Application of Option Models in Evaluation of Innovative Projects of the Aviation Industry

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Abstract

The implementation of investment projects with a high-risk component, as well as innovative projects, is necessary for enterprises, despite the low values of the performance criteria. The theory of managerial options (real options valuation) is a tool that allows one to identify and evaluate additional opportunities (options) inherent in the project, which increase the efficiency of the original project and make it more attractive to potential investors. The mechanism considered in the study, in which the option to increase production volumes is used, allows an initially unprofitable project to be brought to a qualitatively new level.

Key-words: Innovative Project, Investment Project, Project Efficiency, Risk Management, Management Options.

1. Introduction

In classical economic theory, the efficiency of an investment project is defined as a positive value of net present value (NPV).

If the NPV is positive, a project is considered profitable and is accepted for implementation; otherwise, it is rejected. This approach justifies itself in a stable economic environment and in relation to risk-free investments. As a rule, projects related to the expansion of existing production are referred to as risk-free (Troshin: 2016; Nikulina, Tarasova: 2017).

Innovative projects in high-tech industries are associated with uncertainty and high risk. Cash flows arising from the implementation of innovative projects can be built only with a certain degree of probability. Under these conditions, good results in assessing the effectiveness of investment investments are obtained by using the real options valuation (ROV) (Moscviciova et al.: 2017).

ROV is used to assess the economic effect of investing funds, as well as determine the optimal moment to start investing. This assessment method is becoming more relevant in connection with a rapidly changing, dynamic external environment and increased flexibility in making management decisions (Nikulina, Tarasova: 2018; Tarasova, Nikulina: 2014).

The concept of a real option is defined as the right of its owner (project manager, enterprise manager, owner) to perform a certain action that changes the course of the project, depending on the current economic situation.

The presence of management options increases the attractiveness of an investment project for an investor. There are managerial options for expanding (reducing) the project, the option to abandon the project during its implementation, as well as postpone the implementation of the project.

A growth option occurs when the initial investment is a condition for future development, and the current project is viewed as a link in a chain of related projects. A nonprofit project can be vital to the company's future success.

If the situation deteriorates, the management has the opportunity to close, reduce or suspend the project; with a successful coincidence, it is possible to increase capacity, scale up to obtain large profits. Investment projects after their adoption and even after the start of implementation do not remain unchanged. Managers can make changes that affect subsequent cash flows.

Thus, the execution of a project that is ineffective from the point of view of the classical theory can open up prospects for the implementation of new projects by the enterprise, the implementation of which would be impossible without the implementation of the primary project.

Managerial or real options are the manager's ability to choose, which allows making decisions that affect the expected cash flows of the project and the duration of its implementation and even provides an opportunity for an emergency project curtailment. Similar decisions can be made throughout the entire life cycle of a project.

2. Methods

The most commonly used models for pricing real options are:

- Black-Scholes model;
- Binomial option pricing model.

Studies have shown that to assess the effectiveness of innovative projects in the aircraft industry, it is advisable to use a combination of classical valuation methods based on the construction of discounted cash flows and option models. For the basic project, dynamic criteria of investment efficiency are calculated: NPV and internal rate of return (IRR). Then the cost of possible management decisions in the process of implementing the main project is estimated. This valuation is done using ROV. The final version of the project cost for the investor takes into account all the opportunities that the project opens up.

3. Results

Let us consider a project related to the organization of the production of polymer composite materials (PCM) at an aviation enterprise.

Today, there is an active introduction of composite materials in the design of aircraft. At the moment, in the total weight of the aircraft, polymers and composites make up about 15% on average, while in the first aircraft, they made up only 2-3%. The field of application of composite materials in aircraft construction is extensive. They are used for highly loaded aircraft parts (skins, spars, ribs, panels, etc.) and engines (fan blades and compressors). In space technology, they are used to produce units of power structures of vehicles exposed to heating, for stiffeners and panels.

Composite materials are materials formed by a volumetric combination of chemically dissimilar components with a clear interface between them. They are characterized by properties that none of the components, taken separately, possesses. Composite materials are created for specific tasks. When designing a new composite, the technologist performs all the necessary calculations and only then chooses the optimal combination of raw materials for the production of a composite with the specified characteristics.

The use of composite materials makes it possible to reduce the weight of the aircraft by about 30%, which increases the payload by approximately 1.5 times and doubles the flight life of the aircraft. The introduction of composite materials into the structure of the aircraft also allows reducing the costs of its manufacture, which leads to a decrease in its cost.

According to expert estimates, the creation of a high-tech production complex equipped with modern machining and measuring equipment, as well as technological lines for the production of large-sized structures from composites, will require capital investments for 450,000 thousand rubles. The aviation enterprise produces conventionally (con) 30 aircraft per year. The need for composite materials for one aircraft is 394 sq. meters. Cost of production per sq. meter of composite is 12,000

thousand rubles. Due to the introduction of composite materials into the structure of the aircraft, the costs of basic materials are reduced by 8,430 thousand rubles per plane. The investment project is designed for 10 years. Equipment is depreciated on a straight-line basis with a depreciation period of 10 years.

Based on the given data, the cash flows for the project were built, presented in Table 1.

Table 1- The Main Project for Organizing the Production of Composites. Cash Flows (In Thousand Rubles)

Years	0	1	2	3	4	5	6	7	8	9	10
Con production (pc.)		30	30	30	30	30	30	30	30	30	30
Reduced costs for basic materials		252,900	252,900	252,900	252,900	252,900	252,900	252,900	252,900	252,900	252,900
Composite fabrication costs		141,840	141,840	141,840	141,840	141,840	141,840	141,840	141,840	141,840	141,840
Depreciation		45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000
Taxable profit		66,060	66,060	66,060	66,060	66,060	66,060	66,060	66,060	66,060	66,060
Net profit (T = 20%)		52,848	52,848	52,848	52,848	52,848	52,848	52,848	52,848	52,848	52,848
Cash flow	-450,000	97848	97,848	97,848	97,848	97,848	97,848	97,848	97,848	97,848	97,848

The price of the company's capital was used as the discount rate; it is 17.5%. The project efficiency criteria (NPV = -2,333 thousand rubles, IRR = 17.36%) indicate that the project is ineffective.

However, when analyzing this project, it is necessary to take into account that it opens a new direction in the development of the company.

The need for composite materials in the aviation, shipbuilding and other science-intensive industries is constantly growing. At the same time, the requirements for the timing of the development of new materials, as well as the quality of their manufacturing technology, are increasing. Today, many factories use PCM in the construction of their aircraft, but they do not have an established composite production, which makes them resort to buying materials from suppliers.

The high-tech equipment purchased within the framework of the main project makes it possible to produce structures of any complexity and size, and with the help of numerical control, it is possible to reconfigure the equipment for new samples of composite structures. This strengthens the position of the enterprise in the direction of the production of composite materials and allows to get additional profit by concluding contracts for the supply of new PCM for structural and functional

purposes with specified characteristics of corrosion resistance, strength, reliability, rigidity, durability and fire safety.

Currently, negotiations are underway on the supply of PCM to a third party. The new investment project will require the purchase of additional equipment for 47,000 thousand rubles. The annual sales volume will be 3,900 sq. meters of composite per year. The cost of one sq. meter of PCM in terms of variable costs is 8,500 thousand rubles, the sale price is planned at 11,900 thousand rubles. Thus, the return on sales under the new contract is 40%. It is planned to start deliveries of composite material three years after the start of the main project. Cash flows for the new project are presented in Table 2.

Table 2- Cash Flows for the Accompanying Project (In Thousand Rubles)

Year	3	4	5	6	7	8	9	10
Income		46,410	46,410	46,410	46,410	46,410	46,410	46,410
Costs		33,150	33,150	33,150	33,150	33,150	33,150	33,150
Depreciation		6,714,285,714	6,7142,857	6,71428,571	671,428,571	671,428,571	6,714,286	6,714,286
Taxable profit		6,545,714,286	65,457,143	654,571,429	654,571,429	654,571,429	6,545,714	6,545,714
Tax (20%)		1,309,142,857	13,091,429	13,0914,286	130,914,286	130,914,286	1,309,143	1,309,143
Net profit		5,236,571,429	52,365,714	523,657,143	523,657,143	523,657,143	5,236,571	5,236,571
Cash flow (CF)	-47000	1,195,085,714	11,950,857	11,9508,571	119,508,571	119,508,571	1,195,086	1,195,086

The NPV of the project with a discount rate of 17.5% amounted to -794 thousand rubles; the IRR was 16.91%. According to the discounted cash flow method, the new project is also ineffective. Therefore, the inclusion of associated cash flows in the cash flows of the main project will not improve its profitability indicators.

However, the demand for composites is constantly growing. For example, the share of CFRP (Carbon-fiber-reinforced polymer) parts in the Sukhoi Superjet aircraft structure is about 14%, while the share of composites in the new passenger medium-haul aircraft of the Irkut MC-21 Corporation reaches almost 40%. The design of the MS-21 provides for the use of wing and center section panels, as well as tail assembly units made of PCM. Therefore, the implementation of an additional project may represent an entry into a growing market.

On the other hand, more and more new manufacturers of PCM are appearing, which may affect the prices of PCM towards their decrease.

Due to uncertainty about the market prospects, the standard deviation of the value of the new project's cash flows is estimated at about 40% per year.

In these conditions, it is advisable to evaluate the accompanying investment project as a European-style call option.

To implement the Black-Scholes model, the risk-free rate is taken at 8.5%.

The cost of a call option, according to the Black-Scholes model, is calculated by the formula

$$C = S * N(d_1) - X * e^{-rt} * N(d_2),$$

where S is the present value of the asset,

X is the strike price of the option,

e^{-rt} – continuous discount multiplier at the risk-free rate where t is the number of years before the option expires.

In our example, S is the present value of income from the accompanying project, discounted for three years at a rate of 17.5% per annum, X is the size of capital investments in the project, t is equal to three years.

The quantities d_1 and d_2 are determined as follows:

$$d_1 = \frac{\ln\left(\frac{S}{X}\right) + rt}{\sigma\sqrt{t}} + (0.5\sigma\sqrt{t}),$$

$$d_2 = d_1 - \sigma\sqrt{t}.$$

In these calculations, σ is assumed to be 40%.

The first step in assessing the value of an option is to calculate the d_1 and d_2 values:

$$d_1 = \frac{\ln\left(\frac{28,483}{47,000}\right) + (0.085*3)}{0.4*\sqrt{3}} + (0.5*0.4*\sqrt{3}) = -0.00844$$

$$d_2 = (-0.00844) - (0.4*\sqrt{3}) = -0.70126$$

From the tables of the normal distribution we get:

N(d_1)=0.496632

N(d_2)=0.241569.

Substituting these values into the option pricing formula, we get the value of a possible expansion of the project to create a composite production at an aviation enterprise:

$$C = (28,483 * 0.496632) - (47,000 * 0.241569 * e^{-0.085*3}) = 5,347 \text{ thousand rubles.}$$

The Black-Scholes model assumes that the value of the current asset in the future is a continuous random variable distributed according to the lognormal law. At the same time, no restrictions are imposed on the growth or reduction of value. If we are talking about an investment

project implemented at an existing production facility, the asset is the future income from the project. These incomes cannot change indefinitely. The maximum value of future income is limited by the capacity of the production complex. The reduction in future income is associated with a drop in demand and prices for manufactured products. To determine the maximum and minimum cost of future income for the project, the optimistic and pessimistic scenarios of the development of events are considered. The optimistic scenario corresponds to the maximum value of the cost of future income, and the pessimistic scenario corresponds to the minimum value of the cost of income. In this situation, the use of the binomial model to estimate the value of the growth option leads to more reliable results.

In our example, the parameters of the binomial model have the following values:

S_0 is the most probable present value of income from the side project, discounted for three years at a rate of 17.5% per annum,

S_u is the cost of income according to the optimistic scenario, given to the beginning of the implementation of the accompanying project ($t = 3$ years),

S_d is the cost of income under the pessimistic scenario, given to the start of the implementation of the accompanying project,

X is the strike price of the option. In our example, it corresponds to the size of the capital investment in the project.

It is assumed that, according to the optimistic scenario, the current value of project revenues may grow by 40% and amount to:

$$S_u = 46,206*(1+0.4) = 64,688 \text{ rubles}$$

According to the pessimistic scenario, the cost of income may decrease by 40% and amount to:

$$S_d = 46,206 * (1 + 0.4) = 27,723 \text{ thousand rubles.}$$

The size of capital investments (X) is 47,000 rubles, $S_0 = 28,483$ thousand rubles.

Option delta (δ) corresponds to proportional changes in option value at the time of exercise and assets:

$$\delta = \frac{64,688 - 47,000}{64,688 - 27,723} = 0.49$$

The hedge ratio is inversely proportional to δ:

$$n = \frac{1}{\delta} = \frac{1}{0.49} \approx 2$$

By building a replicative portfolio:

$$27,723 = (28,483 \text{-} 2C) * 1.0853,$$

Let us calculate the option value:

C = 3,389 thousand rubles.

Thus, we determined that while implementing the main investment project for organizing the production of composite materials, the enterprise, as it were, buys an option to increase the volume of output worth 3,389 thousand rubles. The cost of the option can be added to the previously obtained value of the NPV, which will significantly increase the attractiveness of the project for the aviation enterprise:

NPV with option = -2,333 + 3,389 = 1,056 thousand rubles.

4. Conclusion

As the result of the study, it was possible to show that the use of ROV, namely the Black-Scholes model and the binomial option pricing model, made it possible to improve the efficiency of the investment project, as well as reduce risks by building a step-by-step algorithm for its implementation.

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