Integral analysis of the model of financial dependence of the Russian construction industry

M V Matveeva¹ and E A Filatov²

¹Irkutsk National Research Technical University, 83 Lermontov str., Irkutsk, 664074, Russia
²Irkutsk scientific center, Siberian branch of the Russian Academy of Sciences, 134, Lermontov street, Irkutsk, Russian Federation

E-mail: expertiza@istu.edu

Abstract. In the context of the COVID-19 pandemic and other crisis phenomena, we can conclude that the construction industry in the Russian Federation is characterized by pessimistic sentiments regarding financial indicators for 2020. Under these conditions, the self-survival of the Russian construction industry is largely determined by the ability of specific construction companies to adapt to the changed economic environment, fully realize their internal reserves, and diversify production in search of new markets. This increases the role of analysis in assessing the production and commercial activities of the construction industry of the Russian Federation and, above all, in the availability, placement and use of their capital and income. The results of this analysis are necessary, first of all, for the owners (founders) of the construction company, its creditors and investors. The article analyzes the model of financial dependence. The object of research of the article is the construction industry of the Russian Federation in the context of three main types of construction: construction of buildings; construction of engineering structures; specialized construction works. The article describes one of the author's methods of integral factor analysis, which allows you to assess the degree of influence of factors on changes in the resultant indicator in an accessible and relatively simple way.

1. Introduction

In modern economic conditions, the analysis of economic activities of construction industry entities is an important element in the management system of their activities, a fairly effective means of determining on-farm reserves, the basis for developing scientifically based planning calculations and management decisions and monitoring their implementation to improve the efficiency of their functioning. In the conditions of modern economy, the independence of economic entities in making and implementing managerial decisions, their economic and legal responsibility for the results of management increases. Objectively, the importance of financial stability of construction industry entities is growing (Van Matre, J. G., & Gilbreath, G. H., 1987; Aczel, A. D., 1989).

2. Research questions

The initial formula for factor analysis of financial dependence (DR) will look like this (formula 1):

\[
DR = \frac{SK}{A} * \frac{ZK}{SK} = FIR * DTER = F_1 * F_2
\]

(1)

where:

- \( FIR (F_1) \) – the coefficient of autonomy (Financial Independence Ratio) is calculated as the ratio of the cost of equity (SK) to the average annual value of assets (A). The coefficient of autonomy (FIR) shows the share of an organization's assets that are covered by its own capital (provided by its own sources of formation). The remaining share of assets is covered by borrowed funds. Investors and banks that issue loans pay attention to the value of this coefficient. The higher the coefficient value, the more likely the company is to repay its debts using its own funds. The higher the indicator, the higher the financial independence of the company (Samarina, V. P., Cherecsov, G. V., & Karpov, E. A., 2020; Korshunov, V. V., 2020).
- DTER \( (F_1) \) – the financial leverage ratio \( \text{(Debt-To-Equity Ratio)} \) is the ratio of debt capital \( (ZK) \) to equity \( (SK) \) (in other words, the ratio between debt and equity). This coefficient is used in the process of analyzing the subject of economic relations to determine the level of its financial stability in the long term. The values of the financial leverage ratio help the company’s analysts identify additional potential for profitability growth, assess the degree of possible risks, and determine the dependence of the profit level on external and internal factors. With the help of financial leverage, it is possible to influence the net profit of the organization by managing financial liabilities, as well as a clear idea of the feasibility of using credit funds (Zvyagin, L. S., Satdykov, A. I., & Besperalova-Milek, O. V., 2020; Kazakova, N. A., 2018).

The resultant indicator in the model is the financial dependency ratio \( (\text{Debt Ratio}) \), calculated as the ratio of debt capital \( (ZK) \) to total capital \( (A) \). This coefficient belongs to a group of indicators describing the capital structure of an organization, and is widely used in economically developed countries of the West. The optimal value of the financial dependency ratio \( (\text{DR}) \) is determined by the same ratios of equity and debt capital as for related indicators – the coefficient of autonomy \( (\text{FIR}) \) and the coefficient of financial leverage \( (\text{DTER}) \). In other words, a financial dependency ratio of no more than 0.6-0.7 is considered normal. The optimal ratio is 0.5 (that is, an equal ratio of equity and debt capital). The coefficient is below the norm, and too low a coefficient indicates that the organization is too cautious in attracting debt capital and that it has missed opportunities to increase its return on equity by using the effect of financial leverage. A coefficient higher than the norm may indicate a strong dependence of the organization on creditors (Suharev, O. S., 2012; Vasil'eva, L. S., & Petrovskaya, M. V., 2016).

The purpose of the research is to analyze the model of financial dependence of the construction industry using the author's integral method of factor deterministic analysis.

3. Materials and methods
The initial data for the integral Filatov method (Filatov, E. A., 2019) analysis of the model of financial dependence of the construction industry of the Russian Federation are presented in table 1.

The object of research is the construction industry of the Russian Federation in the context of three main types of construction: construction of buildings; construction of engineering structures; specialized construction works.

The sources of the information base for analysis are the directory of financial indicators of the Russian Federation's industries, published on the website https://www.testfirm.ru/, which was created by auditors based on data from 2.1 million companies.

Types of construction in table 1 are presented by the scale of companies by revenue for the year:
- nanoenterprises – up to 10 million rubles;
- microenterprises – from 10 to 120 million rubles;
- small enterprise – from 120 to 800 million rubles;
- medium-sized enterprises – from 800 to 2000 million rubles;
- large enterprises – over 2000 million rubles.

| No. | Indicators | № factor's | 2018 year Plan (0) * | 2019 year Fact (1) ** | Deviation \((\Delta) ***\) |
|-----|------------|------------|---------------------|----------------------|------------------------|
| 1   | All enterprises of the Russian Federation | F_1 | 0.300 | 0.290 | -0.010 |
| 2   | Construction of buildings | 0.110 | 0.120 | 0.010 |
|     | including: | | | | |
|     | - nanoenterprises | 0.160 | 0.150 | -0.010 |
|     | - microenterprises | 0.100 | 0.110 | 0.010 |
|     | - small enterprise | 0.060 | 0.080 | 0.020 |
|     | - medium-sized enterprises | 0.070 | 0.080 | 0.010 |
|     | - large enterprises | 0.070 | 0.080 | 0.010 |
| 3   | Construction of engineering structures | 0.180 | 0.170 | -0.010 |
|     | including: | | | | |
| Nanoenterprises | Microenterprises | Small enterprises | Medium-sized enterprises | Large enterprises |
|-----------------|-----------------|------------------|-------------------------|------------------|
| 0.230           | 0.160           | 0.150            | 0.140                   | 0.150            |
| 0.200           | 0.160           | 0.160            | 0.140                   | 0.160            |
| -0.030          | 0.000           | 0.010            | 0.000                   | 0.010            |

4 Specialized construction works
including:
- Nanoenterprises 0.230 0.220 -0.010
- Microenterprises 0.160 0.160 0.000
- Small enterprise 0.150 0.160 0.010
- Medium-sized enterprises 0.140 0.140 0.000
- Large enterprises 0.150 0.160 0.010

DTER (Debt-To-Equity Ratio) \( F_2 \)
1 All enterprises of the Russian Federation 0.860 0.870 0.010
2 Construction of buildings 3.090 3.020 -0.070
including:
- Nanoenterprises 1.330 1.300 -0.030
- Microenterprises 4.490 4.150 -0.340
- Small enterprise 9.110 8.260 -0.850
- Medium-sized enterprises 10.720 8.290 -2.430
- Large enterprises 8.830 7.790 -1.040

3 Article IV. Construction of engineering structures 2.020 2.110 0.090
including:
4 Specialized construction works 1.540 1.650 0.110
including:
- Nanoenterprises 0.770 0.850 0.080
- Microenterprises 2.840 2.800 -0.040
- Small enterprise 6.350 5.770 -0.580
- Medium-sized enterprises 5.990 4.810 -1.180
- Large enterprises 4.350 3.300 -1.050

DR (Debt Ratio)
1 All enterprises of the Russian Federation 0.258 0.252 -0.006
2 Construction of buildings 0.340 0.362 0.023
including:
\[
\Delta DR = \sum_{n=1}^{2} DR (F_n) = \Delta DR (F_1) + \Delta DR (F_2)
\]  
(2)

The algebraic sum of the influence of factors must be equal to the total increase in the effective indicator. The absence of such equality indicates errors in the calculations.

Below we present the author's integral method # 1 of factor analysis.

The calculation of the influence of factors on the change in the performance indicator \((\Delta DR)\) is presented using method # 1 for 2 factors is presented in formulas 3-4:

\[
\Delta DR (F_1) = \left(\frac{\Delta F_1}{n}\right) \ast (FON\#1) + Z\#1
\]  
(3)

\[
\Delta DR (F_2) = \left(\frac{\Delta F_2}{n}\right) \ast (FON\#2) + Z\#1
\]  
(4)

where: an additional increase in the effective indicator due to the interaction of factors equally between them \((Z)\) is presented in the formula 6.

When using the author's integral method, the additional increase in the effective indicator \(\langle\text{indecomposable remainder}\rangle - Z\), formed as a result of the interaction of factors, is distributed equally between them:

\[
Z\#1 = \Delta DR - \sum \left(\frac{\Delta F_n}{n}\right) \ast (FON\#1_n)/n
\]  
(5)

where:

- \(Z\) – additional increase in the effective indicator due to the interaction of factors equally between them; 
- \(FON\#1_n\) – the main part of the formula of the author's integral method No. 1; 
- \(\Delta F_n\) – deviation by a certain factor; 
- \(n\) – number of factors involved in the analysis.

where: \(FON\#1_n\) – the main part of the formula of the author's integral method No. 1 is calculated using formulas 6-7:

\[
FON\#1 = 2 \ast (F_{2(0)} + F_{2(I)})
\]  
(6)
\[ F_{O^1_2} = 2 \left( F_{1(0)} + F_{1(I)} \right) \]  

(7)

4. Results

The calculation of the components of formulas using the author's integral method No. 1 is presented in table 2.

**Table 2.** Components of the formula according to the author's integral method No. 1.

| № formulae | \( \Delta F_n / n \) | main part of the formula \((F_{O^1_2})\) | \( Z \) |
|-------------|----------------------|---------------------------------|-----|
| 1  | \( \Delta DR (F_1) = (\Delta F_1 / 2)* \) | \( 2 \left( F_{2(0)} + F_{2(I)} \right) \) | \( Z \) |
| 2  | \( \Delta DR (F_2) = (\Delta F_2 / 2)* \) | \( 2 \left( F_{1(0)} + F_{1(I)} \right) \) | \( Z \) |

The results of the author's integral method No. 1 for analyzing the financial dependence of the construction industry of the Russian Federation are presented in tables 4, 5, and 6.

**Table 3.** Result for the author's integral method No. 1 in general for all Russian companies.

| № factor's | \( \Delta F_n / n \) | main part of the formula \((F_{O^1_2})\) | \( Z_{\#1} \) | Final result |
|-------------|----------------------|---------------------------------|-----|-------------|
| 1  | \( \Delta DR (F_1) = -0.005 \) | 3.460 | 0.003 | -0.015 |
| 2  | \( \Delta DR (F_2) = 0.005 \) | 1.180 | 0.003 | 0.009 |
| Total  | -0.011 | 0.006 | -0.006 |

**Table 4.** Result for the author's integral method No. 1 in general for all Russian companies engaged in building construction.

| № factor's | \( \Delta F_n / n \) | main part of the formula \((F_{O^1_2})\) | \( Z_{\#1} \) | Final result |
|-------------|----------------------|---------------------------------|-----|-------------|
| 1  | \( \Delta DR (F_1) = 0.005 \) | 12.220 | -0.011 | 0.050 |
| 2  | \( \Delta DR (F_2) = -0.035 \) | 0.460 | -0.011 | -0.027 |
| Total  | 0.045 | -0.023 | 0.023 |

**Table 5.** Result of the author's integral method No. 1 in general for all Russian companies engaged in the construction of engineering structures.

| № factor's | \( \Delta F_n / n \) | main part of the formula \((F_{O^1_2})\) | \( Z_{\#1} \) | Final result |
|-------------|----------------------|---------------------------------|-----|-------------|
| 1  | \( \Delta DR (F_1) = -0.005 \) | 8.260 | 0.002 | -0.039 |
| 2  | \( \Delta DR (F_2) = 0.045 \) | 0.700 | 0.002 | 0.034 |
| Total  | -0.010 | 0.005 | -0.005 |

**Table 6.** Result of the author's integral method No. 1 in general for all Russian companies engaged in specialized construction works.
As can be seen from the final result of tables 1, 3, 4, 5, 6, the goal of the analysis is achieved – the determination of the influence of factors is disclosed without deviations.

### Conclusion based on the results of analysis 1

The final change in the financial dependency ratio of all Russian companies was positively influenced by an increase in the financial leverage ratio by 1%, which caused an increase in financial dependence by 0.9%.

The final change in the coefficient of financial dependence of all Russian companies was negatively affected by a decrease in the coefficient of autonomy by -0.1%, and caused a decrease in financial dependence by -1.5%.

The combined effect of these two factors led to a decrease in the financial dependence of all Russian companies by -0.6%.

### Conclusion based on the results of analysis 2

The final change in the coefficient of financial dependence of all Russian companies engaged in building construction was positively affected by an increase in the coefficient of autonomy by 0.1%, which caused an increase in financial dependence by 5%.

The final change in the coefficient of financial dependence of all Russian companies engaged in building construction was negatively affected by a decrease in the coefficient of financial leverage by -7%, which caused a decrease in financial dependence by -2.7%.

The combined impact of two factors led to an increase in the financial dependence of all Russian companies engaged in the construction of buildings by 2.3%.

### Conclusion based on the results of analysis 3

The final change in the coefficient of financial dependence of all Russian companies engaged in the construction of engineering structures was influenced by an increase in the coefficient of financial leverage by 9%, which caused an increase in financial dependence by 3.4%.

The final change in the coefficient of financial dependence of all Russian companies engaged in the construction of engineering structures was negatively affected by a decrease in the coefficient of autonomy by -1%, which caused a decrease in financial dependence by -3.9%.

The combined effect of two factors led to a decrease in the financial dependence of all Russian companies engaged in the construction of engineering structures by -0.5%.

### Conclusion based on the results of analysis 4

For the final change in the financial dependency ratio of all Russian companies engaged in specialized construction work, an increase in the financial leverage ratio by 11% caused an increase in financial dependence by 4.5%.

The final change in the coefficient of financial dependence of all Russian companies engaged in specialized construction work was negatively affected by a decrease in the coefficient of autonomy by -1%, which caused a decrease in financial dependence by -3.6%.

The combined impact of two factors led to an increase in the financial dependence of all Russian companies engaged in specialized construction work by 0.9%.

Using the data in tables 1 and 2, it is possible to calculate the impact on changes in the financial dependence of the construction industry of the Russian Federation by the scale of companies engaged in various types of construction.

### 5. Discussion

Table 1 shows that the average coefficient of autonomy (Financial Independence Ratio) for the Russian economy is 30%, that is, 30 kopecks of equity refers to the ruble of assets (capital). In world practice, it is considered the minimum allowable up to 30-40% of equity. At the same time, the coefficient of autonomy in the construction industry is significantly lower than the average for the Russian economy. Thus, in the construction of buildings, the coefficient of autonomy is 12%, in the construction of engineering structures 18%, and in special construction works it is about 22%.

According to the second factor, the financial leverage ratio (Debt-To-Equity Ratio) for the Russian economy is 87%, which means that 1 ruble of own funds accounts for about 87 kopecks of borrowed funds.
For Russian organizations, the normal value is ≤ 1. In other words, the norm is the equality of equity and debt capital. In economically developed countries, the standard value is ≤ 1.5. That is, the amount of borrowed capital can exceed its own by 1.5 times. The more this indicator exceeds the norm, the greater the organization's dependence on borrowed funds. In other words, the financial stability of the organization becomes lower. At the same time, the financial leverage ratio in the construction industry is significantly higher for all three types of construction than the average for the Russian economy. Thus, in the construction of buildings, the financial leverage ratio is about 3, in the construction of engineering structures – about 2, and in special construction works – about 1.6.

The resultant indicator – the coefficient of financial dependence (Debt Ratio) on the average for the Russian economy in 2019 and 2018 almost did not change and is 25%, that is, 25 kopecks of borrowed funds account for the ruble of assets (capital). This ratio shows the share of the company's debt in its total assets. The financial dependency ratio shows how much a company relies on debt to Finance assets. The debt ratio allows users to quickly measure the amount of debt a company has on its balance sheet compared to its assets. A low debt ratio indicates conservative financing with the ability to borrow in the future without significant risk.

At the same time, in the construction industry for all three types of construction, the coefficient of financial dependence is about 36%, which is 11% higher than the average for the Russian economy.

6. Conclusion
The main and fundamental source of construction financing in the world is the own funds of construction companies. In Russia, the situation is completely different. One of the features of the construction industry – the significant cost of the object being built – limits the ability of construction companies to use their own capital, the growth of which is mainly due to the net profit received. A short period of existence of Russian construction companies, the formation of most of which falls in the mid-90s of the last century, a significant increase in prices for construction materials led to a significant excess of the cost of constructed objects over the volume of available own funds for construction companies. The advantages of using your own capital in construction are obvious: resources are free, do not require a refund, and give you complete freedom at their disposal. However, as practice shows, own funds are sufficient only for the construction of the foundation of the construction object. As a result, in the conditions of constant shortage of own working capital, it becomes more and more urgent to search for alternative sources of financial resources, which are attracted and borrowed funds (Rayburn, L. G., 1989; Jones, C. P., 1992; Straub, J. T., & Attner R. F., 1994).

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References
[1] Aczel A D 1989 Complete business statistics p 1056
[2] Filatov E A 2019 Author's integrated methods of analysis of the model of return on assets of construction companies IOP Conf. Series: Materials Science and Engineering 667 012024
[3] Jones C P 1992 Introduction to financial management p 704
[4] Kazakova N A 2018 Economic analysis in business assessment and management of the company's investment attractiveness p 240
[5] Korshunov V V 2020 Economy of the organization p 348
[6] Rayburn L G 1989 Principles of cost accounting. Using a cost management approach p 1464
[7] Samarina V P, Cherezov G V and Karpov E A 2020 Economy of the organization p 320
[8] Straub J T and Attner R F 1994 Introduction to business p 764
[9] Suharev O S 2012 Managerial analysis and diagnostics of business activity p 496
[10] Van Matre J G and Gilbreath G H 1987 Statistics for business and economics p 786
[11] Vasil’eva L S and Petrovskaya M V 2016 Business analysis p 606
[12] Zvyagin L S, Satdykov A I and Bespalova-Milek O V 2020 System analysis of business activities in economics and finance p 590