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Investment Project Risk Simulation on the Use of Information Technologies as a Factor for Improving the Financial Safety of the Enterprise

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Abstract

The article justified the feasibility of an investment project by analysing the performance indicators while taking into account risk and uncertainty of the use of information technologies. The impact of the above calculations of the investment project results is due to the fact that the evaluation of the investment performance depends on the projected cash flows. The purpose of the article is to assess the impact of risks on making investment decisions using information technologies in order to increase the financial security of enterprises. Methodological and practical aspects of risk modelling of the investment project were further developed, using the Monte Carlo method, which allows to construct a model by minimizing data, as well as to maximize the value of data used in the model. This model involves the use of probability theory and random number tables. The results show the distribution of probabilities of the successful project variable and the coefficient of variation of the performance indicator, allowing the investor to take uncertainty into account when making a decision.

Keywords: Financial Security, Risk, Investment, Investment Project, Simulation Modelling, Information Technologies.

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Introduction

In the course of their investment activities, enterprises are constantly confronted with problems of uncertainty and risk of the activity and have a direct impact on their financial security. During the development of the investment project, the basic components of the project are defined, including the volume of capital and current expenditures, the volume of output sales, the prices of goods and the duration of the project. Despite the quality and validity of these parameters, the future development of the project is always ambiguous. The outcome of the investment is largely determined by the extent to which uncertainties and risks of the project that exist at the moment and may arise in the future are identified. In addition, they have a direct impact on the rate of return that the investor receives.

It should be noted that uncertainty is a broader concept than risk, first of all it reflects a possible future state of affairs. The second is the impossibility of determining the value of the main indicators of the enterprise's development and of predicting the possible results of the investment project. In today's uncertain environment, there are also prospects for additional opportunities that were not taken into account in the development of the investment project. In general, however, this phenomenon is negative in business activities, so effective decisions must be made in an environment of innocence, as it is the basis of a successful investment project.

Literature Review

The theoretical and practical issues of the use of different modelling techniques for the study of economic processes are the work of many scientists. In particular, Lukasevich noted that the content and credibility of the estimation of the interpretation possibilities of simulation models depends on the proximity of the models to the real structure and on the reliability of the initial information (Lukasevich I.Y, 2006; Gontareva, I., 2021).

According to Bystrovoy I.N. the key goal of simulation simulation is to reconstruct the actions (behaviour) of the object under investigation on the basis of the study of the results of the analysis of essential relationships and relationships between its components or elements, That is, by designing the analogue of the studied medium for the implementation of the respective experiments (Bystrova I. N., 2007; Shumilo, O., 2021).

Simulation modelling allows to see the behavior of an object or system in time parameters. At the same time, this advantage of modeling is that it is easy to control analog and time: this means that it is possible with the need of enabling the processes of schmidcoplinni or to be leaned in a situation of slow dynamics (Vitlinsky V.V., 2003; Pepall L., 1995; Kuzubov M.V, 2010).

A number of scientists note that the simulation method is one of the most effective methods The study of practically functioning economic objects of any nature and degree of complexity and of objects that are under development. The essence of this method is to construct a simulation model of the object to be studied and to target the exposition of this model to study behaviour under different conditions (Loboda O.M., 2018; Gracheva M.V., 2007; Winston, W. L., 2011).

However, it is advisable to carry out a simulation of an investment project from a multitude of alternatives in order to choose the most optimal one.

Methodology

Monte Carlo simulation to assess project risk (possible deviations from planned values) provides for decision-making by establishing the relationship between input and output and evaluating the influence of input parameters on the final result by analysing the distribution of probabilities for the key parameters of the model (Blank I.A.,2015; Dimitrov I., 2019).

In a general sense, risk refers to the possibility of some adverse event, causing some loss, such as loss of property, income below expectations, etc.

Simulation is one of the most powerful methods of analysing the economic system. This paper considers simulation simulation, which allows to choose the best solution to an economic problem that includes random numerical values.

Simulation models can be deterministic and stochastic. In stochastic models, random number generators (sensors) simulate the influence (action) of undefined and random factors. This simulation method has been given the name of a statistical modelling method (or Monte-Carlo method). Today it is considered one of the most effective methods of studying complex systems, and often the only practicable method of obtaining complete information on the behaviour of a hypothetical system (at the design stage). Therefore, the use of simulations to select an investment project from a multitude of alternatives is relevant and important in practice, as the conduct of real experiments with economic systems, At least economically impractical, costly and unlikely to be implemented (Bilotserkivs′kyy O.B., 2013; Vitlinsky V.V., 2005; Bakhrushin V.E., 2004).

A prerequisite for effective analysis and simulation requires reliable information in the development of an investment project.

Financial analysis often employs models that contain random values whose behavior is not determined by management or financial managers who make decisions.

Monte Carlo simulations allow estimation of possible results based on distributions of random factors (quantities) involving the process of conducting experiments with mathematical models of complex systems (Mykytyuk, P.P., 2014), "the objectives of such experiments may vary from identifying the properties and regularities of the system to solving specific practical management problems" at different hierarchical levels (Lukasevich I.Y., 2015).

In general, the Monte Carlo simulation is a procedure by which a mathematical model for determining any financial measure (in this case, NPV) is subjected to a series of software runs. During the simulation process, sequential scenarios are constructed using raw data, project content is uncertain and therefore random values are defined in the analysis. The simulation process is performed in such a way that a random choice of values from certain probability distributions does not disrupt the existence of known or assumed correlation relationships among variables. The results of the simulation are collected and analysed statistically to assess the level of risk.

Simulation simulations are a series of numerical experiments designed to provide empirical estimates of the degree to which various input factors influence some of the dependent outcomes (indicators).

The application of the simulation method has shown its potential for use in investment design, especially under conditions of uncertainty and risk. This method is particularly useful for practical applications in that it combines well with other economic and statistical methods, as well as with game theory and other operations research methods. The practical application of the simulation method has shown that it tends to be more optimistic than other methods. Investment design should take into account risk and uncertainty.

The Monte Carlo method, as one of the most complex methods of quantitative risk analysis, overcomes the limitations of sensitivity analysis and scenario analysis. Both of these methods show the effect of a certain change in the size of one or more variables on the performance of the project (in our case NPV). Unlike sensitivity analysis and scenario analysis, the Monte Carlo method takes into account the correlation between the different components of the project; It is possible to simultaneously simulate random changes in several project components according to the conditions of adjustment; scenarios are random and automatically generated algorithm by the Monte Carlo; Scenarios are formed based on ranges of possible changes in random variables and selected distribution laws; the number of random scenarios can be multiple, as the simulation process is implemented as a computer program. There is a method for selecting the number of scenarios needed, which assures the reliability of the model results with a certain probability.

In order to carry out the simulation experiment, we are convinced that the following sequence of actions can be proposed:

1. Establish the relationship between the initial values and the output in the form of a mathematical equation or inequality.
2. Set the laws of probability distribution for the key parameters of the model.
3. Perform a computer simulation of the values of key parameters of the model.
4. Calculate the main features of the distributions of the reference values and the reference values.
5. Analyse the results and take a decision.

Results and Discussion

The rationale for an investment project is related to the analysis of performance indicators and the risk factors that influence the results of the investment process .that the criteria for assessing the effectiveness of investments depend on the projected cash flows.

Investment design has to take into account risk and uncertainty. Therefore, it is necessary to take into account the full range of possible values of the key parameters of the project, considering the probabilities of each possible option as well as the nature of the probability distribution.

The objective of the work is to assess the impact of risk on investment decision-making in order to enhance the financial security of enterprises.

For this study we use enterprise data, considers investment project of pig farm of family farm. The preliminary analysis identified three key parameters of the project and identified possible boundaries for their modification (Table. 1).

Table 1. Key parameters of the family farm pig farm project.

Indicator	Variable	Scenario	
		worse	best
Production output ,CWT	*Q*	90	120
Sales price of 1 CWT, UAH.	P	4300	4800
Variable cost per CWT of production, UAH.	*V*	*3800*	*2800*

Source: create by the author based on annual reporting.

Other project parameters are considered as constant values (Table. 2).

Table 2. Constant parameters of the Family Farm Pig Farm Project

Indicator	Variable	Most likely value
Fixed expenses, UAH	F	40000
Depreciation	A	4000
Income tax, %	T	18
Discount rates, %	r	10
Project duration, years	n	5
Initial investment, UAH	I_0	200000

Source: create by the author based on annual reporting.

In the first step of the algorithm, the relationship of the resulting indicator to the reference was determined. The net present value of the NPV project was selected as the result (Loboda O.M., 2012):

$$NPV = \sum_{i=1}^{n} \frac{NCF_t}{(1+r)^t} - I_0 , \quad (1)$$

where NCFt - total net flow - payments in the period t

Total net flow NCF for any period t the same and can be determined from the (Lukasevich I.Y., 1998; Dimitrov I.; 2019):

$$NCF = \big((P - V) \times Q - A - F\big) \times (1 - T) + A \quad (2)$$

In the second step of the algorithm the laws of probability distribution of key variables were chosen. All key variables were assumed to have a uniform probability distribution (table 3).

Table 3. Sheet fragment simulation for uniform distribution (project duration: 5 years)

	V	Q	P	NCF	NPV
Simulation model	3666	96	4648	44217,6	-32381
	3518	102	4706	65740,8	49209
	3292	99	4542	67800	57015
	2993	119	4670	128450,4	286928
	2911	116	4455	112083,2	224884
	3015	101	4463	85798,4	125243
	2838	109	4453	109628	215576
	3245	116	4573	92038,4	148898
	2894	94	4546	93030,4	152658
	3301	114	4631	90096	141535
	3373	120	4558	82560	112967

Source: create by the author

Consider the results of the investment project simulation for 5 years (table. 4):

Table 4. Result of simulations for uniform distribution (5 years)

Indicators	Variable cost (V)	Quantity (Q)	Price (P)	Revenue (NCF)	NPV
Average value	3318,072	105,422	4557,402	73 301	77868,39
Standard deviation	277,824	9,066	147,090	27 951	45955,44
Coefficient of variation	0,0837	0,086	0,032	0	0,59
Minimum	2800	90	4300	7 754	-170607,76
Maximum	3793	120	4799	143 136	342598,06
Number of cases					123,00
Amount of losses for all simulations NPV<0					-6675373,94
Total revenue for all simulations NPV>0					45609571,07
The likelihood of occurence NPV<0					0,1277

Source: create by the author

As table 4 shows, the sum of all negative NPV values in the resulting total is 6675,374 UAH. It can be interpreted as the net value of uncertainty to the investor if the project is accepted. Similarly, the sum of all integral NPV values is 45609571 UAH. May be treated as the net value of uncertainty to the investor in the event of a project being rejected. Thus, the figures obtained clearly show that the amount of possible losses is not proportional to the total income (-6675374 and 45609571, respectively). The expected NPV is 77,868.39 pips with a standard deviation of 105955.44. The coefficient of variation is 0.59.

Using the initial data of the investment project, we will evaluate the influence of the type of probability distribution of key parameters on the net typing value by determining the duration of the project 6 years (table.5).

Table 5. Result of the sheet simulation for even distribution (project duration 6 years)

Indicators	Variable cost (V)	Quantity (Q)	Price (P)	Revenue (NCF)	NPV
Average value	3306,898	105,292	4552,092	73 725	121090,56
Standard deviation	285,5207	8,5101575	145,3270778	28 758	125246,93
Coefficient of variation	0,0863	0,080	0,0319	0	1,03
Minimum	2800	90	4303	15 230	-133667,64
Maximum	3791	120	4800	151 584	460187,84
Number of cases					100,00
Amount of losses for all simulations NPV<0					-4761751,15
Total revenue for all simulations NPV>0					65307033,02
The likelihood of occurence NPV<0					0,0680

Source: create by the author

As can be seen from table 5, the expected NPV is UAH 121090 with a standard deviation of 45246.93. The coefficient of variation (0.37) is lower, therefore the risk of the project is generally lower than the average risk of the firm's investment portfolio. The total number of negative NPV values in the sample is 100 out of 500. Thus, it can be argued that the net present value of the project will be greater than 0. The probability that NPV will be negative is 6.8%.

In order to choose the optimal result, we will make similar calculations using the Monte Carlo model for the investment project, the term of which will be seven years (table 6).

Table 6. Results of sheet simulation for even distribution (project duration - 7 years)

Indicatos	Variable cost (V)	Quantity (Q)	Price (P)	Revenue (NCF)	NPV
Average value	3302,244	104,876	4560,724	74 238	161423,90
Standard deviation	278,96781	8,67021	144,896	27 603	34384,77
Coefficient of variation	0,084478258	0,082671105	0,031770537	0	0,213
Minimum	2803	90	4300	13 725	-133181,93
Maximum	3798	120	4799	143 266	497476,94
Number of cases					57,00
Amount of losses for all simulations NPV<0					-3044406,78
Total revenue for all simulations NPV>0					83756358,77
The likelihood of occurence NPV<0					0,0351

Source: create by the author

As can be seen from table 6, the expected NPV is 161,424 UAH with standard deviation of 34,385 UAH. Coefficient of variation (0.21). The total number of negative NPV values in the sample is 57 out of 500, with the probability that the value of NPV will be negative - 3.5%. In other words, it is safe to say that for the investor the most optimal project is a project for 7 years.

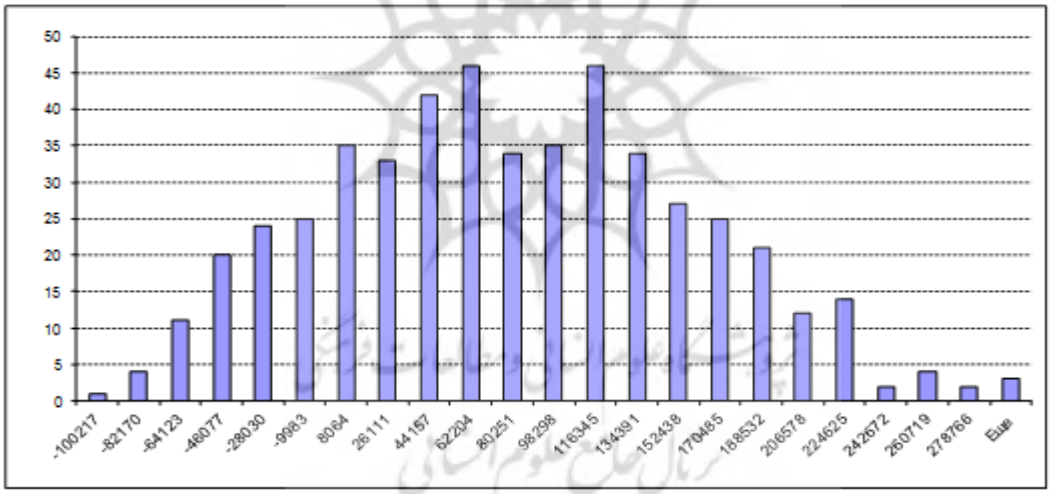

Figure 1. Random value distribution histogram NPV

Source: built by the authors

Graphical analysis also supports the NPV distribution efficiency hypothesis. The value of a reliable interval for a mathematical waiting according to a given level of reliability is sufficiently high. For this project this means that the maximum value of the NPV's expectation is in the range of 8064 to 170485 UAH.

Based on the results of the analysis, the risk of the project and the feasibility of its adoption can be assessed. In this case, indicators such as the normalized expected loss, the asymmetry factor of the distribution of the present value of the project indicate the profitability of the project. On the other hand, indicators such as the coefficient of variation,

the standard rejection of a project indicate project instability, a high degree of variation and unpredictability of results, which entails a high risk of the project itself. For certain raw data it is difficult to make an unequivocal decision.

Conclusion

When making investment decisions, enterprises are constantly confronted with the problems of managing the risks that arise. Because they have a direct impact on the financial security of the enterprise. It is possible to solve this problem by using the simulation method.

Simulation is a rather complex study of enterprise activity, and this is one of the most significant constraints in the dissemination of this risk assessment tool. However, this model is one of the most accurate and reliable in the analysis of the business process (provided that the simulated model is adequate) because it makes it possible to get as close as possible to the real conditions of the economic system. Statistical analysis of model factors and statistical analysis of results are also important when using simulation modelling.

An analysis of the risk assessment of an investment project for an agricultural enterprise using the Monte Carlo method yielded a distribution of the probabilities of a successful project variable, mean, mean square deviation and coefficient of variation of the resulting indicator. When making investment decisions, it is advisable to carry out an analysis of risk meters (rate of expected loss, probability of realization of an ineffective project), which requires further elaboration in the direction of the Study of possible risk zones, from simulation simulations.

Conflict of interest

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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