Quantitative and Qualitative Analysis of Business Risks

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October 26, 2022

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Abstract. The current national and global economic situation is highly unstable with a high degree of uncertainty due to the martial law and hostilities in Ukraine. This situation can seriously threaten the security of the country, so the role of the risk management process is extremely important in such conditions. This article presents various methods of analysis and risk assessment of business processes in IT-enterprises, as risk management is one of the most important tasks, the solution of which is a key point in the successful functioning of the business entity. For any enterprise it is important to assess and analyze the risks before they emerge. This article presents the sequence of steps in risk analysis and risk assessment. It considers the possibility of using different methods to analyze the risks of business processes, gives an example of methodology implementation for IT-company.

Key words: risk analysis, risk minimization, business process analysis, risk assessment, IT-companies, riskology.

Introduction

Risk is an objective and subjective category associated with overcoming uncertainty, randomness, and conflict in a situation of inevitable choice, reflecting the degree to which the subject achieves the expected result. For an arbitrary business it is important not just to avoid risk in general, but to foresee possible cases and make the best decision using a set of criteria that meet the main interests of the entrepreneur. According to classical theory, the risk was identified with the average value of losses and damages that may occur as a result of the decision. In the neoclassical theory of risk, the risk is defined as a deviation from the planned financial results, from the goal. In the modern interpretation, the risk is not the losses that can be incurred during the implementation of an economic decision, but the danger of deviation from the goal for which the decision was made. That is, today risk is determined not so much by losses as by the absence of significant positive economic results and is a financial category associated with changes in the financial results of the decision-making process [2; 4; 6; 7; 9; 10].

Works [1; 2] consider the evolution of views on the phenomenon of risk, the essence of risk as an economic category, the main properties and functions of risk, the influence of subjective factors on the choice of risk. The general principles of risk classification (risk-free zone, minimum risk zone, low-risk zone, permissible risk zone, critical risk zone, catastrophic risk zone), the main types of economic risks are considered in [3; 5]: political, social, environmental, administrative and legislative risks, production (technical risks, directly production, transport, implementation (marketing and commercial risks), financial (risks associated with the purchasing power of money, investment risk, risks of failure to provide economic activity with the necessary financing, risks of unforeseen costs and excess of production costs), risks of foreign economic activity. And in works [4; 6; 7; 9; 10] - methods of risk analysis and assessment. Risk can be divided into two types: dynamic and static. Dynamic risk depends on external conditions, for example, changes in the value of equity capital due to changes in external conditions (currency fluctuations, etc.). This is possible due to economic and political changes. Static risk is possible due to the actions of the firm itself. The factors of static risk include: the level of staff qualification, rational decision-making by the firm, the level of technical support of the firm, etc.

There are objective and subjective factors that affect the degree of risk. Objective factors depend on the external environment, and subjective factors depend on the firm itself. When studying risk, the following sequence of actions should be taken: 1) to identify objective and subjective factors that affect a particular type of risk; 2) to analyze the identified factors; 3) to assess the feasibility of a project, taking into account different types of risk; 4) to set an acceptable upper limit of the risk level; 5) to provide risk mitigation measures.

Both qualitative and quantitative risk analyses are used. Qualitative risk aims to identify risk factors and risk areas and identify possible risks. In qualitative analysis, two aspects are characteristic [3; 11]: The first aspect is related to the need to compare the expected positive (favourable) results with possible adverse consequences; the second aspect is related to identifying the impact of decisions made under conditions of uncertainty and conflict on the interests of business entities. The main criteria for differentiation are: profit, revenue, own funds of the enterprise, losses, risk coefficient, coefficient of variation, coefficient of possible losses. Sometimes, within the zone of acceptable risk, a sufficiently acceptable zone and a high-risk zone are distinguished. Let us give the characteristics of the main risk zones in the implementation of business operations.

1. In the risk-free zone there are no losses during business operations.

2. In the minimum and low-risk zones, the possible amount of losses is less than the expected profit.

3. In the zone of acceptable risk, the possible amount of losses does not exceed the amount of expected profit. In the worst case - the loss of all profits, under favourable circumstances - an insignificant amount of losses that fall on one risky situation.

4. In the critical risk zone, the possible amount of losses exceeds the profit, but does not exceed the revenue.

5. The zone of catastrophic risk is the most dangerous; possible losses exceed revenue and can reach a value equal to the property of the enterprise [1].

There are two main parameters for assessing the degree of risk: the probability of losses (probability of risk realization) - the higher it is, the greater the risk; the magnitude of losses (the amount of possible damage) - the greater it is, the greater the risk. The degree of risk depends on the size of the enterprise, the number of employees, the size of assets, market share, and production volumes.

In the process of entrepreneurial activity such losses as financial, material, social, moral and psychological, sales, environmental, and time losses are possible. For each type of loss, the initial assessment of their magnitude and probability of their occurrence should be carried out for a certain time. In general, it is necessary to take into account only accidental losses that cannot be directly calculated and directly predicted (if losses can be predicted in advance, they should be considered not as losses, but as unavoidable costs and included in the estimated calculation). Depending on the type of business activity, it is advisable to distinguish between losses from production, commercial and financial activities [2; 10; 11; 12].

Since risk is an economic category, its degree can be influenced through the formation and implementation of a strategy, through the creation of a risk management mechanism - risk management, which involves the development of strategic and tactical decisions and includes the following stages: assessment of the economic situation at the enterprise and the emergence of risks; quantitative and qualitative analysis; regulation of the degree of risk (choice of directions and methods of regulation, their implementation); evaluation of the results and their adjustment [13].

The main methods of regulating the degree of risk are:

1) risk avoidance (refusal from unreliable partners, and suppliers; refusal to accept risky projects, decisions);

2) risk compensation (strategic planning of activities; forecasting of the external economic situation; monitoring of the socio-economic and legal environment; active targeted marketing);

3) risk retention (refusal of any actions aimed at the compensation of losses (without financing); creation of special reserve funds in kind or in cash (self-insurance funds or risk funds); attraction of external sources (obtaining credits and loans, state subsidies to compensate for losses and restore production);

4) transfer of risk (insurance; through factoring agreements, suretyship; through exchange transactions (hedging));

5) risk reduction (diversification; obtaining additional information; limitation) [4-10].

The task of risk research is the application of methods of qualitative and quantitative analysis of the degree of risk, in particular the use of a system of indicators based on the statistical method and the practical application of a comprehensive quantitative risk assessment with the determination of the type of risk to make the most informed management decisions. This is extremely important in conditions of instability due to martial law, because the economic security of the country largely depends on the solution of these problems.

Purpose

The purpose of the work is to systematize the system of indicators for the quantitative assessment of business risks based on the statistical method, which consists of absolute and relative values; building an interval assessment of the effectiveness of each strategy and determining the type of risk of each of them using different methods.

Task

Suppose m strategies and n states of nature are given. Given a matrix of profitability (losses) $A = (a_{ij})_{m \times n}$, where a_{ij} – the profit (loss) from the implementation of the ith strategy at the jth state of nature is the probability of the occurrence of the jth state of nature, $j = 1,..., n$; $\sum_{i=1}^{n} q_j = 1$.

It is necessary: 1) to calculate the risk assessments of the IT company's activity, which is considering investments in game industry projects, and to develop a program on MS Excel; 2) investigate the effectiveness of each strategy, the implementation of each of which depends on the state of foreign economic conditions; 3) investigate the riskiness of each strategy based on variation indicators; 4) make an interval assessment of the effectiveness of each strategy and determine the type of risk of each of them; 5) conclude in which strategy (project) IT companies should invest and why.

Theoretical justification

The system of quantitative risk assessment indicators based on the statistical method includes variation indicators, which consist of absolute values (mathematical expectation of efficiency, dispersion, mean square deviation, semivariation, semiquadratic deviation, expected value of favourable and unfavourable deviations relative to the planned value of the economic indicator, average linear deviation, coefficient of asymmetry, coefficient of kurtosis, range of variation) and relative (probability of loss or lack of income compared to the forecasted option, quadratic coefficient of variation, coefficient of risk, coefficient of semivariation, linear coefficient of variation, coefficient of expected losses, coefficient of variation of asymmetry, coefficient of variation of kurtosis, coefficient oscillations, relative risk coefficient).

In addition, an interval assessment of the effectiveness of each strategy is made, the range of variation is found, and the type of risk of each strategy is determined. For the quantitative assessment of risk, it is necessary to determine all possible consequences of a separate event (strategy) and the probability of their occurrence. The absolute value of risks is characterized by the size of predicted (possible) losses (damages) in material or monetary terms. Let's consider the calculation of the system of indicators for the quantitative assessment of the risk of a business entity whose activity is characterized by the most important indicator - profit (losses).

I. Let's consider the quantitative assessment of the riskiness of strategies based on variation indicators consisting of absolute and relative values [2; 3; 4; 6].

Absolute indicators.

1. According to the mathematical expectation of efficiency (the most likely amount of profit or loss) $M_i = \sum_{j=1}^{n} a_{ij} \cdot q_j$ i-th strategy, $i = \overline{1,m}.$ The larger (smaller) this indicator is, the more effective the corresponding i-th strategy is.

2. By dispersion $D_i = \sum_{j=1}^{n} (a_{ij} - M_i)^2 \cdot q_j$ or $D_i = \sum_{j=1}^{n} a_{ij}^2 \cdot q_j - M_i^2$, $i = \overline{1,m}.$ Dispersion is the weighted average of the squared deviations of profit (loss) values a_{ij} from the mathematical expectation of the effectiveness of the i-th strategy M_i, and characterizes the dispersion of the profit (loss) a_{ij}, values corresponding to the i-th strategy M_i relative to this strategy, $i = \overline{1,m}$, $j = \overline{1,n}$. The greater the variance, the greater the risk inherent in the corresponding strategy.

3. By mean square deviation $D_i = \sum_{j=1}^{n} (a_{ij} - M_i)^2 \cdot q_j$ or $D_i = \sum_{j=1}^{n} a_{ij}^2 \cdot q_j - M_i^2$, $i = \overline{1,m}.$ Dispersion is the weighted average of the squared deviations of profit (loss) values a_{ij} from the mathematical expectation of the effectiveness of the i-th strategy M_i, and characterizes the dispersion of the profit (loss) a_{ij} values corresponding to the i-th strategy relative to M_i this strategy, $i = \overline{1,m}$, $j = \overline{1,n}$. The greater the variance, the greater the risk inherent in the corresponding strategy.

3. By mean square deviation $\sigma_i = \sqrt{D_i}$, $i = \overline{1,m}.$ The mean square deviation shows the dispersion of the profit (loss) values a_{ij} corresponding to the i-th strategy relative to the mathematical expectation of the efficiency M_i of this strategy, $i = \overline{1,m}$, $j = \overline{1,n}$, and has the same unit of measure as profit (loss). The smaller this indicator, the more reliable the strategy.

4. By semivariation $SV_i = \sum_{j=1}^{n} \alpha_j \cdot q_j \cdot (a_{ij} - M_i)^2$, where a_{ij} - indicator of deviation from threshold values M_i, $i = \overline{1,m}$, $j = \overline{1,n}$, where M_i - the mathematical expectation of the

effectiveness of the i-th strategy. When calculating positive semivariation SV_i^+ they are accept $\alpha_j = 1$, if $a_{ij} > M_i$, i $\alpha_j = 0$, if $a_{ij} \le M_i$, $i = \overline{1,m}$, $j = \overline{1,n}$. The positive semivariation SV_i^+ characterizes the dispersion of those profit (loss) values a_{ij}, that are greater than the mathematical expectation of the effectiveness of the ith strategy M_i, $i = \overline{1,m}$, $j = \overline{1,n}$. That is, the greater the positive semivariance, the greater the profit (loss) expected from the implementation of the corresponding strategy. When calculating the negative semivariation SV_i^-, on the contrary, $\alpha_j = 1$, if $a_{ij} \le M_i$, i $\alpha_j = 0$, if $a_{ij} > M_i$, $i = \overline{1,m}$, $j = \overline{1,n}$. Negative semivariance SV_i^- characterizes the dispersion of those profit (loss) values a_{ij}, that are not greater than the mathematical expectation of the effectiveness of the ith strategy M_i, $i = \overline{1,m}$, $j = \overline{1,n}$. That is, the smaller the negative semivariance, the smaller the predicted decrease in profits (losses) from the implementation of the corresponding strategy.

5. According to the semiquadratic deviation $SSV_i = \sqrt{SV_i}$. It is obvious that positive and negative half-square deviations are calculated: SSV_i^+ i SSV_i^-: $SSV_i^+ = \sqrt{SV_i^+}$, $SSV_i^- = \sqrt{SV_i^-}$, $i = \overline{1,m}$. Positive semiquadratic deviation SSV_i^+ characterizes the mean square deviation of those profit (loss) values a_{ij}, that are greater than the mathematical expectation of the effectiveness of the ith strategy M_i, $i = \overline{1,m}$, $j = \overline{1,n}$. Or they say that the positive semi-square deviation characterizes the deviation of the absolute value of the expected profit (loss) (a possible increase in profit or an increase in loss). That is, the greater the positive semiquadratic deviation, the greater the absolute value of the actual expected profit (losses) may be when implementing the corresponding strategy. The negative semi-square deviation SV_i^- characterizes the mean square deviation of those profit (loss) values a_{ij}, that are not greater than the mathematical expectation of the effectiveness of the ith strategy M_i, $i = \overline{1,m}$, $j = \overline{1,n}$. The smaller the negative semi-squared deviation, the smaller the predicted decrease in profit (losses) from the implementation of the corresponding strategy.

6. According to the expected value of favorable and unfavorable deviations relative to the planned value of the economic indicator Z or relative to the mathematical expectation of efficiency ($Z = M_i$) (conditional mathematical expectations regarding deviations)

$V_{Zi} = \sum_{j=1}^{n} \alpha_j \cdot q_j \cdot (a_{ij} - Z)$, where $\alpha_j -$ indicator of deviation from threshold values Z, $i = \overline{1,m},\ j = \overline{1,n}.$ When calculating the positive conditional mathematical expectation for deviations V_{Zi}^{+}, they are accepted $\alpha_j = 1$, if $a_{ij} > Z$, i $\alpha_j = 0$, if $a_{ij} \le Z,\ i = \overline{1,m},\ j = \overline{1,n}.$ The larger V_{Zi}^{+}, the greater is the expected profit (loss) for the profit (loss) matrix from the implementation of the corresponding strategy. When calculating the negative conditional mathematical expectation for deviations V_{Zi}^{-}, the opposite is true - $\alpha_j = 1$, if $a_{ij} \le Z$, i $\alpha_j = 0$, if $a_{ij} > Z,\ i = \overline{1,m},\ j = \overline{1,n}.$ The smaller $\left|V_{Zi}^{-}\right|$, the smaller the predicted decrease in profits (losses) for the matrix of profits (losses) from the implementation of the corresponding strategy.

7. According to the average linear deviation $d_i = \sum_{j=1}^{n} \left|a_{ij} - M_i\right| \cdot q_j,\ i = \overline{1,m}.$ The smaller the average linear deviation, the more reliable the corresponding strategy is.

8. According to the coefficient of asymmetry $As_i = \frac{1}{\sigma_i^3} \sum_{j=1}^{n} (a_{ij} - M_i)^3 \cdot q_j,\ i = \overline{1,m}.$ If the coefficient of asymmetry is zero, then the graph of the probability density function of a random variable is symmetric with respect to its expected value. If $As_i > 0\ (As_i < 0)$, then the asymmetry is right-sided (left-sided). If the distribution is almost symmetrical; if $0,1 \le |As_i| < 0,3$, then the asymmetry is insignificant; if $0,3 \le |As_i| < 0,5$, then the asymmetry is moderate; if $0,5 \le |As_i|$, then the asymmetry is significant. The greater the value of the asymmetry coefficient for the profit (loss) matrix, the smaller (greater) the risk of the corresponding strategy.

9. According to the kurtosis coefficient $Ex_i = \frac{1}{\sigma_i^4} \sum_{j=1}^{n} (a_{ij} - M_i)^4 \cdot q_j - 3,\ i = \overline{1,m}.$ If $Ex_i \ge 0\ (Ex_i < 0)$, then the distribution is considered sharp-top (flat-top). The greater the value of the kurtosis coefficient (concentration of performance indicator values near its expected value) for the profit (loss) matrix, the more reliable the corresponding strategy.

10. By the range of variation $R_i = \max_j a_{ij} - \min_j a_{ij},\ i = \overline{1,m}.$ The greater the range of variation, the greater the risk inherent in the corresponding strategy.

Relative indicators.

11. According to the quadratic coefficient of variation $V_{\sigma i} = \dfrac{\sigma_i}{M_i}$, $i = \overline{1,m}$. The smaller the value of the squared coefficient of variation for the return matrix, the better the ratio between the risk and the effectiveness of the strategy.

12. According to the risk factor $K_{Ri} = \dfrac{SSV_i^-}{SSV_i^+}$, $i = \overline{1,m}$. This coefficient for the profit (loss) matrix shows how many times the possible decrease in profit (loss) can exceed the possible increase in profit (loss). The smaller (larger) the risk coefficient K_{Ri}, the smaller the risk of choosing a strategy, respectively, for the profit (loss) matrix.

13. By the coefficient of semivariation $K_{Si} = \dfrac{SSV_i^-}{M_i}$ або $K_{Si} = \dfrac{SSV_i^+}{M_i}$ $i = \overline{1,m}$. The coefficient of semivariation corresponds to the ratio of negative semivariation (for the matrix of gains) or positive semivariation (for the matrix of losses), which take into account only negative deviations from the expected value to the expected value. The smaller the coefficient of semivariation, the less risky the strategy.

14. According to the linear coefficient of variation $V_{di} = \dfrac{d_i}{M_i}$, $i = \overline{1,m}$. The smaller the value of the linear coefficient of variation for the return matrix, the better the ratio between the risk and the effectiveness of the strategy.

15. By the ratio of expected losses $K_{Zi} = \dfrac{|V_{Zi}^-|}{V_{Zi}^+ + |V_{Zi}^-|}$ – for the earnings matrix, or $K_{Zi} = \dfrac{V_{Zi}^+}{V_{Zi}^+ + |V_{Zi}^-|}$ – for the loss matrix, $i = \overline{1,m}$. This ratio shows the ratio of expected losses to the sum of expected profits and expected losses. $K_{Zi} \in [0; 1]$, and if $K_{Zi} = 0$, there are no expected additional losses; if $K_{Zi} = 1$, there are no expected additional profits.

16. According to the coefficient of variation of asymmetry $VAs_i = \dfrac{lAs_i}{M_i}$, $i = \overline{1,m}$, де $lAs_i = \begin{cases} 1/(As_i + 1), & As_i > 0; \\ 1 - As_i, & As_i \le 0. \end{cases}$ The smaller this ratio is, the less (more) risky the strategy is, respectively, for the profit matrix and the loss matrix.

17. According to the coefficient of variation of kurtosis $VEx_i = \frac{lEx_i}{M_i}$, $i = \overline{1, m}$, де $lEx_i = \begin{cases} 1/(Ex_i + 1), & Ex_i > 0; \\ 1 - Ex_i, & Ex_i \le 0. \end{cases}$ The smaller this ratio, the less risky the strategy for the profit matrix.

18. According to the coefficient of oscillation $V_{Ri} = \frac{R_i}{M_i}$, $i = \overline{1, m}$. Чим менший цей коефіцієнт, тим менш ризикована відповідна стратегії для матриці прибутків.

19. За коефіцієнтом відносного ризику – відношення розміру збитків до конкретної бази залежно від специфіки та виду оцінюваного ризику.

II. Розглянемо інтервальну оцінку ефективності стратегій та визначення типу ризику кожної з них. Для інтервальної оцінки розраховують граничну *i*-ту похибку Δ_i, яка є абсолютним показником оцінки ризику.

$\Delta_i = \frac{t_\gamma \cdot \sigma_i}{\sqrt{n}}$, if $n > 30$, і $\Delta_i = \frac{t_\gamma \cdot s_i}{\sqrt{n}}$, if $n \le 30$, where $\sigma_i -$ mean square deviation, corrected mean square deviation: $s_i = \sigma_i \cdot \sqrt{\frac{n}{n-1}}$, $i = \overline{1, m}$. $t_\gamma = t(\alpha = 1 - \gamma, \nu = n - 1)$ is according to the table of critical points of Student's distribution for the two-sided critical region depending on reliability γ and sample size *n*, $\alpha -$ significance level, $\nu -$ number of degrees of freedom. γ - the reliability of the fact that the actual profit (loss) will be in the corresponding reliable interval.

Marginal error indicates how marginally the effectiveness of each strategy can vary with given reliability. The smaller the margin of error (marginal deviation), the safer and more reliable the strategy is. By adding and subtracting the marginal error Δ_i to (from) the mathematical expectation of the effectiveness of the i-th strategy M_i, we will get the marginal limits in which the actual profit (losses) for each strategy will fluctuate: $a_i^{\max} = M_i + \Delta_i$, $a_i^{\min} = M_i - \Delta_i$, $i = \overline{1, m}$. In the case when $a_i^{\min}$ takes a negative value, instead of the expected profit (loss) we have the volume of losses (profit). The smaller the value of the margin of error (marginal deviation), the safer and more reliable the strategy. To assess the risk, the range of variation is used, which is calculated based on the limits $a_i^{\min}$ та $a_i^{\max}$: $R_i^v = a_i^{\max} - a_i^{\min}$, $i = \overline{1, m}$. The greater the range of variation, the riskier the strategy.

Let's consider the definition of the type of risk. One of the methods of determining the type (level, zone) of risk is based on the assessment of the coefficient of possible losses from the implementation of the strategy, as the ratio of the minimum value of the effectiveness of the i-th strategy $a_i^{\min}$ to the mathematical expectation of the effectiveness of the i-th strategy M_i: $K_{vi} = \frac{a_i^{\min}}{M_i}$, $i = \overline{1,m}$. If $K_{vi} \geq 0,9,$ then the risk is minimal; if $0,75 \leq K_{vi} < 0,9,$ then the risk is small; if $-0,3 \leq K_{vi} < 0,$ then they believe that the risk is critical (justified); and if $K_{vi} < -0,3,$ then the risk is assessed as catastrophic (unacceptable), $i = \overline{1,m}.$

The second method of determining the type of risk is based on the value of the quadratic and linear coefficients of variation according to the following scale: [0; 0.1) – minimal risk; [0.1; 0.25) – low risk; [0.25; 0.5) – acceptable risk; [0.5; 0.75) – critical risk; [0.75; 1] is a catastrophic risk.

Risk types are also obtained as follows:

a) for the risk-free zone: H = 0;

b) for the minimum risk zone

c) for a low-risk zone

d) for the permissible risk zone:

e) for the critical risk zone:

f) for the zone of catastrophic risk:

where Pr - profit, Vr - revenue, W - losses, Vk - company's own funds, H - risk factor (the ratio of possible losses to the size of the company's own funds).

Estimating economic risk requires the construction of a risk curve - a probability distribution curve for a certain level of loss/profit (this is a difficult task, so the risk is often assessed using quantitative indicators). The process of constructing a risk curve includes the following stages: 1) establishing risk zones within which losses do not exceed a certain level; 2) determining the dependence of losses on their level; 3) construction of a typical curve of the distribution of probabilities of obtaining a certain level of profit; 4) construction of a risk curve based on a curve of probabilities of obtaining a certain level of profit and risk zones.

Methods such as [4; 6; 7; 9; 10]: statistical, expert evaluation method, analytical and calculation method, regulatory method, cost feasibility analysis method, analogue method, decision tree method, rating method. Decision-making under uncertainty, conflict and the risk caused by them is most often based on the concept of utility theory and statistical solutions of game theory. Methods of fuzzy set theory and fuzzy logic theory are used in complex risk assessment, as well as neural networks, chaos theory, disaster theory, etc. The following methods of quantitative assessment of the risks of investment projects are used: the method of adjusting the discount rate, sensitivity analysis, the scenario method, the "tree" method of decisions, simulation modelling. Quantification of risks and the factors that determine them can be carried out on the basis of the analysis of the variability of the profit. The special methods of risk assessment include: the procedure for assessing the aggregated risk of the enterprise's activity based on financial reporting data, methods of assessing financial and investment risks.

Practical implementation of risk assessment methodology

Let's consider the implementation of the given risk assessment technique based on the statistical method. The IT company is considering investments in game industry projects, analyzing the business plans of these projects. Alternative investment options are defined by certain strategies. The states of foreign economic conditions (for example, the socio-economic state of the state or socio-economic indicators), which will affect the performance indicators of each i-th strategy, have certain probabilities of occurrence q_j $(i=\overline{1,m},\ j=\overline{1,n})$. Profits (gains) a_{ij} for the implementation of each strategy A_i and probabilities of foreign economic conditions B_j are shown in Table 1 (in million gr. units) $(i=\overline{1,m},\ j=\overline{1,n},\ m=6,\ n=5)$.

Table 1

Profits during the implementation of strategies according to the state of foreign economic conditions

A_i \ B_j	Profit according to the state of foreign economic conditions				
	B_1	B_2	B_3	B_4	B_5
A_1	21	19	16	12	10
A_2	17	20	18	17	8
A_3	22	15	13	19	12
A_4	19	16	14	20	10
A_5	18	22	17	14	8
A_6	23	17	14	16	11
q_j	0,14	0,28	0,15	0,18	0,25

Using the above formulas for calculating absolute and relative indicators, we obtain tables of indicators (tables 2-4).

Table 2

Absolute indicators

M_i	D_i	σ_i	SV_i^+	SV_i^-	SSV_i^+	SSV_i^-	V_{zi}^+	V_{zi}^-	d_i	As_i	Ex_i	R_i
15,320	17,438	4,176	8,378	9,060	2,894	3,010	1,928	-1,928	3,855	-0,063	-1,661	11
15,740	21,332	4,619	6,356	14,977	2,521	3,870	1,935	-1,935	3,870	-0,933	-0,842	12
15,650	**12,168**	**3,488**	7,665	**4,502**	2,769	**2,122**	1,492	-1,492	2,984	**0,650**	-1,040	**10**
15,340	13,304	3,648	5,906	7,398	2,430	2,720	1,536	-1,536	3,072	-0,273	-1,295	**10**
15,750	27,448	5,239	**11,881**	15,567	**3,447**	3,945	**2,253**	-2,253	4,505	-0,327	-1,244	14
15,710	13,906	3,729	7,921	5,985	2,814	2,446	1,434	**-1,434**	**2,868**	0,539	**2,614**	12

Table 3

Relative indicators

$V_{\sigma i}$	K_{Ri}	K_{Si}	V_{di}	K_{zi}	VAs_i	VEx_i	V_{Ri}
0,2726	1,0399	0,1965	0,2516	0,5000	0,0694	0,1737	0,7180
0,2934	1,5351	0,2459	0,2459	0,5000	0,1228	0,1170	0,7624
0,2229	**0,7664**	**0,1356**	0,1907	0,5000	**0,0387**	0,1304	**0,6390**
0,2378	1,1192	0,1773	0,2003	0,5000	0,0830	0,1496	0,6519
0,3326	1,1447	0,2505	0,2860	0,5000	0,0843	0,1425	0,8889
0,2374	0,8692	0,1557	**0,1826**	0,5000	0,0413	**0,0176**	0,7638

Table.4

Interval assessment

$t_{0,99}$	S_i	Δ_i	$a_i^{\min}$	$a_i^{\max}$	R_i^v	K_{vi}	Type of risk
4,6041	4,6687	9,6130	5,7070	24,9330	19,2259	0,3725	allowable
4,6041	5,1639	10,6325	5,1075	26,3725	21,2649	0,3245	allowable
4,6041	**3,8999**	**8,0300**	**7,6200**	23,6800	**16,0600**	**0,4869**	**allowable**
4,6041	4,0781	8,3968	6,9432	23,7368	16,7935	0,4526	allowable
4,6041	5,8574	12,0605	3,6895	**27,8105**	24,1210	0,2343	allowable
4,6041	4,1692	8,5845	7,1255	24,2945	17,1690	0,4536	allowable

Value $Z = M_i$. Tables 2 - 4 highlight the values of the indicators corresponding to the best strategies. According to mathematical expectation, the strategy A_5 is slightly more effective. As for the risk, a much better strategy is A_3, and then A_6 i A_5. Other strategies are more risky. According to the second method of determining the type of risk by the quadratic coefficient of variation, strategies A_3, A_4, A_6 correspond to low risk, and strategies A_1, A_2, A_5 to acceptable risk; according to the linear coefficient of variation, strategies A_2, A_3, A_4, A_6 correspond to low risk, and strategies A_1, A_5 to acceptable risk.

IT companies are recommended to invest in the third project.

The given risk assessment technique was effectively implemented using the MS Excel spreadsheet. The initial data are statistical data that correspond to investment strategies, business plans, etc. The computer implementation of the given methodology makes it possible to carry out quantitative risk analysis - to calculate absolute and relative risk indicators and qualitative analysis - to obtain an interval estimate of the effectiveness of the strategy and the type of risk, which is calculated for greater reliability by various methods.

Conclusions

The tasks and methods of risk analysis are highlighted, the characteristics of risk zones and methods of regulating the degree of risk in entrepreneurial activity are given. Systematization of the system of indicators for the quantitative assessment of business risks based on the statistical method, which consists of absolute and relative values of variation, has been carried out. The technique of constructing an interval assessment of the effectiveness of each strategy and determining the type of risk of each of them using different methods is presented.

An example of the results of the program on MS Excel during the risk assessment of the activity of an IT company, which is considering investments in game industry projects, implementing the business plan of these projects, is given. According to the data of indicator calculations, the effectiveness and riskiness of each strategy based on the use of a system of absolute and relative statistical indicators of variation were investigated. An interval assessment of the effectiveness of each strategy was made and the risk type of each of them was determined using different methods. A conclusion is made about the expediency of the IT company's investment in this strategy (project). The above method and its computer implementation can be adapted, in particular, to the needs of the customs service and in information technologies due to the selection of absolute and relative indicators or the use of these indicators and the method of multi-criteria analysis of alternatives, which makes it possible to determine the risks that arise in customs affairs and information technologies. Guided by the obtained results, it is possible to assess and manage risks using the specified methodology in order to make effective management decisions in various spheres of activity.None of the absolute and relative statistical indicators alone is the objective comprehensive characteristic that can indicate the riskiness of the decision. They should be used systematically, as they are interconnected and complementary and take into account the specifics of the task, the importance of statistical indicators, and the enterprise's risk system. It is necessary to further develop the concept of the system of quantitative indicators of the degree of risk, which would allow to adequately reflect its multifacetedness and ambiguity, the construction and adequate use of economic and mathematical methods and risk models, the creation of software complexes of risk assessment, analysis and management for making effective management decisions in various areas socio-economic and information-technical activities.

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СЕКЦІЯ: БЕЗПЕКА ТА РОЗРОБКА ПРОГРАМНОГО ЗАБЕЗПЕЧЕННЯ