St. Petersburg State University
Graduate School of Management

Master in Corporate Finance Program

VALUATION IN REAL ESTATE INDUSTRY WIH REAL OPTION APPROACH (CASE OF RUSSIAN COMPANY)

Master's Thesis by the 2nd year student
Concentration – Corporate Finance:
Anastasia Maltseva

Research advisor:
Anna E. Lukianova, Associate Professor,
Candidate of Physics and Mathematics

St. Petersburg
2020

ЗАЯВЛЕНИЕ О САМОСТОЯТЕЛЬНОМ ХАРАКТЕРЕ ВЫПОЛНЕНИЯ ВЫПУСКНОЙ КВАЛИФИКАЦИОННОЙ РАБОТЫ

Я, Мальцева Анастасия Вадимовна, студент второго курса магистратуры направления «Менеджмент», заявляю, что в моей магистерской диссертации на тему «Оценка недвижимости методом реальных опционов (на примере российской компании)», представленной в службу обеспечения программ магистратуры для последующей передачи в государственную аттестационную комиссию для публичной защиты, не содержится элементов плагиата.

Все прямые заимствования из печатных и электронных источников, а также из защищенных ранее выпускных квалификационных работ, кандидатских и докторских диссертаций имеют соответствующие ссылки.

Мне известно содержание п. 9.7.1 Правил обучения по основным образовательным программам высшего и среднего профессионального образования в СПбГУ о том, что «ВКР выполняется индивидуально каждым студентом под руководством назначенного ему научного руководителя», и п. 51 Устава федерального государственного бюджетного образовательного учреждения высшего образования «Санкт-Петербургский государственный университет» о том, что «студент подлежит отчислению из Санкт-Петербургского университета за представление курсовой или выпускной квалификационной работы, выполненной другим лицом (лицами)».

_____ (Подпись студента)

03.06.2020

_____ (Дата)

STATEMENT ABOUT THE INDEPENDENT CHARACTER OF THE MASTER THESIS

I, Maltseva Anastasia, (second) year master student, 38.04.02 program «Management», state that my master thesis on the topic «Valuation in real estate industry with real option approach (case of Russian company) », which is presented to the Master Office to be submitted to the Official Defense Committee for the public defense, does not contain any elements of plagiarism.

All direct borrowings from printed and electronic sources, as well as from master theses, PhD and doctorate theses which were defended earlier, have appropriate references.

I am aware that according to paragraph 9.7.1. of Guidelines for instruction in major curriculum programs of higher and secondary professional education at St.Petersburg University «A master thesis must be completed by each of the degree candidates individually under the supervision of his or her advisor», and according to paragraph 51 of Charter of the Federal State Institution of Higher Education Saint-Petersburg State University «a student can be expelled from St.Petersburg University for submitting of the course or graduation qualification work developed by other person (persons)».

_____(Student's signature)

03.06.2020

_____ (Date)

АННОТАЦИЯ

Автор	Мальцева Анастасия Вадимовна
Название ВКР	Оценка недвижимости методом реальных опционов (на примере российской компании)
Образовательная программа	Менеджмент
Направление подготовки	Корпоративные финансы
Год	2020
Научный руководитель	Лукьянова Анна Евгеньевна
Описание цели, задач и основных результатов	Цель данного исследования - разработать рекомендации по максимизации прибыли с помощью метода реальных опционов для проекта сферы жилой недвижимости. Для достижения данной цели были поставлены следующие задачи: • Проанализировать существующую литературу по оценке проектов в сфере недвижимости; • Провести анализ рынка жилой недвижимости, определить возможные риски и источники неопределенности, выявить целесообразность использования метода реальных опционов; • Провести анализ реального проекта с помощью традиционного метода оценки, применить метод реальных опционов, чтобы сравнить результаты анализа; • Использовать различные темпы продаж на стадиях проекта, чтобы выявить как это повлияет на ценность проекта; • Разработать систему рекомендаций для данного проекта, которые помогут максимизировать прибыль. В ходе исследования были достигнуты следующие результаты: • Определена инвестиционная привлекательность проекта с точки зрения традиционного метода оценки; • Выявлены опционы, помогающие максимизировать прибыль для данного проекта;

	• Выявлены стадии, продажа на которых увеличивает стоимость проекта; • Разработаны рекомендации действий для реализации проекта.
Ключевые слова	Инвестиции, реальные опционы, оценка проектов, рынок недвижимости

ABSTRACT

Master Student's Name	Anastasia Maltseva
Master Thesis Title	Valuation in real estate industry with real option approach (case of Russian company)
Education program	Management
Main field of study	Corporate finance
Year	2020
Academic Advisor's Name	Anna E. Lukianova
Description of the goal, tasks and main results	The research goal of this paper is to find the best solution for project realization using real option approach. The research objects of the Thesis are the following: • To conduct a literature review of project valuation methods in real estate industry; • To conduct an analysis of real estate market situation, identify existing risks and uncertainty, understand the necessity to use ROA; • To conduct the project valuation with the use of traditional method (DCF analysis), apply ROA, compare results of analysis; • To use different sales distribution at stages, recalculate the model to understand whether it influences project's value; • To develop a system of recommendations for a given project to maximize value. The results of the research are the following: • Investment attractiveness of the project from the point of view of the traditional assessment method is determined; • Real options that help to maximize profit for this project are identified and applied; • Stages where selling helps to increase the value of the project are identified; • Recommendations for actions to implement the project are developed.
Keywords	Investments, real options, project valuation, real estate

Contents

INTRODUCTION

Every company that invests in any activity seeks to maximize its value and profit, while facing the need to overcome and minimize risks. Investment in construction is no exception. This industry is characterized not only by a large number of risks related to Finance, market, design and technical aspects of the project, legislation, etc., but also by the uncertainty that exists in the market where it operates.

The Russian real estate market has recently seen a lot of changes that have affected the entire industry as a whole. Changes in 214- FZ (Federal law of the Russian Federation of December 30, 2004 No. 214-FZ "About participation in shared-equity construction of apartment houses and other real estate objects and about modification of some legal acts of the Russian Federation") provide that from July 1, 2019, developer companies must operate under the new rules. Developers have to switch from shared -equity construction to project-based construction (Consultant+, 2020).

All developers who attract citizens' funds for construction will be obliged to work with the use of escrow account mechanism. During the use of escrow-accounts money of people, involved in shared equity construction purchase, are transferred to special bank accounts and stored there until construction is completed. The developer will be able to receive money from these accounts only after transfer ownership rights to buyers. Construction will be conducted at the developer's own expense or at the expense of Bank loans. In case of problem with completing the construction by developer, the buyer can claim a refund of the amount paid. Thus, the risks of unfinished construction are transferred from home buyers to professional market participants-developers and banks, (the problem of deceived shareholders is still quite relevant, only in St. Petersburg and the Leningrad region there were about 15 thousand people in 2019) Banks started to use a fairly strict system of selecting companies to provide loans.

According to the requirements of banks, the developer company must invest at least 14-15% of the construction cost from its own funds, the remaining 85-86% is provided by the Bank as a loan. The construction period should not exceed 5 years (7 in the case of complex development). The developer company is required to provide a list of documents, which should include information about the company's status, legal rights to the development, justification of the project, technical characteristics and many other documents.

According to experts, due to this change in legislation some companies will leave the market, and prices for primary housing will also increase. At the same time, developer companies will incur higher expenses in comparison with previous periods related to the need to pay interest on loans to banks. The situation is also complicated by the pandemic, part of the construction is

suspended, and the market behavior, in particular demand, that has jumps because people start to invest in premises to save money, competitors changes prices, that carries even more uncertainty.

In these conditions the search for ways to maximize profits for developer companies can become the most relevant. A possible option to increase profitability is the sale of real estate at later stages of construction at prices corresponding to the construction stage or delay start of construction works. Moreover, it can help to obtain more information to make a better decision. Also, in the case of a negative scenario of market development, it is possible to stop construction and minimize losses.

In this regard, the paper offers an analysis of projects based on real options, which helps to incorporate managerial flexibility and maximize value in case of high risks and future uncertainty.

In the paper two variants of project valuation are considered: the first, traditional methods for the company and the industry when sales are planned at all acceptable stages of construction; the second, real option approach to evaluate benefits from the sale at the different stages and possibility to abandon and delay the project.

The research goal is to find the best solution for project realization using real option approach.

Research questions of the thesis are the following:

- What are the peculiarities of the real estate industry are and how they influence on the project valuation?
- What are existing ways/methods of real estate projects valuation?
- Which types of real options do exist to evaluate real estate projects? Which type of real option should be used in the thesis?
- How to evaluate the project in real estate with the use of real option approach? What are limitations of the approach?
- At which stages of construction selling is more profitable?
- In what case company should delay or abandon the project?

To answer the research questions stated above the analysis suggest achieving the next research objectives:

- To conduct a literature review of project valuation methods in real estate industry.
- To conduct an analysis of real estate market situation, identify existing risks and uncertainty, understand the necessity to use ROA.
- To conduct the project valuation with the use of traditional method (DCF analysis), apply ROA, compare results of analysis.

- To use different sales distribution at stages, recalculate the model to understand whether it influences project's value.
- To develop a system of recommendations for a given project to maximize value.

A large number of papers have been devoted to the issue of using the real options method, but those used in real estate industry were mainly related to the issue of feasibility of investments in land or exiting from the project. This paper will consider the interaction of several options and sales at different stages, which was not taken into account earlier. From the point of view of practical applicability, the result of the analysis will be a set of recommendations how to implement the project depending on the situation for managers of this industry. Thus, analysis is proposed to be useful both from a theoretical point of view and from a practical point of view.

CHAPTER 1. THEORETICAL BACKGROUND

This Chapter presents the methodology for evaluating projects using traditional methods, the criteria for selecting projects, and the advantages and disadvantages of these models. The methodology for evaluating projects using real options, comparison with traditional models, and justification for choosing the real options method for specific cases are further investigated.

1.1 Traditional methods of investment project valuation and risk-management

1.1.1 Traditional methods of project valuation

The basis for making decisions regarding investments is the comparison of volume of investments and anticipated cash flows that company can obtain as a result of this investments. Since the indicators being compared relate to different points in time, the key issue here is their comparability. Companies use different methods for appraisal, but all of them can be divided into two groups: based on discounted estimates and based on accounting estimates. In the first case, the time factor is taken into account; in the second, it is not. The first group includes Net present value, Profitability index, discounted payback period, Internal rate of return. The second group includes Payback period, Accounting rate of return (Soboleva, E.A., Kanhva, V. S., 2016).

The Profitability Index (PI) shows the ratio between the present value of future cash flows and the initial investment. The index is a useful method to rank investment projects and represent the value created per unit of investment.

$$PI = \frac{Present\ Value\ of\ futute\ Cash\ Flows}{initial\ investment}$$

To make a decision about the choice of a project using Profitability index the following rules are applied:

- PI > 1 profitability index greater than one implies that the project generates value and the company may want to proceed with the it.
- PI < 1 profitability index less than one implies that the project decreases value and the company should not proceed with the it.
- PI = 1 profitability index equal to 1 implies that the project breaks even and the company is neutral about whether proceed with the project.

The method has several advantages and disadvantages. The main advantages of the method are that:

- It considers all the cash flows during determination of PI;
- It helps to rank projects according to their PI;
- It provides proper consideration of money time value;
- It is consistent with the goal to maximize the wealth of shareholders.

At the same time during the use of the method it is difficult to understand interest rate or discount rate and to calculate profitability index if two projects having different useful life, that constitutes the main disadvantages of the PI method.

The Accounting rate of return (ARR), or the investment performance coefficient, provides a comparison of the average values of profit and investment. ARR is calculated by dividing the average annual return by the average investment value (the coefficient is taken as a percentage).

$$ARR = \frac{Initial\ investments}{Average\ Annual\ Profit}$$

This method has a number of disadvantages since it does not consider the time component of cash flows. Moreover, it cannot distinguish between projects with the same amount of average

annual profit varying by year as well as between projects with the same average annual profit generated over a different number of years.

Another method of project assessment is the Payback period. It is a period of time (usually expressed in years) required for nominal cash flows from the project to cover the initial investment. The payback period is used not the only as a separate decision-making technique, but in combination with another evaluation metric during the choice of the project. The method can be quite useful in case of mutually-exclusive projects: the criterion to choose a project - the length of payback period, the shorter period is preferable.

$$PBP = \frac{Initial\ investment}{estimated\ annual\ Cash\ Flow}$$

The payback period is one of the simplest techniques to calculate and can be used as a risk and liquidity measure, but has several disadvantages as well:

- It cannot measure project's overall profitability because it does not consider cash flows after the payback period.
- It does not take into consideration the time value of money, becase it uses nominal cash flows and assess cash them in the early periods the same as cash flows in the later ones, that can lead to wrong decision.
- It is not appropriate when the investment is spread over time or when there is no initial investment (Soboleva, E.A., Kanhva, V. S., 2016).

Discounted payback period (or adjusted payback period) helps to eliminate some disadvantages of simple payback period, since it uses discounted cash flows, and considers time value of money.

One of the most commonly employed decision-making technique to assess efficiency of projects in NPV Net Present Value. It was approved for implementation by Ministry of Economic Development (Russia), UNIDO, EBRD, The World Bank (Knyazeva, N.V., 2018). This method is widely spread in real estate project valuation and based on the fundamental principle in finance – time value of money. Net present value - the sum of the present values of the expected project's cash flows net of the initial investment.

$$NPV = \sum_{i=0}^{n} \frac{CF_i}{(1+r)^i},$$

CFi = Cash flow in period i

r = Discount rate

n = Number of years

NPV method allows to compare the present values of cash inflows and outflows over a period of time and has the following rule for decision-making regarding the project choice:

- If the NPV > 0 → Positive value indicates that the project should be accepted;
- If the NPV < 0 → In case of negative value, project should be rejected.

Advantages of the method:

- Time value of money (receipts and payments) is fully taken into account;
- Sum of inflows and outflows can vary over the life of the project;
- The full life of the investment is assessed;
- Depreciation, taxes and grants can be considered;
- Risk of future cash flows is considered (through the cost of capital).

Although the method is regarded to be quite universal and use in various industries and businesses, it has its own drawbacks and number of assumptions when it is applied. One of main drawbacks of the methods is connected with comparison of different projects. The difficulties occurred when projects have different investments amount: larger projects require more money and should have a higher NPV, but this is not an indication that this project is more profitable than a smaller one. (Berkovitch, E., 2004) Another difficulty is comparing projects that have different life spans (e.g., comparison of project that produces positive cash flows for 5 years with project that generates it for 20 years), projections can be also upward biased. (Van Putten, A.B., 2008) In addition, the NPV method is not helpful to compare projects of different size, since results of calculation are in particular currency and the size of the NPV output is defined mostly by the size of investment.

It also worth mentioning that NPV method has assumptions about cash flows, discount rates, predictability, etc., that are not always reflect the real situation, and as result it does not consider optionality of a project and cannot handle increases of uncertainty. When uncertainty rises it becomes difficult to calculate the discount rate and predict future cash flows. The method can also neglect potential benefits that project can have despite zero or negative NPV values. (Ragozzino, R., Reuer, J.J., Trigeorgis, L.2016)

One more method to evaluate the profitability of a project as IRR Internal rate of return. The metric works as a discounting rate that equates NPV of cash flows to zero.

$$NPV\ (IRR) = \sum_{i=0}^{n} \frac{CF_i}{(1 + IRR)^i} = 0$$

In contrast to the NPV method, it considers the project's scale. It is the discounted cash flow analog to the accounting rates of return. Decision-making rule for IRR for independent projects is the following:

- If the IRR > Cost of Capital → the project is accepted when the Internal rate of return exceeds the cost of capital;
- If the IRR < Cost of Capital → when the Internal rate of return is less than cost of capital, the project should be rejected. (Damodaran, A., 2011)

This method has advantages of the NPV but can be used in cases where the discount rate is unknown. There are also two drawbacks of the method: it cannot be computed or become almost meaningless when the initial investment is very small or more than one internal rate can exist and makes not clear which decision to choose (Brown, R.J., 2006). The IRR method does not recognize an investment's magnitude when comparing mutually exclusive projects and ignores the project's operational lifespan. In addition, it cannot be used in situations when the sign of project's cash flow changes several times. In the last case modified rate of return can be used (Silva, J. L., Sobreiro, V. A., Kimura, H. 2018).

1.1.2 Risk-management in project valuation.

As it was already mentioned to understand which method of evaluation would be the most suitable for the project, characteristics and peculiarities of the project should be taken into account as well as conditions under which the project is going to be implemented. In this part terms of risks, theirs types and uncertainty are discussed. The approaches to consider risks that used as an addition to traditional project valuation methods and theirs disadvantages are also considered.

Risks arise when a decision represents a number of possible outcomes and when known probabilities can be attached to the outcomes. Uncertainty occurs when there is more than one outcome, but the probability of each outcome is unknown.

Uncertainty can be endogenous or exogenous, endogenous uncertainty arises from insufficiency of knowledge and can be handled actions of company. Exogenous uncertainties relate to the external environment and usually cannot be influenced by company's actions but can become clearer over time. During making investment decisions company can face different types

of uncertainty. In the literature four main types of uncertainty are defined: demand uncertainty, technology uncertainty, macroeconomic uncertainty, partners uncertainty. All these types can also be divided by narrower and more specific measures, which are represented in the table below (Ipsmiller, E., Brouthers, K. D., Dikova, D. 2019):

Table 1

Types of uncertainty

Type of uncertainty	Example measures
Demand uncertainty	Industry uncertainty
	Stock exchange volatility
	Industry production volatility
	Industry demand volatility
Technology uncertainty	Perceived demand uncertainty
	Target industry experience
	Industry R&D intensity
	Perceived technology uncertainty
	Technical experience
	Technical knowledge
	Technical distance
Macroeconomics uncertainty	Self-employment experience
	Entrepreneurial experience
	Price volatility
	Country risk
	Exchange rate
	Institutional/Cultural
	Political
Partner uncertainty	Threat of opportunism

Source: Ipsmiller, E., K.D. Brouthers, and D. Dikova. 2019. 25 Years of Real Option Empirical Research in Management. *European Management Review* 16 (1): 55–68.

All risks can be divided into two types - known and unknown. The risks that are known can be analyzed, planned, and managed, but the risks that are unknown cannot be handled the same way. These risks can pose a serious threat to the successful implementation of projects, and the

possibility of their occurrence is often accepted as their consequences if the benefits of the project are more significant. (Keshk, M. A., Maarouf, I., Annany, Y., 2018)

There is also another broad classification of risks in terms of occurrence frequency and the scope of impact. In terms of frequency systematic risk and specific risk are distinguished, the first means that company cannot influence the risk which is independent from it, in the second case risk is related to specific projects of a company. In terms of impact scope – there are fixed and variable risks. The fixed risk concerns the whole economic system, while variable is related to a company. (Szymański, P., 2017)

In capital budgeting process, when every industry or business has its own risks during development and implementation of projects, risks can lead to change in plan of actions, sometimes in unpredictable way. Main types of such risks, common for different industries are the following:

- Stand-alone risk;
- Project-specific risk;
- Corporate risk;
- Market risk;
- International risk;
- Industry-specific risk.

The purpose of risk management is to identify the risks and possible problems that they entail before they arise, and then develop a plan of measures and actions to prevent or reduce these impacts on the achievement of goals over the life of the product or project. Risk management is a continuous, prospective process that plays important role in business and technical management processes. Risk management is aimed to investigate issues that may endanger the achievement of critical objectives. Regardless of the type of project, risk management includes three main phases- the risk identification, risk analysis and risk response: (Dinu, A.M., 2012)

- Risk identification

As already mentioned, there are known and unknown risks. The company can identify known risks and create a system of measures to manage them, identification of risks which are not recognized cannot be evaluated and dealt with, therefore comprehensive full risk coverage is unattainable, but the goal of risk management remains to cover as many risks as possible. Therefore, risk identification should be carried out both with regard to the future outlook and the progress of the project because not all risks can be identified before the project starts, some of them may additionally occur during the project implementation. Risk identification is performed

by drawing up checklists, organizing meetings for risk identification and analyzing archival documents.

- Risk analysis

The risk analysis consists in describing the situation in which these risks may arise as fully and comprehensively as possible and prioritizing these risks further taking into account the importance of these risks and their consequences for the project. After the risks are identified, they are investigated based on the probability of their occurrence and degree of influence on the project, a portfolio is compiled, and risk costs are assessed respectively for classification purposes. It is necessary to find criteria based on which individual risks can be compared with each other. The risk should be characterized as a damage or loss resulting in the event to which certain value can be allocated. After understanding costs and probabilities for such damages and losses, the value of corresponding risk can be assessed. For these purposes such methods as Monte Carlo simulation, decision trees can be used.

- The risk response

The risk response means control and active influence on the determined risks, measures to implement such control can be differentiated between cause-related and effect-related measures. It is assumed that cause-related measures help to avoid or reduce risks, while effect-related measures serve to reduce or protect against the amount of damage or loss expected in case of event which entail it. (Schieg, M., 2006)

The phase of risks identification is the most important since without successful completion of this phase further analysis is not possible. After identification risks can be assessed with the use of qualitative and quantitative techniques.

Qualitative analysis is used to determine the amount of risk and its potential impact on project execution. When all risks defined they are ranking according to the degree of this impact. Qualitative analysis addresses such issues as description of risk, stages of the project when risk may occur, elements of the project that could be affected, the way risk may influence the project outcomes (Smith, N., Merna, T., Jobling, P., 2006).

Quantitative analysis means quantitative description of risks according to the probability of occurrence and determination the size of risks consequences usually in terms of financial value, time and others. For instance, it helps to define cost increase as an additional expenditure to the estimate of the final cost of the project, or time increase and project delays and corresponding costs, financial perspective of underperforming quality standards and specifications.

There are several main techniques of quantitative analysis to evaluate the risks: sensitivity analysis, scenario analysis, Monte-Carlo simulation, which are usually used with DCF analysis to trace the risks that the DCF method does not include.

In sensitivity analysis, company looks at the consequences for value (and the investment decision) of changing one input at a time, holding all else constant. In scenario analysis, it examines the payoff to investing under the best and worst cases, as well as under specified scenarios. In simulations, it uses probability distributions for the inputs, rather than expected values, and derive probability distributions for the NPV and IRR (rather than one NPV and IRR).

The idea of sensitivity analysis is that only one variable, that is being analyzed, is changed when a number of other variables remain constant. Sensitivity analysis is a financial model that determines how target variables are affected based on changes in other variables known as input variables. This model is also related to "what-if" or simulation analysis. This is the method to predict results of decision-making with a certain range of variables. In case of creating a set of variables an analyst can determine how changes in one variable influence the outcome. (Investopedia, 2020)

Limitations of Sensitivity analysis:

- The analysis of effects due to variations in one variable setting others constant may be not very effective since the variables can be interdependent. In practice variables are often interrelated and change together, e.g., changes in selling prices and expected sales volume are related. Another example of sensitivity analysis drawback is that margin increases while revenue growth is fixed, or interest rates decrease when inflation rate remains high and it may yield higher NPV for a project but has a low probability to happen.
- The sensitivity analysis present outcomes for a range of values but does not provide any idea of the likelihood for these values to occur.
- Losing sight of the objective: analysis implies generating many tables, graphs and numbers to consider uncertainty, but eventually sensitivity analysis should focus on key variables and outcomes should be selected and presented the way helpful for decision-making.
- Sensitivity analysis may be subjective, since the same analysis may lead one decision-maker to reject the project and other to accept depending on the risk preferences. (Brealey, R., 2011)
- Sensitivity analysis is neither technique to measure risk nor to reduce, it does not provide any clear decision-making rule.
- Double counting risk: during implementation of sensitivity analysis even profitable projects (with positive NPV and high IRR) if key variables move adversely. Using these

as criterion for rejecting such projects means potentially double-counting risk, because cash flows are discounted back at risk-adjusted rate to estimate the base scenario.

Despite the existing limitations there are two good ways to use the model of sensitivity analysis. First, its results can be used as a criterion to choose between two equivalent projects in terms of base case net present value or IRR, the project with less sensitivity to changes in key variables is preferable. Second, the use of sensitivity analysis output to more efficiently manage both the operations and the risks of an investment in the post-acceptance phase. Hence, understanding that an investment is sensitive to change of material cost may lead to harsher policy related contract with supplier and keeping these costs under control. Also, the finding that a project's value fluctuates because of change in rates may result in additional hedging of risks. (Damodaran, A., 2011) Nevertheless, sensitivity analysis helps to identify different variables that have an influence on the NPV of the project. It allows to define vulnerability or sensitivity of the project, showing where additional analysis must be implemented before the final selection of the project. This analysis is implemented at the beginning of a project and provides important information about points to which management should pay more attention and focus during the project.

Scenario analysis is based on a singular what-if situation. The analysis takes into account a number of risk factors or variables, while at the same time considering the weakness, all other things being equal, of the sensitivity analysis. It requires an estimation of the best and worst outcomes of the key input variables. While in sensitivity analysis only one input variable is changed at a time and effect on the output (NPV, IRR, accounting returns) is examined, in scenario analysis several cases different from the base one, are outlined where many or all of the inputs can have different values and evaluate the project's value under these scenarios. Generally, scenario analysis can have one of two forms: a best case/worst case analysis or an analysis of multiple possible scenarios. Based on mathematical and statistical methodology, it follows the principle of "what if" analysis and provides a process to estimate shifts in the value of a portfolio, based on the occurrence of different situations (scenarios). An example of a typical scenario analysis situation would be a 10% increase in financial costs or a 10% decrease in profit and a 5% increase in construction costs. This form of analysis identifies where problems may occur since analysts use specific triggers connected with financial ratios to protect their interests. At the same time, scenario analysis is most suitable to deal with discrete risks or that which can be divided into discrete groups, e.g., it is more appropriate to analyze the risk that a competitor will introduce a product similar to your product than to look the risks of interest rate change in future periods. The most

significant disadvantage of the scenario analysis is the limited number of scenarios which can be derived and considered by an individual (Kaczmarzyk, J., 2019).

A Monte Carlo simulation is an analytical technique that uses random numbers and probability distribution to investigate problems, which involve uncertainty. It is widely used in science and business. The method is applied to assess expected value or outcome of the problem under study. It has two main advantages: it can be used in case when it is difficult or impossible to directly solve for expected outcome; when the high degree of uncertainty exists related to final results – Monte-Carlo simulation provides expected range of outcomes. (Dhiensiri, N., 2014) It is a powerful analytical method which provides unbiased estimation, that is important in terms of NPV estimates to which bias or inaccuracy can influence.

In comparison to sensitivity analysis, that allows to consider the effect of changing only one variable and scenario analysis that considers the effect of a limited number of plausible combinations of variables as well, Monte Carlo simulation is a tool for considering all possible combinations. It is able to capture not perfect correlation among variable, which scenario analysis cannot since it would mean that the best or worst case will take place for all variables at once. (Brealey, R., 2011) Although, using random numbers implies that all variables are independent of each other, and this is not the case in many projects. It is often true that variables are interdependent, an example might be is a delay in the design stage which cause to a delay in the construction of a project. Sometimes interdependent project variables are defined as correlated to overcome this assumption.

In case when project's risks are not discrete but sequential decision tree analysis is used (DTA). Traditionally this method was used to assess projects with uncertain cash flows when there is more than one decision path. DTA allows to investigate the risk at different stages and provide the response to results at each stage. Generally building the decision tree requires undertaking the following steps, although some details and sequences can vary depending on the case.

The first step is to divide analysis into phases of risks that the project can be exposed in the future. On the second step probabilities of the outcomes should be estimated at each stage: after phases of analysis defined as well as outcomes at every stage – probabilities of these outcomes should be computed. During the third step decision points should be set. Analyst embeds in DTA decision criteria to for best action course, that based on the outcomes at earlier stages and expectations about future. On the forth step cash flows are computed for each node, the final cash flow outcomes are defined. The last step in DTA is termed "folding back" the tree, when values expected are calculated backward. And eventually the process outcome represents an expected value of an investment or an asset.

One of the benefits of the method is a dynamic response to risk - linking choices and actions to outcomes related to uncertain events DTA allows analysts to comprehend which course of actions is better to choose under different conditions and circumstances. Another benefit is connected to information value, DTA provides an important perspective regarding information in decision-making, e.g., company is considering testing market before developing a product. Moreover, decision trees provide an overview of the way cash flows unfold over time, which is useful to decide about the risks to be protected against and the benefits of these actions. (CFI Program curriculum, 2020)

Decision tree approach yields incorrect results when it uses the same discount rate for the project cash. (Makropoulou, V., 2011) Moreover, in projects where it is necessary to consider several areas of uncertainty such as inflation, demand, regulation – conducting DTA becomes very complicated and not representative (Bailes, J. C., Nielsen, J. F., 2001). Decision trees are best suited for risk that is sequential, risks that affect an asset simultaneously cannot be simply modeled in a decision tree.

Thus, the considered methods of risk assessment have their own specific advantages and disadvantages. In addition, none of these methods, except for DTA gives a course of action and simply provides an overview of the impact of risks on the components of the project. DTA is a rather complex method and it is not always possible to apply it correctly. This analysis allows to find bottlenecks and approach the last phase and decide whether to accept risk, mitigate it, or use other risk response strategies (Broeders, D., Loman, H., Toor, J. 2018).

1.2 Real option approach in project valuation.

1.2.1 Real option concept.

Real option approach (ROA) or real option valuation method (ROV) is another technique applied in project assessment and follow-up decision-making. As an analogy to financial option, real option is a right, but not an obligation to undertake particular business activity: e.g. to defer, to abandon, expand, stage or contract an investment project. The fundamental and inalienable characteristics of real option investment that they made under uncertain conditions, irreversible and sequential (Dixit, A., Pindyck, R., 1994).

Real option approach applies theory of financial options in analyzing real or physical assets, for this reason there are many similarities between financial and real options. As financial

options, real options can be classified as call options or put options: which is respectively option to buy an asset and option to sell an asset. The feature that makes real options similar to financial options is a time to exercise like European option, real option can be exercised on a specific date, or like an American option can be exercised at any time before a set date. All types of real options have as a base an underlying asset and can be characterized by a permit to buy or sell the underlying asset at a fixed price. At the same time, it is necessary to understand the key differences between financial and real options, e.g., in case of financial option underlying asset could a stock or foreign currency, in case of real option asset can vary. These variables may include free cash flows, market demand, commodity prices, etc. – competition and market drive the value of real options. Moreover, real options are non-traded, that cause difference in calculation theirs value, and have longer maturity than financial ones (Carmichael, D. G. 2016).

Table 2

Analogies between financial options and real options

Variable	Financial option	Real option
S	Stock price	The present value of future cash flows generated by the asset
K	Exercise price	Costs/expenses to buy an asset
$\boldsymbol{\sigma^2}$	Variance of stock returns	Riskiness of the asset, variance of the best and worst-case scenario
T	Time to expiration	Length of time option is viable
r	Risk-free rate of return	Risk-free rate of return

Source: Carmichael, D. G. 2016. A cash flow view of real options. *Engineering Economist* 61 (4): 265–288.

Real option types might be classified as follows:

- Single or plain (stand-alone) options. Usually examples of such options are option to expand or abandon, option to contract, option to switch, delay/defer, rainbow option.
- Compound or combined (multiple plain) options (sequential, parallel, choice). Compound options can also have embedded options (dependent or independent). An option is considered independent when its value can be calculated independently of options and event occur which can occur with them. This independent option may have an effect on

another option's cash flows, prevent the exercising of other option or be a prerequisite/ corequisite for it.

This classification for plain and compound options is general, another important classification of real options can be made according to their function: (Chance, D.M., Pamela P. P., 2002)

Table 3

Types of real options

Type of real option	Description
To abandon	The option allows to stop using the asset and realize the salvage value
Flexibility to switch	The option allows to vary output or its mixes in meet to price or demand changes
To enter and exit	The option allows to exit an investment and re-start if conditions become more favorable
To defer/postpone	The option allows to postpone investment until the time when investment is more profitable
To stage investment	The option allows to make investment in sequence exercising the right to stop or continue the project as more information will be available
Growth/expand	The option allows to capitalize on an earlier investment, e.g. in R&D, to start related investment projects
Interacting options	Represent interaction of several options

Source: Chance, D.M., and P.P. Peterson. 2002. *Real Options and Investment Valuation.* 1738 The Research Foundation of the Association for Investment Management and Research (CFA Institute).

Before starting to evaluate real option and apply it as an analytical tool, it is necessary to understand main prerequisites or requirements. The following requirements should be considered to implement the real option approach:

- the real option approach requires financial model since it is based on use its discounted cash flows. Otherwise, it suggests that strategic decisions were made, and no financial justification is required;
- there must a flexibility for decision-making by managers or opportunity to apply changes during the project realization. The real option approach cannot be used when there are no possibilities for changes or flexibility in managing the value;
- uncertainty should exist, otherwise option is worthless, because the discounted cash flows model is sufficient in case everything is known beforehand;

- uncertainty must have influence on decision-making by company during the project implementation and the results of the financial model. In this case uncertainty is a risk and the real options model is the way to handle it to prevent a failure;
- the decision-maker must be credible enough to determine an option at the proper moment. That suggests that options are only useful when they are identified at right time and conditions. (Mun, J., 2002).

After the specified requirements are considered the real option can be evaluated. Although for evaluation of financial options there are numerous methodologies and approaches used to calculate value, the two basic and widely used are: The Black Scholes model and the binomial model based on the decision tree analysis. The choice depends on simplicity desired, available input data, and the validity of the method for a given application (Koducula, Papudesu, 2006).

The Black-Scholes model is rather technically complicated, but simple in its basic structure, exact and quick. The model was created to assess options of European type, and this type cannot be exercised any other date than the maturity date and in case when underlying asset does not pay dividends. Another assumption of the model is that exercise of option does not influence the value of underlying asset.

As it was already defined real options inherit the qualities of financial options and the Black-Scholes formula reflects this with input variables. The original formula to calculate the option price:

$$OP = SN(d_1) - Xe^{-rt}N(d_2)$$

where:

$$d_1 = \frac{\ln\left(\frac{S}{X}\right)+\left(r+\frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}, \qquad d_2 = d_1 - \sigma\sqrt{t}.$$

The input variables for the formula are:

S – stock price (or price of an asset);

X – strike price;

r – current continuously compounded risk-free interest rate;

σ – annual volatility of stock price (the standard deviation of the short-term returns over one year).

t – time remaining until expiration, expressed as a percent of a year;

N(d) – standard normal cumulative distribution function;

ln – natural logarithm;

e – exponential function.

Since this model has a number of assumptions, it may not always be applicable to all types of options, in reality, assets pay dividends, options may be exercised early, and its exercise can influence the value of the underlying asset. (Damodaran, A., 2012) Below is a list of restrictions for using this model:

- the model considers European options (the option can be exercised only on the expiration day), in reality many options are of American type;
- the model suggested the existence of only one source of uncertainty that affects the price of an underlying asset, in practice much more sources of uncertainty during the project realization are possible;
- the model considers the certainty and stability of investment expenditure to realize a particular option;
- the model suggests the logarithmic and normal distribution of the underlying asset value with a fixed level of variation; in real option case the value of a underlying asset may change;
- the model is not proper to assess compound options or investments with a number of excluding options. (Dzyuma, U., 2012)

These constraints reveal that the model is quite specific in nature and could have limited managerial flexibility in regard to particular real option types. It cannot precisely value options of American type which will be used further, when it is necessary to consider steps before an expiration to exercise the option. This peculiarity and other constraints lead to a need to investigate application of binomial model.

The second approach to value options is binomial model. This is a discrete-time model which provides a solution to partial differential equations presented in the Black-Scholes model (Crundwell 2008). It can be used for various types of real options but independently from the kind of problem to solve, solution can be found by the use of two ways. The first one is to use market-replicating portfolios, and the second – use risk-neutral probabilities. The way with replicating portfolio in more difficult for comprehension and implementation in comparison to the one with risk-neutral probabilities, although both provide identical results.

The idea of market-replicating portfolio implies that on the market there are no arbitrage opportunities and the number of assets traded exist can be obtained to replicate the existing payout profile of an asset. This approach makes sense for analysis of financial securities when stocks are

liquid and can be freely traded. When we analyze a firm-specific projects with real options based on a physical asset, it becomes very hard to replicate this asset which can have no tradable equivalents and the mathematics for replicating portfolios is also more difficult for application.

The aim of the method is to create a replicating portfolio. It is made using a combination of risk-free borrowing rate and the underlying asset to create the same cash flows as the option has being valued. The value of the option and the value of the replicating portfolio should be equal, so the arbitrage principles are applicable here.

Regarding the formulation above, when stock prices can either move up to Su or down to Sd in any time period, the replicating portfolio for a call with strike price K will involve borrowing $B and acquiring D of the underlying asset, where:

$$D = (Cu - Cd)/(Su - Sd)$$

D - number of units of the underlying asset bought;

Cu - value of the call if the stock price when Su -stock price;

Cd - value of the call when Sd is the stock price.

The assessment should proceed iteratively in case of a multi-period, i.e., start with the last time period and move backwards to the current point in time. The portfolios which replicate the option are calculated at each step and provide the option values for corresponding time period. The final result of the binomial model provides the option value in terms of the replicating portfolio, composed of the underlying asset, D shares (option delta) and risk-free borrowing/lending. (Damodaran, A., 2005)

In the risk-neutral probability approach the probabilities of particular cash flows to occur at definite times are calculated with risk-adjusted instead of risky cash flows by discounting them with risk-adjusted discount rate. For this model two additional calculations should be made: the up and down factors (u and d) as well as a risk-neutral probability measure (p). Here is the formula for application risk-neutral approach. Independently from the type of problem, the basic structure has the fallowing way:

$$u = e^{\sigma * \sqrt{t}} \; ; \qquad d = \frac{1}{u} \; ; \qquad p = \frac{rf - d}{u - d}$$

The input variables are the following:

S – present value of underlying asset;

t - time to expiration in years;

σ - volatility of the natural logarithm of the underlying free cash flow returns in percent;

rf - risk-free rate or the rate of return on a riskless asset;

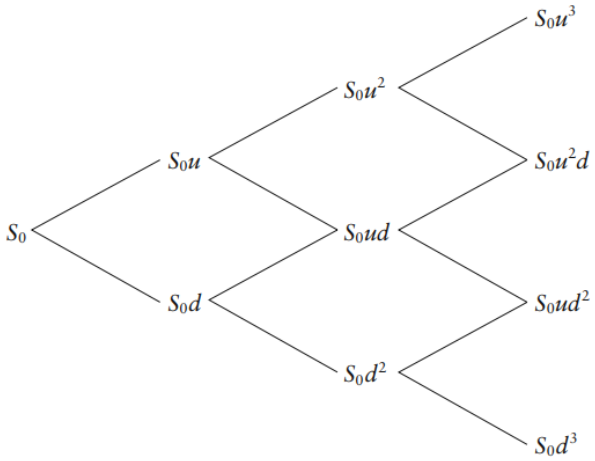
u – upward jump factor;

d – downward jump factor;

p – risk-neutral probability.

The up factor in the formula is an exponential function of the cash flow volatility multiplied by the square root of time steps, that are annual in given case. Then it is necessary to define risk-neutral probability. It can be calculated as a ratio of the exponential function of the difference between risk-free rate and downward factor, to the difference between the up and downward factors (Smith, J. M., Driver, R., Matthews, W. 2018).

Below the example of binomial lattice of the underlying asset value is provided, it involves two branches forward in time for each node, the way that nodes conjoint from two previous nodes. It starts from the present value of the underlying asset at time zero (S0), then it is multiplied by the upward (u) and downward (d) factors to build a binomial lattice branches, the intermediate branches are all recombining.



Graph 1. Example of binomial tree

Source: Smith, J. M., R. Driver, and W. Matthews. 2018. The Real Options Lattice: An Alternative to Discounted Cash Flow. *Journal of Accounting & Finance* (2158-3625), 18(7): 119–129.

The real option approach as well as other approaches has some limitations. Contrary to the financial options, real options can be not liquid and non-traded in organized markets that can lead to challenges of information asymmetry and some unclarity in their terms specification. Another limitation is related to the net present value analysis whether there is uncertainty and irreversibility, if the last high – than real option approach provide the better analysis of the investments' value, than calculation of net present value, since it is unable to capture the value of delaying commitments and is not accounted for other flexibility. Otherwise, when level of uncertainty is low, and everything could be planned, the ROA is useless, and preference should be given to DCF approach (Trigeorgis, L., Reuer, J. J. 2017).

Moreover, some assumptions, e.g. about abandonment flexibility, during real option approach if wrong, can lead to destroy of the projects value. It can happen when net present value shows that project should be rejected, but ROA reveals the contrary situation. Another limitation is connected with investment stages. In case of tradable assets, company has no opportunity to resolve the uncertainty, but it can be specified at the time of the initial investment. In case with real options, which is linked to company's actions, it is hard to make clear difference between investment stages and the application of real options becomes more challenging in analytical and organizational terms. (Adner, R., Levinthal, D. 2005)

1.2.2 Drawbacks of NPV methodology in comparison with real option approach

The discounted cash flow approach to assess the projects is one of the widely spread and important method for analysis in capital investment and has a lot of advantages that were considered in the first chapter, but the choice of the evaluation method should be based on project characteristics and the level of uncertainty during the implementation of the project. The real option approach main proposition is that a firm's overall value will increase if real options are introduced in managerial decision making. It occurs du to flexibility the real option approach provides and disadvantages that NPV model connected to its assumptions, that do not reflect the realities of the situation when investment takes place (Pivoriene, A. 2017).

The first assumption is that decisions are made at the present moment without further changes and cash flows are defined and fixed for the future period. In reality, there is a great share of uncertainty and variability in future results that may not be the same that proposed ones.

Furthermore, not all the decisions are made today, some decisions can be postponed to the future when obtaining of more information is possible to resolve some existing uncertainty.

Another assumption is related to previous one and tells that projects being launched are then managed passively, when in real life the situation is the contrary – projects may require active management through its life cycle, what can include checkpoints, decision options, budget constraints, etc. Future cash flows are also very difficult to forecast, since they are stochastic and risky in nature. In the NPV approach future cash flow streams are deterministic.

The discount rate used for calculations of the projects NPV represents the opportunity cost of capital, that is proportional to non-diversifiable risk. There are a lot of risks in the business environment with various characteristics and some can be diversified across projects or time. It is also supposed that discount rate incorporates all risks, although the project risks can change during its course. The situation with unknown and intangible factors leads to missing opportunities by a company since they are valued as zero in NPV analysis.

It is also worth mentioning that in reality companies can be viewed as portfolios of projects and their cash flows and sometimes these projects cannot be evaluated as separate cash flows, because they can include network effects, diversification, interdependencies, and synergy. Which also contradicts the model's assumptions. Thus, due to the complexity of a project, its externalities it can be complicated or impossible to measure all factors in terms of incremental cash flows.

All these assumptions versus reality show that NPV approach only partially considers risks, not sufficiently appropriate to provide valuation in case of high uncertainty and has a limited managerial flexibility available in many investments, when such decisions as project abandonment, delays, or expansions and others are possible and more beneficial. Real options valuation provides a method of incorporating managerial flexibility into investment decisions, when NPV approach tends to underestimate investments' value, the importance of real option arises (Mun, J. 2002).

Evaluation of real options does not displace traditional methods since the discounted cash flow method provides the base for real option analysis. However, but main idea of real option approach is to show that the value of the investment can extend beyond its value in comparison to results provided by traditional method and the projects value is increased by the value of its options. Because of real options are suppoded to be strategic decisions, obtained as result of such analysis adjusted NPV is called a strategic NPV and represents the sum of the traditional NPV, which is called the static NPV, and the value added of the option analysis (Larabee, D.T, 2013).

CHAPTER 2. INVESTMENT VALUATION IN REAL ESTATE INDUSTRY.

2.1 Risks and uncertainty in real estate industry.

In construction projects there are usually a large number of activities and events, which can contain uncertainties due to lack of resources or data. These projects should be commissioned only after a thorough analysis of the need and risks perceived. Failure to assess the risks associated with a project may lead to problems during the adoption of a contract strategy which in turn could be not best devised to meet requirements of the project and provide an equitable allocation of the identified risks.

Construction industry has several phases: pre-feasibility, feasibility, design, contract/procurement, implementation, commissioning, handover and operation. With each phase its own specific type of risks is corresponded. Project risks are dynamic, they can change continuously, a risk assessment must be carried out at the end of each phase prior to proceeding to the next phase.

These risks can be divided by such criteria as logistic, management, finance, legal issues, etc., and corresponding sub-criteria, depicted in the table below (Makwana, A., Dr. Pitroda, J., 2017):

Table 4

Classification of risks

Criteria		Criteria	
Technical risk	- Incomplete/defective design, design errors - Inappropriate specification - Design changes - Uncertainty of material available - Construction methods - Defective materials	Financial risk	- Inadequate cost estimate - Delayed payment on contract - Custom and import restriction - Constraints on availability of expatriate staff
Logistical risk	- Insufficiency of transportation facility - Non-availability of maintenance - Insufficiency of equipment availability - Non-availability of operators	Legal risk	- Requirement or delay for permits and approval - Change in laws and regulations - Political instability - Labor disputes - Environment regulation procedures

	- Difficulty to assess the site		
Management related risk	- Unstable management - Uncertain productivity - Problematic industrial relation - Poor communication between involved parties - Lack of scope of work definition - Poor project planning and control	Common source risk	- Weather implications - Change in project requirement - Inefficiency of skilled staff - Unfamiliarity with local conditions - Inappropriate scheduling/ time constraints
Environment risk/market	- Economic instability - Fluctuation in foreign exchange - Payment delay/client's financial failure - Local taxes - Inflation, price fluctuation - Contractor competence - Financial default of contractor	Other risks	- Natural disaster/Environmental hazards of the project - Accidents/safety - Damage to equipment - Damage to structure - Force majeure

Source: Bahamid, R.A., and M.A. Al-Sharaf. 2019. Risk factors affecting the construction projects in the developing countries. *IOP Conference Series: Earth and Environmental Science* 244 (1), 012042.

Risks may also change during a phase. Should this be significant then a complete re-appraisal may need to be performed. On long duration projects where the phases themselves may span several months or even years, regular risk assessments and updates must be carried out. This is an essential prerequisite of efficient management and effective decision making. In addition, to the parties involved changing as the phases change, the nature of the risk itself changes. At the earlier stages the range of possible options is very broad. It is important to recognize that one option to achieve the objective may be to carry out what is, in engineering terms, a different project. Any transition must be managed to ensure that the changes to the engineering are reflected in the estimates, programs and business case.

During the implementation phase the range of risks narrows still further to those associated with the procurement, manufacture and delivery of materials and site construction activities.

It is important to realize that each phase will contain a number of key assumptions, which are made to allow the project to continue. As the project progresses firm information will be available to replace these assumptions. Sometimes this information will be different from the original assumption, which it supplants. It is important then to reassess the project and see if this changes fundamentally the basis for the previous work and also what impact this could have upon the future development of the project. From time to time completely new risks may arise. However,

risks should diminish as the project progresses. It is necessary to ensure that risks, which have not occurred and can no longer occur, are removed from future assessments and analyses and are also removed from registers and reports, to assist in managing risks. (Smith, N., Merna, T., Jobling, P., 2006)

It also worth to mention, that real estate industry has particular uncertainties connected with price dynamics and demand.

The dynamics of private real estate markets include other elements, in addition to some degree of RW-type influence. This is for many reasons:

Real estate markets trade unique whole assets (rather than small homogeneous shares). For example, while one barrel of oil is the same as the next, an apartment with a given floor plan on the third floor facing north is not equivalent to an otherwise identical apartment on the twentieth floor of the same building, facing south with an ocean view. Such differences make it difficult to infer the value of a real estate asset from the prices observed in other transactions.

As a result, real estate markets do not process information as efficiently as major public stock exchanges. This makes real estate prices more sluggish or "sticky" than publicly traded stock prices.

Also, the preceding points cause real estate prices to exhibit some inertia, or "autoregression." This means that the return in one year partly reflects the return in the previous year, such that the process is not completely memoryless. News in one period partly gets reflected in the returns in subsequent periods.

Moreover, real estate prices seem to follow a relatively long and prominent pricing cycle, down markets following up markets, with perhaps as much as ±30% or more in price level amplitude around the long-run trend. This is called "cyclicality."

There is typically less uncertainty about future construction costs than about future real estate values. In most countries, the "price elasticity" of supply of construction goods and services, which consists largely of labor and materials, is quite high at any time.

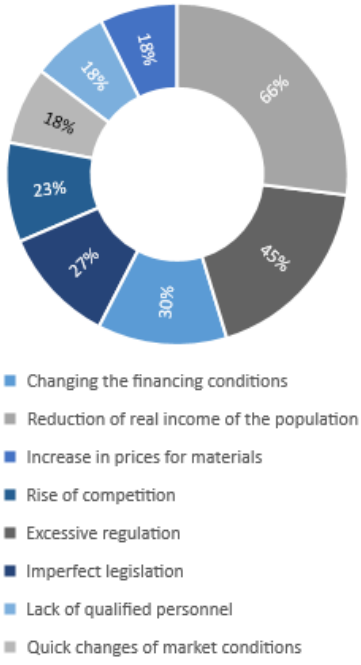
Demand in real estate also has a great portion of uncertainty since it is influenced by a great number of factors such as level of incomes, inflation, mortgage rates, competition, political and economic situation on the whole, etc. and tightly connected with the prices (Geltner, D., De Neufville, R., 2018)

2.2 Residential real estate market analysis

The Russian residential real estate market includes many risks and uncertainties, this part examines the Russian residential real estate market and the factors that affect it. The current market situation, risk factors, and possible trends are described. The market of Saint Petersburg is considered, as further analysis is carried out on the project of a developer company in Saint Petersburg.

The residential real estate segment remains a priority investment area in construction. Developer companies do not plan not to enter the markets of other segments, nor to change their business profile, and the analysis also showed that the most commercially interesting class for development is comfort class. At the same time, the residential real estate market is one of the most difficult to participate in due to high barriers to entry due to difficulties with financing.

Main factors that influence the industry in Russia and can be of the greatest importance in 2020 are: changing the financing conditions, reduction of real income of the population, increase in material prices/cost of production, strengthening competitors, excessive regulation, imperfect legislation, lack of qualified workers, market conditions change too quickly (PWC, 2020).



Graph 2. Risks that can have significant impact on real estate industry in 2020

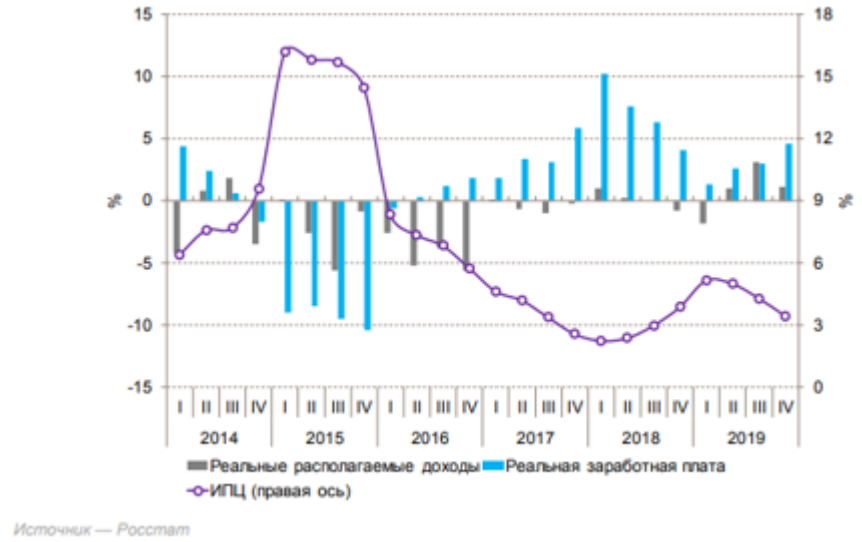
Source: PWC 2020. Real estate 2020: Building the future. https://www.pwc.com/sg/en/real-estate/assets/pwc-real-estate-2020-building-the-future.pdf (accessed April 25, 2020)

Among the most important risks are reduction of real income of the population, over-regulation and change financing conditions. Expectations about reduce of real income of the population is reasonable due to the fact that the decline in the indicator has continued since 2014,

and according to the results of the analysis of the first half of 2019, the annual decline was 1.3%, and the indicator of real wages increased by less than 2%, which is less than the rate of inflation growth. Among the reasons for the decline in real income, there is an increase in interest payments on loans and consumer prices (Rosstat, 2020). Also, possible reasons could be a decrease in demand for labor and a general slowdown in the economy.

In 2019, the Central Bank's key rate was lowered. It was also expected that by the end of 2020 there will be a new reduction to 6%, which occurred earlier, today the rate is 6% (April 2020). Immediately after the reduction of the key rate, many banks started lowering mortgage rates and interest rates on consumer loans.

Also, according to Rosstat data the annual inflation rate shows active decline in recent years. The inflation rate fell from 4.3% in 2018 to 3% at the end of 2019. In March 2020, the inflation rate in Russia was 2.55% (on an annual basis, for the last 12 months), which is 0.23 more than the month before.



Graph 3. Dynamics of wages and disposable income in real terms, consumer price index 2014-2019

Source: Rosstat 2020. https://www.gks.ru/labor_market_employment_salaries?print=1 (accessed April 10, 2020)

Graph 4. Level of inflation in Russia.

Source: Inflation in Russia 2020. https://www.statbureau.org/ru/russia/inflation (accessed April 10, 2020)

Financing of development projects and investment activities in the real estate segment continues to be the most important issue for market players. Among the main points-sources of funding, the proportion of funds, interest rates, rules and work of the industry system.

In the summer of 2019, developers switched to project financing – a new model for financing residential construction projects. The purpose of the innovations is to minimize the risks of buyers of apartments under construction, provide certain guarantees for the safety of funds paid by individuals who purchase housing at the construction stage, increase requirements for developers and control operations involving the funds of shareholders. Among the main issues in the transition of developers to a new financing scheme – how will the prices of offers and the prices of transactions develop in the future, how will the cost of the investment budget change and whether it will be possible to achieve the original goals of entering project financing.

At the beginning of the year before the pandemic, there was forecasts that escrow accounts in the medium term, taking into account the factors of project financing, the level of population's solvency and the level of competition between projects should lead to an increase in residential real estate prices. Growth was predicted in the range of 5-10% as in last two years. Analysis of the data from 2015-2020 showed the following volatility of prices in Saint-Petersburg for residential real estate on the primary market (Bn.ru Saint-Petersburg, 2020):

Table 5

Price changes for residential real estate in Saint-Petersburg, %

Time period	2016	2017	2018	2019	2020
Price change %	Less +1%	-1%	+2%	+7%	+10%

Source: Real estate in Saint Petersburg and the Leningrad region analytics. https://www.bn.ru/analytics/ (accessed May 28, 2020).

There was also an opinion, that the price growth of transactions will not happen, the reason is possible decline in a demand for residential real estate. The demand for buying a home using a mortgage tool directly depends on the level of mortgage rates. From 2015 to 2018, there was an increase in the mortgage market, in 2019 continued growth was also expected, but there was a decrease. In 2020, the Russian mortgage market may be under pressure against the backdrop of slowing economic growth and inflationary risks due to falling oil prices and the coronavirus pandemic (RBC, 2020). In this situation, experts suggest scenarios, which include both the growth of the mortgage portfolio with a decrease in rates, and a significant decrease in mortgage issuance with the growth of inflation and rates. In addition, investment demand for real estate as a means of saving increased at the beginning of the year, for Saint Petersburg, this growth spurt was 30%.

.

Graph 5. Volumes of mortgage loans in Russia.

Source: RA Expert 2020. https://www.raexpert.ru/releases/2020/feb20d (accessed April 12, 2020)

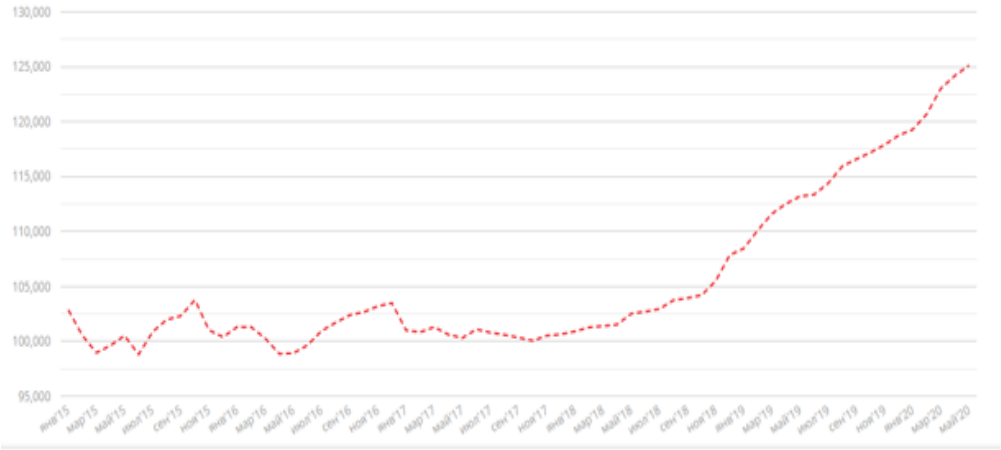
The most likely scenarios for development, according to most industry experts, are now a further 10% drop in prices (RBC, 2020). Whether this drop is short-term will depend on the further situation with the pandemic, the cost of the ruble, the situation with revenues and further government policy. There is also a contrary opinion that the policy of banks, escrow accounts, the increase in the cost of materials and the departure of some developers from the market will

contribute to price growth. Thus, taking into account all the factors, we can conclude that the future situation is quite uncertain.

Residential real estate market of Saint Petersburg

There is a primary and secondary real estate market, and there is also segmentation by property class- there are four classes of residential real estate: comfort class, standard, business-class, elite class. Comfort class constitutes the major part of market taking more than 50% of the whole structure, next comes business and standard class. At the same time, there is a growing trend in demand for comfort-class housing and a reduction in demand for more expensive housing such as business class.

The price of a meter of residential real estate depends directly on the class. The average price of the comfort segment in St. Petersburg at the end of 2019 is 121.9 thousand rubles per square meter, in the suburbs — 86 thousand rubles. In business class, the average price was 183.3 thousand rubles per square meter. The dynamics of average prices over the past 10 years for the primary and secondary markets is shown on the chart, the average price was about 126 thousand rubles.



Graph 6. Price dynamics for residential real estate in Saint-Petersburg 2015-2020

Source: Dynamics of prices in the primary real estate market by types of houses in Saint Petersburg. https://www.emls.ru/stat/index/?module=base-stat-index& (accessed May 19, 2020).

According to the unified register of developers, today the residential real estate market is represented by more than 100 developers. The leaders in the number of introduced housing are “LSR”, “Etalon”, “Setl Group”, “Leader”, “CDS”. There are also many small companies on the market, according to experts ' forecasts, after the introduction of escrow accounts, some small

companies are expected to leave the market, and there will also be consolidation with bigger companies due to the need for sufficient funds to finance the initial stage of the project. In this situation the emergence of new companies on the market seems to be unlikely. Moreover, the industry as a whole has quite high barriers, except finance, to enter the market related to legislation and administrative issues.

2.3 Real options in real estate industry

In the previous parts of this chapter the risks and uncertainties inherent in the residential real estate industry we discussed. They show that there are a lot of risks in this industry and their sources are very diverse and include risks related to the technical side, logistics, finance, market, and so on, which also depends on the construction phase. Moreover, the industry initially stands out with a fairly high degree of uncertainty, primarily related to prices and demand in the market.

Analysis of the current situation in the Russian residential real estate market also showed that much of the market at the moment is quite uncertain. Experts provide various options for market development in the near future. Prices and demand can behave quite unpredictably. On the one hand, the population's income and purchasing power are expected to fall further, on the other hand, there is a possibility of a tendency to maintain existing savings by investing in real estate. In addition, the refinancing rate it is expected to be reduced and, accordingly, there should be a reduction in mortgage lending rates, that can stimulate demand. The answers to these questions also remain rather vague. The main part of the analysis and calculations will be devoted to these problems. Risks related to logistics, technical side, infrastructure and so on will not be considered so may require other methods of assessment related primarily to engineering and construction knowledge.

Given the above, it becomes obvious that using only the discounted cash flow method may not be enough as well as traditional methods of risk-management since the company's strategy based on this method will be fixed without the possibility of changes, which may not only cause lost profits, but also complete collapse. The real options method is more flexible and can help you solve these issues. Under these conditions, the firm can try to maximize profits or abandon the project if it becomes completely unprofitable.

In the field of residential real estate construction there are the following real options:

- Growth/expand option. It can be implemented through additional investments in the future, construction of additional space on the site or adjacent areas, and subsequent phases/phases of the project;

- Flexibility to switch option. This option provides the possibility, if there is such a need in the future, to re-equip the building with a change in its functional use. Or changing the type of construction, for example, from residential to commercial;
- Option to postpone. In case when such course of action is necessary, this option provides an opportunity to delay the implementation of the project and redistribute expenditures over time or prolongate the project this way;
- Option to abandon the project or reduce the scale. In this case company has an opportunity to sell the whole project or its part in case of a negative market situation or any other changes, stop the project and exit from it;
- Staged investment option. Option for phasing the project also means the ability to implement the project in sequences and gradually enter the market after obtaining more information or experience of implementation at earlier stages (Morozova, E., 2009).

Options to abandon or defer a project are usually connected with risks of price fluctuations or rising costs, options to expand – with risks of demand fluctuation and competitor's activity, options to switch and stage – with risks of changing market requirements (Gracheva, M.V., Petreneva, E.A., 2016).

This list of real options for the construction sector is quite general, since not all of them can be applied to a specific market in a particular country due to a number of factors related mainly to the legal framework. Thus, the use of options for expansion or switching to another type of construction will be difficult or even impossible. In this case company will need to by another land plot, and there is no guarantee that it would be possible to buy it at the same place and expand given project. The cost of the land can also differ, demand for residential real estate in another part of the city could differ, other peculiarities could exist, that can make it another project. Moreover, a large number of regulatory documents, legal issues, the need to obtain permits, and a very long time to coordinate these issues concerning urban planning regulations are required in case of growth/expand option. The urban planning regulations include limitations regarding location, area, cadastral number of the plot; types of permission to use the site (conditionally permitted, main, auxiliary); requirements for the intended purpose, parameters and placement of the capital construction object on the specified land plot. All this in turn can require large financial costs which makes the use of such options completely uneconomical.

A fairly similar situation exists in the case of an option to switch. From the one hand, the ability of the project to repurpose real estate objects when the demand for another category of real estate changes can help to obtain additional positive effects or reduce the scale of losses. But in this case company again will need to face regulations, necessity to approve the changes in the project, spend a lot of time and additional money. Furthermore, in this research the case of

residential real estate is investigated, and such type of an option can be applicable before or early stages of construction works, later it may be not possible to change it to commercial estate that format which can meet the demand or would require complete reconstruction and new significant expenditures either. The option to stage will not be considered for the same reasons.

If we talk about the option to postpone the terms of construction periods and commissioning of objects, then in the new conditions with escrow accounts, this also seems unlikely. The new law aimed at fighting developers who delay construction does not allow you to benefit from delays. Developers have to take out a loan and pay interest on a monthly basis. They only receive sales proceeds after transferring the rights to the object. In this case, the loan is issued for a certain period and if the developer does not finish construction by this time, the buyer has the right to return the money, and the bank can cancel the contract and collect penalties or construction as collateral. Although this type of real option can be applied before the company starts the construction works and obtain a loan through escrow accounts. This case implies that company already bought a land plot and wait to obtain more information to start the project. Company also can bare costs connected with taxes for land, but future benefits may exceed these costs. If the current environment will become more favorable, or forecasts and overall conditions will propose it, project can be started. In case when conditions continue to be bot beneficial company can wait further (Targel, K.S., 2015). In case of 2020 and pandemic situation for company may be preferable to wait to understand how situation on the market will develop.

Another option – option to abandon, which is exercised when savings from abandonment outweigh the future revenues, which may exist without such an option (Carmichael, D. G. 2016). An example for real estate industry can be stopping a project and selling a land plot. Exercising of this option can be crucial if the real situation goes according to a negative scenario, the company can at least avoid losses or reduce them. Abandonment can occur at any stage of the project, but detailed analysis is necessary to understand at which stage it would be more beneficial, since the construction costs are not uniform all along the project duration and at particular stages the sum can overcome the price of the land.

In the view of the above, the types of options that will be considered in the given work are option to postpone the beginning of the construction work and option to abandon the project, when developer stops construction works and sell the land plot. As it was mentioned above, both of these options are connected with risk of strong price fluctuations and rise of costs, that according to present situation and forecasts are significant and most important related to the market situation. Moreover, to find ways for profit maximization, options to sell apartments with a different pace at different stages will be investigated to find at what moment, which stage of construction work completeness it would be more profitable.

CHAPTER 3. Investment project valuation. Real case of Russian company.

3.1 Description of a project.

In the master thesis work real data of the project for the construction of residential real estate will be used. Data were provided by the Saint Petersburg developer company, the name of the company and specific details about location of the construction cannot be disclosed. The data includes information about the budget, technical indicators of the project, project implementation period, resource allocation, base prices, etc. All information is in Russian rubles.

The project considers the construction of a residential building "Comfort" class with a selling area of 18450 sq. m. (apartments and built-in attached premises), consisting of 2 buildings with built-in attached premises on the first floor, Parking in the stylobate (building 1) for 183 Parking spaces and Parking in the basement (building 2) for 14 cars. The total land area constitutes 10,515 sq. m. The total, usable and average area for all type of premises realized within the project is given below. The apartment area for a sale is a usable area only. The availability of Parking spaces in the Parking lot is 1 Parking space per 90.5 sq. m. of the sold areas of apartments.

Table 6

Technical and economic indicators of the project

	Total S, sq. m.	Usable S, sq. m.	Quantity, number.	Average S, sq. m.
apartments	24 193	17 836	363	49
built-in attached premises	878	614	8	77
technical room	1 050			
parking	6 485		197	
total	32 606	18 450	568	

According to the data provided the project start is planned in March 2020, the total project duration is 90 months with several stages of implementation: predevelopment, obtaining a building permission, demolition, building, sales. All the stages have a different duration as well and start at different time, the more detailed information is in the table below:

Table 7

Project implementation period

Stage	Start	Completion	Duration, month
Pre-development, incl.:	mar.20	dec.21	21
obtaining a construction permit	dec.21	dec.21	0
demolition	dec.21	mar.22	3
Building, incl.	mar.22	mar.25	36

Sheet piling	mar.22	jun.22	3
construction and installation works	jun.22	jun.25	33
Sales	mar.22	sep.27	66
apartments	mar.22	mar.26	48
built-in attached premises	may.22	mar.26	46
parking	mar.23	sep.27	54
Project implementation period	mar.20	sep.27	91

The pre-development stage requires 21 months and includes market analysis, search and purchase of a suitable land plot, expertise and geodesy, development and evaluation of the project. At the end of this period the company is to obtain a construction permit and only after that it can get a bank loan for further works and starting sales.

Sales start dates are calculated as follows:

- Sales of apartments begin 3 months after obtaining a construction permit;
- Sales of built-in attached premises start 2 months after the start of the sale of apartments, the schedule is provided.
- Sales of Parking spaces begin 12 months after the start of sales of apartments, the schedule is provided.

Construction start dates are calculated as follows:

- The beginning of construction (sheet piling, excavation, etc.) is equal to the beginning of sales, namely, it begins 3 months after receiving the construction permit.
- In the first 3 months after receiving the construction permit, it is allowed to carry out works on demolition, fence installation and other works.

For the calculation of sales company uses basic prices (current sales prices as of December 2019) with regard of increase in next periods. The basic price por apartments is 155 000 rub/sq.m., built-in attached premises 100 000 rub. /sq.m., parking -750 000 rub. /sq.m.

The following increase in sales prices depending on the forecast growth of the market and on the construction readiness of objects is used in calculations:

Table 8

Forecast growth in sales prices

Period	The increase in sales prices		
	apartments	parking	built-in attached premises
2019	0%	0%	0%
2020	3,9%	0%	0%
2021	4,0%	4,0%	0%

2022	4,2%	4,2%	0%
2023 >	4,0%	4,0%	0%

It is also necessary to mention that increase 10% in construction readiness is taken into account in the starting price, and is not applied in the model at stages, which include for Comfort class 0^{th} cycle, ½ box stage, the box completed, commissioning.

Proceeds from the sale of apartments are made for 4 months after receiving the construction permit (1 month after the start of sales), this is due to the electronic registration of the first the equity participation agreement and registration of the project declaration in the construction Committee.

The pace of sales is also provided and implies that it is constant during the project implementation.

Table 9

The underlying pace of sales

	The underlying pace of sales	
	sq. m. per month	pieces. per month.
appartments	412	8
built-in attached premises		0-1
parking		3-4

The formation of the expenditure part of the project with all stages of construction works and related expenditures is also provided.

Table 10

The budget of the project

	sum, rub.	Per sq. m. sel. S, rub.	structure, %
outflows	-3 040 534 405	-164 799	100%
Preproduction	-692 975 873	-37 560	23%
Acquisition of land	-427 370 103	-23 164	14%
Infrastructure charges	-247 605 770	-13 420	8%
Pre-development	-18 000 000	-976	1%
Production	-1 757 439 073	-95 254	58%
Design and survey work	-66 018 527	-3 578	2%
Demolition	-2 607 199	-141	0%
Sheet piling (including extraction)	-24 796 243	-1 344	1%
construction and installation work of a residential building	-1 518 967 075	-82 329	50%
Outdoor networks	-145 050 029	-7 862	5%
Non-production	-175 808 529	-9 529	6%
Advertising expenses	*-86 755 029*	*-4 702*	3%
Agency expenses	*-76 344 426*	*-4 138*	3%
Transfer of an object to shareholders	*-7 986 000*	*-433*	0%
The cost of operation	*-4 723 074*	*-256*	0%

Overhead	-97 818 000	-5 302	3%
Land tax	-3 325 127	-180	0%
Wealth tax	-1 442 804	-78	0%
Interest on loan	-204 308 310	-11 074	7%
Profit tax	-107 416 690	-5 822	4%

3.2 DCF analysis of the project

The data provided is sufficient to build the DCF and find present value of the project and use it for further analysis with real option approach.

The horizon for the DCF model is the whole duration of the project – 90 months as company defined it with the assumption of sale the all constructed premises (apartments, parking, built-attached premises) till the end of 90th month. Cash flows are forecasted monthly. The discount rate accepted in the company is 20%.

Cash outflows.

The land plot is bought at the beginning of the project and the amount of expenses is made at one time. The remaining pre-production costs, which include deductions for infrastructure and pre-development, are distributed evenly from the beginning of the project until December 2021, in which month the company receives a construction permit. The total amount of expenses at this stage is 692 975 873 rubles.

Then at the production stage company first carries out design and survey work several months before the start of construction as well as demolition to prepare the land for works, that takes 3 months with amount of costs respectively 66 018 527 and 2 607 199 rubles. Then the piling is conducted (a construction stage that helps to stabilize the soil, which is in a soft uncompacted state to protect the surrounding buildings and landscape from damage, strengthen the pit) and takes around 3 months as well with the sum of expenditures 24 796 243 rubles. Next comes the most time consuming, lengthy and costly phase - construction and installation. It lasts about 33 months and expenses are distributed unevenly over the months. The distribution is similar to normal with a small difference. the table shows the distribution of expenses by quarter as a percentage of the total amount. Within a quarter, the amount is distributed evenly. Since the project allocates 11 quarters to the construction and installation works, the distribution is presented for this period is the following:

Table 11

Distribution of construction costs

quarter	1	2	3	4	5	6	7	8	9	10	11
distribution	4,3%	6,7%	9,1%	11,7%	11,5%	12,2%	12,8%	11,7%	9,2%	6,6%	4,3%

The total amount of expenses for this type of work is 50% of all expenses and in value terms is equal to 1 518 967 075 rubles. The company also incurs expenses for the supply of external engineering networks, which include pipelines, sewers, heat pipes, etc. the amount of expenses for this type of work for the period is 145 050 029 rubles.

Other outflows are connected with non-production activities, and include marketing costs, particularly advertising costs and agency costs, which represent payments to real estate companies-partners, who sell part of flats constructed. Together, these expenses make up 6% of the total budget, which is equal to 163 099 455 rubles. These expenses start from the moment of construction and last until the end of real estate sales. The company also bears the cost of transferring the object to the owners and the cost of operation, which together constitutes less than 1% of total costs. The cost of transferring the object to the owners are made after the commissioning, which takes place after the state Commission, which provides a conclusion about the complition of the object.

The company pays taxes: property tax, land tax, and income tax. In this case, the costs are made in different terms. Land tax begins to be paid from the beginning of the project, after the acquisition of the plot. Income tax is paid after fixing the income, which occurs after commissioning, when the bank pays the company the profit before the equity agreement, since after the state Commission, the company continues to add the remaining real estate, income is also fixed, and tax is paid. The company pays the land tax until the ownership rights pass completely from the company to a new owner. Property tax is paid from the date of commissioning to the last sales. All taxes are paid in advance payments after each quarter each year. The total amount of taxes is 112 184 621 rubles. During the entire period, the company incurs overhead costs that amount to 97 818 000 rubles. The company also pays interest on the loan, the loan depends on the proceeds from equity agreements, the amount of the loan. Repayment is made after the object is put into operation, when the property under escrow accounts passes to the bank and company gain its revenue. Total amount of infests on a loan 204 308 310 rubles, which is allocated evenly.

Cash inflows.

Cash inflows in the company are formed by sales of three types of real estate: apartments, parking, build-in premises. The main source is the sale of apartments, proceeds from sales in this category without taking into account the time value of money is 3 131 306 054 rubles. Proceeds from sales of parking amount to 179 266 582 rubles, for build-in premises – 61 600 000 rubles.

The main part of income from apartments is made up of sales under equity agreements. These inflows start a month later than sales, which is related to the registration of contracts. For each apartment, the first payment is received, in the first six months from the start of sales, it is 60%, the second six months - 84%, the second year - 90%, the third year - 94%. After the state

Commission and commissioning, sales are made without equity agreements, and in installments for three months, the first month is paid 65% of the total amount, the second - 30% and the last month the remaining 5%. At the same time, the project takes into account the pace of sales, so for apartments the average area sold is 412 square meters. The assumption in the project is that the sales volume is uniform. For Parking, the sales rate is 3-4 units per month, build-in premises are sold equally during the period and in the amount of 8 pieces. The timing of the start of parking sales and build-in premises is also different compared to the sale of apartments: apartments selling starts in March 2022 and continues until March 2026, build-in premises start month later and has the same ending period, and parking is sold from March 2023 until September 2027. In total, sales last 66 months.

The first fees are also different for Parking and build-in premises, and their value changes after the state Commission. They make up 50% for build-in premises and 20% for parking, then are implemented according to the scheme with installments of apartments.

Table 12

Cash flows of the project

Time period		2020	2021	2022	2023	2024	2025	2026	2027
Initial investments	-427370103	0	0	0	0	0	0	0	0
cash inflows, rub.		0	0	478714194	915462756	110159861 2	723967058	113598763	38831254
cash outflows, rub.		-986718101	-158439977	-408249917	-801968634	-792187551	-159168399	-860783 65	-75093564

When the discount rate required by the company is 20%, the NPV of the project is negative and amounts to -97069112 rubles, which indicates that it is not profitable to invest. The entire cash flow model is presented in the Appendix 2.

3.3 Real option analysis of the project

In the second Chapter of this work, various types of real options in construction were identified. This analysis will consider options to abandon the project, when the company can sell the owned land plot and an option to delay the start of construction. It is also suggested to consider situations with different sales rates at different stages of construction to understand whether it is

more beneficial to try to sell at different stages differently. At the same time, the paper separately considers the cost of the project, taking into account future price volatility, in order to understand whether it is advisable to invest in the project at all. The exit option and the situation when we have an option to abandon and the possibility to postpone the start of the project will be considered separately. These options are considered step by step in order to understand what course of action in various situations of changes in housing prices will be most profitable for the company. Thus, the analysis is carried out to understand whether the project will be more profitable if the company will be able to sell in the future the land plot and whether it will be more profitable to postpone the start of construction works.

To calculate options in this case, a binomial model with risk-neutral probabilities is used. In the second chapter prices for residential real estate on the primary market were investigated as well as experts' forecasts for future period with regard present situation with pandemic and its influence. Analysis of past prices from 2015-2020 in Saint-Petersburg showed the tendency to overall rise for 7-10% several last years, but with regard to the black swan of pandemic, currency volatility, situation can change the direction to negative scenario and it would not be correct to make forecast based only on data of past prices. As it was revealed in the second Chapter, most industry experts agree that there will be a decline of 10%, while there is also opinion that if the situation begins to improve soon, growth may continue. Thus, in this paper for further calculations the volatility level was set at 10%.

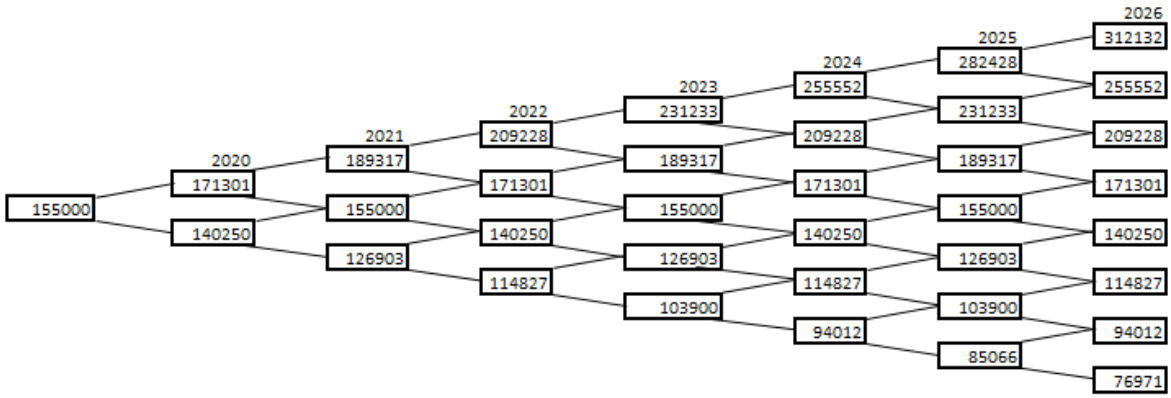
To calculate risk-neutral probabilities, the risk-free rate is used. In a number of studies for a risk-free rate US government bonds are used, but here the case of Russian company is investigated and the rate typical for the country should be used. Today there is no consensus what rate to use as a risk free: possible options are Russian government bonds, Central Bank's refinancing rate, banks' deposits, interbank rate. To date, there are doubts that government bonds are risk-free and reliable (in particular due to the default of 1998) and investing on a deposit in a separate Bank may carry certain risks.

In the given research the MosPrime rate is used. Moscow Prime Offered Rate is an independent indicative rate for providing ruble loans (deposits) on the Moscow money market, based on the offer rates of Russian Ruble deposits as quoted by Contributor Banks — the leading participants of the Russian money market to the first-class financial institutions (Sberbank, Alfa-bank, Gazprom Bank Raiffeisen, UniCredit, VTB). The value of this rate on 29.05.20 is 5.69%. For comparison on this date the refinancing rate has approximately the same value 5,5%, government bonds – 5,131% (5years).

The future sale price of land is calculated with a 50% discount from the original, this is due to both large fluctuations in land prices in Saint-Petersburg (Restate, 2020) and the fact that when

using the option to abandon, the company will try to sell the land as quickly as possible, which in real situation is possible only at a discount. The prices for land regarding the data fluctuated during the last year from -190% to +62%, and the sharpest jumps in prices occurred at time periods when special events as introduction of escrow accounts and pandemic held place and diverse quick changes were the result of uncertainty on the market. The forecast price value for this indicator was found considering the opinion of the company's experts performing this project. The project ends in 2027, but for convenience, it is proposed to consider options with a term of 2025 (in case of option to delay till 2026), when the project has already passed the state Commission and most of the inflows and outflows have already been received and committed.

The full methodology for finding real options was presented in the second Chapter. It was used to calculate options for the base price in the future, taking into account the increasing and decreasing coefficients calculated on the basis of house price volatility. The price was calculated based on the original base price in 2020, when the project was started. The price tree is shown in the diagram below:



Graph 7. Binomial tree of prices

The next steps of analysis were calculation of abandonment option, option to postpone and variations in selling. Calculations of these options were based on the DCF model, that was previously constructed for the project, since calculation with ROA requires cash flows for every year. The cash flows were recalculated separately considering volatility and new prices, based on this volatility, which represented on the tree “Prices”. First, option to abandon was calculated to understand whether the project has a potential for investments, to define it new NPV with an option was found. Criteria here new NPV is more than zero and more than NPV without an option.

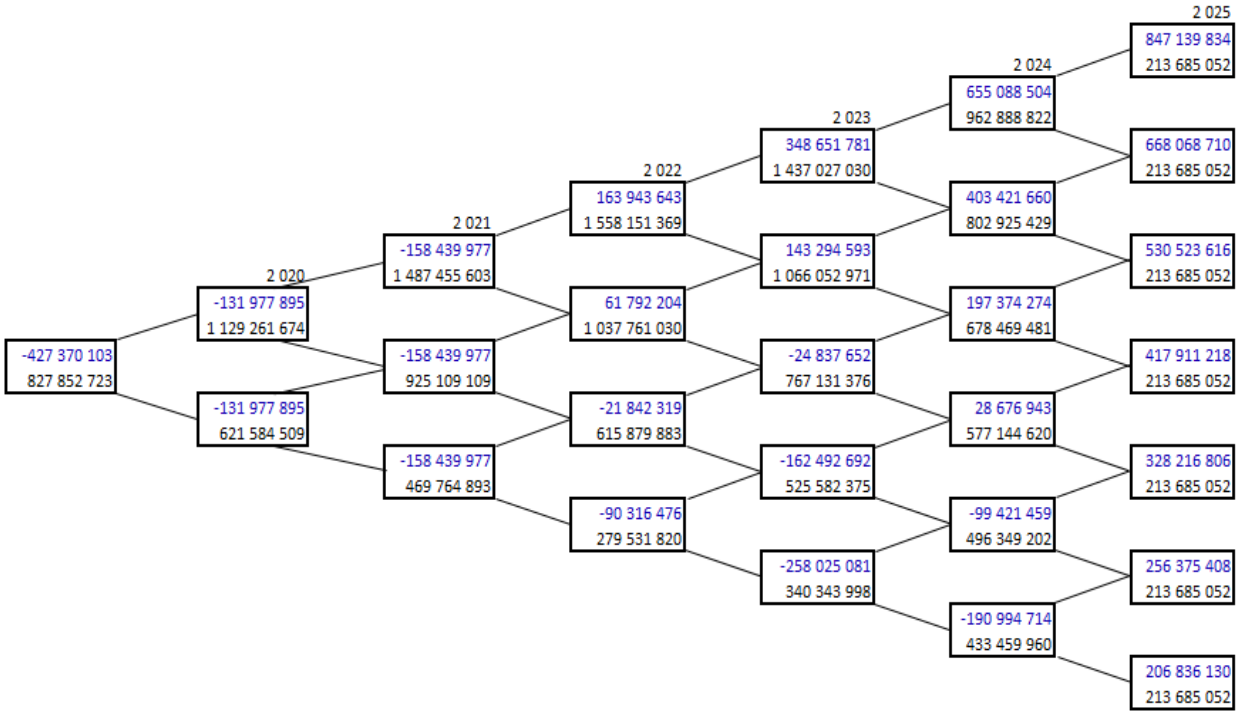
Then to check whether postponement of the construction works would rise the value of the project. Thus, the next step was to calculate the model with an option to abandon plus the option to postpone. This sequential order was chosen to consider all possible actions for company to maximize the value or minimize losses in case of negative development on the market. If the value of the project in case of postponement would be higher than just in case with abandonment option, company should delay the start until the more preferable period.

Further, taking into account these options, situations with different sales rates at different stages are investigated, but within the project and the number of apartments available for sale. The company calculates the project using a uniform sales rate for all periods, which may not only not coincide with the real situation, but also not reflect the real value of the project. This paper analyzes the dependence of the project value on the stages. On the one hand, the company cannot sell any quantity it deems necessary during a certain period only at its own will, since this largely depends on the market situation. But on the other hand, this analysis provides an overview of the possible development of the situation, and if the situation is favorable, the company can use the opportunity to increase profits. This analysis shows what course of action can be chosen for different market situations with given project.

For analysis, in accordance with defined price volatility and a risk-free rate, the up and down factors were calculated, which made up 1,11 and 0,9 and risk-neutral probability equals 0,76.

Option to abandon.

Here is a new graph with option to postpone considered, and in this case the project shows better potential with the value to year 2020 equals to 827 852 723 rubles, net of initial expenditures made in the beginning of 2020 NPV equals 400 482 620 rubles.

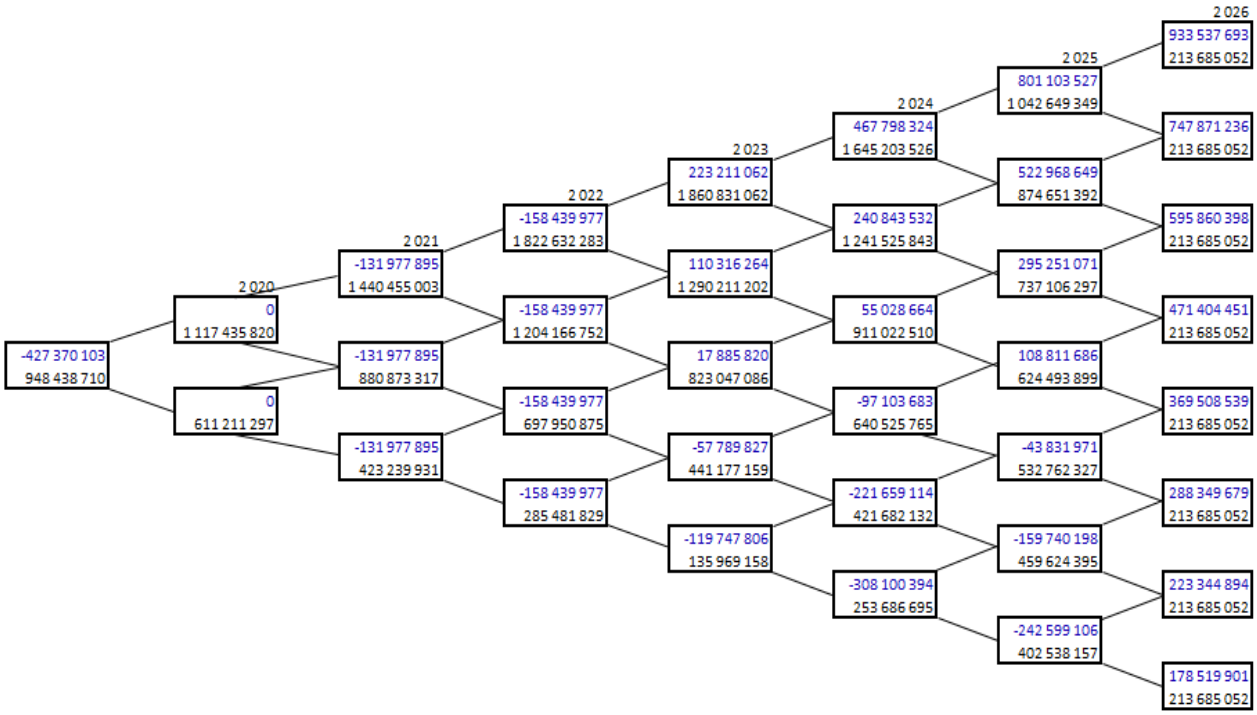


Graph 8. Binomial tree of values for option to abandon

Analysis showed that this option not only increases the cost of the project, but also shows when the price movement in which year will be more profitable to continue the project or sell the land, thus providing a plan of action depending on the situation. So, if the price goes down from the beginning of the project company can still continue it since in 2021 even in case of next decrease company still have a project value higher than cost of land. Even in case of the most negative scenario company can continue the project till 2024 when value again will be more that initial cost of land. Only in case when price fall down even lower, than scenario suggests company should stop the project, otherwise, it is better to complete the project. Whether there will be any extraordinary evens that can influence the price more than analysis suggested company can also understand at the next steps when more information regarding situation or new more accurate forecasts for further period will be available.

Option to delay+ abandon.

Due to the great uncertainty in the market of this industry, an option to delay the start of construction was also considered in order to understand the ways to maximize profits. This option was considered together with the option to abandon the project. In this case, the possibility of postponing the project for one year, while the initial costs will also be distributed according to the budget. If in the past, part of the initial costs included deductions for infrastructure and pre-development, now they are also shifted by one year.



Graph 9. Binomial tree of values for options to abandon + postpone

In this case value of a project will be higher in comparison to a model with only option to abandon, it equals to 948 438 710 rubles and NPV constitutes 521 068 607 rubles, which is also higher than in previous case (NPV with only option to abandon equals 400 482 620 rubles). So, it can be concluded that with forecasted volatility it would be more beneficial for company to postpone the beginning of construction works for one year, which is also logical in the context of a pandemic.

Further, to understand how the company is more profitable to sell: at earlier stages, in the middle or later, sales growth rates were redistributed: for every stage 10% growth was calculated separately, the cash flows were also recalculated for each case, which presented in Appendix 3, Appendix 4. Initially, the model used the same sales rate. Initially company used equal rate at all stages for analysis. This rate depends on the market situation and the company is not always able to increase this rate by only its own actions. But if there is a market movement, such as this year in the context of a pandemic, when a rapid increase or decrease in demand from citizens who want to save their savings is possible, the company can understand further development, and allocate an additional budget for advertising and try to sell more at the particular stage. Here for a further calculations model with option to abandon and postpone was used as base, since it provides more flexibility of actions and as result opportunity to rise the value of the project and provides the complete picture for possible actions.

For every case of sales at different sages separate binomial tree was made and for convenience graphs are represented in the Appendix 8, Appendix 9, Appendix 10. The results of these calculations can be seen in the table below:

Table 13

Values of binomial trees, selling at different stages

Stage	PV, rubles	NPV, rubles	Change, rubles
Equal sales rate	948 438 710	521 068 607	-
Early stages rate increase	955 213 035	527 842 932	+ 6 774 325
Middle stages rate increase	952 541 181	525 171 078	+ 4 102 471
Late stages rate increase	945 411 271	518 041 168	-3 027 439

Here results from modeling with different rates at different stages are presented. In every case new present value of a project was compared with the value of a project with equal sales rate, the same for net present values. Analysis showed that at earlier stages sales are more beneficial and contribute to the overall value of the project 6 774 325 rubles, whereas higher rate at middle stage also rise the value but for a smaller sum 4 102 471 rubles, and sales at the later stage decrease the value to 3 027 439 rubles. This can be explained unequal allocation of expenditures during the project implementation and time value of money. Although, the prices for apartments are higher at a later stage, this increase cannot cover expenditures. Despite these amounts are not very large for this project, this is still a way to maximize profit, it is also important if we are talking about the fact that initially the project has a negative NPV, and the greater the change in demand and the longer the duration of the project, the greater the range of these amounts.

It is also important to remember that to each node of binomial tree of project values correspond a definite price at each year. Hence, the range of prices when it is more beneficial to continue or stop the project with regard of different sales paces can be found. Company can also make a conclusion whether it can afford to sell at a price lower than it is now on the market, if demand is growing, in order to capture most of the demand by putting prices lower.

Taking into account all the results obtained the following recommendations can be made within the framework of this project:

- despite the negative NPV indicator when analyzing using the traditional method, the company should invest in the project, since the option to sell a land plot even with a discount rise the value of the project;

- companies may also consider delaying the start of work as this will also increase the value of the project;
- in case of a favorable market development and increased demand coinciding with the early stages of construction the company should try to sell as much as possible at the early stages and consider an additional budget for marketing;
- if the price for real estate start to decrease and this decrease will be continuous, company should stop the project and sell the land plot independently from the pace of sales at different stages;
- in case of sales at early and middle stages if price decrease in 2020 year, continue decrease in 2021 and fluctuate in range 103900-126903 rubles company should be especially careful when monitoring trends and situations since in different years the project can either be continued or stopped and a clear answer can only be given if the price exceeds 126903 rubles. If sales at later stage considered, then the project should continue with the specified price range;
- if prices fluctuate in the range of 140250-155000 and prices increase in all cases the project should be continued and implemented to the end.

CONCLUSION

In the master's thesis, a real project in the field of residential real estate construction was evaluated using the traditional method of discounted payments and the method of real options.

The issues of investment in the project were considered, as well as options for further actions to maximize profits at various stages in each year of project implementation. The traditional method of evaluation showed that this project, taking into account the criteria of the DCF model, should be rejected because it has a negative NPV. However, this method is not flexible and does not take into account the possibility of changing the decision after investment. The real option approach helps to consider risks connected with both negative and positive changes and incorporate results of undertaken additional actions, that is important especially for projects with long duration as in a real estate industry, when prices can substantially change every year.

In this paper, the project of construction residential estate was analyzed. With the method used by the company, the specified conditions and the required rate of return, the project showed a lot of negative net present value, that according to the criterion means rejection of the project. Using the method of real options, it was possible not only to identify whether the project has the potential to invest, but also to understand what development paths the project has in the future, when the investment has already been made. Thus, the analysis showed that including the option

to abandon the project, when the company can sell the land the project, meets the criteria for its acceptance. At the same time, when the investment has already been made, but the situation is unstable, the company may want to postpone the start of construction work in order to get more information in the future and maximize profits. In this project, the analysis of such an option showed that the cost of the value of the project will be higher than in case with only option to abandon, and the company should delay the start of construction. The results of the analysis, which includes different sales rates at different stages, also showed that if the company sells at an earlier stage, it will be able to extract more profit. The detailed analysis with a set of recommendations were provided in the 3rd chapter.

In addition, the real options method provides an overview of the price spread within which the project cost is sufficient to continue or, conversely, too low and the project must be closed.

Thus, the method provides more flexibility in making decisions at different stages of the project, which is a plus compared to the evaluation methods adopted by the company. Since its usage is based on the existing model and data that the company has, which also makes it quite convenient to implement.

RERENCES

1. Adner, R., and D. Levinthal. 2005. What Is Not a Real Option: Considering Boundaries for the Application of Real Options to Business Strategy. *Academy of Management Review* 29: 74-85.
2. Altshuler, D., and C.A. Magni. 2012. Why IRR is Not the Rate of Return for Your Investment: Introducing AIRR to the Real Estate Community. The Journal of Real Estate Portfolio Management 18 (2): 219-230.
3. Arnold, T., and T.D. Nixon. 2006. Adding Depth to the Discussion of Capital Budgeting Techniques. *Journal of Financial Education* 32 (summer 2006): 78-89.
4. Bailes, J. C., and J.F. Nielsen. 2001. Using Decision Trees to Manage Capital Budgeting Risk. *Management Accounting Quarterly* 2 (2):14–17.
5. Bahamid, R.A., and M.A. Al-Sharaf. 2019. Risk factors affecting the construction projects in the developing countries. *IOP Conference Series: Earth and Environmental Science* 244 (1), 012042.
6. Berkovitch, E., and R. Israel. 2004. Why the NPV Criterion Does Not Maximize NPV. *The Review of Financial Studies* 17 (1): 239-255.
7. Brealey, R. A., S.C. Myers, and F. Allen. 2010. *Principles of corporate finance*. 10th ed cGraw-Hill/Irwin.
8. Broeders, D., H. Loman, and J. van Toor. 2018. A methodology for actively managing tail risks and uncertainties. Journal of Risk Management in Financial Institutions 12 (1): 44–56.
9. Brown, R.J. 2006. Sins of the IRR Source. *The Journal of Real Estate Portfolio Management* 12 (2): 195- 200.
10. Bulletin on current trends in the Russian economy February 2020 No. 58 Dynamics of household income. Analytical Center under the government of the Russian Federation. https://ac.gov.ru/uploads/2-Publications/rus_feb_2020.pdf (accessed May 2020).
11. Carmichael, D. G. 2016. A cash flow view of real options. *Engineering Economist* 61 (4): 265–288.
12. CFA Institute. 2019. *CFA Program Curriculum 2020 Level II Volumes 1-6 Box Set Authors: CFA Institute.* 1st ed. NY: John Wiley & Sons.
13. Chance, D.M., and P.P. Peterson. 2002. *Real Options and Investment Valuation.* 1738 The Research Foundation of the Association for Investment Management and Research (CFA Institute).
14. Copeland T, and V. Antikarov. 2001. Real Options: A practitioner's guide. Texere LLC: New York.
15. Damodaran, A. 2005. The Promise and Peril of Real Options. NYU Working Paper No. S-DRP-05-02. Available at SSRN: https://ssrn.com/abstract=1295849

16. Damodaran, A. 2011. Applied Corporate Finance. Hoboken, NJ: John Wiley & Sons.
17. Damodaran, A. 2012. *Investment valuation: tools and techniques for determining the value of any asset*. 3rd ed. Wiley finance series.
18. Dhiensiri, N., and N. Balsara. 2014. An Introductory Application of Monte Carlo Simulatoin in Capital Budgeting Analysis. Journal of Financial Education 40 (1/2): 94- 114.
19. Dinu, A.M. 2012. Modern Methods of Risk Identification in Risk Management. *International Journal of Academic Research in Economics and Management Sciences* 1 (6): 67-71.
20. Dzyuma, U. 2012. Real options compared to traditional company valuation methods: possibilities and constraints of their use. Financial Internet Quarterly "e-Finance". 8 (2): 51-68.
21. Dynamics of prices in the primary real estate market by types of houses in Saint Petersburg. https://www.emls.ru/stat/index/?module=base-stat-index& (accessed May 19, 2020).
22. Federal law of the Russian Federation of December 30, 2004 No. 214-FZ "About participation in shared-equity construction of apartment houses and other real estate objects and about modification of some legal acts of the Russian Federation". http://www.consultant.ru/document/cons_doc_LAW_51038/
23. Geltner, D., and R. De Neuville. 2018.: *Flexibility and real estate valuation under uncertainty: a practical guide for developers*. Hoboken, NJ: John Wiley & Sons.
24. Gracheva, M.V., and E.A. Petreneva. 2016. Realnye optsiony kak instrumenty upravlenia proektnimy riskamy. [In Russian]. *Financial Analytics* 10: 2–14.
25. Husainov, I. 2020. Krisis 2020, tseny snizatsa no ne nadolgo. *RBC.* March 30. https://realty.rbc.ru/news/5e8184319a794784f6672a20 (accessed April 2, 2020).
26. Igoshin, A. 2020. Kak izmenitsa rynok nedvizhimosty posle pandemii. *RBC.* May 5. https://realty.rbc.ru/news/5eaac7729a7947d6eb56c79b (accessed May 20, 2020).
27. Ipsmiller, E., K.D. Brouthers, and D. Dikova. 2019. 25 Years of Real Option Empirical Research in Management. *European Management Review* 16 (1): 55–68.
28. Kaczmarzyk, J. 2019. Several Sets of Assumptions for the Monte Carlo Simulation for a More Precise Analysis of Enterprise Risk. *Econometrics / Ekonometria*, 23(4): 80–95.
29. Kenton, W. and D. Kindness. 2020. Sensitivity analysis. https://www.investopedia.com/terms/s/sensitivityanalysis.asp (accessed May 2, 2020).
30. Keshk, A.M., I. Maarouf, and Y. Annany. 2018. Special studies in management of construction project risks, risk concept, plan building, risk quantitative and qualitative analysis, risk response strategies. *Alexandria Engineering Journal* 57 (4): 3179-3187.
31. Knyazeva, N.V. 2018. Methodology of decision-making about investments in real estate. *Bulletin of Chelyabinsk State University:* Economic Sciences No. 8 (418) Iss. 62: 103—113.

32. Kodukula, P. and C. Papudesu. 2006. *Project valuation using real options: a practitioner's guide*. Fort Lauderdale, FL: J. Ross Publishing.
33. Larrabee, D.T. and J.A. Voss. 2013. *Valuation techniques: discounted cash flow, earnings quality, measures of value added, and real options.* 1st ed. NY: John Wiley & Sons, Inc., Hoboken.
34. Makwana, A. and Dr. J. Pitroda. 2017. Factors Affecting Risk Management for Construction by Analytic Hierarchy Process (Ahp). *Journal of Structural Technology* 2 (1): 1-7.
35. Makropoulou, V. 2011. Decision Tree Analysis and Real Options: A Reconciliation. *Managerial and Decision Economics* 32 (4):261-264. Wiley & Sons.
36. Morozova, E. 2009. Real options and investment projects in real estate industry. https://www.cfin.ru/appraisal/realty/real_options.shtml (accessed April 8, 2020).
37. Mun, J. 2002. *Real Option Analysis – Tools and Techniques for Valuing Strategic Investments and Decisions*. New York: John Wiley & Sons.
38. Orlov, K. 2020. Transformation of classes. *Kommersant nedvizhimost*. February 27. https://www.kommersant.ru/doc/4267579 (accessed March 14, 2020).
39. Pivoriene, A. 2017. Real Options and Discounted Cash Flow Analysis to Assess Strategic Investment Projects. *Economics & Business* 30: 91–101.
40. Price of land in Saint-Petersburg. https://spb.restate.ru/graph/ceny-prodazhi-zemli/ (accessed May 28, 2020).
41. PWC 2020. Real estate 2020: Building the future. https://www.pwc.com/sg/en/real-estate/assets/pwc-real-estate-2020-building-the-future.pdf (accessed April 25, 2020)
42. Ragozzino, R., J.J. Reuer, L. Trigeorgis. 2016. Real Options in Strategy and Finance: Current Gaps and Future Linkages. *Academy of Management Perspectives* 30(4): 428-440.
43. Real estate in Saint Petersburg and the Leningrad region analytics. https://www.bn.ru/analytics/ (accessed May 28, 2020).
44. Ross, A.S. 1995. Uses, Abuses, and Alternatives to the Net-Present-Value Rule. *Financial Management* 24 (3): 96-102.
45. Schieg, M. 2006. Risk Management in Construction Project Management. *Journal of Business Economics & Management* 7 (2): 369-404.
46. Silva, J. L., V.A. Sobreiro, and H. Kimura. 2018. Prepurchase financing pool: Revealing the IRR problem. *Engineering Economist* 63 (2): 158–170.
47. Smith, J. M., R. Driver, and W. Matthews. 2018. The Real Options Lattice: An Alternative to Discounted Cash Flow. *Journal of Accounting & Finance* (2158-3625), 18(7): 119–129.
48. Smith, N. J., T. Merna, and P. Jobling. 2006. *Managing risk: in construction projects*. 2nd ed. Wiley-Blackwell.

49. Soboleva, E.A. 2016. Razvitie rossiiskogo developmenta v sovremennykh usloviah. Moscow: Ministry of science and education. National research state constr. Univ.
50. Targiel, K. S. 2015. Real Options in a Systemic Approach to the Timing Problem in Development Projects. *Operations Research & Decisions* 25 (3):73–85.
51. Trigeorgis, L. 1996. *Real Options: Managerial Flexibility and Strategy in Resource Allocation*. MIT Press: Cambridge.
52. Trigeorgis, L. 2005. Making use of real options simple: an overview and applications in flexible/modular decision making. *The Engineering Economist* 50: 25–53. Institute of Industrial Engineers.
53. Trigeorgis, L., and J.J. Reuer. 2017. Real options theory in strategic management. *Strategic Management Journal* 38 (1): 42–63.
54. Van Putten, A.B., and I.C. MacMillan. 2008. *Unlocking Opportunities for Growth: How to Profit from Uncertainty While Limiting Your Risk.* 1st. ed. FT Press.
55. Unified register of developers. https://erzrf.ru/zastroyschiki?regionKey=144781001&costFrom=1.46&costType=1 (accessed May 19, 2020).

APPENDIX

Appendix 1. Cash flow from sales of apartments

base prices	60%						84%						
1 installment	1 мес	2 мес	3 мес	4 мес	5 мес	6 мес	7 мес	8 мес	9 мес	10 мес	11 мес	12 мес	13 мес
	25	26	27	28	29	30	31	32	33	34	35	36	37
time period	March 1, 2022	April 1, 2022	May 1, 2022	June 1, 2022	July 1, 2022	August 1, 2022	September 1, 2022	October 1, 2022	November 1, 2022	December 1, 2022	January 1, 2023	February 1, 2023	March 1, 2023
Inflows	0	43141652	47813398	44925979	45797528	46696312	47624089	65839454	70086158	66789624	67215714	70074125	71059872
Apartments													
Inflows from apartments	71902753,19	71902753,19	71902753,2	71902753,19	71902753,2	71902753,19	71902753,19	71902753,19	71902753,19	71902753,19	74778863,31	74778863,31	74778863,31
Inflows from apartments (installments)		71902753,19	71902753,2	71902753,19	71902753,2	71902753,19	71902753,19	71902753,19	71902753,19	71902753,19	71902753,19	74778863,31	74778863,31
		43141652	821746	821746	821746	821746	821746	821746	821746	821746	821746	821746	821746
			43141652	845915	845915	845915	845915	845915	845915	845915	845915	845915	845915
				43141652	871549	871549	871549	871549	871549	871549	871549	871549	871549
					43141652	898784	898784	898784	898784	898784	898784	898784	898784
						43141652	927777	927777	927777	927777	927777	927777	927777
							43141652	958703	958703	958703	958703	958703	958703
								60398313	396705	396705	396705	396705	396705
									60398313	410873	410873	410873	410873
										60398313	426090	426090	426090
											60398313	442478	442478
												62814245	478585
													62814245

base prices												
						90%						
1 installment	14 мес	15 мес	16 мес	17 мес	18 мес	19 мес	20 мес	21 мес	22 мес	23 мес	24 мес	25 мес
	38	39	40	41	42	43	44	45	46	47	48	49
time period	April 1, 2023	May 1, 2023	June 1, 2023	July 1, 2023	August 1, 2023	September 1, 2023	October 1, 2023	November 1, 2023	December 1, 2023	January 1, 2024	February 1, 2024	March 1, 2024
Inflows	76133332	76550669	80837175	77637197	78117863	78624138	79158909	79725575	80328186	84841902	84676521	85450569
Apartments												
Inflows from apartments	74778863,31	74778863,3	74778863,3	74778863,3	74778863,31	74778863,31	74778863,31	74778863,31	74778863,31	77770017,85	77770017,85	77770017,85
Inflows from apartments (installments)	74778863,31	74778863,3	74778863,3	74778863,3	74778863,31	74778863,31	74778863,31	74778863,31	74778863,31	74778863,31	77770017,85	77770017,85
	821746	821746	821746	821746	821746	821746	821746	821746	821746	821746	821746	821746
	845915	845915	845915	845915	845915	845915	845915	845915	845915	845915	845915	845915
	871549	871549	871549	871549	871549	871549	871549	871549	871549	871549	871549	871549
	898784	898784	898784	898784	898784	898784	898784	898784	898784	898784	898784	898784
	927777	927777	927777	927777	927777	927777	927777	927777	927777	927777	927777	927777
	958703	958703	958703	958703	958703	958703	958703	958703	958703	958703	958703	958703
	396705	396705	396705	396705	396705	396705	396705	396705	396705	396705	396705	396705
	410873	410873	410873	410873	410873	410873	410873	410873	410873	410873	410873	410873
	426090	426090	426090	426090	426090	426090	426090	426090	426090	426090	426090	426090
	442478	442478	442478	442478	442478	442478	442478	442478	442478	442478	442478	442478
	478585	478585	478585	478585	478585	478585	478585	478585	478585	478585	478585	478585
	498526	498526	498526	498526	498526	498526	498526	498526	498526	498526	498526	498526
	67300977	325125	325125	325125	325125	325125	325125	325125	325125	325125	325125	325125
		67300977	339904	339904	339904	339904	339904	339904	339904	339904	339904	339904
			67300977	356090	356090	356090	356090	356090	356090	356090	356090	356090
				67300977	373894	373894	373894	373894	373894	373894	373894	373894
					67300977	393573	393573	393573	393573	393573	393573	393573
						67300977	415438	415438	415438	415438	415438	415438
							67300977	439876	439876	439876	439876	439876
								67300977	467368	467368	467368	467368
									67300977	498526	498526	498526
										67300977	534135	534135
											69993016	598231
												69993016

base prices						94%						
1 installment	26 мес	27 мес	28 мес	29 мес	30 мес	31 мес	32 мес	33 мес	34 мес	35 мес	36 мес	37 мес
	50	51	52	53	54	55	56	57	58	59	60	61
time period	April 1, 2024	May 1, 2024	June 1, 2024	July 1, 2024	August 1, 2024	September 1, 2024	October 1, 2024	November 1, 2024	December 1, 2024	January 1, 2025	February 1, 2025	March 1, 2025
Inflows	89401252	90036432	90737474	95369665	92954339	93972572	95172231	96632920	102352735	103059131	109962024	39509175
Apartments												
inflows from apartments	77770017,85	77770017,85	77770017,8	77770017,8	77770017,85	77770017,85	77770017,85	77770017,85	77770017,85	80880818,56	80880818,56	45363326,92
inflows from apartments (installments)	77770017,85	77770017,85	77770017,8	77770017,8	77770017,85	77770017,85	77770017,85	77770017,85	77770017,85	77770017,85	80880818,56	80880818,56
												45363326,92
	821746	821746	821746	821746	821746	821746	821746	821746	821746	821746	821746	821746
	845915	845915	845915	845915	845915	845915	845915	845915	845915	845915	845915	845915
	871549	871549	871549	871549	871549	871549	871549	871549	871549	871549	871549	871549
	898784	898784	898784	898784	898784	898784	898784	898784	898784	898784	898784	898784
	927777	927777	927777	927777	927777	927777	927777	927777	927777	927777	927777	927777
	958703	958703	958703	958703	958703	958703	958703	958703	958703	958703	958703	958703
	396705	396705	396705	396705	396705	396705	396705	396705	396705	396705	396705	396705
	410873	410873	410873	410873	410873	410873	410873	410873	410873	410873	410873	410873
	426090	426090	426090	426090	426090	426090	426090	426090	426090	426090	426090	426090
	442478	442478	442478	442478	442478	442478	442478	442478	442478	442478	442478	442478
	478585	478585	478585	478585	478585	478585	478585	478585	478585	478585	478585	478585
	498526	498526	498526	498526	498526	498526	498526	498526	498526	498526	498526	498526
	325125	325125	325125	325125	325125	325125	325125	325125	325125	325125	325125	325125
	339904	339904	339904	339904	339904	339904	339904	339904	339904	339904	339904	339904
	356090	356090	356090	356090	356090	356090	356090	356090	356090	356090	356090	356090
	373894	373894	373894	373894	373894	373894	373894	373894	373894	373894	373894	373894
	393573	393573	393573	393573	393573	393573	393573	393573	393573	393573	393573	393573
	415438	415438	415438	415438	415438	415438	415438	415438	415438	415438	415438	415438
	439876	439876	439876	439876	439876	439876	439876	439876	439876	439876	439876	439876
	467368	467368	467368	467368	467368	467368	467368	467368	467368	467368	467368	467368
	498526	498526	498526	498526	498526	498526	498526	498526	498526	498526	498526	498526
	534135	534135	534135	534135	534135	534135	534135	534135	534135	534135	534135	534135
	598231	598231	598231	598231	598231	598231	598231	598231	598231	598231	598231	598231
	648083	648083	648083	648083	648083	648083	648083	648083	648083	648083	648083	648083
	73103817	424200	424200	424200	424200	424200	424200	424200	424200	424200	424200	424200
		73103817	466620	466620	466620	466620	466620	466620	466620	466620	466620	466620
			73103817	518467	518467	518467	518467	518467	518467	518467	518467	518467
				73103817	583275	583275	583275	583275	583275	583275	583275	583275
					73103817	666600	666600	666600	666600	666600	666600	666600
						73103817	777700	777700	777700	777700	777700	777700
							73103817	933240	933240	933240	933240	933240
								73103817	1166550	1166550	1166550	1166550
									73103817	1555400	1555400	1555400
										73103817	2333101	2333101
											76027969	4852849

	March 1, 2025	April 1, 2025	May 1, 2025	June 1, 2025	July 1, 2025	August 1, 2025	September 1, 2025	October 1, 2025	November 1, 2025	December 1, 2025	January 1, 2026	February 1, 2026	March 1, 2026
Inflows after commossioning	29486162	13608998	2268166										
		29486162	13608998	2268166									
			29486162	13608998	2268166								
				29486162	13608998	2268166							
					29486162	13608998	2268166						
						29486162	13608998	2268166					
							29486162	13608998	2268166				
								29486162	13608998	2268166			
									29486162	13608998	2268166		
										29486162	13608998	2268166	
											30665609	14153358	2358893

Appendix 2. DCF model with base prices

1 installment										
	1	2	3	4	5	6	7	8	9	10
time period	March 1, 2020	April 1, 2020	May 1, 2020	June 1, 2020	July 1, 2020	August 1, 2020	September 1, 2020	October 1, 2020	November 1, 2020	December 1, 2020
Inflows	0	0	0	0	0	0	0	0	0	0
Total inflows apartments	0	0	0	0	0	0	0	0	0	0
Total inflows build-in premises	0	0	0	0	0	0	0	0	0	0
Total inflows parking	0	0	0	0	0	0	0	0	0	0
Permission obtaining										
Outflows	-440518016	-13314169	-13147913	-13147913	-13314169	-13147913	-13147913	-13314169	-13147913	-13147913
Preproduction	-439443093	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990
Acquisition of land	-427370103									
Infrastructure charges	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808
Pre-development	-818182	-818182	-818182	-818182	-818182	-818182	-818182	-818182	-818182	-818182
Production	0	0	0	0	0	0	0	0	0	0
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential building										
Outdoor networks										
Non-production	0	0	0	0	0	0	0	0	0	0
Advertising expenses										
Agency expenses										
Transfer of an object to shareholders										
The cost of operation										
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax		-166256			-166256			-166256		
Wealth tax										
Interest on credit										
Profit tax										
cash flow	-13147913	-13314169	-13147913	-13147913	-13314169	-13147913	-13147913	-13314169	-13147913	-13147913
d	0,85	0,85	0,85	0,85	0,85	0,85	0,85	0,85	0,85	0,85
dcf	-11124334	-11265002	-11124334	-11124334	-11265002	-11124334	-11124334	-11265002	-11124334	-11124334

1 installment										
	11	12	13	14	15	16	17	18	19	20
time period	January 1, 2021	February 1, 2021	March 1, 2021	April 1, 2021	May 1, 2021	June 1, 2021	July 1, 2021	August 1, 2021	September 1, 2021	October 1, 2021
Inflows	0	0	0	0	0	0	0	0	0	0
Total inflows apartments	0	0	0	0	0	0	0	0	0	0
Total inflows build-in premises	0	0	0	0	0	0	0	0	0	0
Total inflows parking	0	0	0	0	0	0	0	0	0	0
Permission obtaining										
Outflows	-13147913	-13314169	-13147913	-13314169	-13147913	-13147913	-13314169	-13147913	-13147913	-13314169
Preproduction	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990
Acquisition of land										
Infrastructure charges	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808
Pre-development	-818182	-818182	-818182	-818182	-818182	-818182	-818182	-818182	-818182	-818182
Production	0	0	0	0	0	0	0	0	0	0
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential										
Outdoor networks										
Non-production	0	0	0	0	0	0	0	0	0	0
Advertising expenses										
Agency expenses										
Transfer of an object to shareholders										
The cost of operation										
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax		-166256		-166256			-166256			-166256
Wealth tax										
Interest on credit										
Profit tax										
cash flow	-13147913	-13314169	-13147913	-13314169	-13147913	-13147913	-13314169	-13147913	-13147913	-13314169
d	0,71	0,71	0,71	0,71	0,71	0,71	0,71	0,71	0,71	0,71
dcf	-9270278	-9387501	-9270278	-9387501	-9270278	-9270278	-9387501	-9270278	-9270278	-9387501

1 installment					1 мес	2 мес	3 мес	4 мес	5 мес	6 мес
	21	22	23	24	25	26	27	28	29	30
time period	November 1, 2021	December 1, 2021	January 1, 2022	February 1, 2022	March 1, 2022	April 1, 2022	May 1, 2022	June 1, 2022	July 1, 2022	August 1, 2022
Inflows	0	0	0	0	0	43141652	47813398	44925979	45797528	46696312
Total inflows apartments	0	0	0	0	0	43141652	43963398	44809312	45680861	46579645
Total inflows build-in premises	0	0	0	0	0	0	3850000	116667	116667	116667
Total inflows parking	0	0	0	0	0	0	0	0	0	0
Permission obtaining										
Outflows	-13147913	-13147913	-29326700	-29492956	-40026434	-17317448	-17151192	-30404478	-30570734	-30404478
Preproduction	-12072990	-12072990								
Acquisition of land										
Infrastructure charges	-11254808	-11254808								
Pre-development	-818182	-818182								
Production	0	0	-22875242	-22875242	-31140656	-8265414	-8265414	-21518700	-21518700	-21518700
ПИР			-22006176	-22006176	-22006176					
Demolition			-869066	-869066	-869066					
Sheet piling (including extraction)					-8265414	-8265414	-8265414			
construction and installation works of a residential								-21518700	-21518700	-21518700
Outdoor networks										
Non-production	0	0	0	0	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320
Advertising expenses					-1294851	-1294851	-1294851	-1294851	-1294851	-1294851
Agency expenses					-1139469	-1139469	-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders										
The cost of operation										
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax				-166256		-166256			-166256	
Wealth tax										
Interest on credit			-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534
Profit tax										
cash flow	-13147913	-13147913	-29326700	-29492956	-40026434	25824203	30662206	14521501	15226793	16291834
d	0,71	0,71	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59
dcf	-9270278	-9270278	-17231294	-17328980	-23518066	15173356	18015988	8532302	8946706	9572485

1 installment	7 мес	8 мес	9 мес	10 мес	11 мес	12 мес	13 мес	14 мес	15 мес	16 мес
	31	32	33	34	35	36	37	38	39	40
time period	September 1, 2022	October 1, 2022	November 1, 2022	December 1, 2022	January 1, 2023	February 1, 2023	March 1, 2023	April 1, 2023	May 1, 2023	June 1, 2023
Inflows	47624089	65839454	70086158	66789624	67215714	70074125	71059872	76133332	76550669	80837175
Total inflows apartments	47507423	65722787	66119492	66530365	66956455	69814866	70293451	75278708	75603834	75943738
Total inflows build-in premises	116667	116667	3966667	259259	259259	259259	259259	259259	259259	4109259
Total inflows parking	0	0	0	0	0	0	507162	595364	687576	784178
Permission obtaining										
Outflows	-42809376	-42975632	-42809376	-54961112	-54961112	-55127369	-68125494	-68291750	-68125494	-67112849
Preproduction										
Acquisition of land										
Infrastructure charges										
Pre-development										
Production	-33923598	-33923598	-33923598	-46075335	-46075335	-46075335	-59239716	-59239716	-59239716	-58227071
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential	-33923598	-33923598	-33923598	-46075335	-46075335	-46075335	-59239716	-59239716	-59239716	-58227071
Outdoor networks										
Non-production	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320
Advertising expenses	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851
Agency expenses	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders										
The cost of operation										
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax		-166256				-166256		-166256		
Wealth tax										
Interest on credit	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534
Profit tax										
cash flow	4814714	22863821	27276783	11828512	12254602	14946757	2934379	7841582	8425175	13724326
d	0,59	0,59	0,59	0,59	0,49	0,49	0,49	0,49	0,49	0,49
dcf	2828949	13433944	16026838	6950000	6000296	7318472	1436778	3839522	4125270	6719926

1 installment	17 мес	18 мес	19 мес	20 мес	21 мес	22 мес	23 мес	24 мес	25 мес	26 мес
	41	42	43	44	45	46	47	48	49	50
time period	July 1, 2023	August 1, 2023	September 1, 2023	October 1, 2023	November 1, 2023	December 1, 2023	January 1, 2024	February 1, 2024	March 1, 2024	April 1, 2024
Inflows	77637197	78117863	78624138	79158909	79725575	80328186	84841902	84676521	85450569	89401252
Total inflows apartments	76299828	76673722	77067295	77482733	77922609	78389977	78888502	82114676	82712907	86471791
Total inflows build-in premises	451759	451759	451759	451759	451759	451759	4301759	747913	747913	747913
Total inflows parking	885610	992381	1105084	1224416	1351207	1486450	1651640	1813932	1989748	2181548
Permission obtaining										
Outflows	-67279105	-67112849	-70657105	-70823362	-70657105	-73695040	-73695040	-73861296	-68125494	-68291750
Preproduction										
Acquisition of land										
Infrastructure charges										
Pre-development										
Production	-58227071	-58227071	-61771328	-61771328	-61771328	-64809262	-64809262	-64809262	-59239716	-59239716
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential	-58227071	-58227071	-61771328	-61771328	-61771328	-64809262	-64809262	-64809262	-59239716	-59239716
Outdoor networks										
Non-production	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320
Advertising expenses	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851
Agency expenses	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders										
The cost of operation										
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax	-166256			-166256				-166256		-166256
Wealth tax										
Interest on credit	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534
Profit tax										
cash flow	10358092	11005014	7967033	8335547	9068469	6633146	11146862	10815225	17325075	21109502
d	0,49	0,49	0,49	0,49	0,49	0,49	0,59	0,59	0,59	0,59
dcf	5071696	5388452	3900947	4081385	4440250	3247828	6549488	6354630	10179579	12403170

1 installment	27 мес	28 мес	29 мес	30 мес	31 мес	32 мес	33 мес	34 мес	35 мес	36 мес
	51	52	53	54	55	56	57	58	59	60
time period	May 1, 2024	June 1, 2024	July 1, 2024	August 1, 2024	September 1, 2024	October 1, 2024	November 1, 2024	December 1, 2024	January 1, 2025	February 1, 2025
Inflows	90036432	90737474	95369665	92954339	93972572	95172231	96632920	102352735	103059131	109962024
Total inflows apartments	86895991	87362611	87881078	88464353	89130953	89908654	90841894	92008444	93563845	98821098
Total inflows build-in premises	747913	747913	4597913	1297913	1297913	1297913	1297913	5147913	3222913	3222913
Total inflows parking	2392527	2626949	2890673	3192073	3543705	3965664	4493113	5196378	6272373	7918013
Permission obtaining										
Outflows	-82630497	-69972438	-70138694	-69972438	-56808056	-56974313	-56808056	-44909481	-44909481	-45075737
Preproduction										
Acquisition of land										
Infrastructure charges										
Pre-development										
Production	-73744719	-61086660	-61086660	-61086660	-47922279	-47922279	-47922279	-36023703	-36023703	-36023703
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential	-59239716	-46581657	-46581657	-46581657	-33417276	-33417276	-33417276	-21518700	-21518700	-21518700
Outdoor networks	-14505003	-14505003	-14505003	-14505003	-14505003	-14505003	-14505003	-14505003	-14505003	-14505003
Non-production	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320
Advertising expenses	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851
Agency expenses	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders										
The cost of operation										
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax			-166256			-166256				-166256
Wealth tax										
Interest on credit	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534
Profit tax										
cash flow	7405935	20765036	25230971	22981902	37164516	38197918	39824864	57443254	58149650	64886287
d	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,59	0,49	0,49
dcf	4351456	12200774	14824794	13503323	21836507	22443697	23399630	33751551	28472169	31770670

1 installment	37 мес	38 мес	39 мес	40 мес	41 мес	42 мес	43 мес	44 мес	45 мес	46 мес
	61	62	63	64	65	66	67	68	69	70
time period	March 1, 2025	April 1, 2025	May 1, 2025	June 1, 2025	July 1, 2025	August 1, 2025	September 1, 2025	October 1, 2025	November 1, 2025	December 1, 2025
Inflows	59509175	46569290	49020305	54025305	51330305	49405305	49020305	49020305	49020305	54025305
Total inflows apartments	57132140	43095161	45363327	45363327	45363327	45363327	45363327	45363327	45363327	45363327
Total inflows build-in premises	0	0	0	5005000	2310000	385000	0	0	0	5005000
Total inflows parking	2377036	3474129	3656978	3656978	3656978	3656978	3656978	3656978	3656978	3656978
Permission obtaining										
Outflows	-11647601	-7173197	-3661601	-3661601	-14196390	-3661601	-3661601	-14196390	-3661601	-3661601
Preproduction										
Acquisition of land										
Infrastructure charges										
Pre-development										
Production	0	0	0	0	0	0	0	0	0	0
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential										
Outdoor networks										
Non-production	-10572677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677
Advertising expenses	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851
Agency expenses	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders	-7986000									
The cost of operation	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax										
Wealth tax		-46542			-139626			-139626		
Interest on credit										
Profit tax		-3465055			-10395164			-10395164		
cash flow	47861575	39396092	45358704	50363704	37133915	45743704	45358704	34823915	45358704	50363704
d	0,49	0,49	0,49	0,49	0,49	0,49	0,49	0,49	0,49	0,49
dcf	23434756	19289750	22209260	24659889	18182106	22397770	22209260	17051047	22209260	24659889

1 installment	47 мес	48 мес	49 мес	50 мес	51 мес	52 мес	53 мес	54 мес	55 мес	56 мес
	71	72	73	74	75	76	77	78	79	80
time period	January 1, 2026	February 1, 2026	March 1, 2026	April 1, 2026	May 1, 2026	June 1, 2026	July 1, 2026	August 1, 2026	September 1, 2026	October 1, 2026
Inflows	52604833	20602467	6162150	3803257	3803257	3803257	3803257	3803257	3803257	3803257
Total inflows apartments	46542773	16421524	2358893							
Total inflows build-in premises	2310000	385000	0							
Total inflows parking	3752059	3795943	3803257	3803257	3803257	3803257	3803257	3803257	3803257	3803257
Permission obtaining										
Outflows	-3661601	-14196390	-3661601	-14196390	-3661601	-3661601	-14196390	-3661601	-3661601	-14196390
Preproduction										
Acquisition of land										
Infrastructure charges										
Pre-development										
Production	0	0	0	0	0	0	0	0	0	0
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential										
Outdoor networks										
Non-production	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677
Advertising expenses	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851
Agency expenses	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders										
The cost of operation	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax										
Wealth tax		-139626		-139626			-139626			-139626
Interest on credit										
Profit tax		-10395164		-10395164			-10395164			-10395164
cash flow	48943232	6406077	2500549	-10393133	141656	141656	-10393133	141656	141656	-10393133
d	0,41	0,41	0,41	0,41	0,41	0,41	0,41	0,41	0,41	0,41
dcf	19970312	2613872	1020299	-4240711	57800	57800	-4240711	57800	57800	-4240711

1 installment	57 мес	58 мес	59 мес	60 мес	61 мес	62 мес	63 мес	64 мес	65 мес	66 мес	67 мес
	81	82	83	84	85	86	87	88	89	90	91
time period	November 1, 2026	December 1, 2026	January 1, 2027	February 1, 2027	March 1, 2027	April 1, 2027	May 1, 2027	June 1, 2027	July 1, 2027	August 1, 2027	September 1, 2027
Inflows	3803257	3803257	5613607	3947781	3955387	3955387	3955387	3955387	3955387	3955387	3955387
Total inflows apartments											
Total inflows build-in premises											
Total inflows parking	3803257	3803257	5613607	3947781	3955387	3955387	3955387	3955387	3955387	3955387	3955387
Permission obtaining											
Outflows	-3661601	-3661601	-3661601	-14196390	-3661601	-14196390	-3661601	-3661601	-14196390	-3661601	-14196390
Preproduction											
Acquisition of land											
Infrastructure charges											
Pre-development											
Production	0	0	0	0	0	0	0	0	0	0	0
ПИР											
Demolition											
Sheet piling (including extraction)											
construction and installation works of a residential											
Outdoor networks											
Non-production	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677
Advertising expenses	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851
Agency expenses	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders											
The cost of operation	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax											
Wealth tax				-139626		-139626			-139626		-139626
Interest on credit											
Profit tax				-10395164		-10395164			-10395164		-10395164
cash flow	141656	141656	1952007	-10248610	293787	-10241003	293787	293787	-10241003	293787	-10241003
d	0,41	0,41	0,34	0,34	0,34	0,34	0,34	0,34	0,34	0,34	0,34
dcf	57800	57800	663731	-3484784	99895	-3482198	99895	99895	-3482198	99895	-3482198

Appendix 3. DCF model with delay for one year (for option to postpone +abandon).

Example with cash flow calculations with price volatility (case of upward factor)

prices + volatility, rubles		2020	2021	2022	2023	2024	2025	2026	2027
apartments	155000	171301	189317	209228	231233	255552	282428	312132	344959

1 installment										
	3	4	5	6	7	8	9	10		
time period	May 1, 2020	June 1, 2020	July 1, 2020	August 1, 2020	September 1, 2020	October 1, 2020	November 1, 2020	December 1, 2020	January 1, 2021	February 1, 2021
inflows	0	0	0	0	0	0	0	0	0	0
Permission obtaining										
Outflows	0	0	0	0	0	0	0	0	0	0
Preproduction	0	0	0	0	0	0	0	0	0	0
Acquisition of land										
Infrastructure charges										
Pre-development										
Production	0	0	0	0	0	0	0	0	0	0
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential building										
Outdoor networks										
Non-production	0	0	0	0	0	0	0	0	0	0
Advertising expenses										
Agency expenses										
Transfer of an object to shareholders										
The cost of operation										
Overhead										
Land tax										
Wealth tax										
Interest on credit										
Profit tax										
cash flow	0	0	0	0	0	0	0	0	0	0

base prices										
1 installment										
	11	12	13	14	15	16	17	18	19	20
time period	January 1, 2021	February 1, 2021	March 1, 2021	April 1, 2021	May 1, 2021	June 1, 2021	July 1, 2021	August 1, 2021	September 1, 2021	October 1, 2021
inflows	0	0	0	0	0	0	0	0	0	0
Permission obtaining										
Outflows	0	0	-13147913	-13314169	-13147913	-13147913	-13314169	-13147913	-13147913	-13314169
Preproduction	0	0	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990
Acquisition of land										
Infrastructure charges			-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808
Pre-development			-818182	-818182	-818182	-818182	-818182	-818182	-818182	-818182
Production	0	0	0	0	0	0	0	0	0	0
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential building										
Outdoor networks										
Non-production	0	0	0	0	0	0	0	0	0	0
Advertising expenses										
Agency expenses										
Transfer of an object to shareholders										
The cost of operation										
Overhead			-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax				-166256			-166256			-166256
Wealth tax										
Interest on credit										
Profit tax										
cash flow	0	0	-13147913	-13314169	-13147913	-13147913	-13314169	-13147913	-13147913	-13314169

base prices											
1 installment											
	20	21	22	23	24	25	26	27	28	29	30
time period	October 1, 2021	November 1, 2021	December 1, 2021	January 1, 2022	February 1, 2022	March 1, 2022	April 1, 2022	May 1, 2022	June 1, 2022	July 1, 2022	August 1, 2022
inflows	0	0	0	0	0	0	0	0	0	0	0
Permission obtaining											
Outflows	-13314169	-13147913	-13147913	-13147913	-13314169	-13147913	-13314169	-13147913	-13147913	-13314169	-13147913
Preproduction	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990	-12072990
Acquisition of land											
Infrastructure charges	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808	-11254808
Pre-development	-818182	-818182	-818182	-818182	-818182	-818182	-818182	-818182	-818182	-818182	-818182
Production	0	0	0	0	0	0	0	0	0	0	0
ПИР											
Demolition											
Sheet piling (including extraction)											
construction and installation works of a residential building											
Outdoor networks											
Non-production	0	0	0	0	0	0	0	0	0	0	0
Advertising expenses											
Agency expenses											
Transfer of an object to shareholders											
The cost of operation											
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax	-166256				-166256		-166256			-166256	
Wealth tax											
Interest on credit											
Profit tax											
cash flow	-13314169	-13147913	-13147913	-13147913	-13314169	-13147913	-13314169	-13147913	-13147913	-13314169	-13147913

base prices										60%
1 installment							1 мес	2 мес	3 мес	4 мес
	31	32	33	34	35	36	37	38	39	40
time period	September 1, 2022	October 1, 2022	November 1, 2022	December 1, 2022	January 1, 2023	February 1, 2023	March 1, 2023	April 1, 2023	May 1, 2023	June 1, 2023
inflows	0	0	0	0	0	0	0	57160755	62099531	59486997
Permission obtaining										
Outflows	-13147913	-13314169	-13147913	-13147913	-29326700	-29492956	-40026434	-17317448	-17151192	-30404478
Preproduction	-12072990	-12072990	-12072990	-12072990						
Acquisition of land										
Infrastructure charges	-11254808	-11254808	-11254808	-11254808						
Pre-development	-818182	-818182	-818182	-818182						
Production	0	0	0	0	-22875242	-22875242	-31140656	-8265414	-8265414	-21518700
ПИР					-22006176	-22006176	-22006176			
Demolition					-869066	-869066	-869066			
Sheet piling (including extraction)							-8265414	-8265414	-8265414	
construction and installation works of a residential building										-21518700
Outdoor networks										
Non-production	0	0	0	0	0	0	-2434320	-2434320	-2434320	-2434320
Advertising expenses							-1294851	-1294851	-1294851	-1294851
Agency expenses							-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders										
The cost of operation										
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax		-166256				-166256		-166256		
Wealth tax										
Interest on credit					-5376534	-5376534	-5376534	-5376534	-5376534	-5376534
Profit tax										
cash flow	-13147913	-13314169	-13147913	-13147913	-29326700	-29492956	-40026434	39843307	44948339	29082519

base prices				84%						
1 installment	5 мес	6 мес	7 мес	8 мес	9 мес	10 мес	11 мес	12 мес	13 мес	14 мес
	41	42	43	44	45	46	47	48	49	50
time period	July 1, 2023	August 1, 2023	September 1, 2023	October 1, 2023	November 1, 2023	December 1, 2023	January 1, 2024	February 1, 2024	March 1, 2024	April 1, 2024
inflows	60641760	61832609	63061873	87196414	91572030	88409010	88973561	97976134	99157135	106264493
Permission obtaining										
Outflows	-30570734	-30404478	-42809376	-42975632	-42809376	-54961112	-54961112	-55127369	-68125494	-68291750
Preproduction										
Acquisition of land										
Infrastructure charges										
Pre-development										
Production	-21518700	-21518700	-33923598	-33923598	-33923598	-46075335	-46075335	-46075335	-59239716	-59239716
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential building	-21518700	-21518700	-33923598	-33923598	-33923598	-46075335	-46075335	-46075335	-59239716	-59239716
Outdoor networks										
Non-production	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320
Advertising expenses	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851
Agency expenses	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders										
The cost of operation										
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax	-166256			-166256				-166256		-166256
Wealth tax										
Interest on credit	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534
Profit tax										
cash flow	30071026	31428131	20252497	44220781	48762654	33447898	34012449	42848765	31031642	37972743

base prices	90%									
1 installment	15 мес	16 мес	17 мес	18 мес	19 мес	20 мес	21 мес	22 мес	23 мес	24 мес
	51	52	53	54	55	56	57	58	59	60
time period	May 1, 2024	June 1, 2024	July 1, 2024	August 1, 2024	September 1, 2024	October 1, 2024	November 1, 2024	December 1, 2024	January 1, 2025	February 1, 2025
inflows	106814476	111239657	108184958	108818165	109485012	110189274	110935402	111728691	116445796	123772144
Permission obtaining										
Outflows	-68125494	-67112849	-67279105	-67112849	-70657105	-70823362	-70657105	-73695040	-73695040	-73861296
Preproduction										
Acquisition of land										
Infrastructure charges										
Pre-development										
Production	-59239716	-58227071	-58227071	-58227071	-61771328	-61771328	-61771328	-64809262	-64809262	-64809262
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential building	-59239716	-58227071	-58227071	-58227071	-61771328	-61771328	-61771328	-64809262	-64809262	-64809262
Outdoor networks										
Non-production	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320
Advertising expenses	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851
Agency expenses	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders										
The cost of operation										
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax			-166256			-166256				-166256
Wealth tax										
Interest on credit	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534
Profit tax										
cash flow	38688982	44126808	40905852	41705316	38827906	39365912	40278296	38033651	42750757	49910848

base prices							94%			
1 installment	25 мес	26 мес	27 мес	28 мес	29 мес	30 мес	31 мес	32 мес	33 мес	34 мес
	61	62	63	64	65	66	67	68	69	70
time period	March 1, 2025	April 1, 2025	May 1, 2025	June 1, 2025	July 1, 2025	August 1, 2025	September 1, 2025	October 1, 2025	November 1, 2025	December 1, 2025
inflows	124843041	130658932	131504605	132437190	137326651	135200754	136549762	138135326	140059101	146357774
Permission obtaining										
Outflows	-68125494	-68291750	-82630497	-69972438	-70138694	-69972438	-56808056	-56974313	-56808056	-44909481
Preproduction										
Acquisition of land										
Infrastructure charges										
Pre-development										
Production	-59239716	-59239716	-73744719	-61086660	-61086660	-61086660	-47922279	-47922279	-47922279	-36023703
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential building	-59239716	-59239716	-59239716	-46581657	-46581657	-46581657	-33417276	-33417276	-33417276	-21518700
Outdoor networks			-14505003	-14505003	-14505003	-14505003	-14505003	-14505003	-14505003	-14505003
Non-production	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320	-2434320
Advertising expenses	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851
Agency expenses	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders										
The cost of operation										
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax		-166256			-166256			-166256		
Wealth tax										
Interest on credit	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534	-5376534
Profit tax										
cash flow	56717548	62367182	48874109	62464752	67187957	65228316	79741706	81161014	83251045	101448293

base prices										65%
1 installment	35 мес	36 мес	37 мес	38 мес	39 мес	40 мес	41 мес	42 мес	43 мес	44 мес
	71	72	73	74	75	76	77	78	79	80
time period	January 1, 2026	February 1, 2026	March 1, 2026	April 1, 2026	May 1, 2026	June 1, 2026	July 1, 2026	August 1, 2026	September 1, 2026	October 1, 2026
inflows	147835979	164475911	89427739	71994233	75783404	80788404	78093404	76168404	75783404	75783404
Permission obtaining										
Outflows	-44909481	-45075737	-11647601	-7173197	-3661601	-3661601	-14196390	-3661601	-3661601	-14196390
Preproduction										
Acquisition of land										
Infrastructure charges										
Pre-development										
Production	-36023703	-36023703	0	0	0	0	0	0	0	0
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential building	-21518700	-21518700								
Outdoor networks	-14505003	-14505003								
Non-production	-2434320	-2434320	-10572677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677
Advertising expenses	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851
Agency expenses	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders			-7986000							
The cost of operation			-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax		-166256								
Wealth tax				-46542			-139626			-139626
Interest on credit	-5376534	-5376534								
Profit tax				-3465055			-10395164			-10395164
cash flow	102926498	119400174	77780139	64821036	72121803	77126803	63897013	72506803	72121803	61587013

base prices										
1 installment	45 мес	46 мес	47 мес	48 мес	49 мес	50 мес	51 мес	52 мес	53 мес	54 мес
	81	82	83	84	85	86	87	88	89	90
time period	November 1, 2026	December 1, 2026	January 1, 2027	February 1, 2027	March 1, 2027	April 1, 2027	May 1, 2027	June 1, 2027	July 1, 2027	August 1, 2027
inflows	75783404	80788404	83119127	31700873	7788858	3803257	3803257	3803257	3803257	3803257
Permission obtaining										
Outflows	-3661601	-3661601	-3661601	-14196390	-3661601	-14196390	-3661601	-3661601	-14196390	-3661601
Preproduction										
Acquisition of land										
Infrastructure charges										
Pre-development										
Production	0	0	0	0	0	0	0	0	0	0
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential building										
Outdoor networks										
Non-production	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677
Advertising expenses	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851
Agency expenses	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders										
The cost of operation	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax										
Wealth tax				-139626		-139626			-139626	
Interest on credit										
Profit tax				-10395164		-10395164			-10395164	
cash flow	72121803	77126803	79457526	17504483	4127258	-10393133	141656	141656	-10393133	141656

base prices										
1 installment	55 мес	56 мес	57 мес	58 мес	59 мес	60 мес	61 мес	62 мес	63 мес	64 мес
	91	92	93	94	95	96	97	98	99	100
time period	September 1, 2027	October 1, 2027	November 1, 2027	December 1, 2027	January 1, 2028	February 1, 2028	March 1, 2028	April 1, 2028	May 1, 2028	June 1, 2028
inflows	3803257	3803257	3803257	3803257	5613607	3947781	3955387	3955387	3955387	3955387
Permission obtaining										
Outflows	-3661601	-14196390	-3661601	-3661601	-3661601	-14196390	-3661601	-14196390	-3661601	-3661601
Preproduction										
Acquisition of land										
Infrastructure charges										
Pre-development										
Production	0	0	0	0	0	0	0	0	0	0
ПИР										
Demolition										
Sheet piling (including extraction)										
construction and installation works of a residential building										
Outdoor networks										
Non-production	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677
Advertising expenses	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851
Agency expenses	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders										
The cost of operation	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax										
Wealth tax		-139626				-139626		-139626		
Interest on credit										
Profit tax		-10395164				-10395164		-10395164		
cash flow	141656	-10393133	141656	141656	1952007	-10248610	293787	-10241003	293787	293787

base prices									
1 installment	59 мес	60 мес	61 мес	62 мес	63 мес	64 мес	65 мес	66 мес	67 мес
	95	96	97	98	99	100	101	102	103
time period	January 1, 2028	February 1, 2028	March 1, 2028	April 1, 2028	May 1, 2028	June 1, 2028	July 1, 2028	August 1, 2028	September 1, 2028
inflows	5613607	3947781	3955387	3955387	3955387	3955387	3955387	3955387	3955387
Permission obtaining									
Outflows	-3661601	-14196390	-3661601	-14196390	-3661601	-3661601	-14196390	-3661601	-14196390
Preproduction									
Acquisition of land									
Infrastructure charges									
Pre-development									
Production	0	0	0	0	0	0	0	0	0
ПИР									
Demolition									
Sheet piling (including extraction)									
construction and installation works of a residential building									
Outdoor networks									
Non-production	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677	-2586677
Advertising expenses	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851	-1294851
Agency expenses	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469	-1139469
Transfer of an object to shareholders									
The cost of operation	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357	-152357
Overhead	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923	-1074923
Land tax									
Wealth tax		-139626		-139626			-139626		-139626
Interest on credit									
Profit tax		-10395164		-10395164			-10395164		-10395164
cash flow	1952007	-10248610	293787	-10241003	293787	293787	-10241003	293787	-10241003

Appendix 4. Prices for cash flows in model with option to postpone +abandon

1

prices + volatility		2020	2021	2022	2023	2024	2025	2026	2027
apartments	155000	171301	189317	209228	231233	255552	282428	312132	344959

2

prices + volatility		2020	2021	2022	2023	2024	2025	2026	2027
apartments	155000	140250	155000	171301	189317	209228	231233	255552	282428

3

prices + volatility		2020	2021	2022	2023	2024	2025	2026	2027
apartments	155000	140250	126903	140250	155000	171301	189317	209228	231233

4

prices + volatility		2020	2021	2022	2023	2024	2025	2026	2027
apartments	155000	140250	126903	114827	126903	140250	155000	171301	189317

5

prices + volatility		2020	2021	2022	2023	2024	2025	2026	2027
apartments	155000	140250	126903	114827	103900	114827	126903	140250	155000

6

prices + volatility		2020	2021	2022	2023	2024	2025	2026	2027
apartments	155000	140250	126903	114827	103900	94012	103900	114827	126903

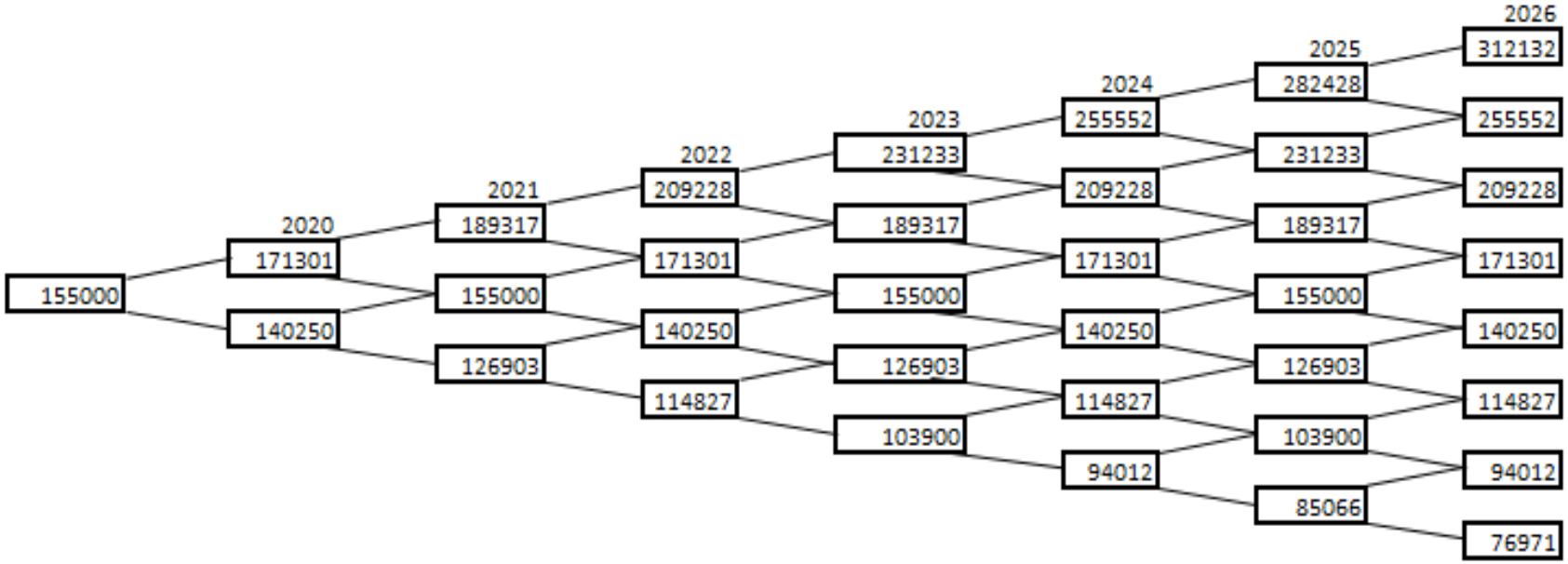
7

prices + volatility		2020	2021	2022	2023	2024	2025	2026	2027
apartments	155000	140250	126903	114827	103900	94012	85066	94012	103900

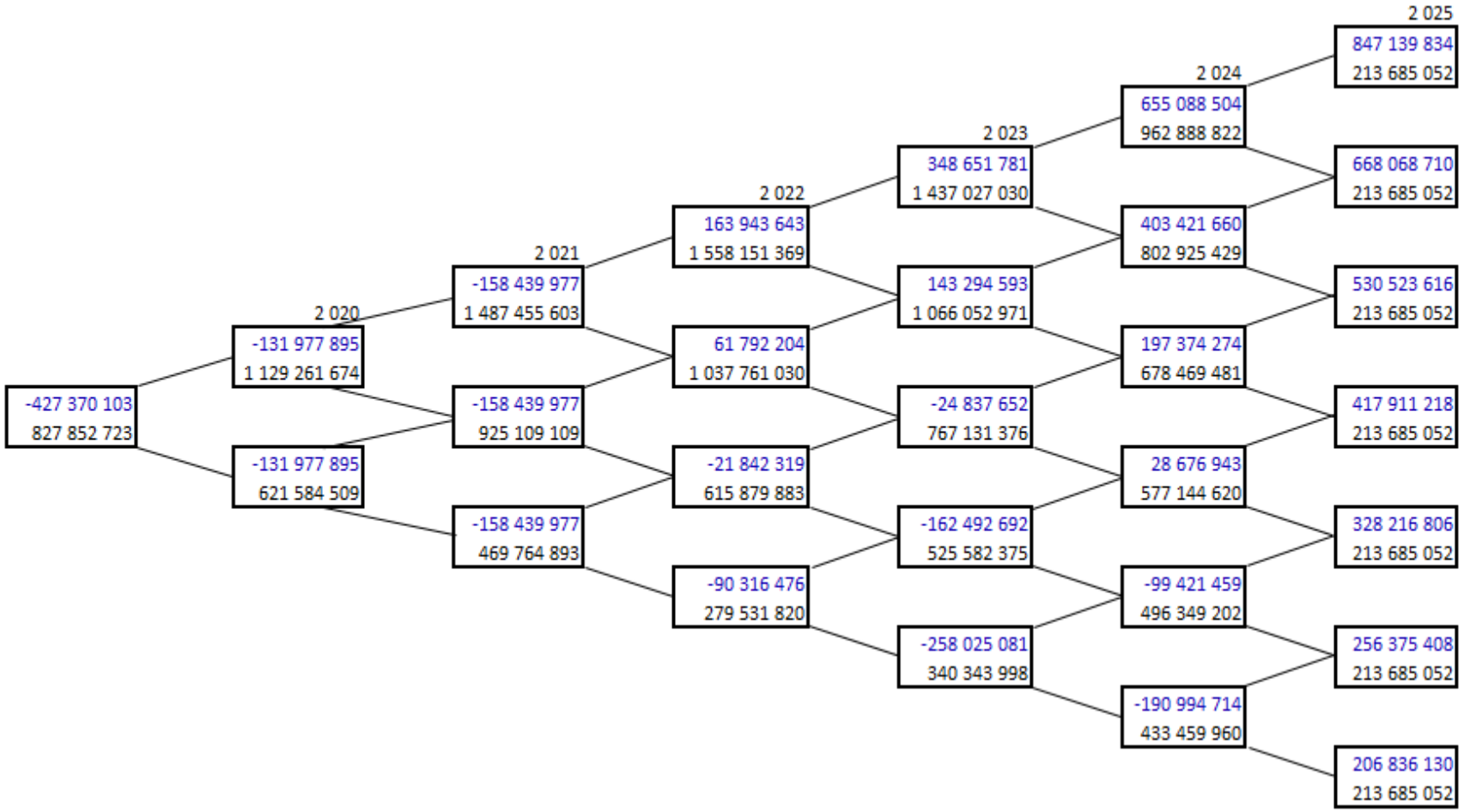
8

prices + volatility		2020	2021	2022	2023	2024	2025	2026	2027
apartments	155000	140250	126903	114827	103900	94012	85066	76971	85066

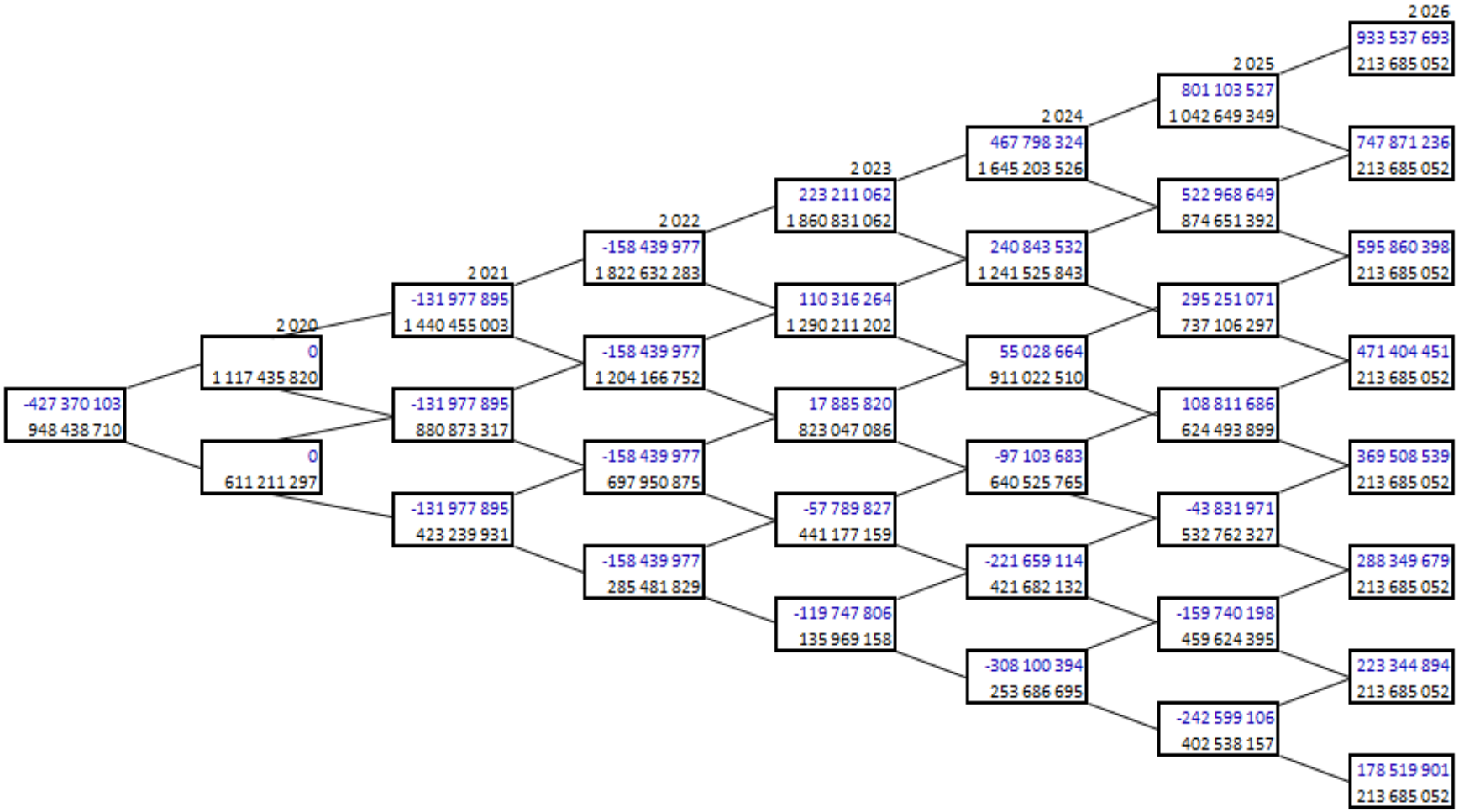
Appendix 5. The binomial tree of prices



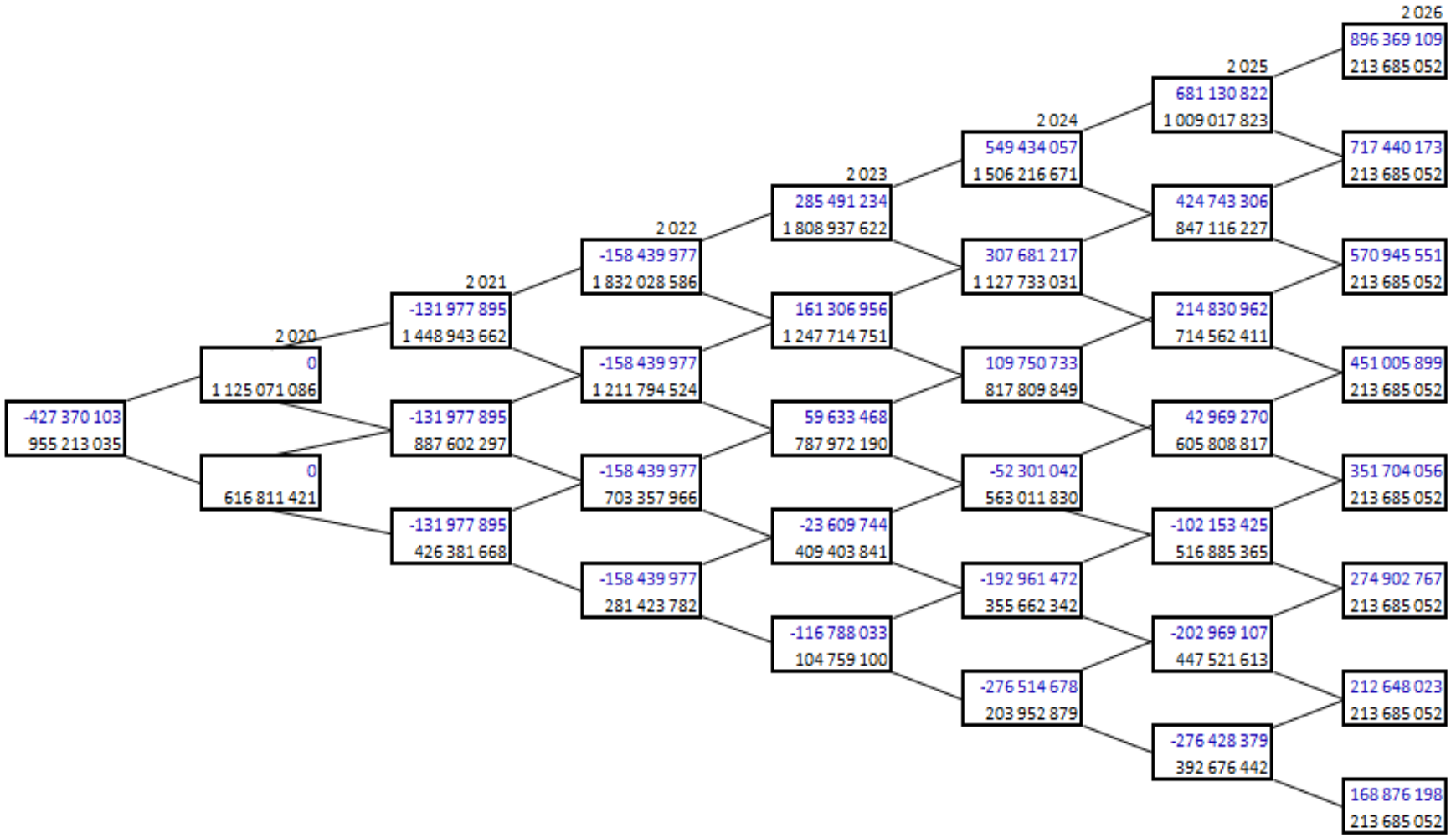
Appendix 6. The binomial tree with option to abandon



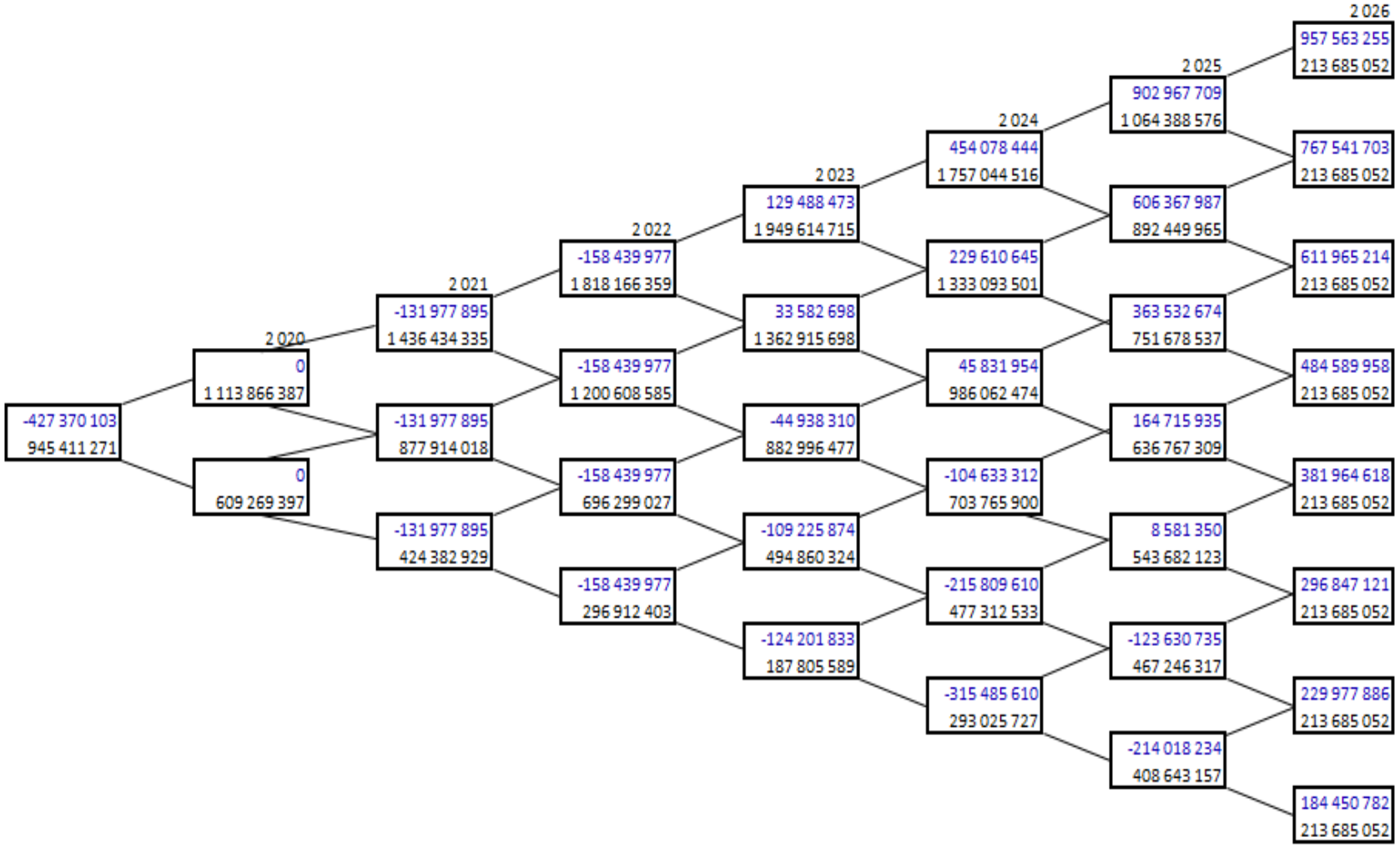
Appendix 7. The binomial tree with option to abandon + postpone



Appendix 8. The binomial tree with option to abandon + postpone. Selling at early stages



Appendix 9. The binomial tree with option to abandon + postpone. Selling at middle stages



Appendix 10. The binomial tree with option to abandon + postpone. Selling at late stages