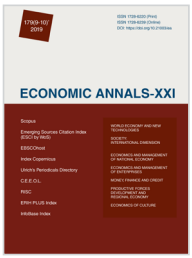

ECONOMIC ANNALS-XXI
ISSN 1728-6239 (Online)
ISSN 1728-6220 (Print)
https://doi.org/10.21003/ea
http://www.soskin.info/ea/

Volume 179 Issue (9-10)'2019

Citation information:
Astanakulov, O. (2019). Real options as a financial instrument to evaluate a project with a high degree of uncertainty: the specifics of application. *Economic Annals-XXI, 179*(9-10), 105-114. doi: https://doi.org/10.21003/ea.V179-09

UDC: 330.1

Olim Astanakulov
PhD (Economics), Associate Professor,
Head of Extramural Department,
Tashkent Institute of Finance
60[A] A. Temur Str., Tashkent, 100000, Uzbekistan
astanakulov@gmail.com
ORCID: https://orcid.org/0000-0002-0536-1214

Real options as a financial instrument to evaluate a project with a high degree of uncertainty: the specifics of application

Abstract. In conditions of instability of financial and commodity markets, the implementation of long-term projects with significant estimated payback periods involves not only long sources of financial resources, but also the use of new approaches to identify «weak signals» of the market, their systematic assessment and proactive response to changes. By itself, the possibility of a proactive response creates additional advantages for project participants (stakeholders), which, in financial and analytical practice, is usually associated with the concept of real options - the right to make management decisions in relation to the current or created asset. Using the investment potential of real options as one of the opportunities for evaluating projects with a high degree of instability allows one to make decisions outside the framework of the classical investment methodology. The instability factor for many investors now plays a significant role, increasing both the risk on the one hand, and the possibility of a multiple increase in capitalization on the other. The «Veriton Communications Inc» (USA) example with a simple financial option that allows an exchange investor to defer a decision about whether to buy or sell shares at a predetermined price has been given to demonstrate the basic approach to the methodology.
When conducting the work, the two large medicines producing companies - «Bioten» and «Pfizer» - were analyzed, taking into account the cash-flow and the investment projects for 2018-2019. The peculiarity of the obtained results is a slight difference in Net Present Value (NPV) for different amounts of funding.
The scientific novelty of the research is revealed in the principles of evaluating the investment attractiveness of projects with different degrees of innovation, which allows determining the possibility of creating innovation through the implementation of innovative investment projects by taking into account management flexibility, optimizing the capital structure according to the criterion of minimizing its cost by using the method of real options, multipliers and reverse induction, which will help to assess investment opportunities at all stages of the process of creating and implementing innovative investment projects.
The practical significance is shown in the universal possibility of using this tool in the project at any stage for making an investment decision.
Keywords: Options; Decision-Making; Financial Tools; Evaluation of Investment Projects; Net Present Value (NPV); «Veriton Communications Inc»; «Bioten»; «Pfizer»
JEL Classification: C18; G11
Acknowledgements and Funding: The author received no direct funding for this research.
Contribution: The author contributed personally to this work.
DOI: https://doi.org/10.21003/ea.V179-09

Астанакулов О.
кандидат економічних наук, доцент, завідувач заочним відділенням,
Ташкентський фінансовий інститут, Ташкент, Узбекистан

Реальні опціони в якості фінансового інструменту для оцінки проекту з високим ступенем невизначеності: специфіка використання

Анотація. В умовах нестійкості фінансових і товарних ринків реалізація довгострокових проектів зі значними розрахунковими періодами окупності інвестицій передбачає не тільки довгострокові джерела формування фінансових ресурсів, а й застосування нових підходів до ідентифікації «слабких сигналів» ринку, їх системної оцінки та попереджувального реагування на зміни, що відбуваються. Сама по собі можливість попереджувального реагування створює додаткові переваги для учасників проекту, які у фінансово-аналітичній практиці прийнято пов'язувати з поняттям реальних опціонів – права прийняття управлінських рішень по відношенню до діючого або створюваного активу.

Використання інвестиційного потенціалу реальних опціонів як одної з можливостей оцінки проектів з високою мірою нестабільності дозволяє приймати рішення за рамками класичної методології інвестування. Фактор нестабільності для багатьох інвесторів у даний час грає значиму роль, підвищуючи як ризик з одного боку, так і можливість кратного збільшення капіталізації – з другого.
В ході роботи були проаналізовані дві компанії («Bioten» і «Pfizer») з урахуванням грошових потоків й інвестиційних проектів за 2018–2019 роки. Особливістю отриманих результатів є незначна різниця в чистій приведеній вартості (ЧПВ, або чистому дисконтованому доході, ЧДД) при різних обсягах фінансування.
Наукова новизна роботи полягає в розкритті принципів оцінки інвестиційної привабливості проектів з різним ступенем інноваційності, які дозволяють визначити можливості створення інновації через реалізацію інноваційно-інвестиційних проектів шляхом обліку управлінської гнучкості, оптимізації структури капіталу за критерієм мінімізації його вартості із застосуванням методу реальних опціонів, мультиплікаторів і зворотної індукції, що сприятиме оцінці інвестиційних можливостей на всіх стадіях процесу створення й реалізації інноваційно-інвестиційних проектів.
Практична значимість роботи проявляється в універсальній можливості застосування даного інструментарію в проекті на будь-якій стадії для прийняття інвестиційного рішення.
Ключові слова: опціон; прийняття рішення; фінансовий інструментарій; оцінка інвестиційних проектів; чиста приведена вартість; «Bioten»; «Pfizer».

Астанакулов О.
кандидат экономических наук, доцент, заведующий заочным отделением,
Ташкентский финансовый институт, Ташкент, Узбекистан
Реальные опционы в качестве финансового инструмента для оценки проекта с высокой степенью неопределенности: специфика использования
Аннотация. В условиях неустойчивости финансовых и товарных рынков реализация долгосрочных проектов со значительными расчетными периодами окупаемости инвестиций предполагает не только долгосрочные источники формирования финансовых средств, но и применение новых подходов к идентификации «слабых сигналов» рынка, их системной оценки и упреждающего реагирования на происходящие изменения. Сама по себе возможность упреждающего реагирования создает дополнительные преимущества для участников проекта, которые в финансово-аналитической практике принято связывать с понятием реальных опционов – права принятия управленческих решений по отношению к действующему или создаваемому активу.
Использование инвестиционного потенциала реальных опционов как одной из возможностей оценки проектов с высокой долей нестабильности позволяет принимать решения за рамками классической методологии инвестирования. Фактор нестабильности для многих инвесторов в настоящее время играет значимую роль, как повышая риск с одной стороны, так и предоставляя возможность кратного увеличения капитализации – с другой.
В ходе исследования были проанализированы две компании («Bioten» и «Pfizer») с учетом денежных потоков и инвестиционных проектов в период 2018–2019 годов. Особенностью полученных результатов является незначительная разница в чистой приведённой стоимости (ЧПС, или чистом дисконтированном доходе, ЧДД) при совершенно разных объемах финансирования.
Научная новизна работы состоит в раскрытии принципов оценки инвестиционной привлекательности проектов с разной степенью инновационности, которые позволяют определить возможность создания инновации через реализацию инновационно-инвестиционных проектов путем учета управленческой гибкости, оптимизации структуры капитала по критерию минимизации его стоимости с применением метода реальных опционов, мультипликаторов и обратной индукции, что будет способствовать оценке инвестиционных возможностей на всех стадиях процесса создания и реализации инновационно-инвестиционных проектов.
Практическая значимость исследования проявляется в универсальной возможности применения данного инструментария в проекте на любой стадии для принятия инвестиционного решения.
Ключевые слова: опцион; принятие решения; финансовый инструментарий; оценка инвестиционных проектов; чистая приведённая стоимость; «Bioten»; «Pfizer».

1. Introduction

The importance and specificity of evaluating projects that have a significant spread of likely results was reflected in the financial and scientific literature on management almost simultaneously with their appearance, because an accurate assessment of their cost is an important step in the development stage of an innovative project and dramatically affects the future decision on investment. Financial evaluation makes an investment decision sound and in a way that ultimately creates value. In scientific literature, there is a wide variety of methodologies and approaches for evaluating investment projects, starting with the traditional discounted cash flow (DCF) method and ending with the modern method of real options analysis (ROA), which essentially determine the cost of investments and help make the right investment decision.

The evolution of methodologies for financial evaluation of projects is mainly related to the limited capabilities of traditional approaches, namely the method of discounting cash flows, in the evaluation of projects with high uncertainty. Until the 1960s, the length of time required to restore the initial cost of a project, regardless of the cost of money over time (Payback period) and the average rate of return (Accounting Rate of Return) were the two main methods of evaluating investments used by large companies. Published in 1951, Joel Dean's research paper «Capital budgeting» and Friedrich Lutz's research «Firm Investment Theory» opened up new directions and opportunities for evaluating investments by discounting cash flows (DCF). DCF-based approaches, such as Net Present Value (NPV), are fairly simple and straightforward. As a rule, they predict the amount of cash flows (both cash inflows and cash outflows) over the expected life of the project and discount them at a rate that reflects both the cost of money over time and the degree of risk of these cash flows. An NPV is calculated based on these input parameters. The rule for making an investment decision is based on a simple logic: if you compare two mutually exclusive projects, the preference is given to the one that has a greater NPV. If there is one project, then the NPV > 0 gives grounds to say that it is an attractive investment.

2. Brief Literature Review

Real options were introduced as a complement to the information provided by the cash flow sequence presented by an investment project (Rambaud & Sánchez Pérez, 2016). Modern option pricing theory has now found its way into the field of capital investment decision making and is referred to as the real options approach to capital budgeting (Moore, 2008). Real options (RO) analysis has been of growing interest to the academic community as a promising approach to supporting investment decisions under uncertainty. In this article, we examine an applied investment decision in the telecommunications industry to highlight the main benefits associated with using real options (Quelin & Krychowski, 2010).

Real Options (RO) has been used to evaluate projects with high uncertainty. However, literature points to challenges and asks for an organizational understanding of its use (Chagas, Sergio, & Sánchez Pérez, 2018). The empirical analysis reveals that the options can effectively hedge the risk, and the call option with a higher exercise price offers higher return per unit of option premium (Wang & Huang, 2019). While exogenous uncertainty influences the growth option market value or price, it is endogenous uncertainty that influences the value of the growth option through the ability to create a competitive advantage from preemptive market entry (Sears, 2019). The key feature of our algorithm is that it exploits the problem structure to explicitly account for reachability that is the sample paths in which resource states can be reached (Maier, Pflug, & Polak, 2019). Scenario planning enhances sense-making over the consequences of future uncertainties, and real options should help in addressing flexibility in decision-making through weighing the pros and cons of flexibility measures (Van Reedt Dortland, Voordijk, & Dewulf, 2014). Profit uncertainty has not incorporated into the real options model under incomplete information, in that the underlying state variable is not formulated as a stochastic process (Shibata, 2008). Real Options is crucial in order to comprehend the implementation issues related to organizational and managerial aspects and mainly in order to capture the value of managerial flexibility (Brasil, Gomes, Salerno, & Reis de Paula, 2017; Čičin-Šain, Krajnović, & Herenda, 2017). Despite significant progress made by each field separately toward our understanding of the theory and application of real options, there exist opportunities for more cross-fertilization and the development of a more interdisciplinary knowledge base and research agenda (Ragozzino, Reuer, & Trigeorgis, 2016). The industry and business-specific factors identified in the industrial organization and strategic management are real options, and their noticeable effects on firm performance are due to the varying intensities of real options that are embedded in them (Adetunji & Owolabi, 2016). The postponement effect implied by the use of real options prevails over the biotech firms' competition effect, which would instead play in favour of an early agreement for pre-emption reasons (Morreale, Robba, Lo Nigro, & Roma, 2017).

An option to abandon that exists on each project gives you the right to sell all assets and exit the project completely (Lin, 2009). The opt-out option is built into almost any project and has the characteristics of a put option. The management's decision on this option is to abandon the project if the expected profit or the value of the underlying asset falls below the project cost or the strike price (Benaroch, Jeffery, Kauffman, & Shah, 2007). An exit option is particularly valuable where the NPV is insignificant, yet there is a possibility of significant losses.

3. The purpose of the article to analyze investment indicators using the example of two companies - «Pfizer» and «Bioten» - by conducting preliminary research based on the companies' financial reports.

4. Materials and Methods

The paper uses a set of methods and approaches, which makes it possible to implement the conceptual unity of the study.

The system and structural methods are used to reveal the essence of the financial mechanism for evaluating innovative investment projects in the process of financial and economic regulation.

Due to comparative and factor methods, the experience of using financial instruments for managing innovation and investment projects in countries with developed and transformational economies is generalized and systematized.

The methods of scientific abstraction and synthesis are used in the process of developing the provisions regarding the assessment of managerial flexibility, its impact on investments and the possibility of determining their fair value, improving approaches to the use of real options methods as a tool for assessing the risks of innovative projects.

5. Results and Discussion

Despite the popularity and simplicity of DCF approaches, they are acceptable if the future can be predicted with high probability. Projects with a high level of uncertainty are not considered as such, because the actual future cash flows may differ significantly from the expected ones. Accordingly, instead of simply estimating the cost of the project, those who make an investment decision should evaluate the various possibilities of their actions in the future for quality management of uncertainties (Rambaud & Sánchez Pérez, 2017). Considering the impact of existing uncertainty on the project evaluation process, a significant amount of research shows that one of the most important aspects of most capital investments is the timing of investments and management flexibility. Thus, it is not surprising that a more precise approach has been developed, which allows investors to better understand the impact of uncertainty and address issues of managerial flexibility and investment timing directly.

Indeed, real options analysis (ROA) has received considerable attention in the research literature on project management over the past decade. The term «real option» was proposed by Professor Stuart Myers in 1977 in the article «Determinants of corporate borrowing» (Mun, 2002). The concept of real options was developed and implemented as a response to the inadequacy of traditional DCF approaches for evaluating projects with a significant level of uncertainty. Using the methods underlying the classical theory of financial options, ROA makes it possible to take into account traditionally difficult to measure quantitative elements such as managerial flexibility and the possibility of changing the strategic decision during the development of an investment project (Kim, Hwang, Oh, & Lee, 2018). In today's world, where unexpected changes are quite common, an investment strategy that includes managerial flexibility in decision-making will respond most effectively to various possible ways of further development and future prospects. In this case, the presence of a selection function, such as deferred or phased investments, which is built into the investment opportunity, is a significant factor for evaluating the investment project. In fact, ROA is an advanced way of recognizing how projects are structured and managed, and combines these additional features in a modern method of evaluating investments.

Since the underlying asset (the asset that is the basis of the option and is its subject) is a real asset, not a financial asset, when evaluating an innovative project, the option is called «real». Real options originated from financial options, which is why the terminology for both types is common. Financial assets are primarily stocks and bonds that are traded on financial markets. Options for most of these assets are listed on the major US exchanges, NYSE and Euronext. Real assets include real estate, innovative projects, and intellectual property that are not traded on financial markets. A real option is a right, not an obligation, to take action on an underlying non-financial real asset. An action may include, for example, abandoning a project, expanding it, entering into a contract or postponing a decision for the future. Real options can be either American, which can be exercised on a pre-determined date or on any pre-determined date, or European, which can only be exercised on a pre-determined date. We will analyze the features of the formation of financial options, terminology, and what is associated with them, and draw parallels with real options as a method of evaluating non-financial assets based on a simple example.

Let us assume that «Veriton Communications Inc» is a public American telecommunications company whose shares are sold at USD 50 per unit. The company's managers, as well as financial analysts, forecast further growth in the share price in the near future due to increased demand, innovative product output and a successful advertising campaign. At the same time, however, there is market uncertainty that indicates a possible sharp drop in the share price. An investor can buy «Veriton Communications Inc» shares today at USD 50 per share, or buy an option to buy or sell shares in the future. By purchasing an option, the investor acquires the right, rather than the obligation, to buy or sell shares (the underlying asset) at a predetermined value at a predetermined time (the European option), or at any time before a predetermined date (the American option). By purchasing an option on an underlying asset of the «Veriton Communications Inc» today at a market price of USD 5, which gives you the right to buy shares without any obligations in a year at the price of USD 50, the investor expects further growth of the company's shares by more than USD 5. In a year's time, if the share price increases by no more than USD 5, the investor will not fulfil the obligation to buy the stock and will lose the USD 5 that he/she spent on purchasing the option, and if the share price increases by, for example, USD 12, the investor will fulfil the obligations under the option, purchase the share at USD 50 and sell it at the market price of USD 62, earning USD 12 per share. After calculating the cost of purchasing an option, the investor's profit will be 12-5 = USD 7. Thus, using the option approach, the investor will only exercise his right (acquire the company's shares) if the share price exceeds the strike price. Otherwise, the investor will fix his losses at the level of the option value.

In another scenario, an investor has an option to purchase a sell option if they expect the share price to fall below USD 50 for the year. By purchasing an option to sell at the market price of USD 5, you have a right to sell the shares at the price of USD 50 in a year without obligation. If the share price of «Veriton Communications Inc» is more than USD 45 in a year's time, the investor will not exercise his/her right. However, if the share price falls to, for example, USD 30, the investor, as a rational person, exercises his/her option to sell one share at USD 50, receiving an income of USD 20 and a net profit of USD 15 after deducting from the initial option price (USD 5). In both of the above cases, the option approach allows the investor to take advantage of the benefit when it is positive and reduce the risk of large losses (lock in a loss) when expectations turn out to be wrong.

The first scenario involves the possibility of purchasing a buy option and is called a «call option». The option to purchase a sell option in the second scenario is called a «put option». The price at which the option is exercised is called the exercise price, which is USD 50 per share in both cases. The above scenarios concerned European options, since they must be exercised on a pre-determined date.

An option is a right, not an obligation, of its owner to buy or sell the underlying asset at a pre-determined price and on a pre-determined date or on any pre-determined date. A financial option is a right to buy or sell an underlying financial asset (for example, shares) at a predetermined price and on a predetermined date, or on any predetermined date. A real option is a right to take action (for example, postpone, expand, reduce, or discard) on an underlying non-financial asset at a predetermined price and on a predetermined date, or on any date determined in advance.

Tax codes of many countries define an option as «a civil contract under which one party to the contract obtains the right to purchase (sell) the underlying asset, and the other party assumes an unconditional obligation to sell (purchase) the underlying asset in the future during the term of the option or on a set date (date of execution) at the price of the underlying asset determined at the conclusion of such a contract. Under the terms of the option, the buyer pays the option premium to the seller» (Janney & Dess, 2018).

Financial options are capital investment instruments and are traded on stock markets, whereas real options relate to opportunities arising from strategic processes, such as using the opportunity to invest in research and development or entering into a contract to sell a portion of assets in the event of adverse external conditions. Unlike financial options, real options are not traded on stock markets because they have intrinsic value for a limited number of stakeholders. Real options represent an important strategic aspect, since they are the basis for strategic planning and investment in conditions of uncertainty (Levaggi & Moretto, 2008).

Similarly to a financial option, if the expected result generated by a real option is evaluated as unprofitable, the option is not exercised. Comparing financial and real options, Ragozzino, Reuer, & Trigeorgis (2016) state the fact that the opportunity to invest in a project is similar to owning a financial call option. In the case of real options, the underlying asset is the present value of cash flows from the completed operational project, while the strike price is the necessary investment expenses (Benaroch, Jeffery, Kaufmann, & Shah, 2007).

After identifying options that are specific to the project, it is necessary to take into account their values as corrections in the investment analysis algorithm. As a result, it is possible to more correctly determine the values of NPV and IRR indicators that reflect the results of applying the analytical model of proactive response. In this case, the composition and value of individual options is determined as a premium for reducing the level of uncertainty. The NPV_{ad} value, adjusted to the value of options, can be calculated as follows:

$$NPV_{ad} = NPV_{dfc} + \sum OP_i , \quad (1)$$

where:
NPV_{ad} - NPV value adjusted to the value of options;
NPV_{dfc} - the net present value calculated through the FCF and the $WACC$;
FCF - the determined calculated value of free cash flow;
$WACC$ - the weighted average cost of capital employed as a source of financing of the project;
OP_i - the estimated value of the i-th option.

Depending on further development and evolution of the market, if later the situation becomes favourable and the current value of the expected cash flows exceeds the current value of investment costs (the cost of converting an investment opportunity into the underlying asset of the option), management can exercise the option by investing, because the NPV of the project is expected to be positive. Otherwise, if the development of the market leads to unfavourable conditions for development, it may be decided not to invest in this project in order to reduce further losses, thus losing only the amount spent on the purchase of the option (fixing losses).

The classic IRR analysis assumes that cash flows generated during the project implementation can be immediately reinvested in the project and generate the same rate of return as the initial investment. However, this premise is not realistic. Therefore, when analyzing the effectiveness of investment projects, we use the modified internal rate of return (MIRR), which is calculated based on the assumption that incoming funds can be invested in a project with a return equal to the current value of the weighted average cost of capital (WACC).

In the case of a call option, if the value of the underlying asset (S) is less than the exercise price of the option (X), the rational investor will not exercise his right, and the option will remain unfulfilled. Thus, the net profit will be negative and equal to the value of the option (call price). If the value of the asset exceeds the strike price, the rational investor will exercise his right and the option will be exercised. In this case, the gross income will be positive. However, the net profit can be positive or negative depending on the call price. If the asset value is equal to the option exercise price, the gross profit will be zero, and the net profit will be negative and equal the price that the investor spent to purchase the option.

In the case of a put option, the investor's net income remains negative and equal to the option value (put price) as long as the value of the underlying asset (S) remains above the option exercise price (X). In this case, a rational investor will fix their losses by ignoring their right for this option. If the value of the asset is lower than the strike price, the investor's income will be equal to the difference between the strike price and the value of the underlying asset. The net profit will be negative as long as the difference between the asset value and the option exercise price is less than the price that the investor spent to purchase the put option. At the break-even point, the investor's net profit is zero.

The price of the call option at the time of its execution is determined by the formula:

$$C = max\,[0, S - X] , \quad (2)$$

where:
C - the price of the call option;
S - the asset value at the time of option execution;
X - option execution price.

The price of the put option at the time of its execution is determined by the formula:

$$P = max\,[0, S - X] , \quad (3)$$

where:
P - the price of the put option.

The «Veriton Communications Inc» example is a simple financial option that allows an exchange investor to defer a decision about whether to buy or sell shares at a predetermined price. Let us consider another example where the company itself is considering postponing the decision to invest in the development of its own technology to minimize financial risks and quality capital management. To simplify the example, the cost of money over time will be ignored, that is, the discount factor is a unit.

Let us assume that «Bioten» is a world leader in the field of biotechnology, the main activity of which is research and development of a number of medical products to treat people with hematological disorders (Table 1). Recently, the company has invented an innovative technology, received several patents and is interested in developing a new product based on this technology. Since the potential market for the product is uncertain, Bioten management does not want to commit to fully investing in development due to the likely low demand for the final product and chooses to sell the technology in the future if it becomes clear during the development process that the revenue from the sale of the newly created product will not bring profit to the company. Let us assume that «Pfizer» is another biotech company that has an interest in «Bioten» technology and is interested in developing its own product portfolio by launching innovative products. Both companies are signing an option that allows «Bioten» to sell its proprietary technology for USD 30 million at any time during the two years of product development. To be able to do this, «Bioten» buys an option and pays «Pfizer» USD 5 million for it. After completing the first year of development of new products, «Bioten» conducts a second market research and, based on its own reports and those prepared by independent analysts, estimates the future revenue from sales of products at the level of USD 20 million. The company's management implements its own put option, selling intellectual property to «Pfizer» for USD 30 million.

The analysis of the features of the formation and execution of options conducted using the above examples demonstrates the fundamental similarity of financial and real options, which suggests the theoretical possibility of using existing approaches to assessing the value of financial options for evaluating real options. We can assume that the companies «Bioten» and «Pfizer» signed a simple real option, because the only one significant source of uncertainty is the demand for a product.

In general, real options can be grouped into two main categories: simple options and complex options. An example of a simple option is the deferral option, where there is a choice between investing in a project today with uncertain future cash flows or delaying a decision until next year, when the expected uncertainty is clear and certain. This option exists for each individual project. For example, today an investor can invest USD 100 in a project with an expected profit of USD 120 for 1 year. According to calculations, the profit can be USD 160 (positive case) with a probability of 0.5 or USD 80 (negative case) with a probability of 0.5. However, the investor has a right to postpone the decision to invest in the project for 1 year, when the expected uncertainty about the profit will be known.

As shown below, using the standard DCF method with a discount rate of 10%, the NPV is USD 9.1. Since the value is greater than 0 and assuming that this level of expected return is acceptable to the investor, the investor will be willing to invest in this project. The NPV is calculated using the formula:

$$NPV = \sum_{t=0}^{N} \frac{CFt}{(1+i)^t}, \quad (4)$$

where:
CF - cash flows;
r - the discount rate;
t - period of time;
n - the number of periods.

Table 1:
Income statement highlights of «Bioten» and «Pfizer» for the 1st quarter of 2019 (USD million, except per share amounts and percentage)

Indicator	«Pfizer»	«Bioten»
Revenues	USD 13.118	USD 63.96
Reported Net Income	3.884	13.65
Reported Diluted EPS	0.68	0.32
Adjusted Income	4.891	2.29
Adjusted Diluted EPS	0.85	0.26

Source: Compiled by the author based on open data presented in:
https://ir.sarantis.gr/Uploads/PAROYSIASEIS/2019/Corp_pres_Sep_H1_19.pdf
https://s21.q4cdn.com/317678438/files/doc_financials/Quarterly/2019/q1/Q1-2019-Earnings-Charts-FINAL.pdf

As mentioned above, there is also a mutually exclusive alternative to postponing the decision for one year, until the uncertainty of cash flows will be clear. Let us calculate the project cost for the positive (NPV^{+}) and the negative (NPV^{-}) cases separately (each with a probability of 0.5).

$$NPV^{+} = 0.5 * \left[\frac{-100}{(1+0.1)^{1}} + \frac{160}{(1+0.1)^{2}}\right] = 0.5 * [-90.9 + 132.2] = USD\ 20.7\ , \quad (5)$$

$$NPV^{-} = 0.5 * \left[\frac{-100}{(1+0.1)^{1}} + \frac{80}{(1+0.1)^{2}}\right] = 0.5 * [-90.9 + 66.1] = -USD\ 24.8\ . \quad (6)$$

If after one year it turns out that this is a positive case, the investor will invest money in the project. Otherwise, the investor will refrain from investing.

The example shows that, in the case in question, postponing a decision (a postponement option) for one year costs USD 20.7 today, when a decision to invest today without waiting for transparency in uncertainty costs only USD 9.1 (using the DCF method without taking into account the flexibility of choice). Thus, the added value for the opportunity to postpone an investment decision is the difference between the two alternatives: USD 20.7 - USD 9.1 = USD 11.6 (Figure 1 and Table 2).

An option to expand is another common example where the investor has a right to expand a project with additional future investments. Let us consider the Example 2. We assume that a highly profitable software development Company «A» is interested in developing rapidly in other financial areas. Having sufficient cash reserves, the company can afford to acquire a small growing company that will provide synergy with the current product portfolio. However, not wanting to risk significant losses, management prefers to enter into an extension option in the future, when uncertainty that creates value for such an option will be dispelled by actual data regarding future cash flows. This option helps the company create a strategic map for future growth.

The extension option and the postponement option are American call options because they can be exercised on a pre-determined date or on any pre-determined date, and the investor gets the right to invest (buy) in the project.

An option to contract provides for the right to reduce the scope of the project (scale) by selling part of the assets if the market conditions are unfavourable for further development, investment and/or expansion. The ability to enter into a contract is an important management decision in a competitive market where companies must be able to quickly reduce costs or outsource through changing external

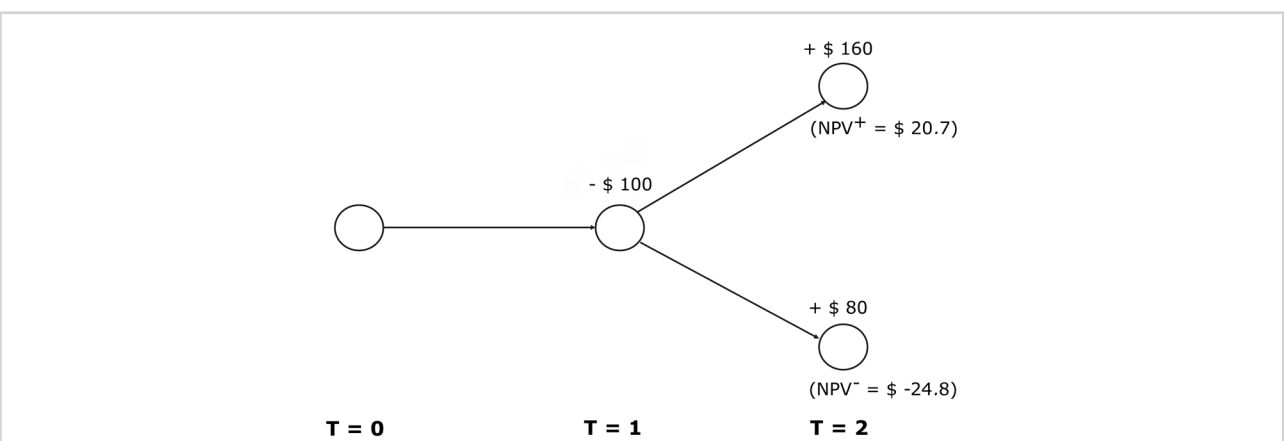

Figure 1:
Expected profit of the project if the decision is deferred for one year under the terms of example 1
Source: Calculated by the author

Table 2
Net present value of the main competitive scenarios facing «Bioten» and «Pfizer» (in monetary units)

Scenario	Project value (S)	Investment Cost (K)	NPV
1. «Bioten» upgrades production technology	63.96	23.5	40.46
2. «Bioten» implements new marketing strategy	40.96	51.4	-1.44
3. «Pfizer» upgrades production technology development	13.119	5	8.119
4. «Pfizer» implements new marketing strategy	8.119	10	-1.881

Source: Author's own research

conditions. Investing in the most volatile projects, investment companies can hedge risks through strategically created options for reduction (Lin, 2009). This type of option has the same as the put option, because the value of the option increases when the value of the underlying asset decreases.

When the uncertainty associated with income shows that the cash returns for this project are not attractive, the investor has an opportunity to abandon the project at an early stage without incurring significant losses (Lin, 2009). For example, let us assume that through potential new legislation that contains updated international trade rules that will come into force in the near future, Company «B» is concerned about having to close one of its main plants because of the high price of reorienting it to a new product type. The management believes that the uncertainty will be clear over the next year. Therefore, using the exit option will give additional time to make a more informed decision about the future of the plant.

Cut and exit options are American put options, because they can be exercised on a pre-determined date or on any pre-determined date, and the investor gets the right to sell part or all of the project assets.

The chooser option gives you a right to choose from a set of options, including the option to defer, extend, enter into a contract, and exit the project. The investor can choose not to execute, keep the option open and continue working on the project, or choose any of the simple options. The main advantage of this type of real option is the choice. This is a unique option in the sense that depending on the choice that the investor has the opportunity to make, it can be considered both a put (reduction or exit from the project) and a call (delay or extension) option.

Using the switching option, you can switch to a different operating mode or an alternative production process. For example, a gasoline car equipped with gas cylinder equipment offers a possibility of switching from gasoline to natural gas and vice versa, allowing you to choose at any time a less expensive fuel or the one that gives more energy. This flexibility has value and takes into account the price premium for dual-fuel cars compared to single-fuel cars that can only use one type of fuel, regardless of the cost of other fuels. A car that has the ability to use three types of fuel is more valuable than a car with two types through additional fuel selection, which will increase the cost of the option. In fact, an investor uses this type of option when it is not clear how external conditions, demand and time will affect future cash flows. The select option and the switch options can be either a call or a put option.

The value of a compound option depends on the value of another option, not the value of the underlying asset. Complex options are quite common in many multi-phase projects, such as developing an innovative product, where the launch of one stage of the project depends on the successful completion of the previous stage. Using a complex option at the end of each stage, it is possible to continue the process of creating an innovation (moving to the next stage), refuse further participation (exit the project or postpone it for a certain period of time (option to postpone).

Options for which there are several sources of uncertainty are called rainbow options. The uncertainty may be related to one or more input parameters that are used in the option valuation, or individual components that make up the input parameter, or it may be changes in the uncertainty itself over the life of the option.

6. Conclusions

An option is a right to perform a certain action in the indefinite future. Uncertainty and risks are inherent in any project. The only difference is their combination for each individual case. In this paper, risk and uncertainty are considered as two different and interrelated concepts. Uncertainty is defined as something unknown that cannot be resolved deterministically (the so-called «known unknown») or something unknown that can only be resolved through time (the so-called «unknown unknown»), a certain action, or obtaining additional information. Adverse consequences of the tendency of the project to uncertainty are characterized as risks. In the context of project cost estimation, a fairly wide range of researchers have similar views on risk and uncertainty.

Traditional DCF methods focus more on risk than on project evaluation and decision-making. In particular, some scientists note that the DCF approach reflects the risk of uncertainty by applying a high discount rate for projects with a high level of uncertainty, yet it does not take into account remuneration when actual cash flows exceed the forecast. This bias may lead to investors abandoning promising (however with a significant level of uncertainty) projects. Real options analysis, on the other hand, provides a systematic approach that actively recognizes and includes uncertainty in the process of evaluating projects and making appropriate decisions by limiting risks during the application of a particular opportunity.

The external environment is a source of the market risk. In fact, this type of risk does not depend on managerial qualities, decisions and the operational process of creating products that do not have an

impact on external financial, economic, political and social risks. Nevertheless, such risks can be predicted with a certain probability and taken into account in the process of making an investment decision.

References

1. Adetunji, O. M., & Owolabi, A. A. (2016). *Real Options and the Drivers of Firm Performance - An Empirical Study.* Retrieved from https://www.researchgate.net/publication/309585501_Real_Options_and_the_Drivers_of_Firm_Performance_-_An_Empirical_Study
2. Benaroch, M., Jeffery, M., Kauffman, R. J., & Shah, S. (2007). Option-based risk management: A field study of sequential information technology investment decisions. *Journal of Management Information Systems, 24*(2), 103-140. doi: https://doi.org/10.2753/MIS0742-1222240205
3. Brasil, V. C., Gomes, L. A. V., Salerno, M. S., & Reis de Paula, R. A. S. (2017). Multilevel approach for Real Options in the innovation management process: integrating project, portfolio and strategy. In: *International Research Network on Organizing by Projects, International Research Network on Organizing by Projects (IRNOP) 2017.* Sydney: University of Technology Sydney ePress. doi: https://doi.org/10.5130/pmrp.irnop2017.5680
4. Chagas, V. B., Sergio, S. M., & de Vasconcelos Gomes, L. A. (2018). Valuation of innovation projects with high uncertainty: Reasons behind the search for real options. *Journal of Engineering and Technology Management, 49,* 109-122. doi: https://doi.org/10.1016/j.jengtecman.2018.08.001
5. Čičin-Šain, D., Krajnović, A., & Herenda, M. (2017). The role and application of real options in managerial decision making. *Oeconomica Jadertina, 1*(1), 46-56. doi: https://doi.org/10.15291/oec.198 (in Croatian)
6. Janney, J. J., & Dess, G. G. (2018). Can real-options analysis improve decision-making? Promises and pitfalls. *Academy of Management Executive, 18*(4), 60 -75. doi: https://doi.org/10.5465/ame.2004.15268687
7. Kim, K. H., Hwang, S. T., Oh, H. S., & Lee, D. J. (2018). The impact of investment lags on investment decision. *European Journal of Operational Research, 190*(3), 696-707. doi: https://doi.org/10.1016/j.ejor.2007.07.020
8. Kim, Y. J., & Sanders, G. L. (2016). Strategic actions in information technology investment based on real option theory. *Decision Support Systems, 33*(1), 1-11. doi: https://doi.org/10.1016/S0167-9236(01)00134-8
9. Kogut, B. (1991). Joint ventures and the option to expand and acquire. *Management Science, 37*(1), 19-33. doi: https://doi.org/10.1287/mnsc.37.1.19
10. Levaggi, R., & Moretto, M. (2008). Investment in hospital care technology under different purchasing rules: A real option approach. *Bulletin of Economic Research, 60*(2), 159-181. doi: https://doi.org/10.1111/j.0307-3378.2008.00274.x
11. Li, G., & Rajagopalan, S. (2017). Process improvement, learning, and real options. *Production and Operations Management, 17*(1), 61-74. doi: https://doi.org/10.3401/poms.1070.0008
12. Lin, T. T. (2009). Applying the maximum NPV rule with discounted/growth factors to a flexible production scale model. *European Journal of Operational Research, 196*(2), 628-634. doi: https://doi.org/10.1016/j.ejor.2008.04.004
13. Maier, S., Pflug, G. C., & Polak, J. W. (2019). *Valuing portfolios of interdependent real options under exogenous and endogenous uncertainties.* European Journal of Operational Research. doi: https://doi.org/10.1016/j.ejor.2019.01.055
14. Marcus, B., & Anderson, C. K. (2006). Online low-price guarantees - A real options analysis. *Operations Research, 54*(6), 1041-1050. doi: https://doi.org/10.1287/opre.1060.0333
15. Moore, T. (2008). Real Options and Modern Capital Investment Decisions. In Fabozzi F. J. (Ed.), *Handbook of finance. Volume 2, Investment management and financial management* (2nd edition). Hoboken, N.J.: John Wiley & Sons. doi: https://doi.org/10.1002/9780470404324.hof002070
16. Morreale, A., Robba, S., Lo Nigro, G., & Roma, P. (2017). A real options game of alliance timing decisions in biopharmaceutical research and development. *European Journal of Operational Research, 261*(3), 1189-1202. doi: https://doi.org/10.1016/j.ejor.2017.03.025
17. Mun, J. (2002). *Real options analysis. Tools and techniques for valuing strategic investments and decisions.* New York: Wiley Finance Publishers.
18. Oriani, R., & Sobrero, M. (2008). Uncertainty and the market valuation of R&D within a real options logic. *Strategic Management Journal, 29*(4), 343-361 Retrieved from https://www.jstor.org/stable/20142024
19. Quélin, B., & Krychowski, Ch. (2010). Real Options and Strategic Investment Decisions: Can They Be of Use to Scholars? doi: https://doi.org/10.5465/AMP.2010.51827776 Retrieved from https://www.researchgate.net/publication/47705321_Real_Options_and_Strategic_Investment_Decisions_Can_They_Be_of_Use_to_Scholars
20. Ragozzino, R., Reuer, J. J., & Trigeorgis, L. (2016). Real Options in Strategy and Finance: Current Gaps and Future Linkages. *Academy of Management Perspectives, 30*(4), 428-440 doi: https://doi.org/10.5465/amp.2014.0153S
21. Rambaud, S., & Sánchez Pérez, A. M. (2016). Assessing the Option to Abandon an Investment Project by the Binomial Options Pricing Model. *Advances in Decision Sciences, 12,* 1-12. doi: https://doi.org/10.1155/2016/7605909
22. Rambaud, S., & Sánchez Pérez, A. M. (2017). The option to expand a project: its assessment with the binomial options pricing model. *Operations Research Perspectives, 4,* 12-20. doi: https://doi.org/10.1016/j.orp.2017.01.001
23. Sears, J. B. (2019). A real options model of market entry: Endogenous uncertainty and exogenous uncertainty. *Journal of International Management, 25*(3), 100672. doi: https://doi.org/10.1016/j.intman.2019.03.003
24. Shibata, T. (2008). The impacts of uncertainties in a real options model under incomplete information. *European Journal of Operational Research, 187*(3), 1368-1379. doi: https://doi.org/10.1016/j.ejor.2006.09.019
25. Van Reedt Dortland, M., Voordijk, H., & Dewulf, G. (2014). Making sense of future uncertainties using real options and scenario planning. *Futures, 55,* 15-31. doi: https://doi.org/10.1016/j.futures.2013.12.004
26. Wang, X., & Huang, X. (2019). A risk index to model uncertain portfolio investment with options. *Economic Modelling, 80,* 284-293. doi: https://doi.org/10.1016/j.econmod.2018.11.014

Received 12.09.2019
Received in revised form 29.09.2019
Accepted 6.10.2019
Available online 11.11.2019