UDC 334.027

L.V. Nikolova, M.D. Velikova

THE INFLUENCE OF CASH FLOW PROBABILITY CHARACTER ON INVESTMENT PROJECTS ASSESSMENT

Л.В. Николова, М.Д. Великова

ВЛИЯНИЕ ВЕРОЯТНОСТНОГО ХАРАКТЕРА ДЕНЕЖНЫХ ПОТОКОВ НА ОЦЕНКУ ИНВЕСТИЦИОННЫХ ПРОЕКТОВ

This article is focused on the possibility of the option theory for assessment of investment projects, cash flows being of probabilistic nature. We discuss the main methods used for assessment of real option value: Black–Scholes model, binominal model, and analyze their benefits and drawbacks. Particular attention is paid to the main characteristic of options for investment projects, creating an additional value, an additional effect.

INVESTMENT PROJECT; OPTIONAL APPROACH; ADDITIONAL COST; CASH FLOWS; PROBABILISTIC NATURE.

Рассматривается возможность применения теории опционов для оценки инвестиционных проектов, денежных потоки которых имеют вероятностный характер. Рассмотрены основные методы оценки стоимости реальных опционов – модель Блэка–Шоулза и биноминальная модель, проанализированы их достоинства и недостатки. Особое внимание уделяется основной характеристике вариантов инвестиционных проектов, созданию дополнительной стоимости, дополнительного эффекта.

ИНВЕСТИЦИОННЫЙ ПРОЕКТ; ДОПОЛНИТЕЛЬНАЯ СТОИМОСТЬ; ТЕОРИЯ ОПЦИОНОВ; ДОПОЛНИТЕЛЬНЫЕ РАСХОДЫ; ДЕНЕЖНЫЕ ПОТОКИ; ВЕРОЯТНОСТНЫЙ ХАРАКТЕР.

The paper considers the possibility of applying the option theory to investment projects assessment, cash flows of which have probabilistic nature. Capital investment options are usually called ‘real options’ as opposite to financial options granting a right to buy or sell financial assets. The option approach was originally used for assessment of financial assets because the latter is based on the principle of ownership rather than management.

The main difference between financial asset assessment and that of real asset (being the basement for investment projects) is the investor’s position. In general shareholder is a passive participant of creating cash flows [1]. In case of absence of shareholder’s controlling stake, his role is narrowed down to monitoring changes in the company and making decision whether to sell shares or hold them at a later stage.

Corporation's financial manager plays an active role in cash flow generation. He/she can effectively influence the process of getting net present value on the project (i. e. can delay investment expenditures or in some cases sell assets at their liquidation value). If cash flow values deviate from figures forecasted, financial manager has certain leverage helping him to return the project to original parameters. In other words, financial manager can generate options himself, i. e. embark on steps towards evening-out project losses or fulfilling new opportunities offered by taking this investment project. Using the method of real options for decision making on investment projects helps manager take into account the possibility of reacting to changing external conditions i. e. it becomes possible to resolve uncertainty in keeping with original assumptions.

The following investment project options are selected for analyzing:

– abandonment option (an option to sell project assets, in fact to abandon/cancel the project);

– timing option (an option to delay the investment project, i. e. to delay expenditure on purchasing or generating real assets);

– strategic investment option (an option of new investment opportunities);

– corporate growth option.

Hereafter the paper discusses main methods used for assessment of real option value (Black–Scholes model, binominal model) and analyze their benefits and drawbacks.

Investment project options. An option is simply a contract enabling for its holder to purchase or sale common stocks at a certain set price. In a large variety of option contracts the most widespread are the 'call' options and 'put' options.

The 'call' option is a contract granting to its holder the right to buy a specified amount of assets at a fixed price (or 'strike price') on a certain date or until its expiry. The 'put' option is a contract granting to its holder the right to sell a specified amount of assets at a fixed price (or 'strike' price) at the time of or before set date expiry [2].

The main feature of all investment project options is creation of additional value/effect.

The term «real option» arose after the methodology by which Black–Scholes theory was applied to real assets, had been developed. The concept of 'real options' (often called as ROA or Real Options Analysis) provides an opportunity to reconcile two opposite sides. Still ROA gives rich conceptual framework for decision making with using, inter alia, quantitative methods specified above.

On investment projects the following types of options are possible:

– abandonment option (an option to sell project assets, in fact to abandon/cancel the project);

– timing option (an option to delay the investment project, i. e. to delay expenditure on purchasing or generating real assets);

– strategic investment option (an option of new investment opportunities);

– corporate growth option.

According to rendering time (exercise of right to sell/buy) all options are divided into two categories: the 'American' and 'European' ones. The holder of an «American» option can use his right for selling or buying at any time before date expiry while the holder of the 'European' one can exercise his option only at a set date.

The application of the real option method to investment projects assessment seems to b reasonable if the following conditions are carried out:

– the project result is exposed to very high degree of uncertainty;

– company's financial manager is capable or has the right to make flexible managerial decisions in case of occurring new input data on the project;

– financial outcome of the project depends on decisions made by its financial manager through project assessment according to the discount cash flow method, NPV value is negative or just above zero.

It makes no sense to use the method of real options towards projects having a high net present value and a high degree of credibility. In fact, very few long-term investment projects display such characteristics. The method of real options is most popular in science-intensive/high-tech/ extractive industries involving heavy marketing/ new product promotion costs.

The option to sell project assets/abandonment option (or convert assets to other sort of production). If project allows its financial manager to build upon selling its assets at their net or current market value in case of undesirable course of events, this project should be valuated higher than the similar one assuming no opportunity for abandonment. Not all projects can provide such a chance. But if there is one (i. e. this right does exist, or an agreement for the purchase of project's non-circulating assets is negotiated so that one can recover assets), it ensures larger cash flows for the project and, inevitably, a higher net present value. In assessing investment projects an opportunity to sell assets has to be taken into account, while in negotiating a contract meaning saleability it is required cost assessment on this contract, i. e. assessment of an option to sell committed assets of the investment project. Here is one of the variations used for option assessment:

Option value = (Value of the project allowing the sale of assets) – (Value of the project not allowing the sale of assets (assuming that investment costs are irreversible)) = = (NPV with the option) – (NPV of irreversible costs).

Because here we are virtually talking about a «put» option, so option pricing models can be used.

Option to delay investment expenditure. A range of projects implies that expenditure-related decisions have to be taken immediately: the «now or never» principle is applied here. The external

environment may be uncertain, and some events may generate new input data, such as: adoption of a new taxation system, introduction of new export taxes whose rate remains currently unknown, prohibition of this business activity or a product, etc. [3, 4]. In this situation company's financial manager ought to postpone his decisions until relevant defining events take place. Project allowing entirely or partially delay of investment expenditure provides a «call» option on its real assets for company's manager and fundholder. An opportunity to delay a project means larger cash inflows in future, i. e. leads to a higher net present value.

During investment project analysis a number of questions arise: Is there an option to delay available? What is the «true» NPV value of the project? What is the value of this option? Besides, there is the more practice-oriented question: How much can the right to delay cost? The general approach of real options assessment is being remained:

Option value = NPV of the project allowing a delay − − NPV of the project with immediate decisions.

Option on future projects. A range of investment decisions generates potential opportunities for increasing cash flows due to implementation of new high income projects [4, 5]. High-tech investment has a huge growth facility, but its results (NPV) are difficult to calculate. It often happens that company managers can only claim that investment in the high-tech sector or in human capital generates opportunities for new projects or ensures a higher flexibility for already working ones [6, 7].

In analyzing an investment project, the baseline NPV has to be adjusted by the net present value generated by various opportunities.

Adjusted NPV = baseline NPV + + NPV of abandonment option + NPV of the option on future projects + NPV of the option to delay.

A project displaying characteristics of an option on future projects is assessed by the 'call' option pricing model.

Corporate growth option. Steward Mayers suggested using real options to identify corporate growth. In his 1977 paper he considered future investments of a company as its real growth options. The author also noted that a company's value reflects expectations of future investment. Future investment is discreet, and its value depends on the net present value of future opportunities. One part of corporate value is the present value of future investment opportunities, if external conditions are going to be friendly. The second part of corporate value depends on the cash flow generated by already existing company assets. Thus, the company's value can be divided into a) the value of assets already committed, and b) the present value of future investments (of the corporate growth option) [7].

The market value of a company can be then defined as the present value of free cash flows (PV of FCF). In its turn, it presents the current value of future growth EVA that is the cost of future growth, the current rate of EVA and the value of capital invested (CI); putting together they give the value of operating cost. FCF is full cash flow generated by all company's assets regardless of financial sources used.

The method for calculation of the growth option involves such a parameter as economic value added (EVA). At the first step it is assumed that the market value of a company (V) = the value of capital invested (CI) + market value added (MVA):

$$V = IC + MVA.$$

MVA, in its turn, is the aggregate net present value of all investments, both current and future. At the same time MVA, as Yong and O'Brian have shown, can be viewed as the discounted value of economic incomes (EVA):

$$MVA = PV(\text{expected EVA}).$$

EVA is one of the versions of the method of residual income (RI) that includes the assessment of loan and equity, but implies entering of updating in accounting:

$$EVA = NOPAT - (CI \times WACC),$$

where NOPAT is the net operational profit after tax; CI − capital invested and WACC − weighted average capital cost.

Further on, the expected EVA value for each year can be divided into two parts:

1. EVA-equivalent for the current year with assumption that the company is not growing (Current-level EVA).

2. Residual component describing the growth potential (EVAGrowth):

$$PV = (\text{expected EVA}) = PV(\text{Current} - \text{Level EVA}) + PV(\text{EVAGrouwth}).$$

Now we can describe the market value of a company as follows:

$$V = CI + PV(\text{Current} - \text{Level EVA}) + PV(\text{EVAGrouwth}).$$

The sum of the first two components – is the value of commercial assets. PV (EVA Growth) – it is the present value of growth potentials of a company, or the real option of the company's growth. By solving this equation for PV (EVA Growth) and taking into account the market value of the company we get the estimate of the growth option value (GOV):

$$GOV = \frac{V - CI - PV(EVA_{\text{Current level}})}{V} = 1 - \frac{CI + PV(EVA_{\text{Current level}})}{V}.$$

The corporate growth option allows making comprehensive assessment of a company's investment activity regarding its market value.

Methods for real option assessment. The conception of real options allows to assess project's opportunities quantitatively and thereby include them into the value of the investment project. Quantitative assessment plays a key role in any investment decision making; in most cases when additional opportunities are assessed only qualitatively and instinctively, they are simply ignored when comparing quantitative project parameters, and at its best reserve additional benefit of the project all other things being equal. For quantitative assessment the method of real options uses the same parameters as the traditional theory of investment project assessment.

Cash flows specify quantitative part of the project. At the same time the bigger the expected value of cash flows, the bigger the value of a real option. The term 'investment cost' refers here to the amount of money needed for project implementation. At the same time, the value of a real option is inversely proportional to the cost of the investment. Increase of time before the project implementation opportunity expires brings up the value of the real option as its holder has more time to exercise it.

Price volatility is also directly proportional to the value of a real option. In general, high volatility means a higher probability of both getting raise income and bearing losses. However, real options enable to reduce losses and retain opportunity to get extra profit, which make them even more valuable in a high volatility environment. The economic significance of this lies in the fact that more risky projects include wider opportunities for extra profits, and higher risk-free interest rate all other things being equal leads to a higher price of the real option and, correspondingly, of the entire project. Although to describe an impact of this project is a bit more complicated. On the one hand, all other things being equal, interest rate development causes decreasing current value of future cash flows which, in turn, reduces the price of real option. On the other, this also diminishes the current value of investment costs needed in future for real option implementation.

For assessment of real options two main methods are used, as described below: the Black–Scholes model and the binominal model.

The Black–Scholes model of option assessment. In their famous paper, Fischer Black and the Nobel Prize winner Myron Scholes presented their method and model for option assessment [8].

Their approach for the pricing of real option has its limitations:

– an assessed asset must be liquid, and there should be a market for the assessed asset;
– asset price dynamics must be balanced;
– the option can not be exercised before its expiry date (European type).

Application of the Black–Scholes model allows for real option assessment, whose price is higher if:

– value of cash flows is higher,
– project costs go down,
– option expiry time increases,
– risk rate increases.

The greatest influence on enhancement in option value is impacted by the discounted value of expected cash flows (DCF), i. e. for

increasing investment attractiveness it is necessary to enhance incomes rather than reduce costs. To use this model we have to obtain relevant reliable data for our calculation (time before implementation of opportunities put in the project, dispersion rate, etc.). Uncritical application of this methodology may have a negative impact on company's business and its competitive position. Maintenance of excessive flexible decisions can lead to frequent revisions of plans, loss of «strategic focus» and as a result – permanent inability to reach the strategic goals set for the company. Another issue of no little interest is correct accounting of the costs linked to generation and maintenance of real options. For instance, an opportunity to increase production (i. e. investment in excess capacity) may remain unused, and not all expenditures on the creation of such an option will be justified. Using the Black–Scholes model is also hindered by the fact that such calculations include many parameters of a purely estimating nature. The model fits to simple options assessment having only one uncertainty source and only one exercise date.

Real options cost assessment by the binominal model. Building up the binominal model helps obtain more correct results than by using the Black–Scholes one in a situation when there are several uncertainty sources or many decision-making dates. The model is based on two assumptions as follows: within one time interval there can be only two variants of the course of events (the best and the worst), while investors are indifferent to the risk involved.

Main problems with the binominal model are related to defining values of relative rise and drop in the value of business within each period, and also probabilities of positive or negative course of events. Real options cost assessment by the binominal model in a situation where a large number of decisions is taken during a year will be close to figures obtained by the Black–Scholes model.

Both models are equivalent from the mathematical point of view. However since the traditional economic analysis involves the «decision tree» model, the binominal one seems to be simpler in practice and more illustrative in its results. Its main disadvantage is clumsy and lengthy calculations, on the other hand this allows to take into account all additional factors and scenarios of the project life.

When assessing real options cost by both Black–Scholes and binominal model we can use the Project Expert 7 ver. software package, which enables to carry out project scenarios by all factors chosen by its manager.

Conclusion. Implementing the method of real options for investment projects assessment is becoming increasingly popular. The result of the present study is grounding the use of the option theory to investment project efficiency assessment in the market economy. Features of the following types of options have been analyzed:

– abandonment option (an option to sell project assets, in fact to abandon/cancel the project);

– timing option (an option to delay the investment project, i. e. to delay expenditure on purchasing or generating real assets);

– strategic investment option (an option of new investment opportunities);

– corporate growth option.

We also would like to emphasize the so-called corporate growth option, whose application will help build the market value of a company in the light of investment process, which is particularly important in modern facilities of developing economy. The benefits and drawbacks of the key methods for real option value assessment (Black–Scholes model, binominal model) mentioned in the paper will allow financial managers to use them properly.

The application of the real option approach requires changes in company's management culture and approaches to business conduct, which may be difficult to implement in some companies. Yet, using this financial tool in the process of company management may help CFOs to pay more attention to identification and specification of alternative ways of company performance. Applying the conventional method of discounted cash flows causes a situation where a financial manager implementing a project feels it hard to abandon actions already planned and can not see new opportunities potentially bringing more profit to the company. Uncritical application of the methods

of real option cost assessment may negatively impact company's business and its competitive position. Maintenance of excessive flexible decisions can lead to frequent revisions of plans, loss of «strategic focus» and as a result – permanent inability to reach the strategic goals set for the company. It is crucial to remember that by implementing real options increase of production may remain unclaimed on the market, which means that not all option costs will be justified.

It can be said that the area of application for real options is unlimited, and that we can find real options wherever there is uncertainty. It seems quite realistic that in 2 or 3 years the number of companies using this approach for investment efficiency assessment will grow significantly.

REFERENCES

1. **Degtereva V.A., Rodionov D.G.** Formirovaniye sistemy pokazateley dlya otsenki urovnya zhizni naseleniya. *St. Petersburg State Polytechnical University Journal. Economics*, 2008, no. 2(54), pp. 15–18. (rus)

2. **Van Horne James C., Vachowicz jr John M.** Fundamentals of Financial Management. Moscow, Izd. dom «Vil'iams», 2001. 807 p. (rus)

3. **Kozlovskaya E.A., Nikolova L.V.** Usloviya formirovaniya i upravleniya investitsionnoy programmoy regiona. *St. Petersburg State Polytechnical University Journal. Economics*, 2008, no. 1(53), pp. 46–48. (rus)

4. **Nikolova L.V.** Modeli upravleniya riskami investitsionnoy programmy regiona. *St. Petersburg State Polytechnical University Journal. Economics*, 2008, no. 1(53), pp. 258–263. (rus)

5. **Rudskaya I.A.** Methods to evaluate uncertainty of investment process in innovative organizations. *St. Petersburg State Polytechnical University Journal. Economics.* 2013, no. 1–2(163), pp. 149–154.

6. **Rudskaya I.A., Plotnikova Ye.V.** Sravnitelnaya kharakteristika metodov prognoza investitsionnykh potrebnostey innovatsionnykh organizatsiy. *St. Petersburg State Polytechnical University Journal. Economics*, 2013, no. 3(173), pp. 66–73. (rus)

7. **Rodionov D.G., Chipkin Yu.V., Sinelnicova S.S.** Effectiveness of the technoparks and business incubators. *St. Petersburg State Polytechnical University Journal. Economics*, 2012, no. 4(151), pp. 150–159. (rus)

8. **Demidenko D.S., Babkin A.V., Kudryavtseva T.Y.** Optimization of budgetary expenses on quality assurance of the public blessings. *St. Petersburg State Polytechnical University Journal. Economics*, 2010, no. 6(112), pp. 204–208. (rus)

9. **Breyli R., Mayers S.** Printsipy korporativnykh finansov. M.: Olimp-Biznes, 1997. S. 276–290. (rus)

10. **Fischer Black F., Scholes M.** The Pricing of Options and Corporate Liabilities. *Political Economy*, 1973, no. 81, pp. 637–654.

СПИСОК ЛИТЕРАТУРЫ

1. **Дегтерева В.А., Родионов Д.Г.** Формирование системы показателей для оценки уровня жизни населения // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2008. № 2(54). С. 15–18.

2. **Van Horne James C., Vachowicz jr John M.** Fundamentals of Financial Management. М.: Изд. дом «Вильямс», 2001, 807 с.

3. **Козловская Э.А., Николова Л.В.** Условия формирования и управления инвестиционной программой региона // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2008. № 1(53). С. 46–48.

4. **Николова Л.В.** Модели управления рисками инвестиционной программы региона // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2008. № 1(53). С. 258–263.

5. **Рудская И.А.** Методы оценки неопределенности инвестиционного процесса в инновационных организациях // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2013. № 1–2(163). С. 149–154.

6. **Рудская И.А., Плотникова Е.В.** Сравнительная характеристика методов прогноза инвестиционных потребностей инновационных организаций // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2013. № 3(173). С. 66–73.

7. **Родионов Д.Г., Цыпкин Ю.В., Синельникова С.С.** Эффективность функционирования технопарков и бизнес-инкубаторов // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2012. № 4(151). С. 150–159.

8. **Демиденко Д.С., Бабкин А.В., Кудрявцева Т.Ю.** Оптимизация бюджетных расходов на контроль качества общественных благ // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2010. № 6(112). С. 204–208.

9. **Брейли Р., Майерс С.** Принципы корпоративных финансов. М.: Олимп-Бизнес, 1997. С. 276–290.

10. **Fischer Black F., Scholes M.** The Pricing of Options and Corporate Liabilities // Political Economy, 1973, no. 81, pp. 637–654.

NIKOLOVA Liudmila V. – St. Petersburg State Polytechnical University.
195251. Politechnicheskaya str. 29. St. Petersburg. Russia. E-mail: nikalvsk@yandex.ru

НИКОЛОВА Людмила Васильевна – профессор Санкт-Петербургского государственного политехнического университета, доктор экономических наук, профессор.
195251, Политехническая ул., д. 29, Санкт-Петербург, Россия. E-mail: nikalvsk@yandex.ru

VELIKOVA Mariia D. – Varna Free University «Chernorizets Hrabar».
9000. VSU. Chajka. Varna. Republic of Bulgaria. E-mail: velikova.mariya@gmail.com

ВЕЛИКОВА Мария Димитрова – зав. кафедрой Варненского свободного университета «Черноризца Храброго», кандидат экономических наук.
9000, ВСУ. Чайка, Варна, Республика Болгария. E-mail: velikova.mariya@gmail.com