The Fuzzy Model for Sectoral Resilience Analysis

YURY ALEKSEEVICH MALYUKOV[1] ,ALEXEY OLEGOVICH NEDOSEKIN[2],
ZINAIDA IGOREVNA ABDOULAEVA[3],
ALEXEY VIKTOROVICH SILAKOV[1]
[1]Administrative Department,
Russian State University named after A.N. Kosygin (Technology. Design. Art),
Malaya Kaluzhskaya St., 1, 119071, Moscow,
RUSSIA

[2]Administrative Department,
"Institute of Financial Technologies",
Engels ave. 53, 194017, St. Petersburg,
RUSSIA

[3]Department of Medical Informatics and Physics,
North-Western State Medical University named after I. I. Mechnikov,
Piskarevsky pr. 47, 195067, St. Petersburg,
RUSSIA

Abstract: - The report describes a process of analyzing sectoral resilience using the strategic matrix model of 4x6. It presents the main measures at the government level that can contribute to the restoration of sectoral resilience in the event of unfavorable impacts such as military, natural, or technological incidents.
Methods. The 4x6 matrix is an oriented graph, with nodes representing the matrix indicators distributed across the matrix cells, and edges representing the links between indicators. The model is dynamic and positioned in discrete time, with the unit of measurement being a year. The matrix models the industry as a cybernetic system with positive and negative feedback loops. Negative feedback loops are generated based on anti-risk management results. Positive feedback loops arise in two ways: a) reinvesting net profits in business and increasing equity; b) proactive decision-making. The report presents a simple example of a sectoral matrix consisting of 15 indicators connected by 22 links. It demonstrates the anti-risk and proactive management of industry resilience by the state, through public-private mobilization partnerships (PPMP). The paper examines the positive impact of the following measures on industry resilience: a) price regulation; b) return industrial mortgage; c) government supply chain factoring; and d) government leasing. The relationship between efficiency, resilience, risks, and opportunities is ambiguous. It is necessary to research the optimal zones where an acceptable value of all four factors can be preserved at the same time. Resilience is lost in both positive and negative senses; progress occurs in leaps, and new qualitative heights in business are achieved through repeated growth of all types of risk accompanying that business. In this case, stabilizing measures can hinder reaching new heights. The proposed modeling technology allows for the analysis of cross-industry interaction, including the creation of cross-industry syndicates (clusters).

Key-Words: - sectoral economic resilience, 4x6 matrix, unfavorable impacts, matrix aggregate calculator (MAC), balanced scorecard (BSC), public-private mobilization partnership (PPMP), anti-risk/proactive management of resilience

Received: March 18, 2023. Revised: August 25, 2023. Accepted: September 10, 2023. Published: September 20, 2023.

1 Introduction

In the conditions of Russia's war efforts, a mobilization economic program is necessary. It assumes that specific sectors will emerge within traditional economic industries that operate under new rules, within the framework of a public-private mobilization partnership (PPMP). During the fulfillment of the state defense order through these sectors, three criteria must be ensured: volume, timeliness, and quality of production. In exchange, the state must be ready to provide businesses with guarantees for protecting both invested capital and return on invested capital (ROE). As a whole, sectoral resilience must be ensured, which we understand to be the ability of sectors to function with the required efficiency in the face of adverse military, natural, or man-made conditions.

The issues of resilience of economic systems are extensively discussed in works, [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11]. Additionally, for our research, it is important to note that when modeling resilience, the economic system must be constructed to the level of a super-system and viewed as a system of systems. This aspect of system modeling is comprehensively discussed in works, [12], [13], [14], [15], [16], [17], [18], [19], [20], [21].

The objective of this study is to propose a fundamentally new scheme for analyzing industry resilience, assuming that the set of negative influences, the industry itself, and the set of solutions for ensuring resilience are all subsystems within a complex super-system that must be comprehensively evaluated as a cybernetic system that loses resilience under certain conditions and seeks to return to its original stable state, i.e. regain balance with the external environment.

The main difference between our approach to the analysis of economic resilience and the cited works is as follows. We consider not individual AE scenarios weighted by significance level, but a continuous spectrum of such scenarios, the parameters of which are represented by fuzzy numbers of a general form. In accordance with this input condition, the response of the supersystem to impacts is a continuous spectrum of ROE, represented by a fuzzy number of a general form.

The sequence of sectoral resilience modeling is as follows:

A. We identify the largest enterprises within the sector and analyze them using the fuzzy-logical technology of a matrix aggregate calculator (MAC), [3], [5].

B. We build sectoral indices by the weighted average method, where assets of companies on the balance sheet act as weights. We apply the method of intelligent filtering to suppress distortions.

C. We obtain forecasts for sectoral indices in the form of fuzzy numbers and functions.

D. We formulate a draft state decision on supporting sectors, to bring the ROE level in sectors to 20% a year or higher.

E. We perform a comprehensive modeling of state decisions according to the 4x6 matrix method.

Let's consider the 5 stages of modeling in order.

2 Assessment of Company Resilience using the MAC Technology

Within the sector, dominant enterprises engaged in the state defense order are selected. A detailed analysis of resilience using the MAC technology is described in, [5]. It is carried out based on the following main indicators, assessed based on the annual reports of companies:

MR –margin profitability (%),
OR – operational profitability (%),
NR – net profitability (%),
TAA – turnover of all assets (once a year),
TCA – turnover of current assets (once a year),
CL – common liquidity (dimensionless),
FL – financial leverage (dimensionless),
LD – loan dependency (dimensionless),
WACE – weight-averaged cost of equity (% a year),
WACL - weight-averaged cost of liability (% a year),
LER – labor efficiency measured by revenue (USD Th per 1 employee a year),
LENP - labor efficiency measured by net profit (USD Th per 1 employee a year).

The indicator of sectoral resilience, RI, is estimated as a two-dimensional convolution using the formulas from [5], and receives values from 0.1 (very low level) to 0.9 (very high level). The first system of weights in the convolution is the significance of factors in the evaluation. The second system of weights in the convolution is nodal points corresponding to qualitative gradations of the indicators included in the evaluation. ROE is also assessed as the ratio of net annual profit per company to its capital.

Based on the assessment of RI and ROE for companies, sectoral indices are constructed using the weighted average method. If Xit is the measurement of factor X for the i-th company in the sector conducted in year t, and Ait is the assets of the i-th company in year t, then the sectoral index Ind_X (t) should be sought using the following formula:

$$\text{Ind\_X}\ (t) = \sum_{(i)} A_{it} * X_{it} / \sum_{(i)} A_{it} \qquad (1)$$

In Table 1 and Table 2, data on RI and ROE indices are compiled, respectively, for five sectors named according to the European classification, [22]. In terms of dimensionality, sectoral indices coincide with the corresponding indicators but are presented in tables as decimal numbers.

Table 1. Sectoral RI Indices

Year	Ind_ RI for sectors:				
	C11	***DJ27***	***DK29***	***DL31***	***E40***
2015	0.398	0.368	0.518	0.389	0.445
2016	0.356	0.371	0.490	0.424	0.448
2017	0.434	0.409	0.516	0.380	0.473
2018	0.469	0.458	0.476	0.395	0.461
2019	0.418	0.399	0.463	0.442	0.468
2020	0.310	0.376	0.422	0.421	0.438
2021	0.459	0.533	0.499	0.490	0.485
2022	0.506	0.581	0.498	0.417	0.476

Source: authors' research

Table 2. Sectoral ROE Indices

Year	Ind_ROE for sectors:				
	C11	***DJ27***	***DK29***	***DL31***	***E40***
2015	0.210	- 0.252	0.273	0.018	0.030
2016	0.027	0.028	0.627	0.107	0.344
2017	0.070	0.068	0.432	-0.001	0.134
2018	0.110	0.122	0.258	-0.219	0.114
2019	0.072	0.013	0.247	0.014	0.102
2020	- 0.085	0.115	0.133	0.104	0.080
2021	0.126	0.208	0.171	- 0.012	0.091
2022	0.183	0.165	0.181	0.066	- 0.037

Source: authors' research

3 Forecasting Sectoral Indices

The information contained in historical data is sufficient to build a fuzzy forecast for the next forecasting year. This forecast can be made in the form of a fuzzy number using the following formulas:

$$\text{Min\_I\_X} = \min_{(t)} Ind\_X(t),$$
$$\text{Av\_I\_X} = \underset{(t)}{\text{average}}\, Ind\_X(t),$$
$$\text{Max\_I\_X} = \max_{(t)} Ind\_X(t), \qquad (2)$$

Here, FI = FI (Min_I_X, Av_I_X, Max_I_X) is a triangular fuzzy number with abscissas expressing the minimum, average, and maximum values across the I_X measurements for the entire observation period, [5]. This is the forecast for the index for the next year.

Table 3 provides data on triangular fuzzy numbers within individual sectoral resilience indices for sector C11 (as a separate sectoral example).

Table 3. Fuzzy sectoral resilience factors (C11)

Factor	Resilience index	FI for C11 indices		
		Min_I_X	***Av_I_X***	***Max_I_X***
Z1	Ind_MR	0.178	0.301	0.368
Z2	Ind_OR	-0.021	0.079	0.155
Z3	Ind_NR	-0.055	0.044	0.104
Z4	Ind_TAA	0.557	0.745	1.106
Z5	Ind_TAE	2.672	4.136	9.909
Z6	Ind_CL	1.165	1.221	1.308
Z7	Ind_FL	1.005	1.304	1.512
Z8	Ind_LD	0.074	0.323	0.789
Z9	Ind_WACE	0.042	0.056	0.081
Z10	Ind_WACL	0.013	0.019	0.048
Z11	Ind_LER	1610	2533	4040
Z12	Ind_LENP	-128	106	411
RI	Ind_RI	0.310	0.419	0.506
ROE	Ind_ROE	-0.085	0.066	0.183

Source: authors' research

4 Development of State Regulatory Policy

To have a basis for protecting capital and ROE, the government must be confident in the effective performance of companies within the framework of the state defense order. Such efficiency is ensured by the following necessary but not sufficient criteria:

Ind_NR > 0.05, Ind_TAA > 1.5, Ind_FL > 1.6 (3)

In this case Ind_ROE > 0.2.

The requirements (3) lead to the following measures of state sectoral regulation:

- Fixing prices for essential goods;
- State supplier factoring;
- State leasing;
- State reverse mortgage of industrial non-current assets.

All data collected as a result of the preliminary analysis is placed in a 4x6 matrix as shown in Figure 1. The 4x6 matrix is a system of six strategically interrelated maps, each with four strategic perspectives highlighted:

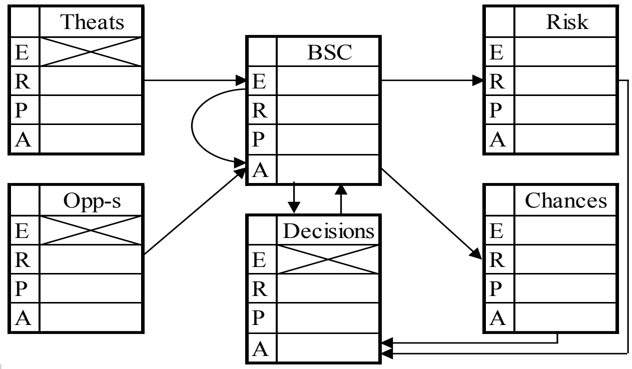

Fig. 1: 4x6 Matrix
Source: [1]

Map labels:
- Threats - Threats map;
- Opp-s - Opportunities map (as in the SWOT matrix);
- BSC - Balanced scorecard map;
- Risk - Risk map;
- Chances - Chances map;
- Decisions - Decisions map.
- Strategic perspective labels:
- A - Resources;
- P - Processes;
- R - Industry relations with its key stakeholders (consumers, suppliers, banks, employees, government, etc.);
- E - Effects - the expected results of the industry's activities.

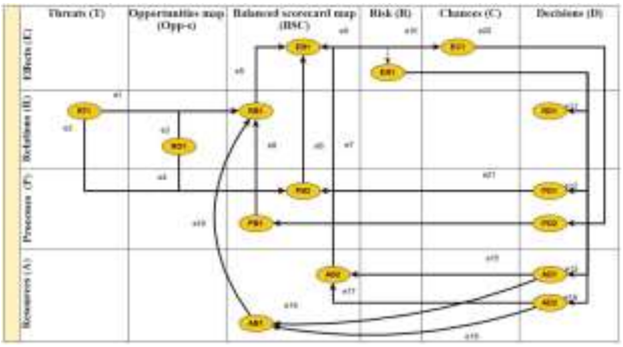

Fig. 2: Simple example of an industry 4x6 matrix
Source: authors' research

The expanded 4x6 matrix is shown in Figure 2.

Table 4 summarizes the node labels of the corresponding graphic, and Figure 2 summarizes the edge labels of the graphic. The indicators on the strategic maps are denoted using the XYZ principle, where X is the code for the strategic perspective, Y is the code for the map, and Z is the indicator number within a cell of the matrix.

Table 4. Indicators of the 4x6 matrix

№	Indicator code	Indicator name	Unit of measurement
1	RT1	Sectoral demand compression index	% year-on-year
2	RO1	Sectoral demand expansion index	% year-on-year
3	EB1	Return on equity (ROE) index	% a year
4	RB1	Net profitability index	%
5	PB1	Labor efficiency index	Thousand USD revenue per employee per year
6	PB2	Asset turnover index	Once a year
7	AB1	Weighted average cost of capital (WACC) index	% a year
8	AB2	Financial leverage index	Dimensionless
9	ER1	Integral sectoral index	From 0 to 1
10	EC1	Integral sectoral chance	From 0 to 1
11	RD1	Sectoral decision factor 1: increase in net profitability	%
12	PD1	Sectoral decision factor 2: increase in asset turnover	Once a year
13	PD2	Sectoral decision factor 3: increase in labor efficiency	Thousand USD revenue per employee per year
14	AD1	Sectoral decision factor 4: increase in financial leverage, decrease in weighted average cost of capital	Leverage – dimensionless, weighted average cost of capital - % a year
15	AD2	Sectoral decision factor 5:	Leverage – dimensionless, weighted average cost of capital - % a year

Source: authors' research

The contents of Figure 2, Table 4, and Table 5 lead to the following explanatory observations:

- The industry in the 4x6 matrix model represents a cybernetic system with the following basic properties:
  – The industry's goal is to achieve steady growth in ROE. The business owner receives their income last in the value chain. This implies that all other stakeholders have already received their share of the profit and are satisfied with it.
  – The industry is open to the world, making it susceptible to adverse effects (AE) both in a negative (Threats) and positive (Opportunities) sense. The impact of AE on the industry could result in a temporary loss of resilience. The industry has a certain level of sensitivity to AE (this thesis is not explained in detail in this article).
  – The industry aims to achieve equilibrium with the environment and maintain homeostasis. Therefore, it responds to AE resilience, and the response is formed by the industry's governing subsystem (the state). In response to a temporary loss of resilience, the government forms anti-risk and pro-opportunity decisions. In the first case, management is carried out within a negative feedback loop (returning the system to its previous state); in the second case, management involves transitioning the industry system into a qualitatively new state.
- The relationships in Table 5 may have the following content:
  – Traditional functional-algorithmic relationships;
  – Fuzzy connections;
  – Production-type connections of IF-THEN.

Table 5. Connections between indicators in the 4x6 matrix

№	Link code (Source node-Target node)	Content of the link
1	**e1** (RT1-RB1)	Compression of industry demand leads to a decrease in net profitability (NP)
2	**e2** (RT1-PB2)	Compression of industry demand leads to a decrease in asset turnover (AT)
3	**e3** (RO1-RB1)	Expansion of industry demand leads to an increase in net profitability (NP)
4	**e4** (RO1-PB2)	Expansion of industry demand leads to an increase in asset turnover (AT)
5	**e5** (RB1-EB1)	Net profitability (NP) directly influences ROE (DuPount formula)
6	**e6** (PB2-EB1)	Asset turnover (AT) directly influences ROE (DuPount formula)
7	**e7** (AB2-EB1)	Financial leverage (FL) directly influences ROE (DuPount formula)
8	**e8** (PB1-RB1)	Growth in labor efficiency measured by revenue leads to an increase in net profitability
9	**e9** (EB1-ER1)	Decrease in ROE leads to an increase in overall risk
10	**e10** (EB1-EC1)	Increase in ROE leads to an increase in overall opportunity
11	**e11** (ER1-RD1)	Increase in overall risk leads to the start of Solution 1
12	**e12** (ER1-PD1)	Increase in overall risk leads to the start of Solution 2
13	**e13** (ER1-AD1)	Increase in overall risk leads to the start of Solution 4
14	**e14** (ER1-AD2)	Increase in overall risk leads to the start of Solution 5
15	**e15** (AD1-AB2**)**	Solution 4 leads to a decrease in financial leverage (FL)
16	**e16** (AD1-AB1)	Solution 4 leads to a decrease in WACC 3
17	**e17** (AD2-AB2)	Solution 5 leads to a decrease in financial leverage (FL)
18	**e18** (AD2-AB1)	Solution 5 leads to a decrease in WACC 3
19	**e19** (AB1-RB1)	Decrease in WACC_Z leads to an increase in net profitability (NP)
20	**e20** (EC1-PD2)	Increase in overall risk leads to the start of Solution 3
21	**e21** (PD1-PB2)	Removal of morally outdated funds leads to an increase in asset turnover (AT)
22	**e22** (PD2-PB1)	Increase in motivation quality leads to an increase in labor productivity

Source: authors' research

5 Example of Modeling within a 4x6 Matrix

Let's consider an example of an abstract industry segment - a group of companies united by certain characteristics (such as geographical, sectoral, product-related, etc.). Let's assume that the level of information disclosure of these companies allows for the synthesis of a consolidated financial statement with a sufficient level of detail to identify all the necessary indicators for model calculations.

Table 6. Reporting and forecasting years based on the results of modeling the industry segment

Indicator	Value EUR			
	Year 1	Year 2.1	Year 2.2	Year 2.3
Revenue (million)	1000	900	850	800
Current operational cost (million)	800	720	680	640
Gross Margin (million)	200	180	170	160
Fixed operational cost (million)	70	70	70	70
Operational profit (million)	130	110	100	90
Non-operational income (million)	0	0	0	0
Current investment cost (million)	30	30	30	30
Financial cost (million)	70	70	70	70
Profit before tax (million)	30	10	0	-10
Profit tax (million)	6	2	0	0
Net profit (million)	24	8	0	-10
Own capital (million)	300	300	300	300
Borrowed capital (million)	700	700	700	700
Fixed assets (million)	800	800	800	800
Current assets (million)	200	200	200	200
Total assets = Total liabilities (million)	1000	1000	1000	1000
Ind_MR (%)	20%	20%	20%	20%
Ind_NR (%)	2%	1%	0%	-1%
Ind_TAA (times per year)	1.000	0.900	0.850	0.800
Ind_WACC (% per annum)	7%	7%	7%	7%
Ind_FL (dimensionless)	2,33	2,33	2,33	2,33
Ind_ROE (% per annum)	8%	2,7%	0%	-3,3%

Source: authors' research

All calculations will be carried out in euros. From a modeling perspective, the choice of currency for the consolidated financial statements does not have a significant impact.

Let's call Year 1 - the reporting year for the company, Year 2.1 - the forecast year under scenario 1, Year 2.2 - the forecast year under scenario 2, and Year 2.3 - the forecast year under scenario 3. Each of the scenarios is modeled outside the 4x6 matrix using its own modeling tools. The modeling results are presented in Table 6.

From Table 6, it can be seen that:

- The industry segment is formally operating on the breakeven point, which is determined by the annual consolidated revenue of 850 million euros.
- The modeling considers market contraction scenarios in the range of 10-20% from the level of the reporting year.
- The segment's borrowed capital has been formed at an average weighted interest rate of 10% per annum.
- Anticrisis measures for the industry segment are not included in scenarios 1-3, as the asset and capital structure remain unchanged.

5.1 Adverse Effects (AE) Dimensions

Let's include a simplified AE model in the matrix, which considers the expected market contraction as a triangular fuzzy number Z = (-10%, -15%, -20%), as shown in Table 6. However, here we model the complete range of scenarios, with the expectations of the impacts distributed unevenly and tending towards the center of the interval.

In this case, the factor Z remains in the "basement" of the matrix model, and it is linked to the "basement" factor Revenue through a regular functional relationship:

Revenue (Year 2) = Revenue (Year 1) * (1 - Z) (4)

5.2 Industry Risk Assessment before Decision

The industry's response to the fuzzy market contraction Z is represented by the industry-specific ROE index in a triangular form as Ind_ROE = (min=-3.3%, av=0%, max=2.7%). A norm of N1=0% per annum corresponds to the breakeven point. The risk of the industry segment incurring losses under this AE scenario can be estimated using the following formulas:

$$\text{Risk} = \begin{cases} 0, \min > N1 \\ R * (1 + \frac{(1-Alpha)}{Alpha} * Ln(1 - Alpha)), min < N1 < av \\ R, \text{H}1 = av \\ 1 - (1 - R) * \left(1 + \frac{(1-Alpha)}{Alpha} * Ln(1 - Alpha)\right), av < N1 < max \\ 1, max < N1 \end{cases} \tag{5}$$

where

$$\text{R} = \begin{cases} 0, N1 < min \\ (N1 - \min)/(max - \min), min < N1 < max \\ 1, N1 > max \end{cases} \tag{6}$$

$$Alpha = \begin{cases} \delta, min > N1 \\ \frac{N1-\min}{max-\min}, min < N1 < av \\ 1, N1 = av \\ \frac{max-N1}{max-min}, av < N1 < max \\ \delta, N1 > max \end{cases} \tag{7}$$

and δ is an infinitely small value. In this case, the uncertainty of the form "zero over zero" in formula (5) is resolved using one of L'Hopital's rules:

$$\lim_{Alpha \to 0} \frac{\ln(1-Alpha)}{Alpha} = -1 \tag{8}$$

Calculating using formulas (5), (6), (7), and (8) gives Risk = 0.550. We can fuzzify this value by introducing the linguistic normalization that has already become a tradition:

High Level: Risk < 0.1 - acceptable non-decreasing risk;

Middle Level: 0.1 < Risk < 0.2 - borderline risk;
Low Level: Risk > 0.2 - unacceptable risk; (9)

Thus, the qualitative value of the integral risk falls on the Risk map in the matrix, while the original quantitative value is moved to the "basement". Since the risk is unacceptable, the red alert light is triggered, indicating that an anti-risk decision is necessary and mandatory. If the yellow light had turned on instead (indicating borderline risk), the decision could have been delayed. However, in this case, the decision is urgent as the fate of the industry segment depends on it.

5.3 Solution Dimensions

The following comprehensive solution, undertaken by the government in relation to the industry segment, is being considered:

- Replace ΔBC = 200-300 million euro of borrowed capital with own funds. This will reduce Ind_WACC and corresponding financial costs.
- Sell ΔFA = 200-300 million euro of non-current assets with an expected discount to the book value d=10-20%. This will increase the turnover of all assets, scale up in the market, even with losses, while also paying off certain loans – and again lower WACC.

If we were in a scenario paradigm of modeling, we would have to "split" the three initial scenarios of AE, overlaying all the options of the proposed solution on them. However, since we are in the paradigm of fuzzy sets and soft computing, it is sufficient for us to connect the indicators of interest in a fuzzy form, creating a similar Table 6 computational scheme based on formulas in fuzzy notation, for borrowed capital and fixed assets, respectively:

BC (Year 2) = C (Year 1) - ΔC; (10)

FA (Year 2) = FA (Year 1) - ΔFA *(1-d) (11)

Losses associated with the sale of fixed assets are attributed to non-operational income, with a "-" sign. These losses reduce the size of equity capital, which is also reflected in the modeling. In turn, profits, if any, are distributed as dividends to the owners of companies in the segment and do not affect the size of equity capital.

5.4 Modeling Results

The modeling results are presented in Table 7.

Table 7. Modeling Results

Indicator	Value EUR			
	Value Year 1	Value Year 2		
		min	*av*	*max*
Revenue (million)	1000	800	850	900
Current operational cost (million)	800	640	680	720
Gross Margin (million)	200	160	170	180
Fixed operational cost (million)	70	70	70	70
Operational profit (million)	130	90	100	110
Non-operational income (million)	0	-60	-37,5	-20
Current	30	30	30	30

	Value EUR			
Indicator	**Value Year 1**	**Value Year 2**		
		min	***av***	***max***
investment cost (million)				
Financial cost (million)	70	26	23,75	22
Profit before tax (million)	30	-26	8,75	38
Profit tax (million)	6	0	1,75	7,6
Net profit (million)	24	-26	7	30,4
Own capital (million)	300	440	512,5	580
Borrowed capital (million)	700	20	237,5	220
Fixed assets (million)	800	500	550	600
Current assets (million)	200	200	200	200
Total assets = Total liabilities (million)	1000	700	750	800
Ind_MR (%)	20%	20%	20%	20%
Ind_NR (%)	2%	1%	0%	-1%
Ind_TAA (times per year)	1.000	1.143	1.133	1.125
Ind_WACC (% per annum)	7%	4%	3%	3%
Ind_FL (dimensionless)	2,33	0,59	0,46	0,38
Ind_ROE (% per annum)	8%	-5,9%	1,4%	5,2%

Source: authors' research

In the case of Table 7 data, Ind_ROE = (-5.9, 1.4, 5.2)% per annum, and the corresponding risk is Risk = 0.323, it is significantly reduced but still unacceptable. From this, the following recommendations for adjusting the initial industry solution arise:

- Do not sell FA at a discount higher than 10%;
- Negotiate with banks to reduce the interest rate on the loan or restructure the debt with reduced current interest payments. This will not solve the situation in a strategic sense, but it will allow for "riding out the storm in the library" (an analogy from the movie "The Day After Tomorrow"), postponing radical decisions until the moment when the market recovers (if it recovers).

6 Conclusion

The 4x6 strategic matrix is a universal tool for modeling enterprises and industries for completely different purposes, including analyzing industry resilience. The conclusions obtained in such modeling cannot be obtained within any other model representations.

The approach incorporated into our modeling system is fuzzy-logical and allows for the possibility of complementing it with probabilistic components depending on the type of uncertainty being studied. In all cases, the uncertainty of the industry's existing conditions must be classified and appropriately described.

The 4x6 matrix reproduces the order of industry management by the state, while the industry as an object of management is seen as a cybernetic system. The feedback arising in the course of management is negative (if the management is anti-risk) or positive (if the management is pro-opportunity Sometimes the decisions that are made can contradict one another.

For example, a strategy of maintaining the status quo in the context of AE may hinder the discovery of new market opportunities and effective management. Industry segments responsible for activities in the face of different types of challenges may be fundamentally different. If specialized inter-industry syndicates are well-suited to the conditions of a particular period, then it is advisable to create special inter-industry clusters for the conditions of market expansion (according to the experience of Uzbekistan, [23]).

The main directions of development of the approach proposed in the article are as follows:

- Transition from a 4x6 matrix to a 7x6 matrix, increasing the number of strategic perspectives.

- Taking into account specific anti-risk and prochance decisions in the model, which involves modeling real options.

In all cases, the activities of such new economic entities are successfully modeled using the 4x6 matrix and other adjacent technologies, such as industry-specific R-lenses, [24].

References:

[1] Vinogradov V., Abdoulaeva Z. Fuzzy-set economic stability analysis model of mineral complex of the Russian Federation // *Proceedings of the 19th International Conference on Soft Computing and Measurements*, SCM 2016. - 2016., p.489-490.

[2] Fuzzy Model for the Analysis of Corporate Degradation in Crisis Conditions / A. O. Nedosekin, Z. I. Abdoulaeva, D. F. Kurbanbaeva, N. A. Karpenko // Proceedings of 2022 25th International Conference on Soft Computing and Measurements, SCM 2022: 25, St. Petersburg. – St. Petersburg, 2022, p.218-221, DOI:10.1109/SCM55405.2022.9794882.

[3] Fuzzy Matrix Aggregate Calculator (MAC) as a Tool for Economic Systems Express Evaluation / A. O. Nedosekin, Z. I. Abdoulaeva, M. S. Kokorin, A. E. Zhuk // Lecture Notes in Networks and Systems. – 2022. – Vol. 307. – P. 81-89. – DOI: 10.1007/978-3-030-85626-7_10.

[4] The Economic Resilience Evaluation Using Fuzzy Sets and Soft Computing / A. O. Nedosekin, Z. I. Abdoulaeva, N. A. Karpenko, T. A. Nikitina // Lecture Notes in Networks and Systems. – 2022. – Vol. 307. – P. 105-112. – DOI: 10.1007/978-3-030-85626-7_13.

[5] Nedosekin A., Abdoulaeva Z., Konnikov E., Zhuk A. Fuzzy set models for economic resilience estimation. *MDPI (Multidisciplinary Digital Publishing Institute) Mathematics* 2020, 8(9), 1516; https://doi.org/10.3390/math8091516

[6] Nedosekin A., Reishahrit E., Kozlovsky A. Estimation of economic resilience as a fuzzy-logical scientific task // Proceedings of 2017 XX IEEE international conference on soft computing and measurements (SCM). p. 752-753.

[7] Kozlovsky A., Nedosekin A., Abdoulaeva Z., Voronov D., Pelymskaya I. Resilience & competition ability comparison for mining companies // Audit & Financial Analysis. 2019. no. 6, p.62-70.

[8] Chaiechi, T. (2022). Foreword- Sustainable and Resilient Economies, Theoretical Considerations. In: Chaiechi, T., Wood, J. (eds) Community Empowerment, Sustainable Cities, and Transformative Economies. Springer, Singapore. https://doi.org/10.1007/978-981-16-5260-8_1

[9] Paun, C., Musetescu, R., Isaic, R., Manea, G. C., & Shayb, H. (2021). Economic resilience and the state: A global panel analysis. Economics, Management and Sustainability, 6(2), p.34–45. https://doi.org/10.14254/jems.2021.6-2.3

[10] Gunduz, M., Nielsen, Y., & Ozdemir, M. (2013). Fuzzy assessment model to estimate the probability of delay in Turkish. construction projects. *Journal of Management in Engineering*, 31(4), 04014055.

[11] Dojutrek, M. S., Labi, S., & Dietz, J. E. (2015). A fuzzy approach for assessing transportation infrastructure security. In Complex Systems Design & Management, p. 207-224. Springer.

[12] W. C. Baldwin, B. Sauser, and R. Cloutier, "Simulation Approaches for System of Systems: Events-based versus Agent Based Modeling," Procedia Computer Science, vol. 44, p. 363-372, 2015, https://doi.org/10.1016/j.procs.2015.03.032.

[13] Ackoff, Russell L. "Towards a System of Systems Concepts." *Management Science*, vol. 17, no. 11, 1971, pp. 661–71. *JSTOR*, http://www.jstor.org/stable/2629308. (Access date 08.06.2023).

[14] C. B. Nielsen, P. G. Larsen, J. Fitzgerald, J. Woodcock, and J. Peleska, "Systems of systems engineering: basic concepts, model-based techniques, and research directions," ACM Computing Surveys (CSUR), vol. 48, no. 2, p.18, 2015.

[15] A. M. Madni and M. Sievers, "System of systems integration: key considerations and challenges," Systems Engineering, vol. 17, no. 3, p.330-347, 2014.

[16] J. C. Kilian and T. M. Schuck, "Architecture and system-of-systems design for integrated missile defense," in System of Systems Engineering Conference (SoSE), 2016 11th. IEEE, 2016, p.1-6.

[17] B. Ge, K. W. Hipel, K. Yang, and Y. Chen, "A novel executable modeling approach for system-of-systems architecture," IEEE Systems Journal, vol. 8, no. 1, p.4-13, 2014.

[18] J. Dahmann and G. Roedler, "Moving towards standardization for system of systems engineering," in System of Systems Engineering Conference (SoSE), 2016 11th. IEEE, 2016, p.1-6.

[19] Fang, Z., & DeLaurentis, D. (2014). Dynamic Planning of System of Systems Architecture Evolution. Procedia Computer Science, 28, p.449-456.

[20] Pape, L., & Dagli, C. Assessing robustness in systems of systems meta-architectures. Procedia Computer Science, 20, p.262-269, (2013).

[21] A. Mour, C. R. Kenley, N. Davendralingam, and D. Delaurentis, "Agent-Based Modeling for Systems of Systems," no. 1991, p.15, 2013.
[22] NACE 1.1. RAMON – Reference and Management of Nomenclatures. – URL: https://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_CLS_DLD&StrNom=NACE_1_1 (Access date 17.05.2023).
[23] Uzbekistan: The Government Will Support The Activities Of Cotton-textile Clusters In Uzbekistan. - URL: https://www.mondaq.com/international-trade-amp-investment/1285706/the-government-will-support-the-activities-of-cotton-textile-clusters-in-uzbekistan (Access date 17.05.2023).
[24] A. N. Kozlovsky, A. O. Nedosekin, Z. I. Abdoulaeva, E. I. Reyshakhrit R-Lenses as a Tool for the Enterprise / Conference: 2nd International Scientific and Practical Conference "Modern Management Trends and the Digital Economy: from Regional Development to Global Economic Growth" (MTDE 2020) https://doi.org/10.2991/aebmr.k.200502.057

Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

- Alexey O. Nedosekin developed the fuzzy model.
- Yury A. Malyukov has written the paper.
- Zinaida I. Abdoulaeva conducted calculations forecasting sectoral indices and more.
- Alexey V. Silakov created an information base for the calculations.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself:
No funding was received for conducting this study.

Conflict of Interest:
The authors have no conflict of interest to declare.