Author's factor analysis of financial dependence of the Russian construction industry

E A Filatov

1Irkutsk scientific center, Siberian branch of the Russian Academy of Sciences, 134, Lermontov street, Irkutsk, Russian Federation

E-mail: johnru3000@rambler.ru

Abstract. Construction is one of the fastest growing and developing business sectors. This is due to the fact that the construction market is almost always in high demand, which is growing every day. Especially profitable is construction in large cities, whose population is constantly increasing due to the influx of new residents from the regions seeking to earn money in large cities. Currently, the construction market in the Russian Federation has opposite trends. The first is the deterioration of the economic condition of citizens, which leads to a decrease in demand. The second is financial instability and fluctuations in the ruble exchange rate, as a result of which people try to save their earned money and invest it in real estate, and this, consequently, leads to an increase in demand for real estate. The article analyzes the model of financial dependence. The article describes 10 methods of factor analysis developed by Filatov E. A., which make it possible to draw an accessible and relatively simple conclusion about changes in the resultant indicator. 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.

1. Introduction
The spread of the COVID-19 coronavirus infection, then the decline in oil prices and the devaluation of the ruble – all these events had a negative impact on the absolute majority of companies in the Russian Federation. The construction industry, like many other economic activities, has faced many challenges: reduced demand, suspension of operations, increase in the cost of construction materials, financial problems for both companies and contractors, problems with the movement of workers due to border closures, and others. As a result, it is important to analyze the financial dependence of the construction industry of the Russian Federation.

2. Research questions
The financial dependency ratio (Debt Ratio – DR) is widely used by economists in developed countries. This indicator is used to assess financial stability (Rumyanceva, E. E., 2019; Shadrina, G. V., 2019; Sheremet, A. D., & Horin, A. N., 2018; Alekseycheva, E. Yu., Magomedov, M. D., & Kostin, I. B., 2020; Baskakova, O. V., & Machabeli, M. Sh., 2019; Novashina, T. S., Karpunin, V. I., & Kosorukova, I. V., 2020).

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

\[ DR = \frac{SK}{A} \times \frac{ZK}{SK} = FIR \times DTER = F_1 \times F_2 \]
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 ($A$).

- **DTER** ($F_2$) – the financial leverage ratio is the ratio of debt capital ($ZK$) to equity ($SK$).

The resultant indicator in the model is the financial dependency ratio (Debt Ratio), calculated as the ratio of debt capital ($ZK$) to total capital (assets) ($A$).

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

### 3. Materials and methods

The initial data for the analysis of the model of financial dependence of the construction industry of the Russian Federation using alternative methods of Filatov (Filatov, E. A., 2019) 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/](https://www.testfirm.ru/), which was created by auditors based on data from 2.1 million companies.

**Table 1.** Initial data for alternative author's methods of factor analysis for the construction industry of the Russian Federation.

| No. | Indicators                      | № factor's | 2018 year Plan (0) * | 2019 year Fact (I) ** | Deviation (Δ) *** |
|-----|---------------------------------|------------|----------------------|----------------------|-------------------|
| 1   | FIR (Financial Independence Ratio) | $F_1$      | 0.300                | 0.290                | -0.010            |
| 2   | All enterprises of the Russian Federation |          | 0.860                | 0.870                | 0.010             |
| 3   | Construction of buildings       |            | 0.110                | 0.120                | 0.010             |
| 4   | Construction of engineering structures |        | 0.180                | 0.170                | -0.010            |
| 5   | Specialized construction works  |            | 0.230                | 0.220                | -0.010            |
| 6   | DTER (Debt-To-Equity Ratio)     | $F_2$      | 0.340                | 0.362                | 0.023             |
| 1   | All enterprises of the Russian Federation |        | 0.340                | 0.362                | 0.023             |
| 2   | Construction of buildings       |            | 0.340                | 0.362                | 0.023             |
| 3   | Specialized construction works  |            | 0.364                | 0.359                | -0.005            |
where: * 0 – past (base) period (year) taken as a basis for comparison; ** I – reporting (current) year; *** ∆ – change for the period is calculated as the difference between the fact and the plan (I – 0).

The balance of deviations according to the author's model of profitability of fixed assets is as follows (formula 2):

\[
\Delta DR = \sum_{n=1}^{2} DR (F_n) = \Delta DR (F_1) + \Delta DR (F_2)
\]

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.

Auxiliary data on comparative coefficients for factor analysis are presented in table 2.

**Table 2. Multiple comparative coefficients for one factor.**

| Comparison of factors | The designation of comparative coefficient | The product of coefficients (value) |
|-----------------------|-------------------------------------------|-----------------------------------|
| \(\frac{F_1 (I)}{F_1 (0)}\) | \(A_1\) | 1.00 |
| \(\frac{F_2 (I)}{F_2 (0)}\) | \(A_1\) | 1.00 |

Author's (alternative) methods of factor analysis are presented in table 3.

Method No. 1.1 (formulas 1.1 – 1.2 in table 3) is based on the difference between the effective targets, which is adjusted by comparative coefficients (\(A_1\)).

Method No. 1.2 (formulas 2.1 – 2.2 in table 3) is based on the difference between the effective actual indicators, which is adjusted by comparative coefficients (\(A_4\)).

Method No. 2.1 (formulas 3.1 – 3.2 in table 3) is based on the relation of deviation of the initial factor to the initial planned factor multiplied by the planned effective indicator which is corrected by the comparative coefficient (\(A_1\)).

Method No. 2.2 (formulas 4.1 – 4.2, in table 3) is based on the relation of deviation of the initial factor to the initial actual factor multiplied by the actual effective indicator which is corrected by the comparative coefficient (\(A_4\)).

Method No. 3.1 (formulas 5.1 – 5.2 in table 3) is based on the difference between the effective actual and planned indicators, which are adjusted by comparative coefficients (\(A_1\)).

Method No. 3.2 (formulas 6.1 – 6.2 in table 3) is based on the difference between the effective actual and planned indicators, which are adjusted by comparative coefficients (\(A_4\)).

Method No. 4.1 (formulas 7.1 – 7.2 in table 3) is based on the ratio of the deviation of the effective factor to the difference between the effective actual and planned factors, which is adjusted by a comparative factor (\(A_1\)).

Method No. 4.2 (formulas 8.1 – 8.2 in table 3) is based on the relation of deviation of the effective factor to the difference between the effective actual and planned factors, which is adjusted by comparative coefficients (\(A_4\)).

Method No. 5.1 (formulas 9.1 – 9.2 in table 3) is based on the ratio of the deviation of the effective factor to the difference between the actual effective factors, which is adjusted by comparative coefficients (\(A_1\)).

Method No. 5.2 (formulas 10.1 – 10.2 in table 3) is based on the ratio of the deviation of the effective factor to the difference between the planned effective factors, which is adjusted by comparative coefficients (\(A_4\)).
Table 3. Methods of alternative factor analysis using comparative coefficients.

| No. | formulae | the main part of the formula | adjustment factors | adjustment factors |
|-----|----------|-----------------------------|--------------------|--------------------|
| 1.1 | ΔDR (F_1) = DR_{10}(A_1) - DR_0 | | | |
| 1.2 | ΔDR (F_2) = (DR_{10}(A_1) - DR_0) | | A_1 | |
| 2.1 | ΔDR (F_2) = (DR_{10} - DR_{10}*(A_2)) | | A_1 | |
| 2.2 | ΔDR (F_2) = (DR_{10} - DR_{10}*(A_2)) | | A_1 | |
| 3.1 | ΔDR (F_2) = (ΔF_1/F_10) * DR_0 | | | |
| 3.2 | ΔDR (F_2) = (ΔF_2/F_20) * DR_0 | | | |
| 4.1 | ΔDR (F_2) = ((ΔF_1/F_10) * DR_0) | | A_1 | |
| 4.2 | ΔDR (F_2) = (ΔF_2/F_20) * DR_0 | | A_1 | |
| 5.1 | ΔDR (F_2) = (ΔF_1/F_10) * DR_0 | | A_1 | |
| 5.2 | ΔDR (F_2) = (ΔF_2/F_20) * DR_0 | | A_1 | |
| 6.1 | ΔDR (F_1) = (DR_{10} - (DR_{10}*(A_2)) | | | |
| 6.2 | ΔDR (F_2) = (DR_{10} - (DR_{10}*(A_2)) | | | |
| 7.1 | ΔDR (F_1) = ΔDR - (DR_{10} - (DR_{10}*(A_2)) | | | |
| 7.2 | ΔDR (F_2) = (DR_{10} - (DR_{10}*(A_2)) | | A_1 | |
| 8.1 | ΔDR (F_1) = ΔDR - (DR_{10} *(A_2) - DR_0) | | A_1 | |
| 8.2 | ΔDR (F_2) = ΔDR - (DR_{10} *(A_2) - DR_0) | | A_1 | |
| 9.1 | ΔDR (F_1) = ΔDR - (DR_{10} *(A_2) - DR_0) | | A_1 | |
| 9.2 | ΔDR (F_2) = ΔDR - (DR_{10} *(A_2) - DR_0) | | A_1 | |
| 10.1 | ΔDR (F_1) = ΔDR - (DR_{10} *(A_2) - DR_0) | | A_1 | |
| 10.2 | ΔDR (F_2) = ΔDR - (DR_{10} *(A_2) - DR_0) | | A_1 | |

4. Results
The results for methods 1.1, 2.1, 3.1, 4.1, 5.1 for all Russian companies in general are shown in table 4, the results for methods 1.2, 2.2, 3.2, 4.2, 5.2 for all Russian companies in general are shown in table 5.

Table 4. Results for methods 1.1, 2.1, 3.1, 4.1, 5.1 for all Russian companies in general.

| No. | the main part of the formula | adjustment factors | result |
|-----|-----------------------------|--------------------|--------|
| 1   | ΔDR (F_1) = -0.009          | 0.967              | -0.009 |
| 2   | ΔDR (F_2) = 0.003           | A_1                | 0.003  |

Table 5. Results for methods 1.2, 2.2, 3.2, 4.2, 5.2 for all Russian companies in general.

| No. | the main part of the formula | adjustment factors | result |
|-----|-----------------------------|--------------------|--------|
| 1   | ΔDR (F_1) = -0.009          | 0.989              | -0.009 |
| 2   | ΔDR (F_2) = 0.003           | A_1                | 0.003  |

The results for methods 1.1, 2.1, 3.1, 4.1, 5.1 for all Russian companies involved in building construction are shown in table 6, the results for methods 1.2, 2.2, 3.2, 4.2, 5.2 for all Russian companies involved in building construction are shown in table 7.
Table 6. Results for methods 1.1, 2.1, 3.1, 4.1, 5.1 in general for all Russian companies engaged in building construction.

| No. | the main part of the formula | adjustment factors | result |
|-----|------------------------------|--------------------|--------|
| 1   | $\Delta DR (F_1) = 0.031$   | –                  | 0.031  |
| 2   | $\Delta DR (F_2) = -0.008$  | 1.091 $A_1$       | -0.008 |

Table 7. Results for methods 1.2, 2.2, 3.2, 4.2, 5.2 in general for all Russian companies engaged in building construction.

| No. | the main part of the formula | adjustment factors | result |
|-----|------------------------------|--------------------|--------|
| 1   | $\Delta DR (F_1) = 0.030$   | 1.023 $A_4$       | 0.031  |
| 2   | $\Delta DR (F_2) = -0.008$  | –                  | -0.008 |

The result for methods 1.1, 2.1, 3.1, 4.1, 5.1 in general for all Russian companies engaged in the construction of engineering structures is presented in table 8, the result for methods 1.2, 2.2, 3.2, 4.2, 5.2 in general for all Russian companies engaged in the construction of engineering structures is presented in table 9.

Table 8. Results for methods 1.1, 2.1, 3.1, 4.1, 5.1 in general for all Russian companies engaged in the construction of engineering structures.

| No. | the main part of the formula | adjustment factors | result |
|-----|------------------------------|--------------------|--------|
| 1   | $\Delta DR (F_1) = -0.020$  | –                  | -0.020 |
| 2   | $\Delta DR (F_2) = 0.016$   | 0.944 $A_4$       | 0.015  |

Table 9. Results for methods 1.2, 2.2, 3.2, 4.2, 5.2 in general for all Russian companies engaged in the construction of engineering structures.

| No. | the main part of the formula | adjustment factors | result |
|-----|------------------------------|--------------------|--------|
| 1   | $\Delta DR (F_1) = -0.021$  | 0.957 $A_4$       | -0.020 |
| 2   | $\Delta DR (F_2) = 0.015$   | –                  | 0.015  |

The result for methods 1.1, 2.1, 3.1, 4.1, 5.1 in general for all Russian companies engaged in specialized construction works is presented in table 10, the result for methods 1.2, 2.2, 3.2, 4.2, 5.2 in general for all Russian companies engaged in specialized construction works is presented in table 11.

Table 10. Results for methods 1.1, 2.1, 3.1, 4.1, 5.1 in general for all Russian companies engaged in specialized construction works.

| No. | the main part of the formula | adjustment factors | result |
|-----|------------------------------|--------------------|--------|
| 1   | $\Delta DR (F_1) = -0.015$  | –                  | -0.015 |
Table 11. Results for methods 1.2, 2.2, 3.2, 4.2, 5.2 in general for all Russian companies engaged in specialized construction works.

| No. | the main part of the formula | adjustment factors | result |
|-----|-----------------------------|--------------------|--------|
| 1   | \( \Delta R (F_1) = -0.017 \) | 0.933              | \( A_4 \) | -0.015 |
| 2   | \( \Delta R (F_2) = 0.024 \) | -                  | 0.024  |
|     |                             | 0.008              |        |
|     |                             |                    | 0.009  |

As can be seen from the final result of tables 1, 4-10 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 0.3%.

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 -0.9%.

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 3.1%.

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 -0.8%.

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 1.5%.

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 -2%.

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 2.4%.

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 -1.5%.

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%.
5. Discussion
A comparison of the results of the author's method (integral No. 1 and alternative-traditional) factor analysis of changes in the profitability of fixed assets is presented in tables 12-15.

Table 12. Comparison of results by author's methods of factor analysis in general for all Russian companies.

| No. | ΔDR (F_n) | The result of the integral method No. 1 | Result for alternative methods | Δ |
|-----|-----------|---------------------------------------|-------------------------------|---|
| 1   | ΔDR (F_1) = | -0.015 | -0.009 | 0.006 |
| 2   | ΔDR (F_2) = | 0.009 | 0.003 | -0.006 |
|     |            | -0.006 | -0.006 | 0.000 |

Table 13. Comparison of the results of the author's methods of factor analysis in general for all Russian companies engaged in the construction of buildings.

| No. | ΔDR (F_n) | The result of the integral method No. 1 | Result for alternative methods | Δ |
|-----|-----------|---------------------------------------|-------------------------------|---|
| 1   | ΔDR (F_1) = | 0.050 | 0.031 | -0.019 |
| 2   | ΔDR (F_2) = | -0.027 | -0.008 | 0.019 |
|     |            | 0.023 | 0.023 | 0.000 |

Table 14. Comparison of the results of the author's methods of factor analysis in general for all Russian companies engaged in the construction of engineering structures.

| No. | ΔDR (F_n) | The result of the integral method No. 1 | Result for alternative methods | Δ |
|-----|-----------|---------------------------------------|-------------------------------|---|
| 1   | ΔDR (F_1) = | -0.039 | -0.020 | 0.019 |
| 2   | ΔDR (F_2) = | 0.034 | 0.015 | -0.019 |
|     |            | -0.005 | -0.005 | 0.000 |

Table 15. Comparison of results on the author's methods of factor analysis in general for all Russian companies engaged in specialized construction works.

| No. | ΔDR (F_n) | The result of the integral method No. 1 | Result for alternative methods | Δ |
|-----|-----------|---------------------------------------|-------------------------------|---|
| 1   | ΔDR (F_1) = | -0.036 | -0.015 | 0.021 |
| 2   | ΔDR (F_2) = | 0.045 | 0.024 | -0.021 |
|     |            | 0.009 | 0.009 | 0.000 |

Variance, as you know, is a characteristic of the dispersion of data around the average value. The variance of the results presented in tables 12-15 in conditions when the resultant indicator changes under the simultaneous influence of several factors with different impact force, objectively says that the use of traditional methods is more reasonable than the integral one.

6. Conclusion
The construction complex is one of the key areas of economic activity in the Russian Federation and largely determines the solution of social, economic and technical problems of its development.

The combined effect of two factors (the autonomy coefficient and the financial leverage coefficient) led to:
- to increase the financial dependence of all Russian companies engaged in building construction by 2.3%;
- to reduce the financial dependence of all Russian companies engaged in the construction of engineering structures by -0.5%;
- to increase the financial dependence of all Russian companies engaged in specialized construction works by 0.9%.

In market conditions, the key to a stable position of the organization is its financial stability (Eraker, B., Johannes, M., & Polson, N. G., 2003; Hyman, D. N., 1988). The financial stability of the company reflects the state of financial resources in which the organization, freely manipulating funds, is able to ensure the continuity of the production process by using them effectively, as well as to minimize the costs of its expansion and renewal (Wonnacott, P., & Wonnacott, R., 1990; Hyman, D. N., 1989; Maurice, S. C., & Phillips, O. R., 1986).

Acknowledgments
The article was carried out within the framework of the scientific project of the Inc SB RAS no. XI.174.1.4 «Activation of the internal development potential of regions of resource specialization (on the example of the Baikal region)».

References
[1] Alekseycheva E Yu, Magomedov M D and Kostin I B 2020 Economy of the organization (enterprise) p 290
[2] Baskakova O V and Machabeli M Sh 2019 Economy of the organization p 306
[3] Eraker B Johannes M and Polson N G 2003 The impact of jumps in returns and volatility Journal of Finance 53 1269-1300
[4] Filatov E A 2019 Author's regional measurement of investment intensity of gross regional product of Irkutsk region IOP Conf. Series: Materials Science and Engineering 667 012023
[5] Hyman D N 1988 Microeconomics p 602
[6] Hyman D N 1989 Modern microeconomics. Analysis and applications p 689
[7] Maurice S C and Phillips O R 1986 Economic analysis. Theory and application p 642
[8] Novashina T S, Karpunin V I and Kosorukova I V 2020 Economics and finance of the enterprise p 336
[9] Rumyanceva E E 2019 Economic analysis p 382
[10] Shadrina G V 2019 Economic analysis p 432
[11] Sheremet A D and Horin A N 2018 Theory of economic analysis p 390
[12] Wonnacott P and Wonnacott R 1990 Microeconomics p 521