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RISK MEASURING METHODS: MODERN APPROACHES

Today, the global financial crisis caused by the unstable economic situation in the world, and in Ukraine in particular, has a direct impact on investment. There appear more and more factors that directly affect the risk of investment; the level of uncertainty is increasing and it becomes difficult to predict future cash flows. That is why, without measuring the level of risk and predicting risky situations, investing any money is potentially a disaster. An investment is called to be risk-free only if its return is stable and reliable. Investors would prefer a Treasury bill, which is a US government security and is a risk-free investment, mainly because its return is certain and guaranteed.

Entrepreneurs usually associate the word «risk» only with the adverse economic consequences of management, leading to loss of profits [1]. Hence a company is constantly trying to achieve the appropriate mix between profitability and risk to meet its shareholders' needs and to achieve wealth maximization. Consequently, the main task of investment analysts is to select attractive projects under conditions of uncertainty. But it is here that business faces real challenges. As Block and Hirt point out: "... the real difficulty is not in finding viable investment alternatives but in determining an appropriate position on the risk-return scale" [2]. In this sense, what companies really need is a theory of decision making under uncertainty since there is always risk in capital budgeting.

The desire of businesses to predict and, thus, minimize potential losses led to a whole range of *qualitative* and *quantitative* methods and techniques for risk measurement (sensitivity analysis, simulation, and other mathematical methods). Each of these methods, with all their recognized efficiency, could either require significant time and money, or depend on specific technologies, software, etc. Therefore, it is essential to determine what methods of risk measurement will provide the most accurate forecast with the least amount of time and resources consumed in each case.

The purpose of this paper is to determine an optimal combination of risk measuring methods in the real investment domain in Ukraine to ensure high reliability of the estimates and to minimize the errors. The optimal combination of risk measuring methods means minimum (financial and time) expenditures on implementing the method, while ensuring its validity, availability, and reliability (minimal error and maximum practicality).

There is such a tendency in Ukraine that investing in projects (90%) prevails over investing in shares (10%). That is why this paper focuses on the capital investment as the object of risk measuring.

The reliability of this research is ensured by its methodology: a comparative analysis, methods of generalization, systematization, and economic-mathematical methods. In this paper risk-measuring methods are practically applied.

To reach the goal this paper examines the methods of risk measurement, their incorporation into the capital budgeting process and suggests an optimal combination of measuring risks for a particular investment project. It is illustrated on the example of a project to be implemented by one of the Donetsk chemical companies on introducing new household chemical products in aerosol packaging free from ozone-depleting substances.

The Ukrainian and foreign authors dealing with the issue under research differentiate between two mutually complementary methods of risk measurement: ***quantitative*** and ***qualitative***. The latter aims at defining the factors and types of risks, while the former helps to determine numerically the level of an individual risk and the risk of the whole business. Being well aware that risk measurement applies both of these approaches, in this paper we will restrict our research to the qualitative methods only because they are more practice-oriented.

In capital budgeting, there is no such thing as a risk-free project. The future cash flows of a project may unexpectedly decrease or increase. The rate at which future cash flows are invested may not remain the same. There are many other factors that may reduce expected cash flows: a loss of a market share, an increase in the cost of goods sold, new environmental regulations, and a rising cost of financing. Since there is always risk in capital budgeting, a major job of investment analysts is to select projects under conditions of uncertainty (Table 1).

When performing in such conditions it is crucial to get a reliable informational support, so one of the key prerequisites for the risk to be measured is the access to reliable databases. As V. Chernov noticed: "... information

Table 1

The Comparison of Risk Measuring Methods

Methods	Opportunities	Deficiencies
Standard deviation, probability distribution and coefficient of variation	It provides high reliability of the project conclusions by taking into account the probability of obtaining a certain level of income in each year of the period studied.	It might happen that the probabilities of selected outcomes are not quite true.
Simulation	Simulation analysis lets decision-makers test various possible combinations of events thus carefully investigate the relationships between the factors affecting the cash flows that leads to a deeper understanding of the project.	Full-scale simulation may require large sums of money.
Sensitivity analysis	1. Sensitivity analysis allows determining those variables to which the NPV is most sensitive. 2. It enables managers to asses how responsive the NPV is to a change in the variables. 3. It helps to explain in details why the project might fail.	1. It requires that changes in each key variable have to be isolated thus it does not allow determining the cumulative effect of changes in two or more variables. 2. It does not give any indication of the probability for the key variables or a combination of these variables to occur.
Certainty equivalent	Provides high reliability of the conclusions by using the most probable value of expected cash flows of the project.	Sometimes it gets difficult to determine with a high level of reliability the certainty equivalent or the percentages of the expected cash flows that are certain. Appropriately, there is a probability of belittling the NPV of the project.
Risk-adjusted discount rate	The capital asset pricing model (CAPM) approach allows determining a fair discount rate of the project.	There exists a risk that the beta for the new project in reality may not be equal to the average beta for a group of firms in the particular industry or to the beta of market portfolio.
Adjusting for inflation	Adjusting for inflation method allows examine the effect of inflation on the NPV of the project.	The rate of inflation which is implicit in the forecasts for the coming year, and is used by this method may, in fact, be different than the actual rate upon the occurrence of this time period.

security during risk measurement does not only serve as a source of data for analysis, but it also means the reduction of risk” [3]. While processing the information it is necessary to take into account the fact that it can be useful and used effectively only under condition it corresponds to certain requirements. Among these requirements the analysts emphasize:

— reliability (a measure of the accuracy of information transfer),

— objectivity (a measure of reflecting the reality of information),

— completeness (exhaustive information received),

— relevance (the degree of how the information corresponds to the task),

— urgency (the significance of information during risk measurement),

— cost (affordable price level of information).

With quality information ensured, the next step is to evaluate which method or their combination can provide reliable data. The applied research by V. Khobta, O. Solodova, S. Kravchenko, O. Fischenko, D. Egorenko [4]. proved that the usage of only one method of risk measurement is impractical; only a combination of methods can provide a reliable research and ensure the validity of accepted investment decisions.

The optimal combination of risk measuring methods means minimum (financial and time) costs of implementing the method, while ensuring its validity, availability, and reliability (minimal error and maximum practicality).

Advisability of making an investment decision that involves a certain degree of risk is detected only by its estimates. Such estimation is especially important when there is a choice of a particular solution from a set of alternatives. Therefore, the problem of modern analysts is to identify correctly a group of methods by means of which the only right decision can be made.

In the economic literature there are several approaches to measuring the risk and magnitude of income of the enterprise in the face of uncertainty. Drury thinks that traditional methods for doing this type of analysis are *standard deviation and probability distributions, simulation technique and sensitivity analysis* [5]. Block and Hirt argue that there should be *quantitative* and *qualitative* measures. To this extent they offer a number of basic statistical devices to measure the extent of risk inherent in different situations. Among them they name *probability distribution, standard deviation, coefficient of variation, the beta (β), risk-adjusted discount rate, simulation models, decision tree* [2]. Shim and Siegel also pick out several methods to incorporate risk into capital budgeting. They are *risk-adjusted discount rate, standard deviation and coefficient of variation, certainty equivalent, semi-variance, simulation, sensitivity analysis and decision (probability) trees* [6]. As Block and Hirt noted, all abovementioned methods have much in common: "... they must recognize the riskiness of a given investment proposal and make an appropriate adjustment for risk" [2].

Before defining the optimum combination of methods for measuring risk, it is necessary to analyze the opportunities and deficiencies of each method. For this research there have been chosen 4 methods (Sensitivity Analysis, Certainty Equivalent Approach, Adjustment for Inflation, Standard Deviation and Probability Distribution Method) that are the most accessible and popular in the real business and 2 (Simulation Technique, Capital Asset Pricing Model) that represent the state of the art in risk measurement.

This part of paper is to illustrate a practical application of the risk measuring methods for a project of introducing new household chemical products in aerosol packaging using energy-efficient and environmentally friendly technology without the use of ozone-depleting substances. This project is in progress at the "Impulse" company located in the town of Alekseyevka, Donetsk region. The founder of this company is JSC "Donetsk Chemical Plant". This company specializes in manufacturing perfumes, industrial products and household cleaning products in aerosol packaging.

The methods of risk measurement are practically applied here. However, it should be specified that the methods of 'Simulation' and 'Capital Asset Pricing Model' can not be used, because they require special costly software that is not currently available.

Initial Data for the Project

Initial Investments (II) of the project is 17 801.84 thousand UAH.

Discount rate (r) is 16%.

Cash flows are the following:

Year	Cash Flow (thousand UAH)
1	339.63
2	3 517.30
3	6 554.83
4	6 995.48
5	7 073.33
6	6 314.66
7	6 283.52
8	6 258.95

After making some calculations, the Net Present Value of the project was founded.

NPV = 3 260 thousand UAH

A positive NPV means that the project is worth implementing. ***Therefore, project should be accepted.***

Based on the data obtained the *Payback Period* of the project and its *Profitability Index* were evaluated.

Payback Period = 6.7 years

Profitability Index = 1.18>1 *Project is acceptable*

After we have found the NPV, Payback Period and Profitability Index of the project, we can move into the risk measurement. First, to detect how sensitive the given project is to the environmental change, it was used the "Sensitivity Analysis".

Sensitivity Analysis

Sensitivity analysis is a popular way to find out how the *NPV* of a project changes if sales, labour or material costs, the discount rate, or other factors vary from one case to another [3].

On the Table 2 you can see the changes in discount rate and its impact on NPV. We have taken the discount rate of 16% as a base and changed it in 3 percent to each direction. As you can see, the project appears to be very sensitive to the changes in discount rate. And than, on the table 3, you can see as the same operations were done with the sales volume. The sales volume was changed by 3 percent in each direction and finaly, from the data obtained it was concluded that the project is extremely sensitive to changes in the discount rate and less sensitive to changes in sales volume

Standard deviation, probability distribution and coefficient of variation

This method gives us the opportunity to calculate exact amount of expected risk for the project, it also gives us the average measure of how far each of the

Table 2

Changes in discount rate

Change in discount rate, %	Net present value at 16 %, Th. UAH	Change in net present value, Th. UAH	Change in net present value, %
- 3%	3 260.60	2 724	83.56
-2%	3 260.60	1 765	54.14
-1%	3 260.60	858	26.32
Base (16%)	3 260.60	0	0
+1%	3 260.60	-812	-24.91
+2%	3 260.60	-1 581	-48.50
+3%	3 260.60	-2 311	-70.89

Table 3

Changes in sales volume

Change in volume of sales, %	Base net present value Th. UAH	Change in net present value, Th. UAH	Change in net present value, %
- 3%	3 260.60	-632	-19.39
-2%	3 260.60	-421	-12.91
-1%	3 260.60	-211	-6.47
Base (100%)	3 260.60		
+1%	3 260.60	211	6.47
+2%	3 260.60	421	12.91
+3%	3 260.60	632	19.39

three outcomes falls away from the expected value. Generally, the larger the standard deviation (or the coefficient of variations) is, the greater is the risk. With the data before us, we compute three important statistical measures— the expected value, the standard deviation and the coefficient of variation [2].

The expected value is a weighted average of the outcomes (D) times their probabilities (P). The standard deviation is the measure of dispersion or variability around the expected value, and the coefficient of variation is standard deviation divided on expected value. [6] In our case, the:

(Expected Value) = 339.63 thousand UAH

(Standard deviation) = 25,2 thousand UAH

(Coefficient of variation) = 0,07 thousand UAH

Certainty equivalent approach

And to determine the Certain NPV, the certainty equivalent approach was held. The idea behind the certainty equivalent approach is to separate the timing of cash flows from their riskiness [7]. Cash flows are converted into risk-free (certain) cash flows, which are then discounted at a risk-free rate. In other words, we should multiply Expected Cash Flows at the Certainty Equivalent Factors and then discount results [5].

The present value of certain cash flows of this project is 16221.67 thousand UAH. Subtracting the initial investment of 17 801.84 from 16221.67, we determine the NPV of the project to be -1579.33. According to the Certainty Equivalent Approach the NPV is negative and indicates a high level of the project risk.

And finally as a result, it can be said that the combination of the above methods has given us a complete picture regarding the risks of the project. By the method of the standard deviation and distribution, the standard deviation of NPV of $ 25.2 thousand UAH

Table 4

The Present Value of the Project Certain Expected Cash Flows at a Discount Rate 16%

Year	Certain Cash Flow	Present Value Interest Factor at 16 %	Present Value of Certain Cash Flow
1	322.65	0.862	278.15
2	3 165.57	0.743	2 352.53
3	5 571.61	0.641	3 569.49
4	5 596.38	0.552	3 090.83
5	5 304.99	0.476	2 525.78
6	4 420.26	0.410	1 814.26
7	4 084.29	0.354	1 445.14
8	3 755.37	0.305	1 145.48
$\sum$			16 221.67

has been received. The method of the sensitivity analysis illustrated the project's sensitivity to change. The discount rate and sales volume changed by 3 percent in each direction. From the data obtained it was concluded that the project is extremely sensitive to changes in the discount rate and less sensitive to changes in sales volume. The method of certainty equivalent approach gave a negative NPV, which indicates that the management should pay special attention to this project, and carry out the ongoing monitoring, as the project is risky.

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Kostenok I. V., Fil E. V. Risk Measuring Methods: Modern Approaches

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Key words: risk, method, investments, project, enterprise.

Костенок І. В., Філь Є. В. Методи оцінки ризиків: сучасні підходи

У статті досліджено методи оцінки ризиків, визначено можливість їх використання у процесі капітального бюджетування та запропоновано оптимальну комбінацію методів для оцінки певного інвестиційного проекту. На прикладі проекту одного з провідних хімічних підприємств міста Донецька було апробовано систему запропонованих методів.

Ключові слова: ризик, метод, інвестиції, проект, підприємство.

Костенок И. В., Филь Е. В. Методы оценки рисков: современные подходы

В статье исследованы методы оценки рисков, определена возможность их использования в процессе капитального бюджетирования и предложено оптимальную комбинацию методов для оценки определенного инвестиционного проекта. На примере проекта одного из ведущих химических предприятий города Донецка была апробирована система предложенных методов.

Ключевые слова: риск, метод, инвестиции, проект, предприятие.

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