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MODELLING INSTRUMENTS IN RISK MANAGEMENT

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ABSTRACT

Methods of modelling risks can be considered as a kind of simulation of the future in laboratory conditions. Since the program chooses the values of input variables from random probability distributions, each resulting result reflects the possible state of affairs in the future. Each of these combinations can actually be realized, and with the same degree of probability. Therefore, the results are also possible in the future and are equally likely. The proposed method allows to select, according to certain criteria, the necessary risk indicators for their further study. The economic interpretation of various aspects of the results of managerial analysis obtained during the calculation of indicators is based on an integrated factor model for assessing the efficiency of the enterprise, and the visualization of the results of the analysis of indicators is carried out using such a tool as a managerial monitor. The second instrument – simulation method – allows obtaining more accurate results of calculating the influence of factors in comparison with the methods of chain substitution, absolute and relative differences, integral, logarithm, index and proportional distribution, and allows avoiding ambiguous evaluation of the influence of factors, because in this case the results does not depend on the location of the factors in the model, and the additional increment of *the effective indicator, which is formed from the interaction of factors, decomposes between them proportions It is also an indicator of influence.*

Key words: modelling, risk, risk management, three-factor model, two-dimensional space

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1. INTRODUCTION

In the previous works of the authors [1-5], much attention was paid to risk management, however, not all aspects of this process were covered in full.

Risk is inherent in any field of human activity, which is associated with a variety of conditions and factors that influence the positive outcome of the decisions taken. The risk factor may arise and have an impact on any enterprise, regardless of the degree of its sustainability in the market. This influence, as a rule, has a negative character and can bring the company before the crisis [6-9].

In the case when determining the probability of offensive a new project scenario can be calculated using spreadsheets, they conduct a risk analysis using the simulation model, that is, when the analyst determines the type and probability of the scale distribution of the project and the method of selecting the measures of significance of the uncertain variables calculates the possibility of developing each model [10-11].

Modelling techniques can be considered as a kind of imitation of the future in laboratory conditions. Since the program chooses the values of the input variables from random probability distributions, each resulting result reflects the possible state of affairs in the future. Each of these combinations can actually be realized, and with the same degree of probability. Therefore, the results are also possible in the future and are equally likely. In fact, of course, only one of these results is realized, and we can not predict exactly what. But thanks to this method, an analyst has an important tool for managing the situation: if many of these equally likely outcomes are undesirable, they can prevent them from rejecting relevant investments. And vice versa: if a fairly large number of these results prove to be favorable, one can decide and take risks in order to obtain one of these results. The simulation method allows:

- to investigate the combined effects of risks;
- to analyze the consequences of the accumulation of risk situations;
- Determine the impact of risks on the financial position of project participants, which may be manifested in the form of delays in income generation and loan growth.

After determining the probability of the project results being passed, a decision should be made that would balance the risk associated with the project. Usually, after such a risk analysis, adjustments are made that reduce the risk of specific actions and plans. For example, after carrying out work on project risk analysis, it should be stipulated that contracts with raw material suppliers should be based on fixed prices, long-term sales contracts have been concluded, sales are insured, and an accurate project management system has to be provided to ensure control over its implementation. In any case, the analyst can balance between the degree of risk and the amount of profit. For example, project managers can offer the buyer lower prices for guaranteed future purchases, which will reduce not only profits but also the risk of failure to sell products.

2. METHODOLOGY OF CRITERION SELECTION OF INDICATORS

For the implementation of this method, the paper proposes using twelve main varieties (areas) of analysis, which in today's market conditions contain about two hundred indicators that characterize the efficiency of the entity's operation, and form a system of indicators for risk management. It is not possible to quickly calculate and analyze such an amount of indicators, and then take the appropriate management decision at the present moment of economic activity companies in traditional ways is not possible. The traditional approach to assessing the results of management involves the highly skilled analysts who use in their work automatic economic calculations in the presence of a powerful information base, which should be based on the accounting data and will maintain a considerable amount of initial data necessary for analysis over a sufficiently significant period of time (preferably from the moment of the entity's establishment).

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As practice shows, companies do not want or can not afford to attract analysts because of the high cost of their services. It is also important that, for each specific case, for each specific economic entity it is necessary to compile a combination of indicators that take into account the risks of the specifics of its work, the interests of its founders, managers, and since this process is also time-consuming, it must be carried out promptly and with then the selection of indicators should, firstly, be scientifically substantiated, and secondly, be automated.

Therefore, it is advisable to select the necessary indicators that would correspond to the demands of the risk management control system at the present moment and correspond to the capabilities of the system of managerial analysis. The selection of indicators should be based on the criteria defined by the management system.

Each type (area) of analysis can be marked with a set of n-identifiers – identification criteria. In this case, the whole set of varieties of analysis forms n-dimensional space – the space of varieties of risk analysis (VRA), which combines (includes) all possible areas of such analysis. If then each indicator of risk analysis is characterized by the individual values for each criterion, then the whole set of indicators will be distributed in the VRA space. After that, by choosing according to the criteria of identification, the specific area (or variety) of the analysis, within which to perform the calculations, we automatically receive a set of indicators that lie within this area and corresponding to the type of performed analysis. As an illustration, consider the two-dimensional space of the VRA (Fig. 1).

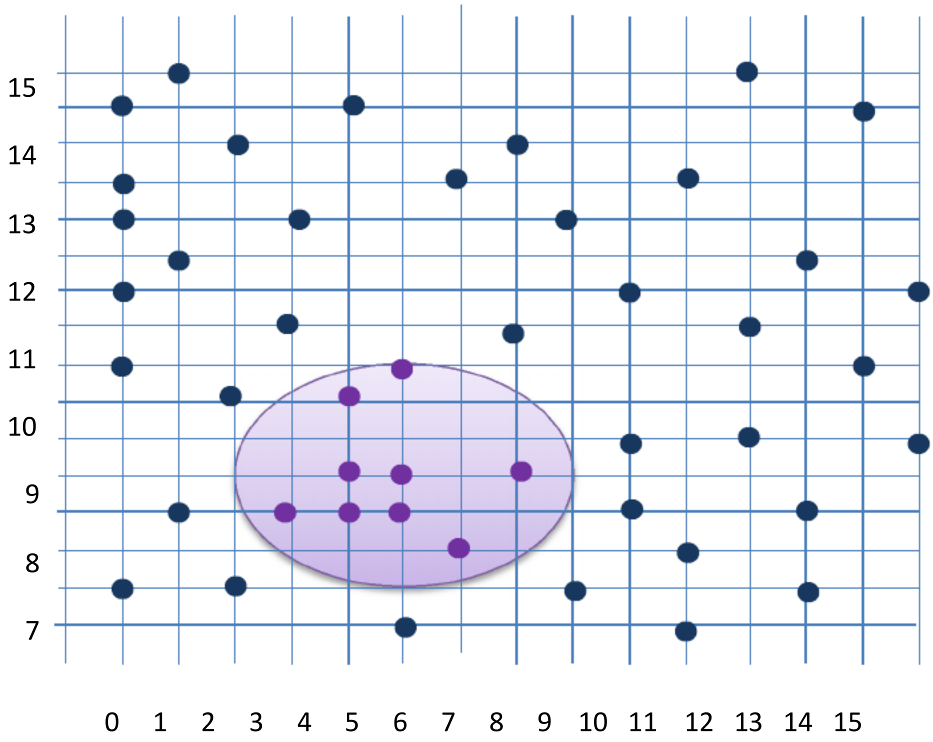

Figure 1 The two-dimensional space of the VRA

Let each of the two criteria take values from one to fifteen. All possible indicators, having a unique combination of criteria values, are distributed in the RUA space (points in Figure 1). Suppose you need to perform a kind of analysis, which is characterized by the values of the criteria (6; 4). In this case, if you set the breadth of coverage to three, then all the indicators that fall into the circular area with the centre (6; 4) will correspond to the area of the performed analysis. In the general case, the indicators are distributed in the n-dimensional space of the VRA.

In order to evaluate the impact of each factor separately, it is necessary to calculate the change of the effective indicator from the change of one factor with all possible combinations of all other factors, and as an indicator of influence take the average value of the growth of the effective indicator.

This requires changes in factors vary in different combinations and calculate the value of the effective rate for each combination of factors. Possible variations for the n-factor model are presented in Table. 1, where the symbol *A* corresponds to the initial value of the factor, the symbol *Z* is the final one.

The number of combinations of factors *m* (the number of columns in Table 1) is 2^n ($m = 2^n$), where *n* – is the number of factors of the model under study.

The table is filled in this way. In the factor line Xj, $2^{(j-1)}$ times the initial value of the factor (symbol A) is written successively, then $2^{(j-1)}$ times the final value of the factor (symbol Z), the procedure is repeated $2^{(n-j)}$ times.

Table 1 Variation series of the factor model

Factors	1	2	3	4	5	6	7	8	9	*i*	*m*
X_1	A_1	Z_2	A_3	Z_4	A_5	Z_6	A_7	Z_8	A_9	A_i	A_m
X_2	A_1	A_2	Z_3	Z_4	A_5	A_6	Z_7	Z_8	A_9	A_i	Z_m
X_3	A_1	A_2	A_3	A_4	Z_5	Z_6	Z_7	Z_8	A_9	A_i	A_m
…	…	…	…	…	…	…	…	…	…	…	…
X_j	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_i	Z_m
…	…	…	…	…	…	…	…	…	…	…	…
X_n	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	Z_i	Z_m
Y	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7	Y_8	Y_9	Y_i	Y_m

The overall increase in the effective indicator is equal to the difference between the value of the indicator of the last combination of factors and the first:

$$\Delta Y = Y_m - Y_1$$

Consider the proposed method on the example of a three-factor risk-model $Y = X_1 * X_2 * X_3$. Let risk X_1 changes from 11 to 15, X_2 – 21 to 22, X_3 – 30 to 34. The number of factors n = 3, the variation series for this case will consist of eight ($m = 2^3 = 8$) combinations of factors (Table 2):

Table 2 The variation range of the three-factor model

Factors	Number combination of factors							
	1	2	3	4	5	6	7	8
X_1	11	15	11	15	11	15	11	15
X_2	21	21	22	22	21	21	22	22
X_3	30	30	30	30	34	34	34	34
Y	6930	9450	7260	9900	7854	10710	8228	11220

Total increase in the performance indicator:

$$\Delta Y = Y_8 - Y_1 = 11220 - 6930 = 4290$$

To analyse the influence of the change of the risk-factor Xi on the resultant parameter, we need to find $2^{(n-1)}$ pairs of combinations of factors (variation pairs), in which Xi is variable, and all other factors are constant. For example, for factor X_1 in Table. 2 such a pair will make combinations 1 and 2, 3 and 4, 5 and 6, etc., for the factor X_2 – combinations of 1 and 3, 2 and 4, 5 and 7, 6 and 8, and others.

For found pairs of combinations of factors it is necessary to calculate the value of Y at the initial value of X_i and at the finite value of X_i, then subtract from the second first (calculate the increment of the effective index *d* in the variation X_j). So for factor X_1, the gain $d_{11} = Y_2 - Y_1$, $d_{21} = Y_4 - Y_3$, $d_{30} = Y_6 - Y_5$, etc., for the factor X_2, the gain $d_{15} = Y_3 - Y_1$, $d_{22} = Y_4 - Y_2$, $d_{34} = Y_7 - Y_5$, $d_{42} = Y_8 - Y_6$ and others. So for finding dYkj it is required from each Y_j, which I is in column, where $X_i = A$, subtract Y_u, which is in the column$u = \left(i - 2^{(i-1)}\right)$:

$$\mathrm{dYkj} = Y_I - Y_{\left(i-2^{(i-1)}\right)}$$

The results of calculations are summarized in the table. By the size of the indicator of influence is already visible, the change of a factor influences the change of the result most of all. But since, according to one of the main rules of factor analysis, the sum of increments of the effective indicator from individual factors should be equal to the overall increase of the effective indicator, the product of the factor of influence and the increase of the function should be attributed to the sum of indicators of influence:

$$\Delta Y(X_j) = \frac{\frac{2}{m}\sum_{i=1}^{\frac{m}{2}} \mathrm{dY_{ij}} * \Delta Y}{\sum_{u=1}^{n}\left(\frac{2}{m}\sum_{i=1}^{\frac{m}{2}} \mathrm{dY}_{iu}\right)}$$

Calculated by this formula, the value indicates the growth of the effective index, which is related to the growth of the factor Xj, does not depend on the location of the factor in the model or on the sequence of factors growth, and is applied to factor models of any kind and any complexity.

In the considered example, for factor X_1, the variation pairs will be combinations of 1, 2, 3, 4, 5, and 6, 7 and 8 - in each of these combinations, the value of X_1 changes from the original to the finite, and the values of X_2 and X_3 remain unchanged. For factor X_2, the variation pairs are combinations of 1, 3, 2, 4, 5, and 7, 6 and 8 - in each of these combinations, the value of X_2 varies from initial to finite, and values X_1 and X3 remain unchanged. For factor X_3, the variation pairs are combinations of 1, 5, 2, 6, 3, and 7, 4, and 8 - in each of these combinations, the value of X_3 changes from the original to the final, and the values X_1 and X_2 remain unchanged. Accordingly:

For factor X_1:

$d_{11} = Y_2 – Y_1 = 9450 – 6930 = 2520$,

$d_{21} = Y_4 – Y_3 = 9900 – 7260 = 2640$,

$d_{31} = Y_6 – Y_5 = 10710 – 7854 = 2856$,

$d_{41} = Y_8 – Y_7 = 11220 – 8228 = 2992$;

For factor X_2:

d12 = Y3 – Y1 = 7260 – 6930 = 330;

d22 = Y4 – Y2 = 9900 – 9450 = 450;

d32 = Y7 – Y5 = 8228 – 7854 = 374;

d42 = Y8 – Y6 = 11220 – 10710 = 510.

For factor X_3:

d13 = Y5 – Y1 = 7854 – 6930 = 924;

d23 = Y6 – Y2 = 10710 – 9450 = 1260;

d33 = Y7 – Y3 = 8228 – 7260 = 968;

d43 = Y8 – Y4 = 11220 – 9900 = 1320.

So

$$\Delta Y(X_1) = \frac{2752 * 4290}{4286} = 2754.6$$

$$\Delta Y(X_2) = \frac{416 * 4290}{4286} = 416.4$$

$$\Delta Y(X_3) = \frac{1118 * 4290}{4286} = 1119.0$$

The results of computations in the form are summarized in Table 3.

Table 3 Calculation of the influence of factors on the resultant indicator

Factors	Combinations				Impact indicator	Increase of the effective index $\Delta Y(X_i)$
	1	2	3	4		
X_1	2520	2640	2856	2992	2752	2754,6
X_2	330	450	374	510	416	416,4
X_3	924	1260	968	1320	1118	1119,0
Total indicator					4286	4290

Thus, using this simulation method allows obtaining more accurate results of calculating the influence of factors in comparison with the methods of chain substitution, absolute and relative differences, integral, logarithm, index and proportional distribution, and allows avoiding ambiguous evaluation of the influence of factors, because in this case the results does not depend on the location of the factors in the model, and the additional increment of the effective indicator, which is formed from the interaction of factors, decomposes between them proportions It is also an indicator of influence.

3. CONCLUSION

An important advantage of the proposed approach is that matrix methods are relatively easy to automate, which, with large volumes of accumulated information, becomes of great importance.

The proposed method allows to select, according to certain criteria, the necessary risk indicators for their further study. The economic interpretation of various aspects of the results of managerial analysis obtained during the calculation of indicators is based on an integrated factor model for assessing the efficiency of the enterprise, and the visualization of the results of the analysis of indicators is carried out using such a tool as a managerial monitor.

In the end, the developed method provides more efficient analysis management in companies.

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