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Method of Real Options in Managing Investment Projects

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Abstract**:** ***A key factor for the success of the project management is the availability of a clear pre-defined plan, minimizing risks and deviations from the plan, efficient management of changes (as opposed to process, functional management, service level management). Using the binomial method to estimate the value of real options, they proceed from the assumption that the number of links is discrete and known in advance. The logic of this approach requires that their number corresponding to the frequency of making the most significant decisions for the project. The nodes of the lattice should be those moments in time in which strategic decisions are made on reducing, developing, switching business, etc. In general, the use of the real options method extends the tools to justify decisions in managing investment projects.***

Index Terms**:** ***Binomial Approach, Real Options, Investment Project, Project management, underlying asset lattice, option valuation lattice, decision lattice.***

I. INTRODUCTION

Project management – in accordance with the definition of the national ANSI PMBoK standard [1], it is an area of activity in which clear objectives of the project are defined and achieved when balancing between the amount of work, resources (such as money, labour, materials, energy, space, etc.), sometimes, quality and risks. A key factor for the success of the project management is the availability of a clear pre-defined plan, minimizing risks and deviations from the plan, efficient management of changes (as opposed to process, functional management, service level management).

Project products can be products of the company or organization (the results of scientific and marketing research, design and technological documentation for a new product developed for the customer) and the solution of various internal production tasks (for example, improving product quality and efficiency of the organization of work, optimization of financial flows) [2-5].

At first glance, it may seem that project management is something simple and elemental, consisting of budget, staff and deadlines for completion. However, it often happens that the project goes beyond the budget, or unskilled personnel are selected, which entails delaying the deadlines for the project.

Traditionally, for making decisions in the field of project management, the discounted cash flow method is used, which is focused mainly on companies operating in stable business areas and often cannot adequately assess the effectiveness of innovative projects [6; 7]. Therefore, there is a need to improve the methodological support for the evaluation of innovative projects with the introduction of the latest methods used in world practice, but have not yet found wide application. In world practice, when evaluating large investment projects, tools are used to determine the adjusted value of investments, which will be determined by the further course of the project. These tools are called real options.

The concept of real options has arisen as a result of the transfer of the created risk management tools with the help of option contracts from the financial sector to the real economy [8-12].

II. METHODS AND CRITERIA COMPARISON FOR EVALUATING THE ECONOMIC EFFICIENCY OF INVESTMENT PROJECTS

The set of methods and the corresponding criteria used to assess the economic efficiency of investments and investment projects can be divided into three groups, depending on the method of taking into account the time factor in the implementation of investment costs and obtaining return investment flow, as well as a number of other criteria:

- dynamic (taking into account the time factor) or discount, classical methods - models of discounted cash flows;
- static (accounting) or accounting, traditional - models that provide for the use in the calculations of accounting data on investment costs and incomes without discounting over time;

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- alternative or non-standard - models that take into account the limitations and disadvantages of the other two groups of methods.

Fig. 1 schematically shows the classification of the most widely used methods for evaluating investments with regard to their group division.

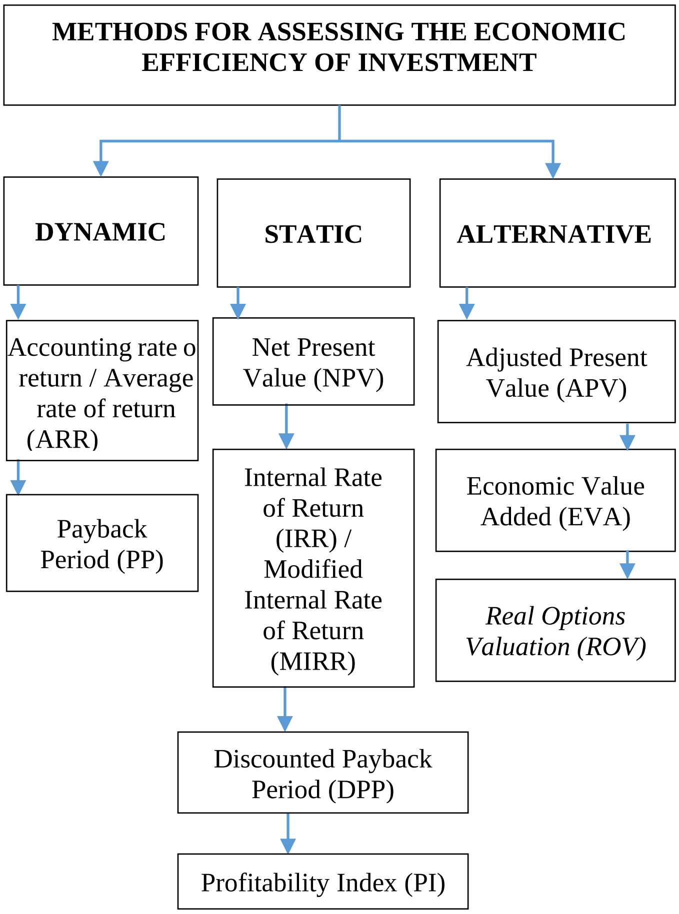

Fig. 1 Classification of methods for assessing the economic efficiency of investment

A preliminary analysis of the literature showed that for our task, the most appropriate is the *method of real options*.

Real options are not contracts, unlike trading options that are concluded between the parties. They are called options for the similarity of an idea: management has the right (but not the obligation!) To take some action in the future. For example, postpone the start of the project or exit it. At the same time, no one buys such a right, no contracts are made. This is an approach to evaluation. The theory of real options does not reject the ideas of traditional valuation methods. It complements them, corrects shortcomings, takes into account the ability of managers to make the best decisions based on current economic conditions. Real options allow management to be farsighted and not abandon potentially very interesting projects. For example, suppose that, according to DCF, the value of a plot is equal to 2.5 million dollars, and according to the valuation with the use of options - 3.08 million dollars. The owner sells it for $ 2.75 million. In this situation, the company in the traditional assessment (DCF) refuses to acquire this site. And the estimation taking into account options will allow to get it. Moreover, the company in this case will understand how much it can spend on an unplanned basis, for example, on infrastructure.

III. METHODOLOGY

The development of the theory of the options approach contributed to the creation of several types of models and methods for assessing the value of real options. They are based on classical models for estimating the fair price of production financial assets, including [13]:

1) the Black-Scholes model (1973) - an analytical solution obtained by R. Merton for the stochastic equation for a simple European option per share (Black) Scholes model, BSM);

2) the Koch and Ross assessment model (1976) with the assumption of risk neutrality (replicating portfolio model);

3) Binomial Cox-Ross-Rubinstein estimation method (1979) (CoxRoss-Rubinstein model). The main idea of this approach is to simulate the movement of the value of the underlying asset based on the binomial law. It is assumed that in the considered period of time the variable can change only in two directions: increase with probability p or decrease with probability (1 - p). That is, the stochastic behaviour of the asset value over time is modelled - (u) an increase (1 + relative price increase) or (d) a fall (1 - relative price drop) with given characteristics. The condition $d < (1 + r) < u$ is also necessary, where r is the risk-free rate of return. If d and u are lower than the risk-free rate, the risk-free asset will always have higher returns than the risky asset, which conflicts with financial theory. Increasing the number of time periods, we obtain a graphic figure, called a binomial lattice, or a binomial tree (Fig.2):

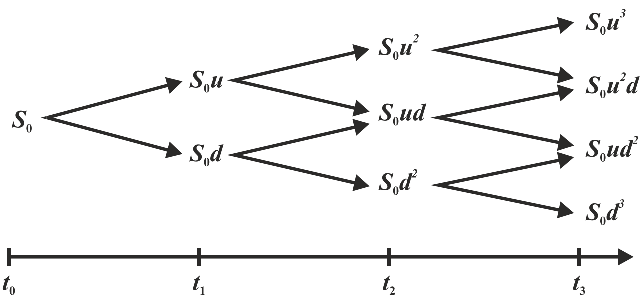

Fig. 2 Binomial lattice

Initial conditions of the model: for each period (t) there are only two possibilities for the asset price to move: up to the value of Su or down to the value of Sd. It is assumed that the probability of price change is known.

To determine the value of real options, it is proposed to use the Black - Scholes model, despite the fact that it comes from a number of limitations:

- the assessed asset must be liquid (it is necessary to have a market for the assessed asset);

- the price of the asset does not change dramatically;

- The option cannot be exercised until the date of its execution (European option).

The value of a real option is calculated using the Black-Scholes formula, which was developed to evaluate financial options of the type `call`:

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$$ROV = PV \cdot N(d_1) - EX \cdot \exp(-r \cdot t) \cdot N(d_2) \quad (1)$$

$$d_1 = \frac{\ln\left(\frac{PV}{EX}\right) + \left(r + \frac{\sigma^2}{2}\right) \cdot t}{\sigma \cdot t^{0.5}} \quad (2)$$

$$d_2 = d_1 - \sigma \cdot t^{0.5} \quad (3)$$

where ROV – option value;

PV – the present value of cash flows from the realization of the investment opportunity that the company will receive as a result of the investment project;

$EX \cdot \exp(-r \cdot t)$ – the present value of the investment for the project or the liquidation value of the investment for the project or the residual value when rendering from the project;

$N(d_1), N(d_2)$– integral functions of normal distribution d_1 and d_2

σ – standard deviation, that is, the "asset price volatility" (market-valued risk). For real assets, the usual way to evaluate is to analyze historical data;

r – short-term risk-free rate of return;

t – the time until the expiration date of the option (the exercise of the option contained in the option) or the time until the next decision point.

The binomial approach involves the phased implementation of calculations.

First, the ***underlying asset lattice*** is created by multiplying its current value by the growth and decline rates. Further, it is necessary to understand what influence these or other decisions may have on the results of the project. To do this, build an ***option valuation lattice*** using the method of backward induction. In accordance with this approach, the final nodes of the lattice are evaluated, and the intermediate nodes are evaluated from right to left. At each node, the most advantageous solution is selected. The difference between the estimated effect of the project, taking into account the options and the base effect without taking them into account, is the value of the real options.

There is another option to perform calculations. After the grid asset has been built, the second grid can be built for the option itself. For this, it is necessary to evaluate the effect obtained directly from the option in the lattice nodes, and not from the combination “project + option”.

The third stage is optional, but it is recommended to perform it to increase the visibility of the analysis results. It consists in building a lattice called a ***decision lattice***. In its nodes indicate the most profitable solutions.

Using the binomial method to estimate the value of real options, they proceed from the assumption that the number of links is discrete and known in advance. The logic of this approach requires that their number corresponding to the frequency of making the most significant decisions for the project. The nodes of the lattice should be those moments in time in which strategic decisions are made on reducing, developing, switching business, etc. To simplify the work, we recommend using the software, for example, DerivaGem.

IV. PRACTICAL APPLICATION OF THE METHOD OF REAL OPTIONS

Consider a five-month investment project to buy a stock that provides for a one-time dividend payment of $ 2.15 over the life of the option. The initial share price is $ 35, the strike price is $ 33, the risk-free interest rate is 10% per annum, the price volatility is 35% per year, and the dividend payout period is 24 days.

$$2.15e^{-0.2917*0.1} = 2{,}02\ \$ \quad (4)$$

First, we construct a tree to calculate the component S* (Fig. 3), i.e. share prices not exceeding the present value of future dividends, the payment of which will take place during the term of the option. At the initial moment of time, the size of the dividend is equal to

Consequently, the initial value of S* is equal to $ 33.00. Assuming that 35% volatility relates to component S*, we conclude that the binomial tree for its calculation has the form shown in Fig. 3. (This is explained by the fact that S * has the same initial value and the same volatility as the share price for which Fig. 3 is built).

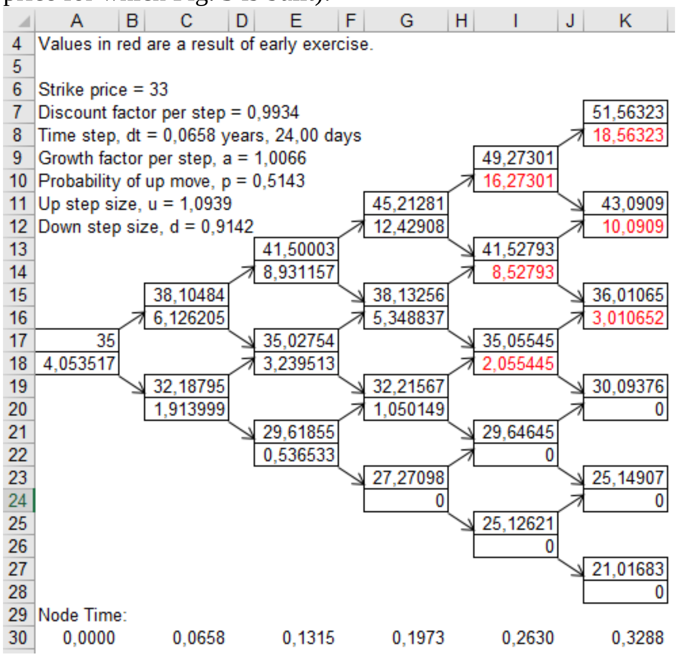

Fig. 3 Binomial lattice for the investment project

V. ANALYSIS OF RESULTS

Adding the current cost of dividends to each of the nodes leads to Fig. 3, which is a binomial model for calculating the value of S. As in Fig. 3, the probability of growth of the share price in each node is 0.5143, and the probability of its fall is 0.4857. Carrying out a reverse round of the binomial tree, we find that the assessed value of the option is 4.0535 dollars. (With 50-time steps, the result is 4.05 dollars, and with 100 steps, 4.0955 dollars.).

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VI. PERSPECTIVES

The real options method for evaluating investment projects is becoming increasingly common. The use of a tool such as real options in the management of a comp any allows the management to pay less attention to creating "ideal" forecasts and to devote more efforts to identifying alternative ways of the company's development. The use of the traditional method of discounted cash flows leads to the fact that management in the course of the project can be difficult to abandon the planned actions and see new opportunities that will bring the company great profits. Taking into account that the scope of application of this technique is almost unlimited and wherever there is uncertainty, you can find real options, in three or four years the number of companies that have adopted this method will increase significantly.

VII. CONCLUSION

Using the binomial method to estimate the value of real options, they proceed from the assumption that the number of links is discrete and known in advance. The logic of this approach requires that their number corresponding to the frequency of making the most significant decisions for the project. The nodes of the lattice should be those moments in time in which strategic decisions are made on reducing, developing, switching business, etc.

In general, the use of the real options method extends the tools of a venture investor used by them to justify decisions on investment projects.

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