{xy}{x_1 y_1} - 1.$$

Returning to the original notation, we obtain:

$$\frac{\Delta M}{M_0} = \frac{ROS_0}{ROS_1} \cdot \frac{Y_0}{Y_1} - 1. \quad (4)$$

Note that from the formula $\Delta M = M_1 - M_0$, where M_0 — is the value of the variable in the reference period; M_1 – is the value of the variable in the base period, it follows that $M_1 = M_0 + \Delta M$, that is, the determinant *M* (as well as other determinants) acquires the status of a lag variable.

Ratio (4) makes it possible to express the desired value of the multiplier M_1 interms of the ratio of the reference and projected values of profitability of sales and resource efficiency:

$$M_1 = M_0 \cdot \left[\frac{ROS_0}{ROS_1} \cdot \frac{Y_0}{Y_1}\right]. \quad (5)$$

[1] Kremer H.S., ed. Higher Mathematics for economists: a textbook for university students studying economics. 3rd ed. Moscow: UNITY-DANA; 2010.

Formula (6), presented below, allows you to model the capital structure, provided that the change in return on equity, turnover and return on sales are non-zero ($\Delta R > 0, \Delta ROS \neq 0, \Delta Y \neq 0$).

Using the increment formula (3) again, we obtain:

$$\Delta M = M_0 \cdot \left(\frac{ROS_0}{ROS_1} \cdot \frac{Y_0}{Y_1} - 1 \right) + \frac{\Delta R}{ROS_1 \Delta Y_1},$$

where

$$M_1 = M_0 \cdot \left[\frac{ROS_0}{ROS_1} \cdot \frac{Y_0}{Y_1} \right] + \frac{\Delta R}{ROS_1 \cdot Y_1}. \quad (6)$$

Thus, in order to model the capital structure from the perspective of ensuring a given level of return on equity based on the increment formula, it is necessary to have information about the capital structure of the reference period (M_0), return on sales and resource efficiency of the base and forecast periods [24–26].

The information base for calculating formulas (5) and (6) is the publicly available accounting data. However, the three-factor model does not take into account the impact of the tax burden and the cost of borrowed funds on the resulting *ROE* indicator and, as a result, on the capital structure. Therefore, it is of interest to use a five-factor lag model [27], where tax and interest burden coefficients are added to the previously listed indicators of profitability of sales, resource efficiency and multiplier

$$ROE = ROS \cdot Y \cdot M \cdot T_b \cdot I_b, \quad (7)$$

where T_b is the tax burden coefficient, calculated as the ratio of net profit to profit before taxation[2]; I_b is the percentage burden coefficient, calculated as the ratio of profit before taxation to the amount/profit before taxation and interest payable.[3]

To maintain the return on equity (ΔROE = 0) at the same (reference) level, provided that all indicators (*ROS, Y, M,* I_b), except for the tax burden[4] (T_b), change after a series of transformations, assuming that the variables in formula (6) have a lag character, we obtain:

$$M_1 = M_0 \cdot \frac{ROS_0}{ROS_1} \frac{Y_0 I_{b0}}{Y_1 I_{b1}}. \quad (8)$$

If we assume that four indicators (*ROS, Y, M,* I_b) are changing again, and the profitability increment ΔROE is positive, then the new ratio (M_1) of total capital to equity will be calculated using the formula:

$$M_1 = \frac{M_0}{ROS_1 Y_1 I_{b1}} \left(\frac{\Delta ROE}{M_0 T_{b0}} + ROS_0 \cdot Y_0 I_{b0} \right). \quad (9)$$

The dependence of the return on equity on the determinants discussed above allowed the authors to develop simple, understandable and practical tools. These tools, based on the increment formula, allow you to manage the capital structure so that when these factors change, a given level of the resulting *ROE* indicator is provided.

This raises a legitimate question about the impact of the cost of debt and taxes on the capital structure. To answer this question, we compared the results of modeling and forecasting the capital structure using the three-factor (excluding the cost of debt and taxes) and the five-factor (including the cost of debt and taxes) Demidova-Bogatov lag model.

MODELING THE CORPORATE CAPITAL STRUCTURE USING A THREE- AND FIVE-FACTOR LAG MODEL

Let's turn to testing formulas (5) and (8) in the context of modeling the corporate capital structure of companies that are among the world's largest steel producers.[5]

Modeling the capital structure using formula (5) of the three-factor model and formula (8)

[2] Tb = page 2400/page 2300 Form 2 "Financial Results Report".

[3] Ib = page 2300/(page 2300 + page 2330) Form 2 "Financial Results Report".

[4] The Tb tax burden ratio has remained constant, as the income tax rate has not changed since 2012.

[5] PJSC Severstal TIN 3528000597 OKVED 24.10, PJSC Novolipetsk Metallurgical Combine TIN 4823006703 OKVED 24.10, PJSC Magnitogorsk Iron and Steel Works TIN 7414003633 OKVED 24.10.

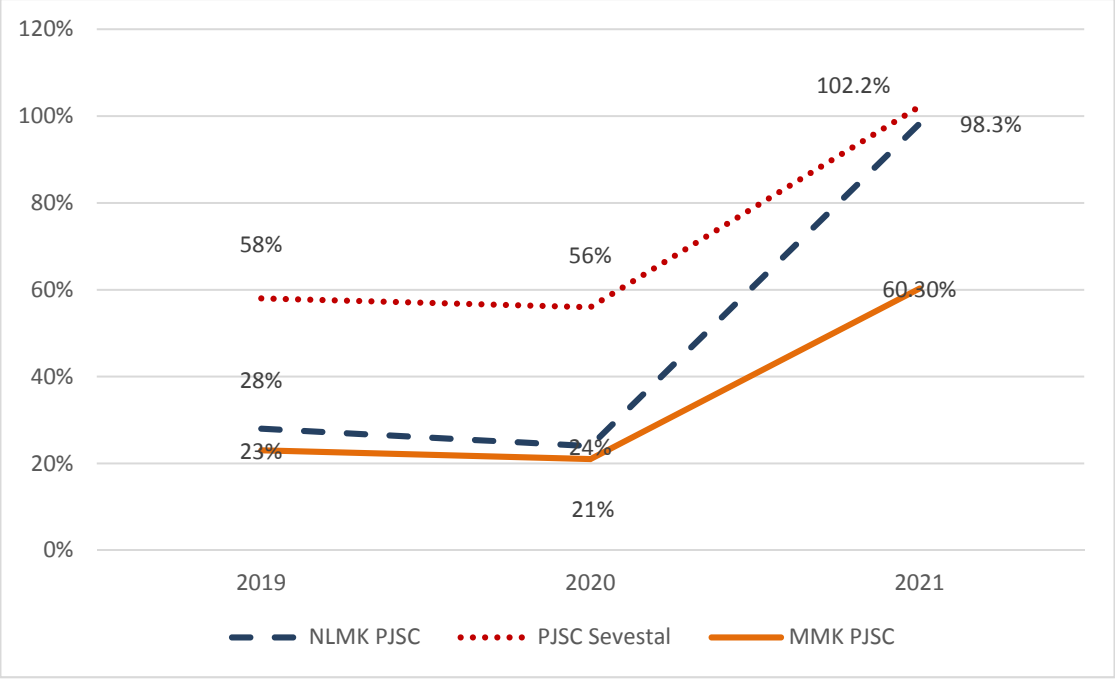

Fig. 1. **Return on Equity of PJSC NLMK, PJSC Severstal and PJSC MMK for 2019–2021, in %**

Source: Author's calculations.

of the five-factor model involves calculating the multiplier M_1, provided that the increase in return on equity ΔROE is zero, that is, it allows us to answer the question: "What should be the capital structure in a given period if we want to ensure the level of return on equity as in the reference year?".

The reference year for the analyzed enterprises will be 2021, as the year with the highest *ROE* (*Fig. 1*).

The result of modeling the capital structure that ensures the specified *ROE* level of NLMK PJSC in 2019–2020, provided that 2021 is taken as the reference year, is presented in *Table 1*.

The capital structure that meets the requirement to maintain the return on equity at the 2021 level is presented in *Table 2*.

As can be seen from the data in *Table 2,* if the company's capital in 2019 consisted of 15.98% of its own and 84.2% of borrowed funds, this would ensure a return on equity at the level of 2021 according to both the three-factor and five-factor models. In 2020, to achieve the *ROE* level as in 2021, it would be worthwhile to form assets consisting of 10.4% equity and 89.6% borrowed funds, taking into account changes in the interest burden under the five-factor model and 10.9% equity and 89.1% borrowed under the three-factor model.

The results of applying the three- and five-factor models to determine the capital structure that ensures a given *ROE* level for NLMK PJSC for 2019 and 2020 are shown in *Fig. 2*.

The simulation results shown in *Fig. 2* confirm the previously obtained data. It is in 2019 that the three-factor and five-factor models for ensuring return on equity at the 2021 level give the same result, rounded to hundredths. If rounded to ten thousandths, the difference is 0.0025%. For equity in 2019, according to the three-factor model, the share of the five-factor model is 0.000004 percentage points less. The difference in equity/debt shares in 2020 is 0.05 percentage points.

The modeling of the capital structure of PJSC Severstal for 2019–2020 was carried out using a similar methodology. 2021 was also chosen as the reference period as the year with the highest *ROE* = 102.2%.

The results of modeling the capital structure of PJSC Severstal, provided that $\Delta ROE = 0$ (formulas (5) and (8)), 2019–2020 are shown in *Fig. 3*.

Table 1

Modeling of the Capital Structure of NLMK, Assuming $\Delta ROE = 0$ [Using Formulas (5) and (8)], for 2019–2020

Years	Indicators	FACT PJSC NLMK	Calculation formula for the three-factor model	The Result of modeling according to formula (5)	Calculation formula for the five-factor model	The Result of modeling according to formula (8)
2019	Resource efficiency ratio (*Y*)	0.8	*Y* = Revenue / Assets	0.8	*Y* = Revenue / Assets	0.8
2020		0.77		0.77		0.77
2021		1.13		1.13		1.13
2019	Return on Sales (*ROS*) Ratio	0.20	*ROS* = Net profit / Revenue		*ROS* = Profit before taxes + % / Revenue	0.24
2020		0.14		0.14		0.17
2021		0.35		0.35		0.41
2019	Percentage Burden Ratio (*Ib*)	0.95	Not calculated	–	*Ib* = Profit before taxes / profit before taxes + %	0.95
2020		0.92		–		0.92
2021		0.98		–		0.98
2019	Tax Burden Ratio (*Tb*)	0.87	Not calculated	–	Tax burden ratio (*Tb*) = PE / profit before taxes	0.87
2020		0.91		–		0.87
2021		0.87		–		0.87
2019	Equity Multiplier (*M*)	1.8	*M* = Assets / Equity	6.33	*M* = Assets / Own capital	6.33
2020		2.2		9.16		9.58
2021		2.49		2.49		2.49
2019	Return on equity (*ROE*) ratio	0.279	$ROE = X \cdot Y \cdot M$	0.98	$ROE = X \cdot Y \cdot M \cdot T_b \cdot I_b$	0.98
2020		0.24		0.98		0.98
2021 (reference)		0.98		0.98		0.98

Source: Compiled by the authors.

As can be seen in the figure, if the company's capital in 2019 consisted of 20.8% of its own and 79.2% of borrowed funds, this would ensure a return on equity at the level of 2021 when modeled using a three-factor model. The five-factor model provides a capital structure consisting of 20.7% of own funds and 79.3% of borrowed funds. In 2020, to achieve the *ROE* level, as in 2021, it would be worthwhile to form assets consisting of 20.7% of own and 79.3% of borrowed funds, taking into account changes in the interest burden under the five-factor model and 20.8% of own funds and 79.2% of borrowed funds under the three-factor model.

The capital structure obtained using the three-factor model in both 2019 and 2020 differs very slightly from the structure obtained using the five-factor model. In 2019, the difference is 0.1 percentage points, and in 2020–1.4 percentage points.

The results of modeling the capital structure providing a given level of *ROE* = 60.3% of MMK

Table 2

The Capital Structure of NLMK to Maintain ROE, in 2029–2020

Indicator	Years	Fact	A Three-factor model	A Five-factor model
Multiplier, coefficient	2019	1.8	6.33	6.33
	2020	2.2	9.16	9.58
Total capital, thousand rubles.	2019	537 183 756	537 183 756	537 183 756
	2020	569 499 288	569 499 288	569 499 288
Equity, thousand rubles.	2019	299 472 372	84 824 924	84 827 334
	2020	255 738 358	62 154 504	59 421 760
Borrowed capital, thousand rubles.	2019	237 711 384	452 358 832	452 356 422
	2020	313 760 930	507 344 784	510 077 528
Capital structure, Equity/BC, %	**2019**	**55.7/44.3**	**15.8/84.2**	**15.8/84.2**
	2020	**44.9/55.1**	**10.9/89.1**	**10.4/89.6**
ROE, ratio	2019	0.28	0.98	0.98
ROE, ratio	2020	0.24	0.98	0.98

Source: Compiled by the authors.

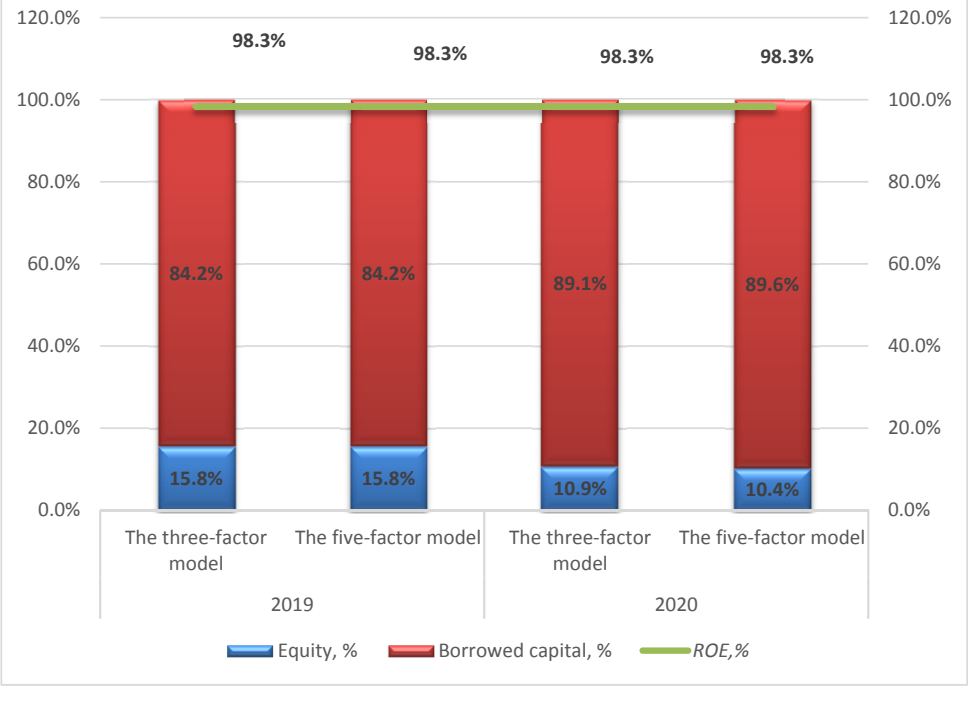

Fig. 2. **NLMK's Capital Structure for 2019 and 2020 Using a Three-Factor and Five-Factor Lag Model** $\Delta ROE = 0$

Source: Author's calculations.

PJSC according to formulas (6) and (9) in 2019–2020 are shown in *Fig. 4*

As can be seen from *Fig. 4*, similar results were obtained for MMK PJSC using the three- and five-factor models. The capital structure has minor differences, namely: in 2019, the share of equity in the total capital of the company differs by 0.3 percentage points or 0.39% from that calculated using the five-factor model. In 2020, the difference in

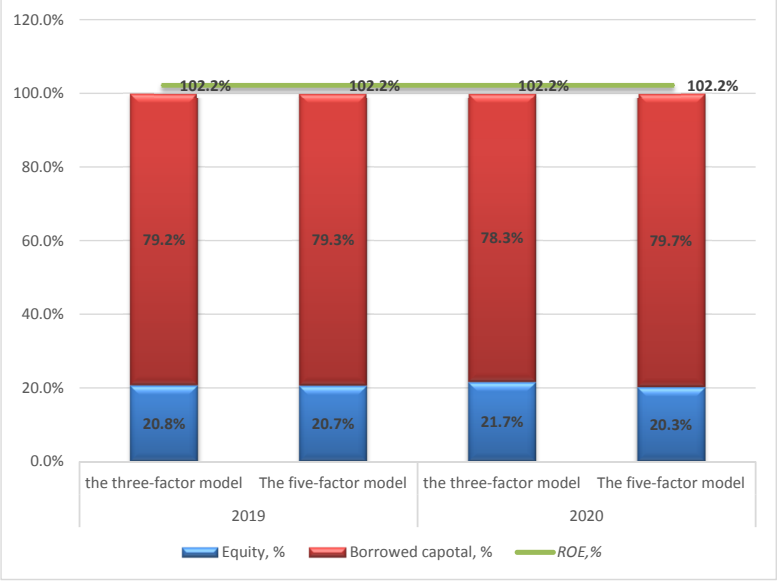

Fig. 3. **Severstal's Capital Structure Model in 2019 and 2020 Using a Three-Factor and Five-Factor Lag Model $\Delta ROE = 0$**

Source: Author's calculations.

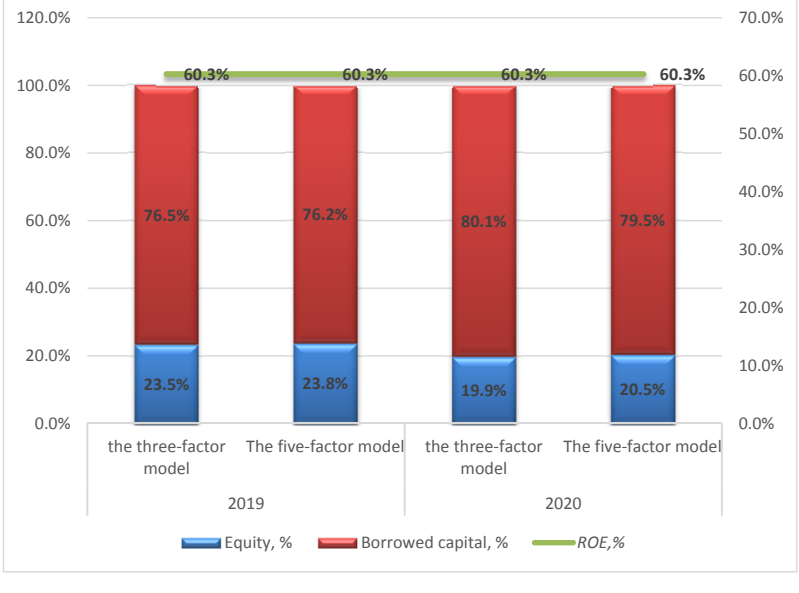

Fig. 4. **MMK's Capital Structure Model in 2019 and 2020 Using a Three-Factor and Five-Factor Lag Model $\Delta ROE = 0$**

Source: Author's calculations.

the capital structure is 0.6 percentage points or 0.75%.

Thus, modeling using a three-factor and a five-factor model gives a very close result. The capital structure calculated using the five-factor model differs by less than 2% from the modeling results based on the three-factor model. At the same time, calculations using the five-factor model are more laborious and require information about the amounts of taxes and interest paid for the use of borrowed funds. This information is not always fully presented in the forms of public financial statements.

Therefore, in financial management, we believe that it is more appropriate to use formulas based on the three-factor model for initial decisions regarding changes in the

Table 3

Economic Indicators for Forecasting NLMK's Capital Structure in 2023

Indicators	Years	Indicator value
Total capital, thousand rubles.	2021	704 458 010
Forecast	2023	704 458 010
Revenue, thousand rubles.	2021	792 927 899
Forecast	2023	713 635 109
Net profit (PE), thousand rubles.	2021	278 191 581
Forecast	2023	225 691 129
Coefficient Y (resource utilization)	2021	1.13
Forecast	2023	1.01
Ratio ROS (EBIT margin of sales)	2021	0.41
Forecast	2023	0.37
Ratio ROE (return on equity)	2021	0.98
Plan	2023	1.10
Profit before taxes	2021	319 460 630
Forecast	2023	256 467 192
Interest payable	2021	5 392 327
Forecast	2023	7 577 799
Coef. Ib (percentage burden)	2021	0.98
Forecast	2023	0.97
Coef. Tb (tax burden)	2021	0.87
Forecast	2023	0.88

Source: Compiled by the authors.

corporate capital structure, as it is simpler and more information-based.

We also assume that when forecasting the capital structure, the use of both three- and five-factor models would give a similar result.

FORECASTING THE CAPITAL STRUCTURE

Forecasting the capital structure of PJSC NLMK, PJSC Severstal and PJSC MMK using the formula

$$M_1 = M_0 \cdot \left[\frac{ROS_0}{ROS_1} \cdot \frac{Y_0}{Y_1} \right] + \frac{\Delta R}{ROS_1 \cdot Y_1},$$

allowing for the modeling capital structure, subject to the changes of return on equity, turnover, and return on sales ($\Delta ROE \neq 0$, $\Delta ROS \neq 0$, $\Delta Y \neq 0$) for the three-factor model and the following formula lag five-factor model

$$M_1 = \frac{M_0}{ROS_1 Y_1 I_{b1}} \left(\frac{\Delta ROE}{M_0 T_{b0}} + ROS_0 \cdot Y_0 I_{b0} \right),$$

assuming that all indicators are changing, except for the tax burden

$$(\Delta ROE \neq 0, \Delta ROS \neq 0, \Delta Y \neq 0, \Delta I_b \neq 0, \Delta T_b = 0).$$

The following assumptions were made here:

- the increments of the values included in formulas (5) and (8) are calculated using the usual formula: $\Delta F = F_1 - F_0$;
- revenue in the forecast period, namely in 2023, will decrease by 10% relative to the reference level of 2021[6];
- *EBIT* margin of sales will be 37%[7];
- the set *ROE* rate of return is 110%.

These assumptions will lead to changes in turnover, profit, tax and interest burden. Economic indicators for forecasting NLM's capital structure are presented in *Table 3*.

Table 4 shows the results of forecasting and the capital structure that will ensure the specified level of return on equity of NLMK PJSC in the forecast period (2023).

The capital structure that ensures a given level of return on equity of NLMK PJSC is presented in *Table 5*.

Fig. 5 shows the results of forecasting and comparing NLM's capital structure using a three- and five-factor model.

[6] This forecast was presented by the RIA Novosti news agency based on the results of 6 months of 2023. In addition, analysts believe that it is clearer to compare the figures of 2023 with a successful 2021, when there were no sanctions yet and production was recovering rapidly after the pandemic. URL: https://www.prometall.info/ (accessed on 09.01.2024).

[7] Kuznetsov E. And the latter became the first. What does the reporting of key industry players show? Vedomosti. Capital. URL: https://www.vedomosti.ru/kapital/investments/articles/2023/12/15/1011112-metallurgi-raskrili-karti (accessed on 17.01.2024).

Table 4

Forecasting of NLMK's Capital Structure, Assuming $\Delta ROE \neq 0$, 2023

Indicators	Fact PJSC NLMK 2021	A Three-factor model	The Result of modeling according to formula (6)	A Five-factor model	The Result of modeling according to formula (9)
Y_0	1.13	Y_1	1.01	Y_1	1.01
Net profit margin 0	0.35	*Net profit margin 1*	0.32	*Operation profit margin 1*	0.37
Ib_0	0.98	Not counted	–	Ib_1	0.97
Tb_0	0.87	Not counted	–	Tb_0	0.87
M_0	2.49	M_1	3.43	M_1	3.47
ROE_0	0.98	$ROE_1 = X \cdot Y \cdot M$	1.1	$ROE_1 = X \cdot Y \cdot M \cdot T_b \cdot I_b$	1.1

Source: Compiled by the authors.

Table 5

NLMK's Capital Structure Ensuring the Specified *ROE* Level, 2023

Indicator	Fact 2021 ("zero")	A Three-factor model	A Five-factor model
Multiplier, coefficient	2.49	3.43	3.37
Total capital, thousand rubles.	704 458 010	704 458 010	704 458 010
Equity, thousand rubles.	282 876 522	205 173 753	203 082 184
Borrowed capital, thousand rubles.	421581488	499 284 257	501 375 826
Capital structure, Equity/BC, %	40.2/59.8	29.1/70.9	28.8/71.2
ROE, ratio	0.98	1.1	1.1

Source: Compiled by the authors.

When forecasting the capital structure, it was taken into account that revenue in the forecast period would decrease by 10% relative to the reference level of 2021, the return on sales on *EBIT* would be 37%, and the required rate of return on equity would be 110%, that is, $\Delta ROE = ROE_1 - ROE_0 = 1{,}1 - 0{,}98 = 0{,}12$ or 12%.

Based on the forecast, we conclude that ensuring a given level of return on equity in 2023 can be achieved through the following capital structure:

- 70.9% of borrowed funds and 29.1% of own funds according to the three–factor lag model;
- 71.2% of borrowed and 28.8% of own funds according to the five-factor lag model.

The difference in equity/debt shares using the three-factor and five-factor models is 0.3 percentage points.

A similar methodology was used to forecast the capital structure of PJSC Severstal and PJSC MMK.

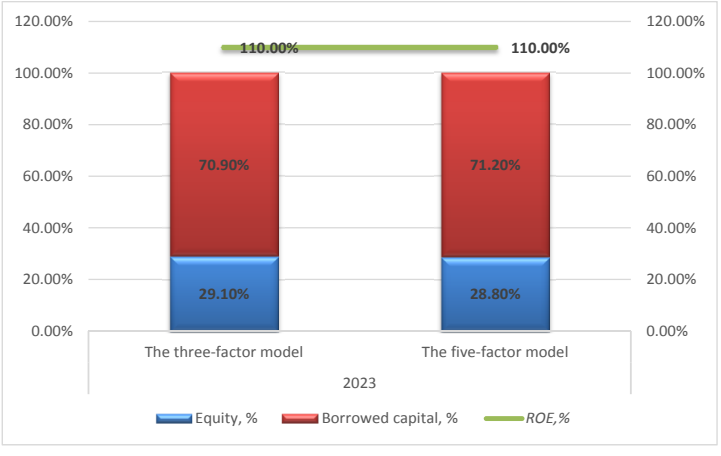

Fig. 5. **Forecasting NLMK's Capital Structure,** $\Delta ROE \neq 0$

Source: Author's calculations.

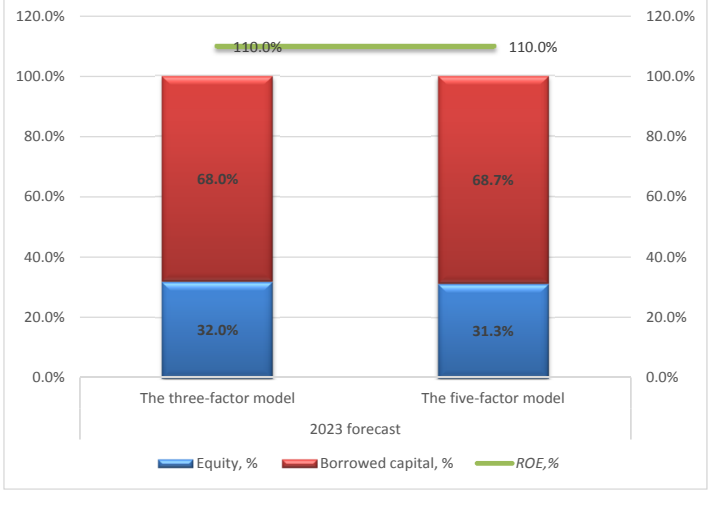

Fig. 6. **Forecasting Severstal 's Capital Structure,** $\Delta ROE \neq 0$

Source: Author's calculations.

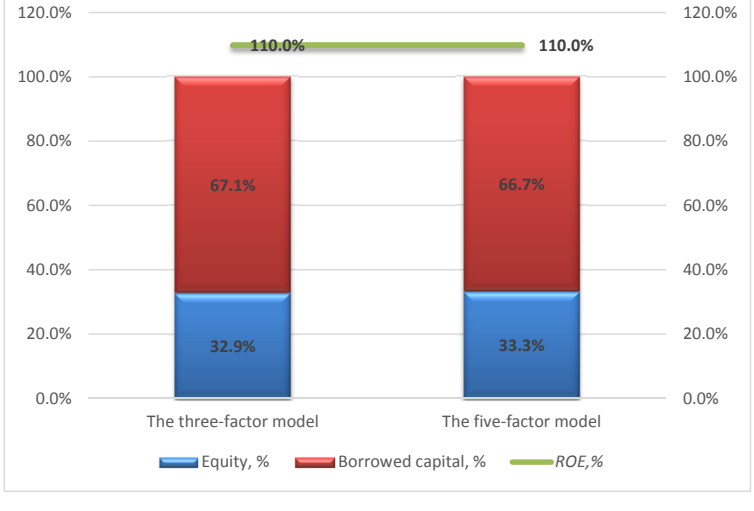

Fig. 7. **Forecasting MMK's Capital Structure,** $\Delta ROE \neq 0$

Source: Author's calculations.

Table 6

The Capital Structure of PJSC NLMK, PJSC Severstal and PJSC NLMK Using a Three- and Five-Factor Lag Model, *ROE* = 110%

Company	The Capital structure a three-factor model (EC/BC, in %)		The Capital structure a five-factor model (EC/BC, in %)		The Difference in the capital structure between a three- and a five-factor model, in abs. units
	EC	BC	EC	BC	
NLMK PJSC	29.1	70.9	28.8	71.2	0.3
PJSC Severstal	32.0	68.0	31.3	68.7	0.7
MMK PJSC	32.9	67.1	33.3	67.7	0.4

Source: Compiled by the authors.

Figure 6 shows the results of forecasting and comparing the capital structure of PJSC Severstal using a three- and five-factor model.

Based on the conducted forecasting using the increment formula, ensuring a given level of return on equity in 2023 can be achieved through the following capital structure:

- 68.0% of borrowed and 32.0% of own funds according to the three-factor model;
- 68.7% of borrowed and 31.3% of own funds according to the five-factor model.

The difference in the capital structure using the three-factor and five-factor models is 0.7 percentage points, or 1.0% for borrowed capital and 2.2% for equity.

The graph shows the results of forecasting and comparing the capital structure of MMK PJSC using these models (*Fig. 7*).

Based on the forecast, we conclude that ensuring a given level of return on equity in 2023 can be achieved through the following capital structure:

- 67.1% of borrowed and 32.9% of own funds according to the three-factor model;
- 66.7% of borrowed and 33.3% of own funds according to the five-factor model.

The difference in the capital structure using the three-factor and five-factor models is 0.4 percentage points, or 0.6% for borrowed capital and 1.2% for equity.

We summarize the results in *Table 6*.

DISCUSSIONS

When modeling the capital structure using formulas (5) and (8) for $\Delta ROE = 0$, as well as when forecasting formulas (6) and (9) for $\Delta ROE \neq 0$, the difference in the capital structure using the three- and five-factor models is less than 2%.

It can be assumed that the difference in the capital structure depends on the ΔROE, namely: the greater the ΔROE, the greater the difference in the capital structure when using the three- and five-factor models. Thus, for NLMK PJSC, when modeling the capital structure, $\Delta ROE = 1.1 - 0.98\% = 0.12$. For Severstal PJSC, $\Delta ROE = 1.1 - 1.02 = 0.08$. For MMK PJSC, $\Delta ROE = 1.1 - 0.6\% = 0.5$.

To test this hypothesis, we will forecast the capital structure under the condition of the same percentage growth in *ROE* relative to the "zero" period for all analyzed companies.

The lowest ΔROE is noted for PJSC Severstal. The ROE_{2021} coefficient, which we assume for the "zero" period, is 1.02, and the desired ROE_{2023} is 1.1. The difference is 0.08 percentage points or 8.16%.

Let's assume the same *ROE* growth in the forecast period for PJSC NLMK (*Table 7*) and MMK PJSC (*Table. 8*) and we will forecast the capital structure on these terms.

With an increase in *ROE* by the same amount, namely by 0.08, the difference in the capital

Table 7

Forecasting the Capital Structure of PJSC NLMK ΔROE = 0.08 in Relation to the "Zero" Period

Indicator	Fact 2021 ("zero")	A Three-factor model	A Five-factor model
Multiplier, coefficient	2.49	3.32	3.35
Total capital, thousand rubles.	704458 010	704458 010	704458 010
Equity, thousand rubles.	282876 522	212227 778	210745 663
Borrowed capital, thousand rubles.	421581488	492230 232	493712 347
Capital structure, Equity/Borrowed Capital, %	40.2/59.8	30.1/69.9	29.8/70.2
ROE, ratio of HC	0.98	1.06	1.06

Source: Compiled by the authors.

Table 8

Forecasting the Capital Structure of PJSC MMK ΔROE = 0.08 in Relation to the "Zero" Period

Indicator	Fact 2021 ("zero")	A Three-factor model	A Five-factor model
Multiplier, coefficient	1.58	1.89	1.86
Total capital, thousand rubles.	578009 427	578009 427	578009 427
Equity, thousand rubles.	366198 262	306123277	310233196
Borrowed capital, thousand rubles.	211811 165	271886150	267776231
Capital structure, Equity/Borrowed Capital, %	63.4/36.6	53.0/47.0	53.7/46.3
ROE, ratio	0.6	0.68	0.68

Source: Compiled by the authors.

structure when using the three- and five-factor models is:

- for NLMK PJSC — 0.3 percentage points;
- for PJSC Severstal — 0.7 percentage points;
- for MMK PJSC — 0.7 percentage points.

If we assume that ΔROE = 0.1 and calculate the capital structure of NLMK PJSC, then we will see that there will be a difference of 0.3 percentage points according to the two models, since the capital structure will consist of 29.6% of own funds and 70.4% borrowed according to the three-factor model and 29.3% of own and 70.7% borrowed funds according to the five-factor model. The capital structure of PJSC Severstal will be represented by the ratio of 31.4% of equity and 68.6% of debt under the three-factor model and 30.7% of equity and 69.3% of debt under the five-factor model. The difference in the capital structure is 0.7 percentage points. The capital structure of MMK PJSC, which was modeled using two models, results in 51.7% of its own funds and 48.3% borrowed under the three-factor model and 52.4% of its own and 47.6% borrowed under the five-factor model. The difference is 0.7 percentage points.

It is interesting to consider the option of a negative ΔROE, for example, —0.1.

The difference in NLMK's capital structure when modeled using the three- and five-factor models is 0.4 percentage points; for Severstal,

Table 9

The Results of Modeling the Capital Structure of PJSC NLMK, PJSC Severstal and PJSC MMK, *ROE* = 1.1, ΔROE = 0.08, ΔROE = 0.1, ΔROE = –0.1

Company	ROE_0	*ROE* = 1.1				ΔROE = 0.08				ΔROE = 0.1				ΔROE = –0.1			
		a 3-fact. model		a 5-fact. model		a 3-fact. model		a 5-fact. model		a 3-fact. model		a 5-fact. model		a 3-fact. model		a 5-fact. model	
		EC	DC	EC	DC	EC	DC	EC	DC	EC	DC	EC	DC	EC	DC	EC	DC
NLMK PJSC	0.98	29.1	70.9	28.8	71.2	30.1	69.9	29.8	70.2	29.6	70.4	29.3	70.7	36.4	65.6	36.0	64.0
PJSC Severstal	1.02	32.0	68.0	31.3	68.7	32.0	68.0	31.3	68.7	31.4	68.6	30.7	69.3	38.2	61.8	37.3	62.7
MMK PJSC	0.6	32.9	67.1	33.3	66.7	53.0	47.0	53.7	46.3	51.7	48.3	52.4	47.6	71.9	28.1	72.9	27.1

Source: Compiled by the authors.

Table 10

ΔROS Used in Calculations Under 3-Factor and 5-Factor Models

Indicator	ROS_0 by Net profit $margin_0$	ROS_1 by Net profit $margin_1$	ΔROS for the 3-factor. model	ROS_0 by *EBIT* Earnings before interests and $taxes_0$	ROS_1 by *EBIT* Earnings before interests and $taxes_1$	ΔROS for the 5-factor model
NLMK PJSC	0.35	0.32	–0.03	0.41	0.37	–0.04
PJSC Severstal	0.35	0.32	–0.03	0.4	0.37	–0.03
MMK PJSC	0.28	0.30	0.015	0.35	0.37	0.024

Source: Compiled by the authors.

it is 0.9 percentage points; and for MMK, it is 1.0 percentage points.

Let's summarize the results. When analyzing changes in the capital structure in modeling using three-factor and five-factor lag models for three companies and four different ways to change *ROE*, the following options were considered:

No. 1 — the same *ROE* level was set for all companies = 1.1 regardless of the base period;

No. 2 — for all companies ΔROE = 0.08 compared to the base 2021;

No. 3 — for all companies ΔROE = 0.1 compared to the base 2021;

No. 4 — for all companies ΔROE = –0.1 compared to the base 2021.

The results of capital structure modeling for all *ROE* variation options are presented in *Table 9*.

The information presented in *Table 9* allows us to draw the following conclusions.

For two companies (NLMK PJSC and Severstal PJSC) for all options for changing the return on equity, the five-factor lag model shows a larger share of borrowed capital compared to the three-factor one. This is due to the presence of tax and interest burden coefficients in the five-factor model, the values of which are less than or equal to one. The other three indicators (return on sales, asset turnover, and multiplier) are present in both models. Δ *ROS* for both net profit and *EBIT* for these

Table 11

The Difference in the Capital Structure When Forecasting Using Three- and Five-Factor Lag Model (Four Variants of ΔROE)

Company	ROE_0	*ROE* 1,1			*ΔROE* = 0.08			*ΔROE* = 0.1			*ΔROE* = –0.1			Average *ΔROE*
		ΔROE		Difference in capital structure, abs. units.	*ΔROE*		Difference in capital structure, abs. units.	*ΔROE*		The Difference in the capital structure, in abs. units.	*ΔROE*		The Difference in the capital structure, in abs. units.	
		abs. units.	%		abs. units.	%		abs. units.	%		in abs. units.	%		
NLMK PJSC	0.98	0.12	12.25	0.3	0.08	8.16	0.3	0.1	10.2	0.3	–0.1	10.2	0.4	0.33
PJSC Severstal	1.02	0.08	7.84	0.7	0.08	7.84	0.7	0.1	9.8	0.7	–0.1	9.8	0.9	0.75
MMK PJSC	0.6	0.5	83.3	0.4	0.08	13.3	0.7	0.1	16.7	0.7	–0.1	16.7	1.0	0.7

Source: Compiled by the authors.

Table 12

Changes in ΔROS, ΔY and ΔI_b for the Analyzed Companies

Company	Indicator	A 3-factor model	A 5-factor model	The average capital structure difference between a 3-factor and a five-factor model
NLMK PJSC	ΔROS	–0.03	–0.04	0.33
	ΔY	–0.12	–0.12	
	ΔIb	–	–0.01	
PJSC Severstal	ΔROS	–0.03	–0.03	0.75
	ΔY	–0.13	–0.13	
	ΔIb	–	–0.03	
MMK PJSC	ΔROS	0.0015	0.024	0.7
	ΔY	–0.14	–0.14	
	ΔIb	–	0	

Source: Compiled by the authors.

companies has a negative value of –0.03. For MMK PJSC, the value of Δ*ROS* is positive when forecasting, that is, the expected return on sales is 37%, which is more than the achieved value in the "base" 2021, therefore, the share of equity in the structure of the company's total capital increases during forecasting. This is because Δ*ROS* compensates for the effect of tax and interest burden coefficients less than 1. For clarity, information about Δ*ROS* used in calculations based on three- and five-factor models is systematized in *Table 10*.

Comparison of the data presented in *Tables 9* and *10* allow us to conclude that with an increase in return on sales, the share of equity in the company's total capital structure increases, and against the background of a decrease in return on sales, the share of

borrowed capital increases to ensure a given return on equity (the multiplier *M* increases).

The difference in the capital structure in forecasting using the three- and five-factor lag models is presented in *Table 11*.

Within a single company, with different options for changing *ROE*, there is a similarity in the magnitude of the difference in the capital structure when forecasting using three-factor and five-factor models. Thus, for NLMK PJSC, the difference in the capital structure predicted using three- and five-factor models averages 0.33 percentage points, that is, on average, at different levels of desired *ROE*, the share of borrowed capital in modeling using the five-factor model is 0.33 percentage points more than the three-factor model, and equity is the same amount less.. According to PJSC Severstal, the difference in the capital structure when modeling using the three- and five-factor models averages 0.75 percentage points. According to MMK, the difference in the capital structure when using 3- and 5-factor lag models is 0.7 percentage points. This allows us to conclude that forecasting the capital structure using 3- and 5-factor models shows a slight (less than one percentage point) difference in the structure of total capital.Since for each company individually, fluctuations in the capital structure when forecasting using three- and five-factor models with a change in the set value of *ROE* are relatively stable, and ΔROE are different, therefore, the assumption that the difference in the capital structure when forecasting using different models depends on ΔROE has not been confirmed. This means that the forecast result is influenced by the values of changes in internal indicators, namely: ΔROS, ΔY, ΔI_b ,ΔT_b.

Generalized information on changes in return on sales ΔROS, asset turnover ΔY and the percentage burden coefficient ΔI_b for the analyzed companies is presented in *Table 12*. In the five-factor model, when forecasting the capital structure, the tax burden coefficient ΔT_b taken equal to the "base" period, i.e. $\Delta T_b = 0$, since the income tax rate in Russia has not changed since 2012 and is 20%. Therefore, the dynamics of this indicator is not given in *Table 12*.

Resource allocation Y is calculated equally in both the three-factor and five-factor models, namely as the ratio of revenue to assets (total capital). Therefore, the difference in modeling is due to ΔROS and ΔI_b. Moreover, if ΔROS (increase in return on sales) is greater than ΔI_b (increase in interest burden), then the share of equity will increase. In addition, the capital structure calculated using the five-factor lag model provides a slightly higher share of borrowed capital than when modeling using the three-factor model against the background of lower return on sales.

CONCLUSIONS

1. The choice of a model for forecasting the capital structure should be based on the availability and objectivity of information for calculation. As the three-factor and five-factor lag models produce a very similar result for the capital structure, it would be more appropriate to use a three-factor model in situations where information is limited. This is because the data for calculating indicators is contained in accounting statements and only two indicators need to be predicted: expected return on sales and asset turnover.

2. In order to consider the impact of debt costs and the tax burden on the capital structure, while achieving a given level of return on equity, it is recommended to use a five-factor lag model. However, the accuracy of the model will depend on the accuracy of forecasts for four key indicators: return on sales, asset turnover, interest rate and tax burden. The calculation and forecasting of these indicators require information about changes in interest rates, tax rates, market prices and costs, which can make calculations more complex.

3. The difference in equity and debt capital shares when modeling using the three- and five-factor models varies for each company. Regardless of how *ROE* (return on equity) changes, the trend of the capital structure remains the same. Therefore, we believe it is necessary to perform forecasting using both models, and in practice, the obtained forecast results should be used as a range for possible changes in the total capital structure.

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