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REAL OPTIONS APPROACH IN THE ASSESSMENT OF INVESTMENT PROJECTS

Розглянуті питання використання опціонів у практиці купівлі-продажу нерухомого майна. Проаналізовані спільні риси фінансових опціонів та опціонів на нерухомість, а також їх особливості. Запропоновано механізм використання опціонів на нерухомість у практиці господарювання.

The issues of using the options in the practice of purchase and sale of real assets have been considered. The common features of the financial options and options on real assets as well as their peculiarities have been analysed. The mechanism of employing the options on real assets in the management practice has been suggested.

1. Introduction

Each decision about the realization of an investment project should be proceeded by the assessment of its effectiveness. Such assessment should answer the basic question: if and to what extent the project analyzed affects the realization of various company goals, in all – economical, social, technical or innovative areas of its functioning. There is a broad range of methods of investment assessment, which for years have been used in the practice. The methods comprise both qualitative and quantitative ones. The first group, qualitative methods, is used for preliminary appraisal or when the criteria that are not measurable quantitatively have to be taken into consideration. The second group, quantitative methods, are based on simple (payback period PB, accounting rate of return ARR) and discounted (discounted payback period DPB, net present value NPV, internal rate of return IRR) measures. All these measures are well-known and widely used in market economy conditions. They have been the subject of numerous research and presented in many books and articles (see for instance [1], [2], [3]). And as the major part of all appraisals takes place under risk and uncertainty connected with project realization, several methods enabling the investor to assess their investment in the conditions of risk (sensitivity analysis, scenario analysis, decision trees etc.) were invented and applied broadly [1], [3].

During the last years the range of investment appraisal methods has been extended through the introduction of the achievements of financial engineering, first of all through the concept based on real options approach. The aim of this paper is to present this concept – its sources as well as valuation rules and possible applications. As it will be demonstrated in the paper, *it is possible by the means of real options approach to supplement projects evaluation. There are two important sources of project value: its flexibility and expandability (strategic value) and these components are comprised in real options approach to project evaluation.*

2. Genesis of real options

Financial engineering seems to be one of the most dynamically developed and most interesting areas of contemporary economic sciences. It is possible to find various definitions of financial engineering. Financial engineering is regarded as a scientific discipline of risk management or as a group of methods used to construct derivatives adjusted to investors' needs. The most often quoted Finerty's definition treats financial engineering as creation, development and application of new instruments and financial processes as well as formulation of creative solutions of financial problems [2].

There were several factors that affected fast development of financial engineering. Among the others one should point at the fluctuation of prices on financial markets and connected with them increase in investment risk, the changes in banking systems resulting in the development of new banking products, as well as the development of information technology and telecommunication facilitating the trade with new financial instruments. The focal point of financial engineering are derivatives (options, futures,

forward contracts, swaps) commonly used in the risk management. The broad usage of financial options was possible after development of mathematical tools of financial options pricing, for instance Black-Scholes model. Moreover, Black and Scholes, the Nobel Prize winners, have predicted more complex and extended application of their formula taking into account also non-financial areas. However, several years had to pass by until 'option' started to appear in another context as well.

One of the important reasons which affected the non-financial applications of options seemed to be the critics of NPV method as a tool of the appraisal of investment projects. It is possible to find in the literature a long list of factors which are pointed at as the most important advantages of NPV [4], [5]:

- it corresponds to the company goals,
- it enables the investor to select projects, pointing at these projects which affect mostly the increase of company value,
- it takes into consideration the whole period of project life,
- it considers time value of money,
- it is not sensitive of non-conventional cash flows,
- it enables the investor to choose among investments in financial and non-financial assets.

However, the NPV method has also some disadvantages, The most often quoted in the literature are as follows [1], [4], [5]:

- it limits the risk analysis to the market risk comprised in the height of discounting factor,
- it does not enable the investor to assess the value of the possibilities offered by the project for the future development of the company, it is not possible to assess 'project chain' initiated with the project analyzed,
- it does not take into account the possibilities of the active management of project realization, it assumes that the realization will be run according to the rules 'now or never', 'all or nothing', i.e. it assumes that the project will be carried out according to the plans and forecasts and that no important changes in the environment will influence its realization.

These drawbacks of NPV usage have given rise to the search for alternative methods of project appraisal, enabling one to comprise valuation of flexibility and active management of project realization in the assessment process. Additionally, the more and more common approach to company management called *Value Based Management* resulted in the search for such appraisal methods that will not limit the assessment to one single project treated as an isolated venture, but which will enable the investor to assess its influence on the whole strategy of the company. The isolated analysis of a project could not take into consideration the opportunities which will appear after the realization of the project. In many research and development projects the performance of one project allows one to perform next projects. Moreover, many investors looked for the methods which will confirm their intuitive higher assessment of project profitability in such situation. Many investors, on the basis of their experience, assess the value of a project as higher than the value assessed by traditional methods, if the project opened the future opportunities, so called 'strategic options' [3].

The search for alternative methods of project assessment resulted in research on the adoption of financial options to the valuation of non-financial investments. The main idea of real option approach was to apply financial option theory to real investments such as manufacturing plants, line extension, research and development investments etc.

At the beginning the concept of real option was introduced into practice in the oil industry to assess the value of hydrocarbon reserves and tracts in the bidding process [6], [7]. There were some crucial reasons for such applications. At first, oil exploration projects are realized under risk and uncertainty (for instance as to the oil reserves or oil prices). Next, geological leases – similarly to financial options – have certain expiration date. The application of real options was adopted then in the assessment of geological projects connected with exploration of other mineral resources, such as zinc,

gold and cuprum [8]. Nowadays the range of application of real options is much broader, it is possible to find in the literature numerous examples in almost all industries, for instance pharmaceutical, biotechnology, information technology, telecommunication, aviation and many others.

3. Financial options

As it was mentioned in previous chapter, one of the basic and most interesting areas of financial engineering are derivatives used in the process of investment risk management and among derivatives financial options seem to be used most often. The concept of financial options has given rise to the creation and development of real options approach and therefore some more important definitions and rules connected with financial options will be presented below.

Option could be defined as *a contract between two parties, one of them (writer) takes the obligation to sell (or buy) certain asset at an agreed upon price (exercise price) before or on a certain date*. A financial option *gives its owner the right – but not obligation* – to purchase (it is called *call option*) or to sell (*put option*) a financial instrument at a given price. If the owner can purchase a stock before a certain date such option is called *American option*, if the option is exercised at a certain date – it is called *European option* [9].

According to the definition the basic characteristics of an option are as follows:

- exercise price – i.e. price of financial instrument agreed upon,
- premium – it is paid for the right to buy or sell financial instrument,
- expiration time.

It must be underlined that the owner of the option has the right to buy or sell a certain financial instrument, but he will use this right only when it is profitable. The example below illustrates such rule. Let's assume that the actual market price of share A is 25 USD, and the price of option (premium) is 5 USD. Investor who buys options to purchases 100 shares A has to pay total premium $100 \times 5 = 500$ USD. Next, let's assume that the exercise price is 30 USD, and expiration time 4 months. If at the day of expiration the price of the share A is below 30 USD this investor will not exercise the options, as it is more profitable to buy shares at the market price. The investor will loose premium 500 USD. If the market price is higher, for instance 40 USD per share, and if the investor exercise options (i.e. buys shares per 30 USD) and sells the shares on the stock exchange, he will gain $(40 - 30) \times 100 - 500 = 500$ USD. The rule presented in the example above is also illustrated on Fig. 1.

Investor's profit can be written with mathematical formula:

$$D = \max(S_T - X, 0) - C$$

S_T – the market price of a share at the expiration day,

X – expiration price,

C – cost of buying the option (premium).

As it was demonstrated in the example above, exercising of an option depends upon the comparison of the exercise price (which is determined) with the market price of underlying instrument (which fluctuates). According to financial option theory, the value of an option (C) depends on the following factors [9]:

- price of underlying instrument S,
- exercise price X,
- expiry date T,
- volatility of prices σ^2,
- risk-free interest rate r,
- dividends expected in the period until expiration date.

It should be also underlined that there are two important sources of financial option value:

- *Intrinsic value* – depend on the relation between exercise and market price of the share. Call option has its intrinsic value if exercise price is lower that market price (see the example above).

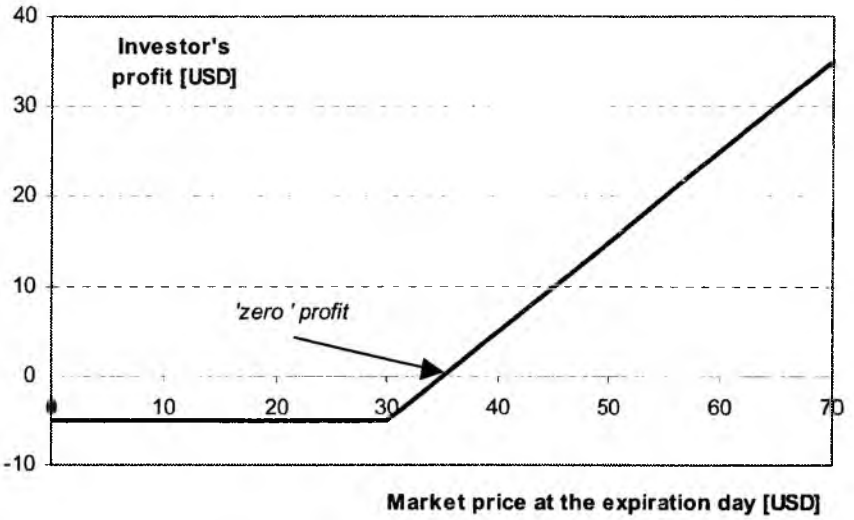

Fig. 1. Investor's profit, call option

- *Time value* – depends on fluctuation of market prices and on expiration time. As the exercise date is approaching, time value decreases as the probability of favorable situations is lower.

One of the most important but additionally most difficult issues connected with options theory seems to be option pricing. In the literature it is possible to find various models of option pricing. First group of models assumes that the prices of underlying assets change discretely, for instance binomial tree model (Cox, Ross and Rubinstein model). The second group of models assumes that the changes in price level are continuous. The most popular model of this group, Black-Scholes model, is regarded as the basic instrument of option valuation. The other models of option pricing (Merton model, Garman and Kolhagen model) can be found in various books and papers on financial engineering, for instance [3], [9], [10]. In these books it is possible to find more detailed analysis of options pricing and applications.

4. Real options

When realizing an investment project managers have often a certain range of flexibility to alter their decisions as further information becomes available, it is possible to postpone some terms, maker shorter (longer) realization time, change the scope of works etc. The existence of such flexibility should be mirrored in the results of project appraisal. The meaning of flexibility in managers' decisions could be demonstrated clearly if two situations are compared:

- approach based on the assumption that the realization of the project will go according to plans and forecasts and no important changes, even in the environment, will happen,
- approach taking into consideration flexibility of decisions in relation to new information, experience and changes in the environment.

If we analyze different scenarios of future situations, from less to most favorable ones, in the traditional method of assessment (the first approach) the assessment results could be presented as a line bell-shaped, where most probable value, median and expected value are equal. In the case of flexible approach, the results are different. If we take into account that the manager has the ability to use favorable situations or limit the scope of a project (or even call off its realization), the probability distribution of possible future results will become right-hand skewed, and expected value appears right comparing to mode (see Fig. 2).

The flexibility in the project management and strategic value create opportunities to increase the potential of the project and simultaneously to limit loses and risk. The general rule is as follows – the higher strategic value and more elasticity in the project management, the higher value of project analyzed. One of the possible means to assess all these additional elements is valuation based on real options concept.

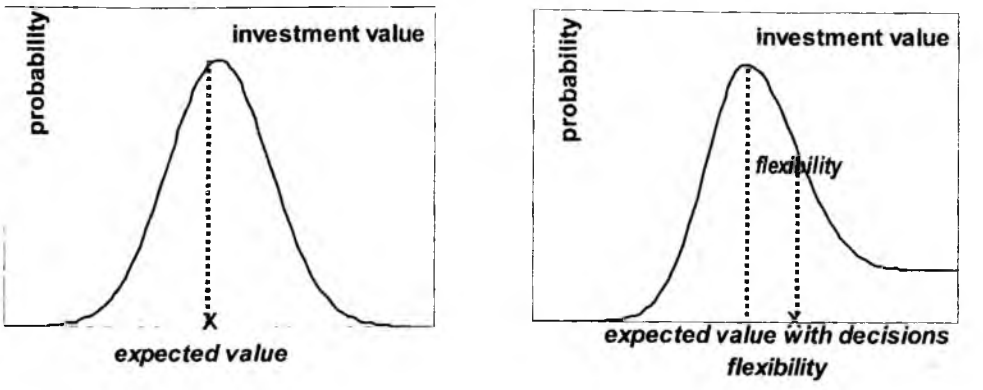

Fig. 2. Value of flexibility in investment project appraisal

The supporters of real option applications in the assessment of non-financial investments underline the fact that to invest means to change the capital into rights to cash flows generated by the project within its lifetime. A financial option gives its owner the right but not the obligation to purchase a security at a given price. Analogously, a company that has real option has the right but not the obligation to make a potentially valuable investment.

In the project assessment based on real option approach the following assumptions are required [10], [11]:

- *the price of underlying instrument S* is the sum of discounted cash flows generated by the project in its lifetime,
- *exercise price X* is the sum of discounted capital required to realize the project,
- *expiration time T* equals to the time of the investment possibilities,
- *volatility* σ^2 is equal to the estimated variance of future cash lows,
- *interest rate* is risk-free interest rate (for instance estimated on the basis of long-dated bonds).

Similarly to financial option, real option has also two important sources of its value:

- *Intrinsic value* – which is the result of the difference between estimated cash inflows and capital requirements,
- *Time value* – which is connected with the uncertainty as to the prices, production volume etc., it means with the possibility of favorable conditions which will be used to increase investor's profit.

As to the valuation of real option, the most popular models used in financial option pricing – Black-Scholes, Merton, binomial tree models – are also used as the tools of real options valuation. The method based on binomial tree, which presents the possible scenarios of project realization, is used quite often. The valuation with this model is regarded as quite easy to apply and interpret because of the analogy to decision tree method. The more complex and difficult models, which assume continuous distribution of changes in underlying asset prices, have one important disadvantage – it is not easy to keep to the assumptions required to the proper use of such method. It is possible to find in the literature a broad range of examples of applications of mentioned models based on financial engineering, as well as some specific models constructed for certain types of real options [6], [8], [12], [13]. As in many cases the solution of constructed models is impossible in analytical way, some numeric methods have to be used, with simulation among the others.

It should be pointed out that regardless of what mathematical model is used in the assessment process, the value estimated by the means of real options approach is never lower than the value assessed by traditional NPV method. According to the major concept of real options, the option will be exercised only when it brings benefit to its holder. The difference obtained when using real option and traditional approach could be treated as the measure of the flexibility and strategic value connected with the realization of a project. This rule has been presented on Fig. 3.

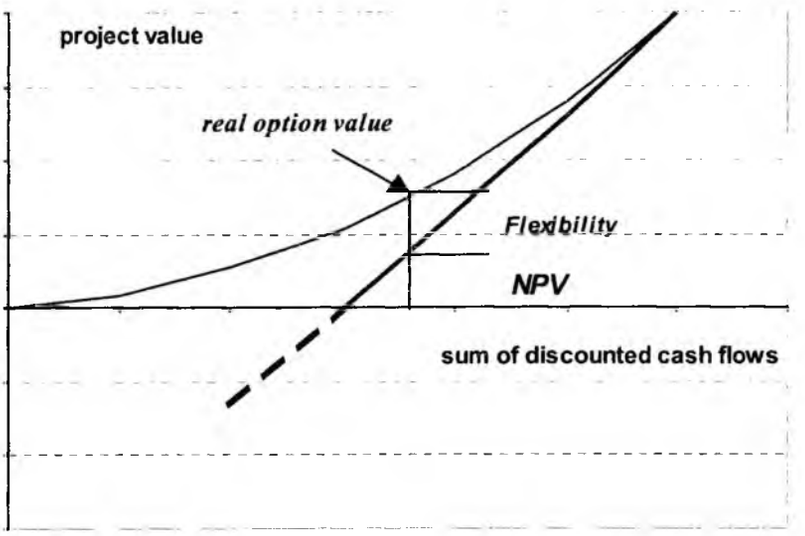

Fig. 3. Real option value and value assessed by NPV method (comparison)

5. Types of real options

There are various ways of classifying the projects realized in a company. One important category are *projects with inbuilt option* – it concerns often research and development projects which give to the company rights to the effects of these projects in the forms of patents or know-how. In some other situations projects enable the company to extend the scope or to realize following projects, and these projects are called *projects creating options*. There are also *staged projects* which are realized from their very beginning in a sequential way.

The variety of projects as well as of investors' approaches cause the existence of various types of real options. The types of real options most often presented in the literature are as follows [4], [10], [14], [15]:

1. *Option to defer* occurs when the manager has the possibility to postpone the moment of the final decision as to the way the project will be realized and can wait until new information is obtained. For instance, an investor who has the right to exploit cuprum reserves can assess the reserves and the capital needed to initiate (or continue) the exploitation. If the expenditure is much higher than income from cuprum the decision about running the mine can be postponed. If the cuprum prices will go up and the project is profitable the owner of the mine can start exploitation.
2. *Time-to-build option* – exists in such cases when the project is realized as a chain of single projects. Each stage is assessed an the basis of the information the investor has at a given moment but also taking into consideration the fact that each stage creates an option for the next stage of chain analyzed.
3. *Option to alter operation scale* – assumes that there is the possibility both to extend and to limit the scope of the project, to stop works and then to start again at a favorable moment.
4. *Option to abandon* – assumes that there is the possibility to abandon the project when market changes are unfavorable but that there exists the possibility to sell the assets or to use them for other purposes.
5. *Option to switch* – occurs when there is the flexibility to change input (resources) or output (product) according to the changes in the environment.
6. *Option to expand* – applies when the project is required to conduct any other projects leading to the development of the company.
7. *Multiple interacting option* – appears when the realization of a project can influence the strategy of the company giving additional synergic effect.

There are many projects which open not one but several options at the same time. The complex assessment of such projects cannot be regarded as a sum of all options but should be the result of their synthetic analysis.

6. Conclusions

The assessment of investment projects based on real option approach cannot be considered as a substitute or should not be treated as the methodology replacing the use of traditional measurements such as NPV or IRR. It is rather an additional area in project assessment methodology which enables investor to take into consideration such elements as flexibility in decisions and actions. The real option approach has many supporters among the managers of leading corporations such as Merck, Hewlett-Packard, Exxon, British Petroleum, Airbus Industries. The supporters of real options concept point at the fact that the company has a portfolio of real options no matter if their management is aware of this or not. These companies that are able to identify their options gain competitive advantage.

The real option concept has also many supporters among mathematicians, IT specialist or financial engineering specialists, as they can find new, interesting applications for their models invented.

However, it seems that more interesting and beneficial is to regard real option as a way of strategic analysis of investment projects, which make possible to discover new hidden opportunities (options) connected with the project analyzed. Real option concept offers the means used not only to assess but also to manage the project in a more active way.

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