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Graduate School of Management

Master in Corporate Finance

Real Options as a Tool For Investment Decision Making in Russian Residential Construction Industry. Case of Etalon Group

Master's Thesis by 2nd year student

Concentration – Corporate Finance

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ЗАЯВЛЕНИЕ О САМОСТОЯТЕЛЬНОМ ХАРАКТЕРЕ ВЫПОЛНЕНИЯ ВЫПУСКНОЙ КВАЛИФИКАЦИОННОЙ РАБОТЫ

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АННОТАЦИЯ

Автор	Глебов-Зелинский Игорь
Название магистерской диссертации	Реальные опционы как инструмент принятия инвестиционных решений в сфере жилищного строительства
Факультет	Высшая Школа Менеджмента
Направление подготовки	080200 “Менеджмент” (Профиль: Корпоративные финансы)
Год	2017
Научный руководитель	Окулов Виталий Леонидович, доцент, к.ф.-м.н.
Описание цели, задач и основных результатов	Цель: Оценить инвестиционную привлекательность российского девелоперского проекта в сфере жилищного строительства методом реальных опционов. Задачи: 1. Определить используемые девелоперами методы оценки проектов и проанализировать их возможные недостатки; 2. Определить основные неопределенности, с которыми сталкиваются застройщики в процессе реализации проектов; 3. Определить какие реальные опционы могут быть использованы для оценки проектов в российской отрасли жилищного строительства; 4. Определить, как выбранные опционы могут быть оценены; 5. Оценить проект компании Эталон, используя как стандартные инструменты, так и метод реальных опционов; 6. Проанализировать, как применение метода реальных опционов влияет на результаты оценки и принимаемые инвестиционные решения на примере исследуемого проекта; 7. Разработать практические рекомендации для компании на основании проведенного анализа. Результаты: На примере реального инвестиционного-строительного проекта, было продемонстрировано, как применение метода реальных опционов может повысить точность оценки и, как следствие, эффективность принимаемых инвестиционных решений.
Ключевые слова	Реальные опционы, жилищное строительство, девелопмент, оценка проектов

ABSTRACT

Master Student's Name	Igor Glebov-Zelinskiy
Master Thesis Title	Real Options as a Tool For Investment Decision Making in Russian Residential Construction Industry. Case of Etalon Group
Faculty	Graduate School of Management
Main field of study	080200 “Management” (specialization: Master of Corporate Finance)
Year	2017
Academic Advisor’s Name	Vitaliy L. Okulov Associate Professor
Description of the goal, task and main results	Research goal: To evaluate investment attractiveness of the Russian residential real estate project with the help of real options analysis. Objectives: 1. To define the industry specific project valuation tools and analyze their drawbacks; 2. To analyze key uncertainties associated with residential real estate projects; 3. To define which real options are applicable for Russian residential real estate projects; 4. To analyze how chosen options could be evaluated; 5. To evaluate the case project of Etalon Group using standard valuation technics and real options method; 6. To analyze how real options impact on the valuation results and final investment decisions in the case project of Etalon Group; 7. To develop recommendations for the company based on the analysis done. Results: Having evaluated the real investment project, it has been proved that application of real options analysis in residential real estate could improve the accuracy of potential projects valuation and increase efficiency of corporate investing decisions.
Keywords	Real options analysis, residential real estate, valuation, investing decision-making, construction, development

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Introduction

The contribution of residential construction industry to the socio-economic development of any country is hard to overestimate. In Russia, it accounts for 6% of GDP (GKS, 2016) and provides enormous number of working places, 7.2% of total employed population (GKS, 2016). The industry directly influences on the people's quality of life and accumulates great part of their capital, since a property acquisition is the most significant investment and the lift-time goal for majority of Russian citizens. Thus, well-being of the population is tightly linked with sustainability of the residential development industry

Long-term capital-intense projects in developing markets are always subjects of significant uncertainty and, consequently, risks. Recent macroeconomics and geopolitical factors even worsen the situation on the Russian real-estate market. Developers face with the pressure from shareholders and other stakeholders, tighter budgets, drop in demand and noticeable increase in costs due to raising prices of construction materials and equipment as well as additional social burdens. All these factors force them to be more accountable, use resources as efficient as possible and do their bests in managing risks and future uncertainties through careful planning and control.

At the same time, scarcity of the land market supply in big cities excites competition and endows landlords with significant market power. Consumers are becoming more and more demanding that forces developers to invest heavily in new designs and solutions, keeping prices at the market level. Under these conditions, developers are to be agile to acquire most promising land plots before their peers and to understand and meet potential consumer's needs.

In order to stay competitive, developers should be fast and precise in potential projects valuation, carefully assess risks and uncertainties, and, as a result, make right investing decisions, which will increase shareholders' welfare.

Nevertheless, the majority of residential real estate development firms utilize conventional valuation technics, which do not take into account managerial flexibility and, hence, underestimate potential projects' profitability and may lead to wrong investing decisions. Besides, currently employed risks assessment and management tools are solely focused on negative side of future uncertainties. Developers try to mitigate possibilities of unexpected losses, creating substantial contingency reserves, which also affect valuation results. Treating uncertainty as threat indeed protects investors from unfavorable outcomes, but it also limits managers' ability to recognize and exploit opportunities to increase project value (Ford, 2010).

One of the possible solutions for listed above issues is a real option analysis (ROA). The real options approach is a more advanced valuation and risk management tool, which brings a

new perspective on capital investment decision-making to managers and investors. Viewing investment opportunities as options on real assets provides valuable insights and may challenge popular beliefs, one of which is the perception that uncertainty is bad. ROA enables managers to conduct more comprehensive valuation and obtain more precise results for better corporate investing decisions.

In this Thesis, application of real options analysis in Russian residential real estate industry will be analysed.

The practical relevance of the topic is reached by in-depth industry analysis in order to define what types of real options could be used in Russian residential construction, taking into account all the industry specifics. Moreover, an authentic real estate project will be evaluated, using most appropriate real options analysis tools. The Thesis also presents scientific value that consists in filling the gap in the field of real options application in Russian residential construction market, which is badly presented in modern literature.

Research goal of this paper is to evaluate investment attractiveness of the Russian residential real estate project with the help of real options analysis.

In order to achieve this goal, the following objectives are to be met:

1. To define the industry specific project valuation tools and analyze their drawbacks;
2. To analyze key uncertainties associated with residential real estate projects;
3. To define which real options are applicable for Russian residential real estate projects;
4. To analyze how chosen options could be evaluated;
5. To evaluate the case project of Etalon Group using standard valuation technics and real options method;
6. To analyze how real options impact on the valuation results and final investment decisions in the case project of Etalon Group;
7. To develop recommendations for the company based on the analysis done.

Both primary and secondary sources of information have been used in the research. The primary information has been obtained through a series of structured and unstructured interviews with representative of Etalon Group and industry experts from leading residential construction firms, operating in Saint-Petersburg. Besides, a survey among biggest housing developers has been conducted to get relevant statistical data. Active usage of primary sources could be explained by relatively closed form of the market players and, as a result, poor publically available data.

The secondary sources have been mostly employed for theoretical part of the Thesis and included such portals as EBSCO and Elsevier. In addition, professional real estate development literature has served as a valuable source of industry technical aspects and insights.

The Thesis is divided into three chapters. Each chapter pursues certain goals, which are linked to the research objectives mentioned above.

The first chapter demonstrates both practical and theoretical relevance of the research through analysis of currently used valuation and risk assessment tools as well as scientific literature devoted to the topic. It also introduces the real option analysis and describes it from theoretical point of view.

The second chapter is devoted to the practical side of real options in residential development. The main goal of this section is to identify which real options are applicable in Russian residential construction industry and define how they should be evaluated.

The third chapter represents the application of real options analysis to a real business case, using all the findings of previous chapters. The value of the real option is estimated and a conclusion regarding the impact of real options analysis on project valuation results is made.

Chapter 1. VALUATION AND RISK MANAGEMENT IN REAL ESTATE INDUSTRY

The first chapter of the Thesis is mainly devoted to analysis of the industry specific valuation and risk assessment methods. The chapter pursues the certain goal – to demonstrate how real options analysis could fill the existing research gap as well as enhance investing decision making in residential construction industry.

In order to achieve the goal, several distinct sections are to be presented. Firstly, real estate development process is described to provide basic understanding of the business. Then, valuation tools which are employed within the industry are identified and assessed, using both theoretical and practical perspectives. After that, risk identification and assessment tools are analyzed with help of the same approach. Finally, drawbacks of currently used methods are summarized and new, more advanced approach of real options analysis is introduced.

Real estate development process

Real estate projects development process always consists on certain phases that form project's life-cycle. Understanding of each stage is crucial for proper valuation and investing decision-making. This particular part of the Thesis is devoted to brief overview of each phase, including its peculiarities, main steps and results. Since the scope of the Thesis is limited to Russian residential construction market, the specifics of the Russian real estate industry are also incorporated into this overview.

Generally, many authors define three main phases in real estate development process, basing on international experience. There are (1) pre-investment phase, (2) investment phase, and (3) operation (Gralla, 2011). However, this classification needs further break-down into more distinct parts to provide more relevant overview with all Russian industry specifics. Professor of Moscow State Civil Engineering Morozenko A. A. describes four stages that any residential construction project passes through (Morozenko A. , 2013):

1. Project preparation
2. Pre-Development phase
3. Development phase
4. Operation

These phases are not perfectly consecutive and do overlap each other.

Project preparation

This stage includes formulation of investment idea (project concept) and development of project business-plan, which is based on historical data analysis as well as experts' opinions regarding key project drivers. In case of positive results of the initial market research and feasibility study, the project analysis is getting deeper in terms of financial aspects, potential risks, timeframe, partners and contractors, logistics, and general concept. Basically, the first stage of real estate development process pursues the following goals:

- Evaluate key economic indicators of a project under basic scenario: total costs, payback period, profit margin;
- Evaluate liquidity of final products (apartments, commercial facilities, parking slots, etc.);
- Evaluate potential risks on every stage of the project life-cycle and methods of their mitigation.

Project preparation phase results in initial project concept and includes the following parts:

- Organizational structure of the project
- Technical construction plan
- Objects description and deployment details
- Resources support issues
- Sources and methods of financing
- Logistics
- Financial model of the project

The initial project concept is presented to top-management and board of directors who assess the initiative and make an investing decision. In case of accepting the project, the land plot is acquired or rented and the process moves forward.

Pre-development phase

Pre-development stage consists of three main milestones: front end engineering design (FEED), specification for connecting installation to utilities, and inspection. The bottom-line of pre-development stage is a construction permit, issuing by the State Construction Supervision and Expertise Service (GOS), that enables firms to start actual development activities.

FEED includes design and construction documents preparation as well as engineering investigations and surveys. FEED activities are strictly regulated and inspected by special compliance monitoring authorities, which are responsible for permitting. Thanks to great variety of norms and standards, significant bureaucracy and complicated procedures, which are to be

repeated every time a project is experiencing even slight changes, this stage is extremely time-consuming. FEED activities are multistep and last till the signing of operational acceptance certificate that means that the object is ready for operation.

Receiving specifications (aka technical conditions) for connecting to utility networks is also an indispensable condition for getting a construction permit. Specifications are issued after the analysis of the real estate project plan and contains requirements for laying pipelines and cables of certain characteristics in certain areas. This particular task is a very challenging one even for leading developers. The reason is the monopoly power of companies controlling city resources: Lenenergo (electricity), Vodokanal (water supply), State Unitary Enterprise "TEK SPB" (heating networks). Apart from monopolistic pricing, there are other issues that will be described in the special section of the Thesis.

Pre-development phase pursues not only permitting goals. During this stage, developer defines the resource base and design detailed work plan that enables the firm to accurately estimate up to 90% of the total project costs (Vailyeva & Panibratov, 1997). Besides, the project team is also created and agreements with main contractors are signed. In overall, pre-development activities are accounted for minimum 5-7% of total project costs (Vailyeva & Panibratov, 1997).

Development phase

The biggest part of this stage is basically construction and assembly works, which are done in accordance with the plans and specifications developed during the design phase. Following construction, the facilities and equipment are integrated and tested by special monitoring authorities in order to get commissioning permit to start operation. The works are fulfilled by either professional contractor or by developer itself in case of vertically integrated firms. For Russian residential construction market the second way is more common among biggest developers. Although developer and contractor in this scheme are usually two different legal entities, both of them are controlled by a parent holding company. Development phase is a period of highest levels of activities in terms of number of personnel and costs incurred per day. Big construction projects require complicated system of subcontractors and suppliers which are supervised by the contractor. The managerial complexity and comparatively undeveloped market of professional subcontractors and suppliers lead to unexpected cost overruns, delays, quality issues, design changes and claims that create significant risks for projects. Thus, all these risks are to be carefully studied and took into account during initial project concept preparation.

It also should be mentioned that after getting a construction permit a developer is allowed to start sales of the flats/parking spots/commercial spaces. Thus, the development phase is a starting point of all marketing promotion activities.

Operation

Operation phase starts as soon as a developer has prepared all the necessary documentation and succeeded to pass a number of inspections, which test the quality of the object and its compliance with original plans and designs. The project might be operated by the developer, but for Russian market it is more common when investing company goes out of the project and leave all the operating activities to special management firms or homeowners associations.

As described above, the real estate development process is complex and passes through certain stages. The stages are very different in terms of time-period and associated costs, but their importance is not proportional to required resources. Despite the fact that project preparation accounts for less that 2% of the overall project costs and lasts significantly less time than FEED or construction itself, it plays extremely important role, defining investing activities of the firm and main project concepts (Morozenko A. , 2013).

Since this thesis is focused on investing decision-making and methods of valuation and risk managements, the next section of the current chapter will be devoted to more in-depth investigation of the first phase of real estate process and particularly to valuation procedures which assess financial attractiveness of a potential project.

Real estate projects valuation

According to gurus of corporate finance (Brealey, Myers, Allen), the main goal of management in a company is to increase its value (Brealey, Myers, & Allen, 2011). Thus, the company should invest its resources in value-generating projects. Big companies face with many business opportunities and potential projects which should be carefully studied before making investing decisions. There are certain valuation methods which are used by analysts to determine economic attractiveness of a project. This section will briefly describe main valuation approaches in general and in real estate industry particularly.

General investment projects valuation methods

Financial managers and analysts are equipped with many different methods which assist them in investing decision making. All of them have distinctive features, assumptions and procedures. However, each method utilizes the same idea. Any project might be considered as a set of periodic cash flows which define the value of a particular project. Another thing that all the methods have in common is a challenge to predict these future cash flows. To be a proper measure of the expected cash flows, “the forecast ought to consider the full range of the potential outcomes and weigh the resulting cash flows in each outcome by their respective probabilities”

(Ruback, 2010), that is rarely used in the business practice due to complexity of the approach and insufficiency of relevant data.

All the valuation methods and indicators might be divided into two groups with respect to taking into account the time value of money. The time value means that "a dollar today is worth more than a dollar tomorrow" (Brealey, Myers, & Allen, 2011) The first group represents dynamic methods which incorporate this idea in valuation with the help of discounting future cash flows by the discount rate, which is also known as hurdle rate or opportunity cost of capital. The second group, which is called static or simple (Tworek, 2009), does not take the time value into consideration (Copeland, Weston, & Shastri, 1983).

The dynamic methods are the following:

- Net present value (NPV)
- Internal rate of return (IRR) / Modified internal rate of return (MIRR)
- Profitability index (PI)
- Discounted payback period (DPP)

Static methods group includes:

- Payback period (PP)
- Accounting rate of return

In general, static methods are characterized as more simplistic in terms of calculations and interpretation of results, while dynamic ones provide more accurate evaluation of the project attractiveness thanks to application of discounting factors. More specifically, every method has its own advantages and disadvantages that will be demonstrated further for most widely used ones.

Absolute leadership across all the capital budgeting tools is held by NPV and IRR. Many surveys and researches have been conducted to define a champion. John Graham and Cambell Harvey (2001) surveyed 392 CFOs of the biggest enterprises from all over the world and identified that 75.7% of CFOs "always" or "almost always" use IRR, while NPV is applied by 74.9%. The second significant research was conducted by Patricia Ryan and Glenn Ryan (2002), who surveyed Fortune 1000 companies and claimed that 85.1% of CFOs "always" or "often" utilize NPV, while IRR was chosen by 76.7% respondents. One of the most recent surveys in this particular field has been made by Andres Horn, Peter Molnar, and Frode Kjærland (Horn, Molnar, & Kjærland, 2015). Although the scope was limited to Denmark, Sweden, and Norway, the sample size is impressive – 1500 largest companies. The authors concluded that NPV is used by 74% of the respondents, while IRR stands for only 51%. Patricia and Glenn Ryan paper also covered other relevant to capital budgeting process topics. They indicated positive relationship the size of the capital budget of a company and usage of NPV and IRR as well as other

discounting based tools. Moreover the authors answered another challenging question: "What is the best discount factor?"; Up to 83.2% of respondents mentioned WACC. To sum up, NPV seems to be a slightly more popular metrics based on the results of the mentioned surveys.

Net present value could be defined as a difference between a project's value and its costs. It is computed by discounting of the cash flows at the firm's opportunity cost of capital. The basic formula is the following:

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

where CF_i is a cash flow at period i, r is a opportunity cost of capital and n is a number of periods. A project generates value, if its NPV is greater than zero.

Internal rate of return is a discount rate that makes NPV of all cash flows of a particular project equal to zero.

$$\text{NPV} = \sum_{i=0}^{n} \frac{CF_i}{(1+IRR)^i} = 0 \quad (2)$$

where CFi is a cash flow at period i, r is a opportunity cost of capital and n is a number of periods. IRR estimates the real interest rate which the investment generates which is to be compared with required rate of return or cost of capital. If IRR exceeds the cost of capital, the project should be accepted since it adds value to the company, otherwise – not.

Although NPV is criticized due to some biasness in comparing different projects, since higher NPV is not always a prerequisite of the better project, because they can differ in terms of risks, initial investments and other factors, academics argue for superiority of NPV over IRR (Ryan & Ryan, 2002). There are several reasons behind this statement. Firstly, NPV presents the expected change in shareholders wealth given a set of forecasted cash flows and a discount rate. Secondly, when cash flows come in over a longer period of time, NPV assumes that intermediate term cash flows are reinvested at the cost of capital, while IRR assumes the intermediate term cash flows to be reinvested at the IRR, which for any positive NPV project is greater than cost of capital. Finally, NPV is not sensitive to multiple sign changes in cash flows (Ryan & Ryan, 2002). However, it should be mentioned that the two latter cons of IRR could be fixed by introducing of modified internal rate of return (MIRR), but this particular tool has not gained wide traction (Graham & Harvey, 2001). Another interesting idea was covered by Michael Osborne (2010) who stated that "NPV is richer concept than IRR", because single internal rate of return employs only the difference between orthodox IRR and cost of capital, while NPV uses all the differences between every possible IRR for a project and its cost of capital.

Even though the net present value metric is considered to be superior over other most popular capital budgeting tools, it is also criticized a lot. Myers (1984), Brennan and Schwartz

(1985a, 1985b), Kester (1984, 1993), McDonald and Siegel (1986), Pindyck (1991), and Trigeorgis (1993c) all pointed out that NPV modeling ignores the value of flexibility of real asset investment. That leads to undervaluation of potential investment projects. Being more specific, Myers (1984), Pinches and Lander (1997), Brennan and Schwartz (1985) claimed that NPV is missing strategic value of a project. Consequently, this tool kills many prospective projects with an expected NPV benchmark (Wang & Halal, 2010).

Investment project valuation in real estate

This section is devoted to description of a standard approach to residential investment project valuation.

The most common process starts from careful analysis of available land plots or potential redevelopment projects which is held by special department (for instance land development department) within the company. Then, selected plots are investigated by marketing specialists in terms of potential demand and appropriate pricing. Finally, the project is calculated by investment department, using figures given by marketing people.

Initial feasibility analysis is rather qualitative, than quantitative and based on the following factors:

- Total land plot area in hectares;
- Current state of the plot (necessity of renovation works, rehousing of current residents, ground work, etc. and associated costs);
- Total build-up area in square meters with break-down of total living area, commercial facilities, other non-living premises, parking);
- Status of the future project (standard/premium/one-family housing);
- Number of stories allowed;
- Living environment creation area;
- Current state of utility networks and connection conditions.

Listed above factors enable the company or individual investor to assess general attractiveness of the projects and define potential works, risks, and constraints and costs associated with them. These aspects are used for calculation of total construction costs of the project which could be divided into the following categories:

- Land plot acquisition costs;
- FEED costs;
- Costs associated with preparation activities of the land plot;
- Costs of construction materials;
- Construction and assembly costs;

- Costs of utility networks connection and installation;
- Other costs such as transportation, depreciation, utilities.

Revenue side of any real estate project in residential construction is based on sales figures of both living and non-living areas, including parking slots and commercial spaces. Projected or basic price is defined by marketing department that analyzes current industry trends in terms of demand and supply, historic prices of the region and same-class projects. Many construction firms do not collect such data by their own and outsource these activities to special consulting agencies which provide the analytics. Later the average price is adjusted to a particular project, using the following dimensions:

- Availability of cultural, entertaining, social, and household infrastructure;
- Proximity of transport junctions and subway stations;
- Noise and ecological state of the area;
- Proximity and size of planted area;
- Competing real estate objects pricing strategies;
- Additional services designed within the project such as security, individual boiler-station, parking, sport grounds, etc.

Revenue expectations and anticipated construction costs are not the only indicators of economical attractiveness of a project. The next step in the process of feasibility study is cofounding factors analysis which includes taxes, inflation, and risks. Every company has its own risk classification and methods to assess and mitigate them that will be described in the next section of the thesis.

Other important aspects of the real estate valuation are sales plan and price appreciation rate. In multifamily housing apartments are not sold at a time, besides the value of a flat perceived and risks held by a consumer as well as market conditions are changing over the time of the project realization. Hence, in order to maximize revenues, the developer should define in what proportions and at what price flats are to be sold. Marketing folks, who are responsible for this particular task, take into account many different factors such as market conditions, mortgage interest rates, phase of construction process, infrastructure development in the region, seasonality (more flats are bought in simmer time). Apart from the external factors, sales are influenced by marketing campaigns and promotions which are budgeted at the very beginning of the project.

Based on the information gathered by marketing and development departments and construction costs estimates, the investment department proceeds with detailed analysis of the initiative, designing in-depth financial model and defining attractiveness of the project.

The procedure that is briefly described above is a standardized approach that is used in majority of big vertically integrated construction firms. However, methods of valuation as well

as criteria for investing decisions differ significantly among market players. In order to get a big picture, the author has conducted a survey and distributed among leading construction firms, operating on Saint-Petersburg market (Appendix 1). The results are illustrated below.

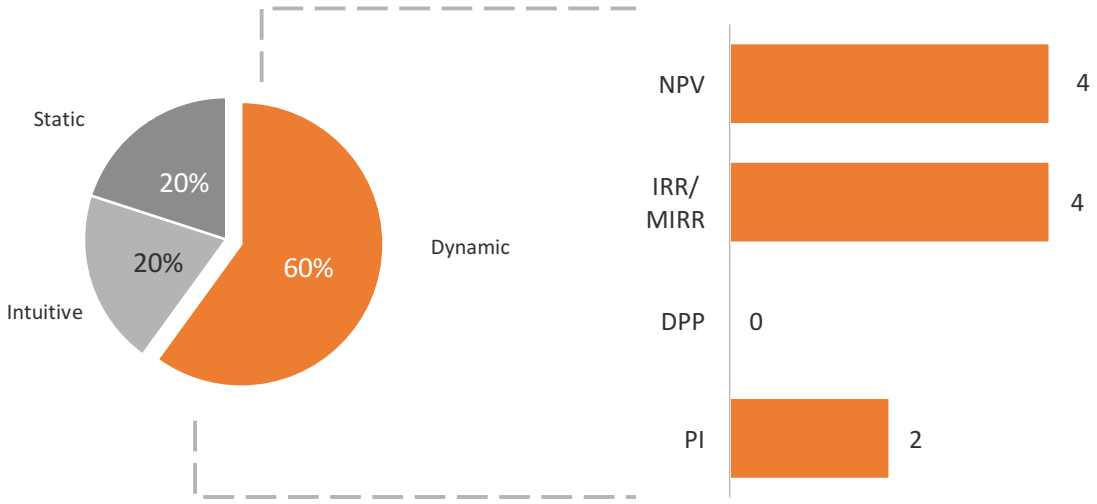

Figure 1. *The industry-specific valuation tool*

It could be inferred from the survey that only 60% of the biggest construction firms evaluate investing projects, taking into account time value of money. One of the possible explanations is associated with the nature of residential real estate projects, more specifically with the nature of cash flows. Even though the inflows of cash start at the same time with development costs, it is common for housing projects that free cash flows (FCF) are mainly negative for a long period of time and they turn into positive only after certain level of the property readiness. Hence, positive FCF are multiplied by greater discount factor, than negative FCF that results in unattractive project profitability metrics.

Besides, 20% does not even have investment department and assess attractiveness of the project, using expertise and inside information regarding land tenders' conditions and infrastructure development plans. Such companies could obtain land plots at very low prices that makes their potential projects almost inevitably profitable.

Another interesting implication is that none of the companies, which apply discounting, use payback period as investing criteria. It could be partially explained by the fact that developers are more interested in total value, generated by the project, while DPP does not consider project performance after the payback period.

Main drawbacks of current practices in real estate projects valuation

Based on the literature review and results of the survey, two main drawbacks of current valuation tools and metrics might be identified:

Time value of money. Since even the biggest companies make investing decisions without taking into account such fundamental concepts as time value of money, using findings of Patricia and Glenn Ryan about positive correlation between dynamic metrics and the size of company's capital budget, it could be concluded that the industry overall overestimate real estate projects.

Managerial flexibility. Current methods do not include the value of managerial flexibility. Besides, traditional tools such as DCF assume that all outcomes are static and all decisions made are irrevocable. That is also an issue, because in real business environment and especially in residential construction, decisions are in a highly fluid environment where uncertainties abound and management is always vigilant in making changes in decisions when the circumstances require a change. To value such decisions in a deterministic view may potentially grossly underestimate the true intrinsic value of a project. New sets of rules and methodology are required in light of these new managerial flexibilities (Mun, 2002).

There are also distinct problems which are typical for majority of residential developers (Ilyin, 2010):

Costs underestimation. Russian Federal Property Management agency states that in majority of cases, developers take into account only profit centers and costs associated with their activities, naturally construction costs. Other costs such as access roads development costs, social burdens, etc. are frequently ignored, while they might account for up to 10% of total project costs.

Externalities tracing. Real estate development projects, by their nature, substantially impact many stakeholders. Most dramatic are environmental and social such as congestion of access roads, lack of parking spots and as a consequences faster depreciation of green zones due to illegal parking habits, noise and waste pollution of neighborhood area, overloading of local cultural, entertaining, social, and household infrastructure Such effects almost never considered by the companies as well as the costs associated with these effects.

Long-term result recognition. Effectiveness of the investing decision made at the very beginning of real estate process could be fully assessed only in a long period of time.

All in all, it could be concluded that current valuation methodologies indeed have significant drawbacks, which limit effectiveness of investing decision making, and should be improved through more advanced tools and technics.

Risks in real estate projects

Construction projects in today's world are marred by great variety of risks which could result in delays and costs overruns, ruining expected value of the project. The losses are multiplied if the size of the project and investment made are huge, that is almost always a case in

residential construction sector. Thus, risk management becomes a vital tool in the industry and its effectiveness defines the competitiveness of the firm.

Project management institute (PMI) defines risk management is one of the core activities that determine a project success. According to their PMBOOK Guide, risk management procedure includes the following stages (PMI, 2014):

- Risk management planning
- Risk identification
- Qualitative risk analysis
- Quantitative risk analysis
- Risk response planning
- Risk monitoring and control

Since the scope of the Thesis is limited to project preparation stage of the real estate projects, the emphasis on risk identification and analysis will be made within this section. Risk identification presents the process of defining the most significant risks that could impact on the whole project bottom-line. Thus, main risks and uncertainties associated with residential real estate projects will be presented at the first place. Then, more Russian specific risks will be added to better describe the environment of Russian residential construction market. After that, both traditional as well as industry-specific risk assessment tools will be presented and analyzed in terms of their efficiency with respect to investing decision making and valuation.

Risks in real estate investment projects

Every company tends to define its own risks classification that better reflects the peculiarities of firm's activities. There are many theoretical concepts and classifications as well. Most relevant from author's perspective will be described further.

Sun Yijian (2008) has developed comprehensive risks classification which is summarized in the scheme below.

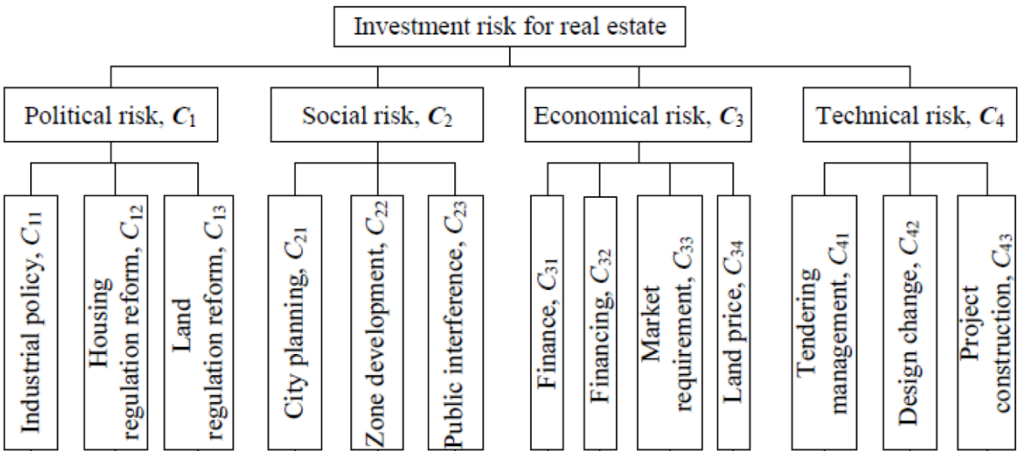

Figure 2. *Risk factors in real estate (Sun Y. 2008)*

As could be inferred from the scheme, all the risk factors are divided into four main groups, which resemble PEST-analysis for macro environment of a company.

Political factors mainly include regulation issues. The real estate industry plays substantially important role in any country's economy and directly linked to overall people's welfare, thus it is usually strongly controlled by authorities. Any change in current regulation norms may significantly influence on real estate projects bottom-line and companies' business-model, hence this group of risk factors is to be considered as extremely important (Linjie, 2010).

Overall city planning and zone development define the vector of real estate industry and could create either valuable opportunities or serious risks for the market players, depending on their strategy and its alignment to city strategy and main social trends. As a result, developers should carefully assess various social factors and craft their corporate strategies accordingly.

Economic risks incorporate such factors as interest rate, which defines not only cost of projects financing, but also significantly affect cash inflows resulted from mortgages, overall economic situation in the country, which determines investment climate and people's purchasing behavior, and so on. Sun (2008) also added some micro-factors to the model such as market trends and land price, which undoubtedly consists evident risks for real estate investment projects.

Multifamily housing property is a result of complicated design and engineering activities, which require intense collaboration of many parties and are obliged to pass numerous inspections and commissions. Such a difficult process bears a great number of different risks which could severely impact the total project costs and timeline.

Another interesting perspective in terms of risk classification is to divide them into controllable and uncontrollable. Such classification enable the company management to develop relevant risk management strategy, minimizing controllable risks and budgeting uncontrollable.

Satyendra Sharma (2013) presented such approach and added two more dimensions: internal and external factors.

Table 1. Risk factors classification (Sharma, 2013)

Internal and controllable	Internal and uncontrollable	External and controllable	External and uncontrollable
• Defective Design • Ambiguous Specifications and Plans • Low Safety at Sites • Inconsistent Cost, Time and Scope Objectives • Lack of Prioritization of Projects • Resource Conflicts with Other Projects in the Organization • Lack of Top Management Commitment to the Project	• Availability of Professional Services • Availability of Transport and Communication Facilities • Quality of Local Contractors • Availability of Construction Materials • Availability of Skilled and Unskilled Workers • Labor Cost • Labor Disputes/ Strikes	• Expropriation • Monetary Inflation • Exchange Rate Fluctuation	• Political Continuity • Government's Attitude Towards Investors • Legal Environment and Enforceability of Contracts • Bureaucratic Delays • Corruption and Dishonesty • Societal Unrest and Instability • Erratic Weather Patterns

Traditionally, researchers, who work in the field of real estate, highlight risks and uncertainties only as a project costs driver that is fair enough, taking into account the complexity and capital intensity of such projects. However, the value uncertainties should be also assessed for proper valuation. In order to do that, one should understand what factors affect residential housing demand. William Brueggeman and Jeffrey Fisher (2011) in their book "Real Estate Finance and Investments", which is used as the basis in majority of university courses in real estate field, define the following factors:

- Population growth
- Household formation
- Employment
- Household income
- Interest rates
- Federal income tax
- Cost of renting housing

Obviously, all the mentioned above factors are the subjects for uncertainty that makes predicting residential real estate prices a very difficult task. Besides demand factors, it should be also pointed out that supply function has a great impact on prices as well. Residential real estate market could not be considered as efficient, thus over and under supply issues arise quite often. The reason behind it is that real estate projects are very capital-intense and long-term by their nature that makes it rather difficult to adjust supply pipeline to rapidly changing demand that creates substantial risks or opportunities for market players, depending on how agile their investing strategies and risk management procedures.

Russian industry-specific risks

In order to get an understanding of Russian real estate development risks, it is sensible to refer to Russian authors, whose studies are devoted to this topic. Selina (2014) identified controllable and uncontrollable for three most important metrics of a residential property project: timescale, overall project value, and quality of the end-product.

Table 2. Russian development risks (Selina, 2014)

Project metrics	Controllable risks	Uncontrollable risks
Timescale	• Project development pace • Putting the object into operation • Choice of project start time	• Governmental approvals and permits • Technical conditions • Weather conditions
Project value	• Choice of the land plot • Project concept • Choice of sub-contractors	• Demand factors • Social burdens • Existing networks and infrastructure • Zone development plan
Quality	• Choice of sub-contractors • Accuracy of technical tasks • Construction technologies used • Quality of FEED works	• None

Although majority of residential construction projects risks are described in previous section, some distinct risks which are more common for Russian real estate industry should be mentioned separately (Glebov-Zelinskiy, 2015).

Constantly raising social burdens. Some time ago, developers were obliged to construct social infrastructure such as schools or kindergartens, if it was required in accordance with the rules of land use and development, and then they sold them to authorities at the price close to break even. Now, developers are forced to give such social objects and the piece of previously bought land plot to the state for free. If we add the costs of all the networks, which are traditionally constructed by developers and then gifted to the authorities, we can calculate that these gifts might be accounted for more than 10% of the total construction costs in case of big residential projects. The most recent regulatory initiatives also conclude that construction firms ought to build road systems by themselves and present them to municipal authorities. Developers pay huge taxes, buying land plots, but then, they are obliged to donate significant part of the plot and all the social buildings and networks erected there. The trend is obvious – government tends to transfer all the social infrastructure costs to developers that negatively influence their margins, financial sustainability and, as a result, prices for final consumers.

Rules for land use and development. This set of rules literally defines what could be built in a given piece of land. It regulates such factors as type, height, construction area, social burdens, etc. These parameters are crucial for development projects since they determine revenue and cost structures and volumes. Hence, any change in these rules may significantly affect the bottom line of the project. Instability of the clauses of this document is considered as one of the main risks associated with residential real estate. There are many cases then authorities and third parties manipulate the terms of the rules for land use and development for their benefits. For instance, developer may assess the project and enter to pre-agreement with land owner, when the rules allow to build a 75 meters high property, but after some time when FEED activities are almost done, the height might drop to 60 meters that dramatically decrease expected revenues from the project[1]. Such issues make developers to create sophisticated contracts with land owners, transferring the risks of rules changes to landlords. Developers pay a prepayment for a land plot in advance and the rest is paid when the building permit is received. If the conditions are changed, the developer cover the losses, reducing the payment to the land owner. Such mechanisms are relatively costly to developers and possible mainly for big developers with significant market power. The rules of land use and development are not only unstable, they are formulated quite controversially. It is often a case when height regalements for two adjacent quarters are significantly different or when height is specified after the slash, for

[1] Unstructured interview with an industry expert

example, 40/60 meters. It means that 40 meters are allowed, but for 60 additional negotiations with authorities are required that leads to extra costs for developers.

Monopolistic power of utility networks providers. As was stated at the very beginning of this chapter, construction firms face significant difficulties in receiving technical conditions which are an indispensable condition for getting a construction permit. These services are monopolized by state-owned organizations such as Lenenergo (electricity), Vodokanal (water supply), State Unitary Enterprise "TEK SPB" (heating networks). Apart from monopolistic pricing, there are three issues that complicate permitting process for construction companies in St. Petersburg:

1. Unfair compliance by these organizations with their obligations. For example, Lenenergo actively used the practice of imposing its own services on the installation of power networks to construction sites and significantly delaying the execution of those works, which affected the timing of the project, as well as the operating costs of companies, which were forced to solve the problem in court and / or on their own;
2. Deliberate complication of technical conditions, not justified by economic and technical considerations;
3. Falsification of technical conditions for land plots. The matter is that some lots are sold with already prepared technical conditions, however, in some cases, these conditions were obtained due to collusion with monopolists to increase the value of the land. As a result, after the acquisition of the site, the developer could face the situation when the technical conditions that existed at the time of the transaction are recognized as erroneous.

All these challenges significantly complicate the permitting process, negatively affecting timing of the project realization. It takes on average 1.5-2 years in biggest Russian cities to get a construction permit (Morozenko A. , 2013). By duration of this particular activity, Russia holds 115th place out of 190 countries in the Doing Business ranking, conducted by the World Bank in 2017 (The World Bank, 2017). Listed above factors also impact the costs which are, in turn, incorporated into final price for consumers. For example, the price per square meter of the Finnish developer YIT in St. Petersburg, before a significant weakening of the Russian currency, was higher than in the prestigious districts of the biggest cities in Finland, where labor and materials are several times more expensive than Russian analogues (Glebov-Zelinskiy, 2015).

Risks assessment tools in real estate

Risk management process consist of many stages which are changing in alignment with real estate process phases. It could be described in the following manner.

Table 3. Real estate project life cycle and risk management process (Selina, 2014)

Real estate project phase	Sub-phase	Phases and content of risk management system
Project preparation phase	Project concept	Risk management planning Analysis of potential risks Identification of risk factors Qualitative analysis Determination of significance of risks Prioritization of risks
	Feasibility study	Quantitative analysis Decision tree Sustainability analysis Break-Even analysis Sensitivity analysis Formal risks description Scenario analysis Simulation (Monte-Carlo)
Pre-Development phase	FEED	Planning of response to potential risks Determination of the size and the structure of contingency reserves Risk adjustments in the financial model Tax risk Credit risk Construction completion risk
Development phase	Contracts	Construction budgeting Risks insurance
	Construction	Risks monitoring and control Control of contingency reserves usage Construction budget adjustments
Operation	Acceptance of construction works	Analyze of contingency reserves usage
	Selling	Project risks report (analysis of factual risks occurrences and uncertainties)

The most important stage of the risk management process is the second one – analysis of potential risks, which includes risks identification, their qualitative and quantitative assessment and analysis.

Traditionally, construction management literature has been placing more emphasis on the negative effects of uncertainty, which means researchers seem to be more concerned with ways

to deal with the risks involving the construction activities and how they may affect the project's expected Net Present Value (NPV) through a negative impact in the construction costs. In fact, few authors have been addressing uncertainty as a source of opportunity (Ribeiro & Pereira, 2013), as it is the case of Ford et al. (2002), Ng and Bjornsson (2004) and Yiu and Tam (2006). The results of the survey of leading residential developers in Saint-Petersburg is presented below (Appendix 2).

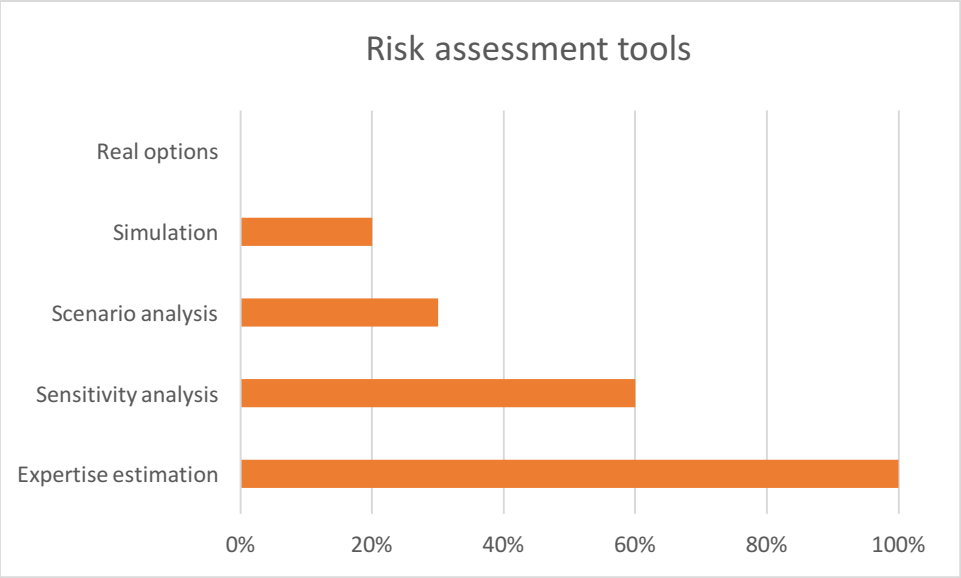

Figure 3. *The industry-specific risk assessment tools*

The general approach of Russian residential construction firms to analyze risks is expertize estimation. If a risk is measurable and has a high probability of occurrence, the costs associated with it are included into the prime construction costs. If a risk is not measurable in terms of potential costs, it is described in a special section of the feasibility study and presented to top-management who is responsible for final investing decisions. It is important to mention that despite the fact that construction projects contain great variety of uncertainties in both value and costs, the companies rarely try to quantitatively asses the risks. Many firms do not use even sensitivity analysis of projects' net present value, saying nothing of scenario planning or other more advanced valuation and risk management procedures.

According to the survey, leading construction companies mainly use quite simple risk management technics that may lead to inaccuracies in feasibility studies and budgeting processes. Besides, all these tools are focused on limiting possible project losses by identifying, measuring, and mitigating potential risks and uncertainties. Although these processes help to reduce negative effect of uncertainty, they indeed "limit managers' ability to recognize and exploit opportunities to increase project value" (Ford, 2010). That causes a need in big contingency reserves and often underestimates projects value that, in turn, influence on

efficiency of investing decision making. One of the possible solution for this issue is real option analysis (ROA), which brings a new perspective on capital investment decision-making to managers and investors. Viewing investment opportunities as options on real assets provides valuable insights and may challenge popular beliefs, one of which is the perception that uncertainty is bad. This tool is the main focus of the Thesis. The next section will provide theoretical background of ROA in general and in real estate sector particularly.

Real options

Traditional approach of project valuation with the help of discounted cash flow model (DCF) assumes that the company will hold the assets passively. However, managers would not be paid, if they were dummies. Having invested in a new promising project, they do not simply sit back and watch the future unfold. There are many managerial decisions that could be made during the project realization. For instance, if everything goes well, the project may be expended, if the market situation has worsened, the management could choose to cut back or abandon the project. Not every project could be modified, thus projects which provides such flexibility are more valuable. This flexibility enables management to modify the project, adjusting it to changes in business environment and making value-maximizing decisions, consequently, the more uncertain the outlook, the higher value of this flexibility becomes.

The option to modify projects is known as a real option. Managers rarely use this term to describe such opportunities, mainly because it is still not widely known. However, they may refer to "intangible advantages" of easy-to-modify projects and when they assess major investment proposals, these option intangibles are often the key to their decisions (Brealey, Myers, & Allen, 2011).

There are great variety of real options. The most common are the following (Buhvalov, 2016):

- The opportunity to make a follow-up investments (expand)
- The opportunity to abandon a project
- The opportunity to wait and invest later
- The opportunity to vary firm's output or production methods

These real options as well as less common ones will be described later in the next chapter of the Thesis with the focus on construction projects.

Real options as a term has been introduced by Stuart Myers (1977), however, the real options analysis as a scientific field has been originated by Cox, Ross and Rubinstein (1979), who described the application of real options, using binominal approach, which is still the basis for majority of real option valuations nowadays.

Real options vs traditional valuation methods

Luehrman (1998) in one of his articles in Harvard Business review devoted to real options, claimed that currently used capital investment valuation technics, which are primarily based on discounting of anticipated project cash flows, assume that managers "will follow a predetermined plan regardless of how events unfold". The author suggests that real options analysis (ROA) is the better valuation tool, because it incorporates both the uncertainty inherent in business and the active decision-making required for a strategy to succeed. ROA enables managers to think strategically, capturing the value of managing projects actively rather than passively.

Pomykacz (2013) states that traditional valuation approach does not analyze the probability and associated cash flows of each option. Conventional appraisal analyzes solely the most likely, predominate, most representative of the strategic choices. While the potential risks are either capitalized, or accounted in the discount rate. Hence, traditional methods are to be considered as deterministic, while real options analysis – probabilistic or stochastic.

Mun (2006) described the value which is added by application of real option analysis in the following way. He stated that conventional discounted cash flow technics assume a single decision pathway with fixed outcomes, when all the decisions are to be made in the very beginning of the project and managers are not able to change or develop these decisions afterwards. Real options analysis, at the same time, considers multiple decision pathways, taking into account high future uncertainty and managerial flexibility in choosing the optimal strategies or options along the way when new information, which resolved some uncertainty, becomes available. Hence, conventional DCF is static while ROA assumes multidimensional dynamic series of decisions, where management has the flexibility to adapt given a change in the business environment.

Some academics also claim that NPV misses the time value of money. When the project development horizon extends father in the future, the time value of real options drives the value. Thus, net present value of the project with high future uncertainty "embedded renders wrong decisions" (Wang & Halal, 2010).

Since conventional valuation methods do not recognize managerial flexibility, they may underestimate promising projects and result in not value-maximizing investing decisions. Laate (2006) conducted a study where he compared valuation of a great sample of different R&D projects in biotechnology industry, using traditional NPV and real options. In many cases, NPV criterion rejected investment projects, while real options approved them (Wang & Halal, 2010).

Real options provide additional insights beyond conventional analyses. It does not mean that this technique should replace traditional approaches such as NPV. Many researches suggest

that ROA should be treated as an extension of traditional discounted cash flow methods. According to MacMillan & Putten (2006), the combination of these methods could fix the flaws associated with NPV analysis in practice (Wang & Halal, 2010). Trigeorgis (1993) quantified the idea by:

$$\textit{NPV of the real asset investment} = \textit{NPV of estimated cash flows} + \textit{option values} \quad (3)$$

Real options analysis, at its least, provides a sobriety test of the results obtained using discounted cash flow and, at its best, provides a robust approach to valuation when coupled with the discounted cash flow methodology (Mun, 2006).

Real options in real estate. Literature review

Real estate is one of the most strategy-intense types of business. Each project has both independent and interrelated economic, social. and political constituents. Besides, it represents a process of constant and complex collaboration of various parties. At every stage of a project, all the participants obtain new information that influences their plans. Developers learn about the market and regulation trends, consumers' behavior, contractors' and competitors' actions. This information enables them to modify their strategies and maximize the bottom line of a given project. The nature of business requires and rewards flexibility (Pezeshkian, 2014). That is why, this particular industry has been a subject of application of real options theory for comparatively long time.

Pezeshkian (2014) suggested that "in recent decades real estate has evolved in terms of complexity. It has adopted concepts related to valuation from the research-rich field of finance. This trend will logically continue as the real estate industry becomes more efficient and institutionalized." They express the opinion, that real options will become more popular in real estate sector, driving the number of scientific articles and interest of practitioners.

First Achour and Brown (1984) concluded that option valuation methodology might be used for valuing land options. However, the approach was criticized by Shilling, Sirmans, and Benjamin (1987), who explored conceptual issues within real options analysis application in real estate. They underlined such concerns as "higher transaction costs, longer transaction periods, relatively illiquid markets and the fact that real estate options are frequently purchased in an effort to gain some control over the property rather than as speculative investments with an intent to arbitrage fluctuations in the price of the underlying asset (Pomykacz, 2013). Another pioneer in implementation of real options to the real estate industry was Titman (1985) who introduced the approach that employed binomial model of Cox, Ross and Rubinstein (1979) to vacant land valuation. Timan's model had several important implications for real estate industry. Firstly, it explained the behavior of many land owners who wait with construction activities in order to generate higher value thanks to higher expected prices or rent rates. Besides, Titman

proved mathematically that higher uncertainty in the future value of built property leads to a higher option value that encourage developers to delay the exercise of the option. The first empirical study that proved this idea took place in 1993 when Quigg conducted a research regarding real options value of vacant land in one of the US states. Her study also indicated the average 6% premium, which is paid for the option to wait (Quigg, 1993).

Dorothea M. Colwell and Peter F. Colwell (2004) in their study "The Timing of Development Revealed by the Market: An Options Approach" introduced a new type of thinking about real options in real estate. They focused on real options as a contribution to the real estate's overall value and defined the following formula:

$$V_o = V_{f/i} + V_{option} \quad (4)$$

where, V_0 is the overall value of the real estate, $V_{f/I}$ is fundamental or intrinsic value of the real estate, and V_{option} is the value of the option included in the overall value.

The authors also highlighted that the concepts of fundamental and intrinsic values are relatively undeveloped in real estate sector, in contrast to this topic in financial options theory. Financial options theory accounts that fundamentals can vary significantly over the time, while traditional real estate valuation theory assumes that the fundamentals are knowable and the outcomes do not change once being forecasted. They claimed that this is a reason why real estate valuation has traditionally been described as deterministic (Colwell & Colwell, 2004).

Andrejs Čirjevskisa (2015) highlighted that real estate industry, in comparison with pharmaceuticals and Oil& Gas sectors, is badly presented in scientific studies in terms of real options. He also added that application of real options analysis in real estate practice is even more rare case. Kokukula and Papudesu (2006) argue that "that the current real options literature has been primarily academic, whereas practical "how-to" guides as well as publications on real world success stories have been rare".

The penetration of real options analysis in Russian real estate professional journals and study materials is still comparatively poor that creates opportunities for researches who are interested in the topic and capable to fill this scientific gap.

Speaking about the practical side, real options tool was not mentioned by any participant of the survey (Appendix 2). Taking into account that the respondents were representatives of leading construction firms in Saint-Petersburg, it could be inferred that this technique is not enough studied and tested in practice that adds practical value to the Thesis as well.

Conclusion

Having analyzed currently used valuation and risk identification tools, it could be concluded that developers primarily use technics which simplify the real business environment and undermine effectiveness of investing decision making. There are two main concerns which should be addressed: managerial flexibility and uncertainty.

Companies ignore the value of managerial flexibility that leads to underestimation of potential projects profitability and wrong investing strategies. Their valuation based on static forecasts and often even does not take into account such fundamentals as the time value of money.

The risks are assessed mainly qualitatively, using expert opinions. Firms treat uncertainties only from negative perspective, creating significant contingency reserves which leads to projects underestimation.

Real options analysis is a more advanced valuation and risk management tool which enables management to look at feasibility study from new viewpoint and assess potential projects more precisely, improving corporate investing decisions. Real options theory is a promising field of research not only from practical perspective, but also from academic standpoint, since the topic is badly covered in Russian scientific journals.

Chapter 2. REAL OPTIONS IN RUSSIAN RESIDENTIAL CONSTRUCTION INDUSTRY

The second chapter of the Thesis is devoted to the practical side of real options in residential development. The main goal of this section is to identify which real options are applicable in Russian residential construction industry and define how they should be evaluated.

Firstly, the managerial flexibility in the context of real options will be analyzed from both theoretical and practical viewpoints. Then, new pattern of thinking regarding real options in residential real estate projects will be introduced and adjusted to specifics of Russian residential construction industry. In conclusion of the first section, the classification of analyzed real options will be made with respect to different types of developers.

The second section of the chapter will cover the process of real options analysis: the stages and main valuation instruments. After that, previously described real options valuation models will be analyzed with respect to peculiarities of residential construction market and associated real options. Finally, most relevant valuation technics will be chosen and described in detail.

Real options in real estate

Option to defer. The most common type of real options that is broadly described in the literature is option to defer. Having bought a piece of land, a developer theoretically could decide whether to build a real estate object immediately or wait for a better moment in the future. In other words, the company buys a call option. The value of this option was highlighted by many researches. Titman (1985) investigated why in Los Angeles, where land prices are among the highest in the US, one could observe so many vacant land plots that had not been developed for a long time. He argued that developers prefer to defer the start of development, anticipating higher returns thanks to real estate prices appreciation. Cappoza and Sick (1992) continued his ideas and concluded that the ability to defer the real estate projects in future increases their value. Quigg (1993) numerically analyzed and proved the value of the option to defer, using a large sample of market prices. Later, Sing and Patel (2001) calculated the premium for the option to wait to develop the land and stated that this premium should be taken into account during the feasibility study of potential real estate projects.

In practice, waiting option is not universal. When the land is acquired from the Property Fund of Saint-Petersburg, there are usually strict deadlines for project start and completion that makes the option to wait impossible. Having bought the land from the private party, developer,

in most of the cases, has no legal obligation to start the project and theoretically could wait as much as it is needed. However, as has been inferred from interviews with representatives of leading construction firms (Appendix 3), waiting strategy is used only for rural and suburb locations. It could be explained that it is not economically reasonable to defer residential development projects within the city, because the prices per square meter have been historically growing at a rate which is close to inflation, while regulative pressure is growing year to year dramatically, increasing construction costs and making long term planning even more complicated. Some multifamily property developers indeed keep the land undeveloped for a long periods of time, but in suburbs. The reasoning behind this strategy is that companies wait for infrastructure development that could significantly raise the prices. Besides, suburbs traditionally used to be softer regulated that attracted many developers. However, recent economy downturn has led to significant increase in social burdens for suburbs project due to deficit of local budgets. From real options perspective that means further limitation of managerial flexibility, since if the project includes social burdens as schools or other social infrastructure, developers could be set relatively tough deadlines by local authorities for finishing the objects. Moreover, social burdens significantly increase the total project costs and narrow the margin, because they are usually very costly in terms of construction and have to be gifted to municipal or city authorities. As a result, suburbs are becoming less economically attractive for developers due to the fact that prices are still at least twice lower than within the city. Single family housing projects, in contrast to multifamily, are more flexible in terms of project start manipulations since the regulations and required capital investments are relatively lower.

Abandon option. As was described in the first chapter of the Thesis, this is a put option that company may exercise and sell the underlying assets to a third party. Abandoning option in real estate development was introduced by Williams (1991) who decided to expand real option theory in real estate. He investigated an option to quit the property development and tried to quantitatively assess its value, considering this option as an American put without dividends.

In case of residential real estate, the company can sell the project at its salvage value. Although this option is considered to be one of the most popular ones in real estate literature, it is restricted by many limitations. Abandoning as an option is possible only before the start of flat sales which take place simultaneously with getting a building permit. Besides, not all the land plots are liquid enough to be sold quickly and at a reasonable price, especially during the periods of unfavorable demand.

Option to switch. Since the rules of land use and development frequently allow to build either commercial or residential real estate, developers have an option to switch from one type to another, if market conditions for an alternative project are more attractive. Developers may also

choose between selling or renting the property that was covered by Grenadier (1995) study, where he analyzed optimal selling/renting mix for real estate developers. However, these two alternatives are more common for commercial real estate, since the practice of centralized renting is not widely spread in Russia. Switching option could be also implemented through changing the concept of the future project, including such dimensions as property class, construction design and materials, but all these modifications are rationale only before the start of FEED activities, because, otherwise all the project works should be redone and inspected again that implies significant time and capital costs.

Option to freeze. Peiser (2003) mentioned that real estate developers may benefit from freezing the development process and wait till better market conditions. The same idea was expressed by the Russian author Selina (2014). Indeed, developers may stop the project realization process and wait till the better conditions in terms of demands, contractors' offerings, competitors' actions etc. However, the value this option is very questionable, since any conservation or freezing of residential project bears high reputational risks and associated with significant administrative costs due to the fact that such actions should be approved by controlling governmental organizations that, in turn, requires prolongation of building permit and renewal of selling contracts. Hence, freezing is more reasonable during predevelopment stages or in other real estate market segments such as commercial or single-family property development. Commercial real estate implies lower social issues and fewer parties to negotiate, while cottage market is less strict in terms of regulation.

More common practice is artificial slowing down of the construction process in order to reallocate resources to other projects and accumulate more cash for further construction works. The other, less trivial motive, might be the will to adjust the selling plan. Some developers keep best flats till the end of construction period in order to sell them without installments, thus they want to sell out all the less liquid flats before the end of the construction, hence, slowing down the development phase they get more time to sell these flats out. Slowing down the project, especially during construction phase may also bear reputation risks, hence this strategy is more typical for not publically traded firms. Besides, this strategy is economically vital only for projects which do not employ 214 Federal Law, since this law sets very high fines for any delays. Usually, developers use different excuses for slowing down such as problems with key contractors or suppliers. Russian consumers have got accustomed to residential housing projects delays that makes such practices very popular among dishonest developers.

Phase option. There are two distinct project realization strategies in real estate development that are to be introduced: simultaneous and sequential (phase) investments. Simultaneous investments enable developers to finish a project sooner that implies lower

construction costs. This strategy requires significant capital budget, so the project is typically not financed by its cash inflows, thus it is primarily used by big developers. Besides, this tactic limits managerial flexibility and makes returns more uncertain, hence it is more relevant for periods of increasing market demand. Sequential strategies face the risks in sequence that enables developers to learn about new information and vary, to some extent, the output. This strategy is more capital-consuming and increases overall project payback period, but helps to manage uncertainty better. Developers may choose sequential investments during periods of high future uncertainty in demand, regulations or other important factors. Since this strategy assumes lower initial investments, it is often pursued by firms with high financial constraints.

Simultaneous strategy limits flexibility to the number of options described above, while sequential investments literally increase the number of real options by the factor of construction stages. Rocha (2007) identified four most relevant options associated with this strategy:

- Information option. How the success/failure of the first construction phase (first launch) will affect the performance and expectations of the next development phases;
- Waiting option. A firm can defer the launch of next stages, if it expects better market conditions in the future;
- Abandonment option. A firm could abandon some project stages if it becomes an optimal decision under given conditions;
- Freezing option. A firm can stop construction works on a given stage.

It should be said that phasing option also has rather serious limitations under real business conditions. Developer could decide to develop buildings one by one, starting new phase once he finished the previous one. Indeed, such practice will add flexibility to the project, however, not all the options described by Rocha (2007). In fact, abandonment option for a given phase could not be executed even if construction works for this stage has not been started. The thing is that all the buildings (stages) are highly interrelated in terms of networks and resources, they have common landscape architecture products, green zones, and parking places. All these factors are indicated in the rules of land use and development and included in the project design that is carefully inspected before getting a build permit. Abandoning of even one phase will break the norms stated in the rules and result in deviations from the initial project design that will lead to significant troubles regarding putting the project into operation.

Option to expand. This particular option is described by many authors such as Miller and Lessard (2000), Ford (2010) who stated that construction firms could increase the scale of their projects in case of favorable demand shifts by erecting additional real estate space. In practice, developers are not able to increase the size of the buildings once the project designs

have been submitted. Besides, traditionally developers try to design and construct housing property up to the top size limits in order to maximize selling space per meter of the land developed. Hence, they basically do not have a room for expansion of the current objects.

Even if the land plot physically contains vacant place, usually it could not be utilized for additional stages due to the fact that the rules of land use and development determine the developable area and the density of real estate objects within the given piece of land. All the stages should be planned in advance, since they require common energy and water resource base as well as infrastructure solutions. In case if developer has decided to buy one more piece of land and construct a building, it would be a new project that has nothing in common with the previous one, consequently, such strategy could not be consider as a real option.

All the options listed above describe managerial flexibility in residential real estate projects. Depending on the strategy, simultaneous or sequential investments, this flexibility is implied for the project as a whole or its particular phases. As mentioned before, phasing creates additional flexibility, because every phase is theoretically considered as a separate project. Although phasing strategy application is rather limited due to administrative and technological restrictions, this pattern of thinking about real estate project indeed helps to identify new sources of managerial flexibility. Following up upon this idea, we can try to utilize phasing concept, but from another perspective. If we phase a development project not on construction stages as it is usually done, but on components of value chain, we will find new opportunities for developers and new way of thinking about flexibility in real estate.

Daniel B. Kohlhepp (2012) has identified 7 consecutive stages in real estate process, each of them represents a separate market with distinct players and rules.

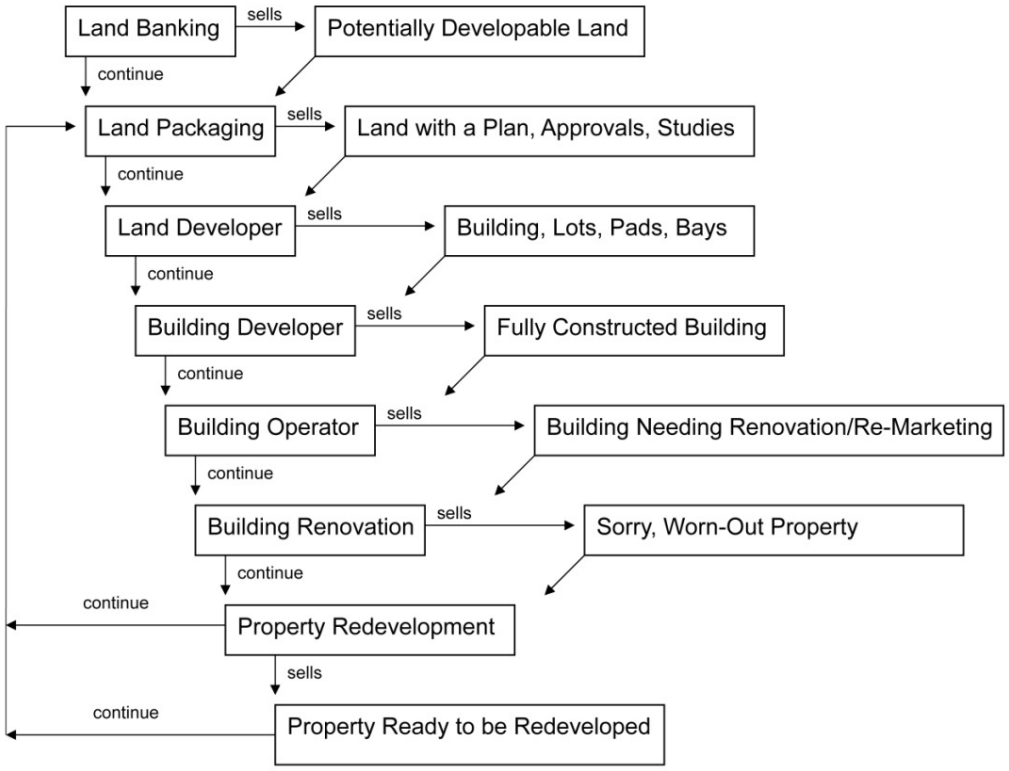

Figure 4. *Real estate process (Kohlhepp, 2012)*

This graph describes the value chain of the development process that is usually distributed through many participants in Western countries. Russian developers represent more vertical integrated companies which run majority of these stages by themselves, fulfilling works with help of own subsidiaries or attracted professional contractors, hence such value chain representation might be unfamiliar for the Russian audience. Nevertheless, it is very helpful to look at the traditional development process from another perspective.

In order to get a full picture of the development process and key strategic decisions which are to be made by its participants, brief description of each stage will be done further.

Land Banking Stage. The "Land Banker" is a participant of real estate development process who acquires and holds undeveloped land, trying to benefit from future land appreciation thanks to market trends, infrastructure development or other economic and legal factors. Largest Russian developers actively use their administrative and huge capital resources to buy land plots to enrich their land banks. In many cases, acquired land is not expected to be developed and such investments are mainly made to benefit from reselling the asset later.

Land Packaging Stage. The "Land Packager" buys the undeveloped land from the passive land banker and enhances its value through conceptual land planning, zoning changes, receiving of technical conditions, preserving or improving potential project parameters of the rules of land use and development, getting building permit, conducting environmental studies, etc. As was mentioned before, these procedures are very challenging and require substantial

administrative resources, thus the role of land packager could be taken by only specific companies with relevant capabilities. In Russian business realities, land packaging is extremely marginal activity. Packaged land might be priced twice as much as undeveloped.

Land Development Stage. The "Land Developer" buys the packaged land with all paper enhancements and improves it so the land plot could be further sold as finished building pads to building developer. Land developers typically prepare so called horizontal infrastructure that includes road networks, utilities, and general improvements such as water dentition and recreational amenities. This particular stage is rarely fulfilled by a separate company in Russian residential construction that is more common for industrial engineering and construction market where developers acquire either green or brown fields and develop horizontal infrastructure for the whole industrial zone and then either sell or rent its parts to third parties, keeping the control over maintenance and playing the role of operation company. In developed European countries and in the US, there are many land developers on both residential and industrial construction markets, for instance, master-planned community developers who are specialized solely on these services.

Building Development Stage. The "Building Developer" acquires the finished building pad and makes the vertical development, constructing the building improvements. Depending on the building developer strategy, finished building could be sold/leased to "building operator" or to final consumers. Home developers are the typical and most obvious example of building developers.

Operating stage. The "Building Operator" usually leases up the property, manages it, and develops a building operation history so the building could be sold to other building operators during its economic life or sold to a "building renovator" at the end of its economic life. In Russia, in case of residential housing, the obligation on operating the building is transferred to flat owners who can either hire a managing company, which could be a firm associated with the building developer or an external organization, or organize a condominium partnership. The idea of building operators is more common for commercial real estate and apartments housing which are out of the scope of the Thesis. Nevertheless, it should be mentioned that building operation is a very big market in developed countries where this role is usually played by institutional investors such as pension funds, insurance companies, or public real estate investment trusts (REITs). Constantly growing popularity of apartment real estate projects in Russia may open new opportunities for developers, raising new strategic question and enhancing their flexibility in managing housing projects.

Renovation stage. The "Property Renovator" buys the property with substantial economic and/or physical depreciation and renovate it by necessary improvements. Property renovator then

may re-position the property and operate in until the object will have to be redeveloped. Renovation is rarely a case in Russian residential construction for the same reasons as building operation – the ownership as well as all the obligations for maintaining the property is transferred to many individual flat owners, while in western societies the ownership is concentrated in hands of developers, operators, and renovators respectively, who rent the apartments to individual tenants.

Redevelopment stage. The "Property Re-developer" buys the property that could not be economically and physically renovated. Re-developer deconstruct the property and the whole process repeats. The difference between redevelopment and land banker stage is that the former acquires brown fields, while the latter - green fields. Redevelopment is a popular way of land plots acquisition in big cities, especially in historical city centers.

Coming back on track of real options, one important conclusion could be made. Russian developers may treat their projects as a set of sub-projects. Each transition from one sub-project (stage) to the next one is a point where a firm should make a decision whether to move on or sell the project results. Such decisions empower developers with managerial flexibility that is nothing else but a real option.

Taking into account Russian residential real estate market conditions and peculiarities, not all the stages might be considered as sub-projects. As was stated before, operating and renovation stages are not relevant in the sense they are described in Kohlhepp's model due to ownership principles and undeveloped apartment market. In Russian realities, operation could be considered in terms of managerial flexibility for developers only as a choice between maintaining the finished and sold property on their own or transferring these obligations to external management companies or condominium partnership. Land developing stage might be taken into consideration for rather industrial development, than for residential, thus this stage is to be merged with development phase. The rest are land banking/redevelopment, packaging, and development. These stages plus operation could be incorporated into real option theory as an option to phase the project.

As a result, we have another perspective towards phasing option for Russian residential real estate developers. Each stage has its own peculiarities regarding managerial flexibility that has already been covered, but should be summarized again and supplemented with new details.

Land Banking/Redevelopment. Developer may acquire a piece of land or totally depreciated property with land and decide whether to start preparation phase or wait. Besides, depending on the market conditions and characteristics of a given land plot, developer may choose between various types of real estate objects and concepts, because this stage occurs before any FEED activities and commissions. Finally, the land might be sold if developer

decides that it is more economically reasonable thanks to changing market conditions or raising demand for capital resources in other more marginal projects. Although the main source of land in Saint-Petersburg is not the state tenders anymore, international construction corporations as well as smaller firms with weaker administrative resources, in comparison with market leaders, face significant challenges in obtaining most "sweet" pieces of land. That is why, big Russian construction firms often buy the land and then resell it that makes the value of abandoning option for such firms even more valuable. To sum up, several options could be described for this stage:

- Option to wait
- Option to switch
- Option to abandon

If developer, based on feasibility study and overall corporate strategic situation, decides to keep the land for its own project and supposes that it is a high time to start this project, it makes a transition to the next phase.

Land Packaging. Land packaging phase represents pre-development stage, which has been described in the first chapter of the Thesis. During this stage developer receives all the necessary permissions and technical conditions which enable the company to start development phase. The flexibility amid this phase is more limited than in previous one. Land packaging starts with development of detailed project design that could not be easily changed afterwards, hence the option to switch is fairly restricted and valid only at the very beginning of the process. Waiting option becomes freezing option, since transition from land banking to land packaging has already been done and the company can only stop or slow down the process. Finally, abandoning option is still valid, since the company still does not have any contract obligations with main subcontractors and flat owners and has a right to sell the land if the market conditions has become less favorable or other corporate projects require additional cash. In addition, it should be stated that abandoning option has some other interesting implications within land packaging stage. It was already stated that some firms earn significant return on land packaging, because the land plot with all the "paper" enhancements could be sold with significant premium. The reason for this added value is that the process of developing project design and getting all the necessary permissions is very complicated due to bureaucracy, administration issues, and corruption. Big companies may pass through all these challenges comparatively easier than their smaller peers, thus they can benefit from selling the packaged land with the ready project concept, technical conditions, and permissions to other companies who face with higher time and capital expenditures during this phase. Having summarized ideas mentioned above, only two valid real options could be identified during this stage:

- Option to abandon

- Option to freeze/slow down

If developer decides to proceed with the project after getting building permit, it makes a transition to the next stage – development.

Development. As we have agreed on before, this stage incorporates both land and building development due to their indivisibility in Russian residential construction industry. This stage gives the start to selling and marketing activities and consists of both horizontal and vertical development. Due to the fact that development stage involves many parties and substantial flows of cash, it is highly regulated. Basically, there is no managerial flexibility on the strategic level during development stage apart from questionable, in both moral and economical perspectives, practices such as freezing or slowing down the development process.

Operating stage. As was mentioned before, after putting the property into operation, developers have a right, but not an obligation to maintain all the facilities on their own or to delegate this obligations to other parties. Typically, the choice is defined by the politics within the company, but this strategic option anyway is worth mentioning.

Up to now the general picture of existing real options in residential real estate has been drawn. The limitations and peculiarities for Russian market have been also covered. The next stage is to conclude which options are valid and what types of companies indeed obtain them.

In Saint-Petersburg several groups of developers could be identified with respect to the scale and type of projects.

Publically traded market leaders. There are a few development firms focused on residential construction which have done IPO. Such companies are the biggest in the industry with strong vertically-integrated structures, which enjoy the access to capital markets that creates additional competitive advantage over their peers. Their administrative resources enable them to play the role of land bankers and land packagers that create additional strategic flexibility. Due to high transparency requirements on stock exchanges and great impact of any reputation risks on the market capitalization, these firms are fairly limited in managerial flexibility which is connected with different manipulations of project timing decisions. Besides, the process of making strategic decisions is more complicated than in case of non-publically traded firms, thus any significant changes in investment plans such as reallocation of resources or acquisition of new land plots should be confirmed shareholder, the board of directors, and top management representatives.

Big construction holdings. These are the companies of usually a bit smaller size, whose strategic objectives or operational transparency do not allow them to go public on capital markets. As a result, their cost of debt is slightly higher and capital resources are more limited.

From the perspective of real options, such firms have higher degree of flexibility since they bear less reputational risks and their decision making process is much quicker.

Small and medium sized companies. This group of firms is still the most numerous in the industry, even though the number of medium and especially small developers has been constantly going down since the crises of 2008-2009 due to stricter regulations and raising capital requirements. Since residential construction is a very complicated and capital-intense industry, where final customers usually make most significant purchases in their lives, smaller companies faces with outstanding difficulties in financing their projects as well as attracting new clients. People make very big stakes and trust only credible and well-known developers, thus in order to sell the flats, smaller firms have to provide big discounts that together with higher financing and construction costs substantially decrease their margins. Their projects are usually delayed and always slowed down, but it could badly be considered as implementation of real options since such actions are out of necessity due to financial constraints.

Cottage developers. This group of companies is a very diverse and consists from both professional small and medium construction firms who moves from city development because of intense competition and tough regulation and individual investors and non-professional firms who consider development as one of the investment opportunities or simply holds big bunches of land bought or acquired as a collection of receivables. Cottage development is the best example for real options analysis. Their real estate objects are more technologically independent and the regulations are much softer. That enables when to hold simultaneously all the options that have been described before. They are free in their will to defer the start of the projects or to zone the land and define the output since FEED activities are much cheaper and easier in modifications. They enjoy all the possible flexibility from phasing strategy and could easily expand or contract the scale of the projects.

As the summary of the findings of this section, the classification and comparison table has been created. The main conclusion that could be done is that many options which are covered in the literature are not applicable in real business conditions for project of big construction firms. There are two main limitations: (1) regulatory, which includes all the commissions, permissions, rules, and laws, and (2) reputational, since flexibilities often arises as a consequences of questionable practices. Depending of the type of project and developing company, one could employ different real options into his or her valuation, hence this section has absolutely practical results.

Type of real option	Description	Limitations	Degree of utilization by type of developers (L-low, M-medium, H- high)				Type of projects
			PT	B	SME	Cot.	
Simultaneous investments strategy							
Option to wait	Developer may choose to start the project immediately after land acquisition or defer it, anticipating better market conditions in the future	The land acquired from the state, should be usually developed within a certain period; If the project is accompanied with social burdens, the deadlines might be set by local authorities; Increasing regulation pressure	M/L	M	M	H	• Project in rural areas and suburbs; • With low social burdens pressure
Option to abandon	In case of unfavorable internal or external factors shift, developer can sell the project at its salvage value	The project could be abandoned only before the start of selling activities; During severe crises, the liquidity of land could be low.	M	M	H	H	• Projects in good locations; • Developed project design and technical conditions add premium
Option to switch	Developer could choose among different project concepts	The option is valid only before the start of the project design works.	L	L	L	H	• Single family housing projects
Option to freeze	Developer may stop or slow down the development process to wait for better market	Shut down of the project is conducted via complicated procedure that requires controlling organizations approval, prolongation of building permit and renewal of selling contracts; Such practice bears significant reputation risks and increases construction costs 214 Federal Law	L	M/L	H	H/M	• Projects without social burdens; • Located primary in rural areas
Option to expand	Developer may increase the project scale in case of favorable demand trends	Developers use the maximum possible limits of development size; Any changes could be made only before the start of design works.	L	L	L	H	• Single family housing projects
Sequential investments (option to phase)							
Option to wait	Defer the start of a particular phase	The same as in simultaneous strategy; Prolongation of development process increases the costs	L	M	M	H	• Single family housing projects; • Projects located in areas of softer regulations and control (rural, suburbs).
Option to abandon	Abandon a given stage	Initial project design; Technological interdependence of different buildings.	L	L	L	H/M	
Option to switch	Choose among different project concepts for a given stage	The same as in simultaneous strategy	L	L	L	M	
Option to expand	Add new stages of construction	The same as in simultaneous strategy	L	L	L	H	

Real options analysis

The second section of the chapter introduces real options analysis framework, describing the process step-by-step. Separately, real options valuation tools are analyzed with respect to the industry specifics.

Real options process

Mun (2002) developed the real options process framework which consists of eight critical steps that should be completed in order to fulfill a comprehensive project valuation, using ROA approach. The framework is based on Mun's vast experience in successful implementations of ROA both in consulting and in industry-specific problems, hence it perfectly fits the practical focus of the Thesis. The overall process is presented on the Figure 5.

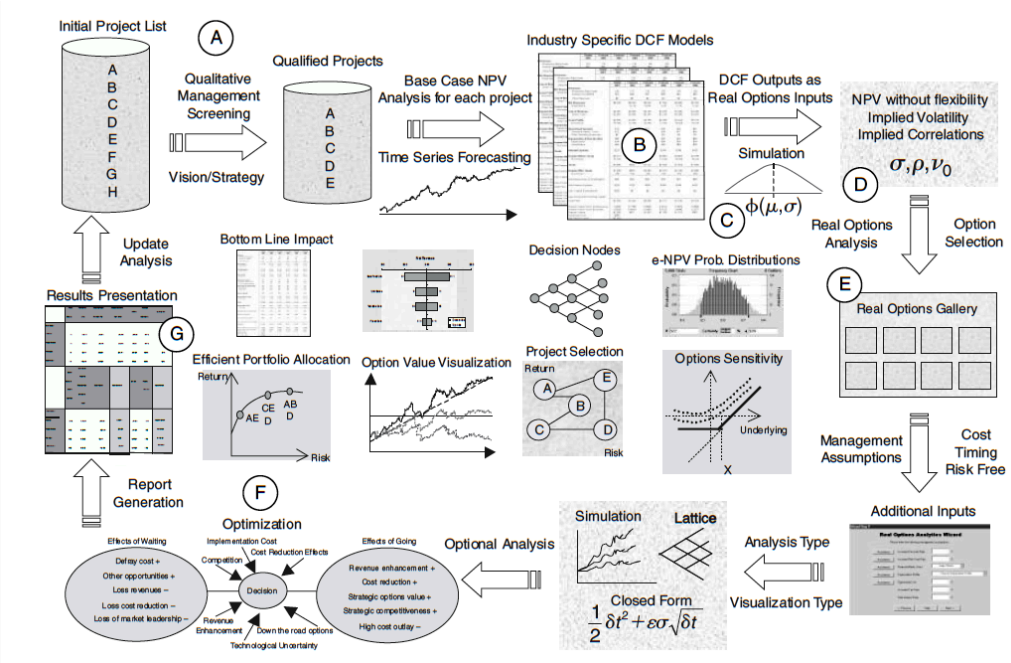

Figure 5. *Real options process framework (Mun, 2002)*

The steps are the following:

1. Qualitative management screening
2. Base case net present value analysis
3. Monte Carlo simulation
4. Real options problem framing
5. Real options modeling and analysis
6. Portfolio and resource optimization
7. Reporting
8. Update analysis

Each step has its own features and should be at least briefly described to provide the full picture of the process.

Qualitative Management Screening. This stage is a starting point of any ROA. Firms analyze the market, internal resources, and macro-trends in order to define which projects or strategic initiatives are worth deeper investigation. In residential construction, this step is usually performed by development and marketing departments which assess currently available land plots and choose ones which seems the most economically attractive and are in alignment with corporate long-term strategy.

Base Case Net Present Value Analysis. Selected projects are then transferred to investing departments for more precise evaluation which is conducted with help of basic DCF model. Free cash flows are calculated based on static revenue and costs forecasts and, then, discounted at an appropriate risk-adjusted rate. Time-series forecasting might be conducted if representative historical data exist and the future could be predicted within reasonable confidence interval using past experience. For variables, which could not be predicted this way, managerial assumptions are to be used instead.

As was concluded from the findings of the first chapter, developers utilize basic valuation tools and in many cases even ignore time-value of money, which is definitely a redundant simplification of real business conditions. The financial model variables are static, predetermined by marketing and construction departments, and indexed on the level of inflation.

Monte Carlo Simulation. Basic discounted cash flow model is static by its nature since it produces only a single-point estimate result which represents only one case scenario of the future events. However, the future state of factors, affecting the project bottom-line, especially in long-term capital-intense projects, is uncertain and base case scenario might be far from actual figures. Hence, this approach is fairly treated by both theorists and practitioners as inaccurate, which could lead to bias valuation results and wrong investing decisions. Mun (2002) suggest that Monte Carlo simulation approach should be used with regard to main project uncertainties to get more precise estimation of project's value.

In order to define the variables which are to be simulated, sensitivity analysis is usually preformed at first. As a resulting variable it is common to use project's NPV. Then, an analyst changes each of its precedent variables and analyze the impact on the NPV. By tracing back all these precedent variables, one can change each one by a preset amount and see the effect on the resulting value. Having analyzed the sensitivity of the net present value to changes in other variables, the main candidates for Monte Carlo simulation could be selected. If chosen variables are correlated, then correlated simulation should be employed to get closer approximation to the variables' actual behaviors.

As could be inferred from previous chapter, developers rarely practice simulation for valuation purposes and use static forecasts for key variables, which are mainly obtained from expert estimation. There are three main variables which do influence the value of a residential real estate project: square meters sold per a given period of time, selling price, and construction costs, which include all the direct materials expenditures. Developers use common tools to forecast them, which will de briefly described further.

Sales in physical units are predicted by marketing department, which takes into account historical data, managerial assumptions, the project peculiarities, market trends, and current company's strategy. As a result, sales plan is developed and provided to investing department for feasibility study.

The price is determined by the marketing department as well and used as a starting price level. Depending on developer's type and its policies, the price might be adjusted to the stage of development process and indexed by inflation or more comprehensive rate.

Construction costs are calculated by development or construction departments based on initial project concept, past experience, and current conditions with contractors. Similar to prices, the forecast is usually stable and only indexed by predefined coefficients.

To sum up, currently used financial modeling methods are indeed static and could provide bias results. Consequently, simulation tools should be applied in order to get more accurate valuation results.

Real Options Problem Framing. The next step in real options process is to identify the strategic options which are associated with previously selected projects. To fulfill this task properly, one should understand the nature of the business and particular company's processes, policies, and overall corporate strategy. In the previous section of the current chapter, most common strategic options typical for residential development has been analyzed and classified in accordance with types of the projects and developers. Designed concept could be used for real options problem framing in Russian residential real estate industry. Based on those findings and information regarding the given project, analyst could identify which options are applicable and analyze them in more detail.

Real Options Modeling and Analysis. Having performed Monte Carlo simulation, one could obtain a values distribution of the resulting stochastic discounted cash flow model. In real options theory, the underlying variable is considered to be the future profitability of the project, which is the series of future cash flows. Based on the results of Monte Carlo simulation, an implied volatility of the future free cash flow or underlying variable can be calculated. Usually, the volatility is measured as the standard deviation of the logarithmic returns on the free cash

flows stream. In addition, the present value of future cash flows for the base case discounted cash flow model is used as the initial underlying asset value in real options modeling.

Real options modeling or valuation could be performed using various tools and methods. More precisely and with respect to the industry specifics, this topic will be covered in the next section of the Thesis.

Portfolio and Resource Optimization. Portfolio optimization is an optional step in the analysis. It is relevant for the cases when multiple projects are analyzed simultaneously and management is to consider the results as a portfolio of rolled-up projects due to the fact that the projects are usually interrelated and viewing them separately will not present the true picture.

Given that certain projects are correlated, firms might have opportunities for hedging and diversifying risks through portfolio optimization. Similar to investment banks, companies form their project portfolio, taking into account their budget, time, and other resources constraints, while keeping required levels of returns and risk tolerances of their shareholders.

Big construction firms indeed evaluate and develop many various projects at the same time. However, the effect from possible diversification is quite limited. The most significant risks for developers are systematic which are influenced by macro factors and could not be diversified, using portfolio optimization strategies.

Reporting. The goal of any valuation procedure is to enable management to make optimal investing decisions. To achieve this goal, the results of conducted analysis should be presented in a clear manner. Mun (2002) also highlighted the importance of the process explanation, not only final results, what is a valid advice for the case of ROA implementation in real estate as well. Based on the survey conducted by the author (Appendix 2), it could be states that with great probability none of the residential developers, operating in Saint-Petersburg, employs real options analysis, so this tool represents a black-box for the industry. Thus, clear, concise, and precise explanations are to be provided in to order to transform a difficult black-box set of analytics into transparent steps.

Update Analysis. ROA assumes that the future is uncertain and that management is able to make midcourse corrections when these uncertainties become resolved or risks become known. Since the analysis is performed ahead of time and, consequently, ahead of such uncertainty and risks, it should be adjusted to the decisions made and new information about input assumptions received.

Real option valuation tools

As was stated before, this particular section will introduce most popular real options valuation tools. There are three main approaches to apply real option analysis:

- Binomial Approach

- Closed Form Solutions
- Monte-Carlo Simulation

Binomial Approach. The binomial approach introduced by Cox, Ross and Rubinstein (1979) is a widely used method to value financial and real options. The binomial approach is based on the number of assumption (Peter, 2012), such as:

- Perfect markets: Full information is available, therefore there are no arbitrage opportunities, there is no sure gain of money.
- Complete markets: Any risk can be replicated without transaction cost.
- Rational behavior: Market participants act rationally and therefore exercise options in an optimal way.
- Geometric Brownian Motion: In most models the underlying asset follows a geometric Brownian motion, also known as a random walk.

Cox, Ross and Rubinstein model evaluates options with the help of so called binominal lattice or binominal tree which is designed, using either market replicating portfolios or risk neutral probabilities, both approaches will lead to the same result. The idea of the former approach could be briefly describes as follows. Under listed above assumptions, investor will be indifferent in holding the actual option or of owning a replicated portfolio consisting of bonds and equity that results in the same payoff structure. Risk neutral probabilities approach states that instead of using a risky set of cash flows and discounting them at a risk-adjusted discount rate, one can risk-adjust the probabilities of specific cash flows. Hence, using these risk-adjusted probabilities on the cash flows allows us to discount these cash flows at the risk-free rate. Since both methods leads to the same results, application and expositional ease is to be emphasized. Thus, the risk neutral approach seems to be more favorable due to the fact that it is easier to understand and apply (Mun, 2002).

The lifetime of an option is split up in multiple time steps, resulting in multiple up-or-down movements of the underlying asset, thereby creating a tree of possible states of the underlying asset, which could be graphically represented as on the figure 6.

As any other model, binominal lattice requires certain input parameters. They are the same for valuing of financial and real options. S denotes the present value of the underlying asset, S_0 stands for this value at 0 time period. In financial options underlying value is a stock price, while in real options it is a present value of future cash flows. Exercise price is usually labeled as K and in real options theory represents present value of initial investments. Sigma (σ) stands for the volatility of an underlying asset and risk free rate is typically yield of governmental bonds.

It is worth mentioning that there are a number of authors who suggest using the weighted average cost of capital instead of risk free rate. Tom Arnold and Timothy Falcon Crack introduced WACC-based real options valuation as an alternative to risk-neutral-based real options valuation, arguing that such method could be "preferable for educating associates, clients, and colleagues about risk-neutral pricing" (Arnold & Crack, 2004). Nevertheless, the traditional approach implies usage of risk-free rate, thus it has been decided to apply it in the Thesis.

These inputs are used to calculate binominal tree coefficients (u and d) and associated risk-neutral probabilities (p).

$$u = e^{\sigma\sqrt{\delta t}} \tag{5}$$

$$d = e^{-\sigma\sqrt{\delta t}} = \frac{1}{u} \tag{6}$$

$$p = \frac{e^{(r_f - D)(\delta t)} - d}{u - d} \tag{7}$$

where,

u – up factor;

d – down factor;

δt – time step;

σ – volatility of an underlying asset;

D –dividend yield;

p – risk-neutral probability;

r_f – risk-free rate.

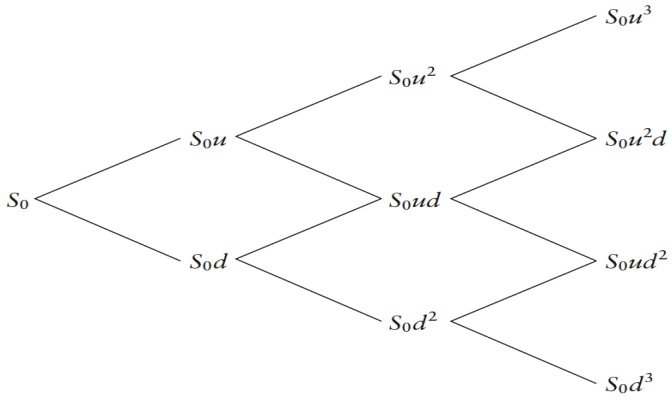

Figure 6. *Binominal tree (Mun, 2002)*

The value of the option is then calculated, using dynamic programming and Bellman's principle of optimality, which states that "an optimal policy has the property that whatever the initial state and initial decision are, the remaining decisions must constitute an optimal policy with regard to the state resulting from the first decision" (Bellman, 1957). The value is obtained

through backward valuation, when the tree is worked from the end to the beginning. At each node the value of the option is calculated taking into account the state of the underlying asset and possible states one step ahead. The advantage of this method compared to classic NPV valuation is that we do not account for the riskiness of the pay-out structure over the discount rate, but with probabilities, thereby separating risk and the time value of money.

Options are valued using equations for the option value ($C_{j,i}$), the risk-neutral probability (p), the up factor (u) and the down factor (d). The formulas are:

$$C_{J,i} = \frac{p \times C_{j+1,i+1} + (1-p) \times C_{j+1,i-1}}{e^{r_f \times dt}}; \quad (8)$$

$$p = \frac{e^{(r_f - D) \times dt} - d}{u - d}; \quad (9)$$

$$u = e^{\sigma \times \sqrt{dt}} \; ; \; d = \frac{1}{u}, \quad (10\text{-}11)$$

where,

C – option value;

D –dividend yield;

u – up factor;

d – down factor;

δt – time step;

σ – volatility of an underlying asset;

r_f – risk-free rate;

j - index of time;

i - index for state at time.

Binominal tree method enables us to value any type of options, excepting very advanced ones, which are rarely applied in practice and are out of scope of this Thesis. Besides binominal tree is a vivid and clear representation of valuation process which properly works during management discussions.

While the binomial model provides an intuitive feel for the determinants of option value, it requires a large number of inputs, in terms of expected future prices at each node (Damodaran, 2010). To simplify the valuation process, usually, so called, closed form solutions are used.

Closed Form Solutions. There are many closed-form models, but all of them are derived from the most well-known Black-Scholes (1973).This closed form solutions can often be interpreted as binomial model with infinitesimally small time steps.

The Black-Scholes formula is the following.

$$C_t = S_t N(d_1) - Xe^{-r\tau} N(d_2) \tag{12}$$

$$d_1 = \frac{\ln\left(\frac{S_t}{X}\right) + \left(r + \frac{\sigma_s^2}{2}\right)\tau}{\sigma_s \sqrt{\tau}} \tag{13}$$

$$d_2 = \frac{\ln\left(\frac{S_t}{X}\right) + \left(r - \frac{\sigma_s^2}{2}\right)\tau}{\sigma_s \sqrt{\tau}} = d_1 - \sigma_s \sqrt{\tau} \tag{14}$$

where, C denotes call option value, $N(d_1)$ – the probability that normally distributed variable is less or equal to d_1, S – current share price, X – strike or exercise price, r – the risk free rate, and t – periods to exercise date.

As could be inferred from the formulas, all the dimensions could be replaced by real projects metrics that makes the valuation process fairly straightforward and far less time-consuming. Since it is based on Cox, Ross and Rubinstein (1979) model, it has similar assumptions. However, the model is even more limited, because it allows to assess only European options, which can not be exercised before the expiration. This limitation significantly constraints the usage of this formula for real options analysis due to the fact that they are primarily American ones.

Monte-Carlo Simulations. Other widely used methods for valuing real options are based on Monte-Carlo simulations. This approach uses thousands of randomly generated scenarios of possible future market outcomes and calculates the value of the project under these scenarios. As with the other real option frameworks, the value of the option is the difference between the project with and without the option, but here we do not necessarily base the model on the idealized assumptions of financial option models. One of the difficulties with this approach is that analysts have to implement flexibility into the model manually so that it behaves under the market scenarios. This can be seen as a disadvantage against the other two approaches that exercise options always in an optimal way. Another difficulty lies in the modelling of the underlying asset value. In contrast to the other models, one is free to choose how the value of the project is determined and there is no assumption about geometric Brownian motion. Depending on the required sophistication of the model, one will need to apply advanced statistical tools that are to be handled with great care, in order to get meaningful results.

Model choice

As was mentioned before, all three models have both advantages and disadvantages. Binominal approach applies the concept of risk-neutral world, which is consider by many authors (Costello, 2011) as an evident simplification of real business environment. Black-Scholes model relies on the assumption of continuous price process of underlining asset that is rarely a case in real projects, thus this approach will underestimate the value of deep out-of-the-money option, besides the model does not allow to value options which could be exercised before the maturity (Damodaran, 2010). Simulation approach requires advanced statistical tools usage and is based on complicated mathematical models with many assumptions that significantly increases the risk of making mistake and the time of conducting valuation process. The latter factor is crucial for big real estate development firms which should assess many perspective projects in a short period of time. In residential real estate industry the number of profitable land plots is fairly limited, thus companies should define the value of potential projects very quickly to develop optimal negotiation strategy and the size of the bid.

Taking into account that chosen real option pricing model should be practical oriented and, consequently, meet industry needs, simulation modeling could be eliminated from the list. The rest are the two model which are unarguably most popular in real options valuation that again proves their practical relevance (Selina, 2014). Since the most valid real options such as to wait and to abandon the project are to be considered as American ones, choosing Black Scholes model would seem as irrelevant simplification of the valuation process, hence the binominal tree method is to be employed.

Conclusion

The second chapter has been devoted to the practical side of real options theory with respect to residential construction industry. Main real options described in the literature have been analyzed and challenged by Russian industry specifics in order to define the most applicable strategic options. Then, they have been classified by types of projects and market players. Finally, real options process framework has been introduced and adjusted to real estate industry. The findings of the chapter could be summarized in several statements:

- The real options literature considers residential real estate industry more flexible than it is;
- Option to abandon is the only real option which could be applied in most of the residential real estate projects on the Russian market;
- Big, publically traded firms, operating in the city have the least possible managerial flexibility in contrast to cottage developers;

- Binominal lattice method is the most applicable for real options valuation in real estate projects.

Chapter 3. ETALON GROUP CASE STUDY

The third chapter of the Thesis is devoted to practical implementation of all the findings of previous sections. The main goal of the chapter is to apply real options analysis to real business case and define whether the real options add value to the real estate development projects.

The chapter starts from the brief overview of the case company, its operations, and valuation approach. Then, the real multifamily real estate project will be evaluated, using real options process framework, which has been introduced before.

Finally, the results will be analyzed with respect to possible managerial implications.

Etalon Group

This section is created to provide general information about the case company and its valuation and risk management procedures.

Brief overview

Etalon Group is one of Russia's largest and oldest residential real estate developers, with a market-leading position in St. Petersburg and a growing presence in the Moscow Metropolitan Area. The company is publically traded firm listed on London Stock Exchange.

The company has generated more 32 billion rubles in revenues and 6 billion rubles in net profit in 2016. Saint-Petersburg and Leningrad region represent 82% of the revenue streams, the rest is accounted for Moscow. The company holds significant land bank which is evaluated at 104 billion rubles.

Etalon Group's core operating entities include two strong construction-management companies, four general contractors, eight subcontractors, a crane company, a brick factory and a nationwide sales network. Etalon Group also has its own acquisition and permitting teams, as well as in-house architects.

This model gives the Company greater control over costs, quality and timely project delivery. At the same time, Etalon can get feed- back from its in-house sales and marketing teams to help design residential complexes that meet customers' needs (Etalon Group, 2015).

Etalon Group's strategic focus is on building apartments for middle-class Russians, whose demand for housing is generally more sustain- able than the economy and elite segments.

The group has developed more than 40 residential real estate projects and have 16 projects under development at the current moment, 6 of them are situated in Moscow

Metropolitan Area (Appendix 4). According to the corporate strategic objectives, the company tends to further scale up operations in Moscow to achieve 50/50 balance of sales.

Investment valuation and risk assessment procedures

Based on regular interactions with company's representatives in the form of unstructured interviews, it has been inferred that Etalon group employs standard approach for potential projects valuation and risk management. Since the traditional process, that is typical for residential real estate developers, has been covered in the first chapter of the Thesis, only several main items will be described in this section.

Investment valuation is conducted by special department. It collects the inputs from several other departments. Development department, which monitors land market in target geographical locations, selects most promising objects and sends them to marketing folks who analyze the demand side of the project. If the project meets predefined criteria, the more in-depth marketing study is conducted and initial project concept is developed as the result. The concept and basic price figures are then shared with investment valuation department. The cost side is analyzed by construction department using the initial project concept, past experience, and overall market conditions.

Investment department develops the detailed financial model and defines the profitability of the project using special metrics which could not be disclosed. The firm uses conventional valuation tools. The projected price at the start of the sale, which is provided by marketing department, is taken for granted and then only indexed on inflation and anticipated price changes factor. Construction costs are taken from similar previous projects and adjusted to current conditions.

Risk assessment and management procedures are in alignment with the industry. The firm takes into account only construction risks which are identified based on expert opinion. Then, risks which could be quantified are capitalized in the project, the rest are described qualitatively and added to feasibility study report, which is later presented to top-managers who are in charge of making investing decisions.

As could be inferred from this section, Etalon group employs valuation and risk management methods which do not take into consideration potential managerial flexibilities. Besides, cost uncertainties are analyzed only in negative sense, while price uncertainty is not assessed at all and mentioned only in sensitivity analysis which is conducted at the final stage of feasibility study.

Real options analysis, as was stated before, enables to improve the process of investment valuation, treating uncertainty not only as source of risk, but also opportunities and capturing the value of managerial flexibility that exists in real estate projects. As a result, ROA

implementation may enhance efficiency of investing decision making thanks to more precise evaluation of potential projects, which are frequently rejected due to underestimated results of static valuation methods.

The next section will present a real potential real estate project, which has been recently assessed by the investment valuation department and considered as unattractive. Then, the real options analysis will be applied in order to assess whether it could improve valuation results and affect the investment decision.

Project X in Primorskiy district of Saint-Petersburg

On the given land plot, it is planned to implement the project of large-scale quarter construction of the "comfort plus" class and "business" class (on parts of the sections with good views characteristics). The property type is a complex of residential buildings, built-in premises, parking lots (both above-ground and underground), and social facilities. Construction is expected to be fulfilled in three non-consecutive stages. The complex is supposed to be erected according to the technology of brick-monolithic housing construction with hinged ventilated facades. The apartments are sold without finishes.

Table 4. Object output

Object squares	To be developed	Transferred to the state	Etalon's share
Total complex area, m^2:	**425 350**	**46 700**	**378 650**
Residential and built-in accommodations, m^2	**298 550**		**298 550**
Parking, slots / m^2	**2 670 / 80 110**		**2 670 / 80 100**
Social objects, m^2	46 700	46 700	0
I phase, residential (m^2*)*	90 350		90 350
I phase, built-in (м2)	5 240		5240
I phase, parking slots / m^2	710 / 21 300		710 / 21 300
I phase, social objects	4 500	4 500	0
II phase, residential (m^2*)*	108 950		108 950
II phase, built-in (м2)	6 490		6490
II phase, parking slots / m^2	1010 / 30 300		1010 / 30 300
II phase, social objects	5 200	5 200	0
III phase, residential (m^2*)*	82 750		82 750
III phase, built-in (м2)	4 800		4800
III phase, parking slots / m^2	950 / 28 500		950 / 28 500
III phase, social objects	37 000	37 000	0

The project has predefined deadlines for all the phases:

- I phase – 121 390 м2 – Q4. 2021
- II phase – 150 910 м2 – Q2 2022
- III phase – 153 050 м2 – Q4. 2022

More specifically, the project time scale with break-down for all types of objects and phases in presented in Appendix 7.

The project will be analyzed using real options process framework which has been described in the previous section. However, the number of steps will be reduced thanks to the nature of the project. We can skip the first stage, qualitative management screening, since the project has already been selected by the development and marketing departments. Then, it was decided to prepare financial model for net present value analysis and supplement it with Monte Carlo simulation. Last three steps will be also eliminated, because the project is single one, results are no to be officially reported to the top-management team, and the model updates could obviously be done only in the future. Thus, the structure of the section is the following:

1. Base case net present value analysis
2. Monte Carlo simulation
3. Real options problem framing
4. Real options modeling and analysis

Base case net present value analysis

Base case model has been developed using not only data provided by Etalon representatives, but also expert opinions, time-series analysis, and simulation modeling. The rationale behind implementation of more sophisticated financial modeling tools could be justified by the fact that some financial data could not be disclosed to third parties due to NDA and, hence, it has to be simulated or estimated by industry experts. Besides, static forecasts, which are usually employed by the company, do not reflect potential uncertainties, thus, it was decided to simulate some components of the financial model, using Monte Carlo method.

Obtained data is used to forecast project free cash flows, which are, then, discounted at weighted average cost of capital for the particular investing projects. Later in the section, cash flows calculation will be presented with break down into cash inflows and cash outflows as well as more distinct components.

It should be mentioned that in the financial model, all the calculations are performed on a monthly basis. However, the length of the project life-span does not allow the author to present the graphs and tables with such a short time step. Thus, all the data is presented in annual format.

Cash inflows

There are three revenue streams – sales of flats, built-in commercial premises, and parking places in both under- and aboveground parking facilities. It is important to mention that Etalon does not rent any objects out.

All three categories of output could be bought either through immediate payment or with help of installment plan. Installment conditions are defined in advance and are different for all three categories.

Table 5. Base prices and installment plan

	Base price (average)	**First payment %**	**Installments duration**
Flats	130,000/m^2	35%	24 months after operation start
Built in premises	150,000/ m^2	50%	12 months after operation start
Underground parking	1,400,000 / slot	30%	24 moths from the first payment
Aboveground parking	800,000 / slot	30%	

The base price (Table 5) has been defined by the marketing department and represents the projected average price (weighted average of the comfort-plus and business class) at the start of sales (March 2020).

It is crucial to mention that Etalon flat as well as other products prices are not differentiated with respect to stage of construction as many developers do. The reason is that big, financially-sustainable companies such as LSR and Etalon can finance their projects with cash inflows from other projects and do not have to pay a risk-premium to their clients thanks to flawless reputation. In contrast, firms, whose financial state is less stable, have to provide more favorable offerings in order to finance capital-intense construction works, besides, such companies are not that reliable from the customers' viewpoint who demand lower prices as a trade-off for risks they bare, buying property in undeveloped objects[2]. Etalon also does not use such practices as selling out most illiquid flats first, keeping the rest for later stages of sales period.

The sales plan which defines the distribution of flat, built-in premises, and parking slots sales in physical terms over the project period was received from Etalon group representatives.

[2] Unstructured interview with Dmitriy Speranskiy (Chief sales officer of LenSpecSMU)

Since the indexing method, which is currently used for price forecast in Etalon, has not been disclosed to the author, the time-series analysis of historical residential real estate prices has been conducted.

The prices on real estate, as was mentioned in the first chapter, depends on many macro and micro factors such as:

- Population growth
- Household formation
- Employment
- Household income
- Interest rates
- Federal income tax
- Cost of renting housing

It was decided to use time-series analysis only for flat prices since cash flows from flat sales represent on average 88% of total project cash inflows. Besides, representative historical data for parking prices as well as built-in premises is not available.

The forecasting process has been done in three consecutive stages:

1. Historical data for real estate prices in Primorskiy districted is obtained
2. Using expert opinion the time series is adjusted to the project product mix
3. ARIMA model for natural logarithmic returns is applied using @RISK statistical software

The historical data for last 10 years on a weekly basis has been obtained in open sources (Real Estate Bulletin , 2017). Then, the prices have been adjusted to the product mix of the current project (10% of flats are classified as business class, 90% ad comfort-plus) and other project features with help of representatives of Etalon managers from marketing department and the representative of one of the biggest real estate agencies in Saint-Petersburg[3]. As a result, the time-series of real estate prices for the given project type has been obtained.

Then, statistical tools for time-series analysis has been applied. Using @RISK statistical software, optimal ARIMA model for the first difference of natural logarithms has been identified. As a result, ARIMA (0,1,1) model has been used for price forecast. Based on the model, future prices on real estate are growing with compounded annual growth rate of 5.6%. The same growth rate is assigned to built-in premises and parking places.

Based on the forecasts of the future prices, the following distribution of cash inflows over the project life-cycle has been designed (Figure 7).

[3] Unstructured interview with Dmitriy Speranskiy (Chief sales officer of LenSpecSMU)

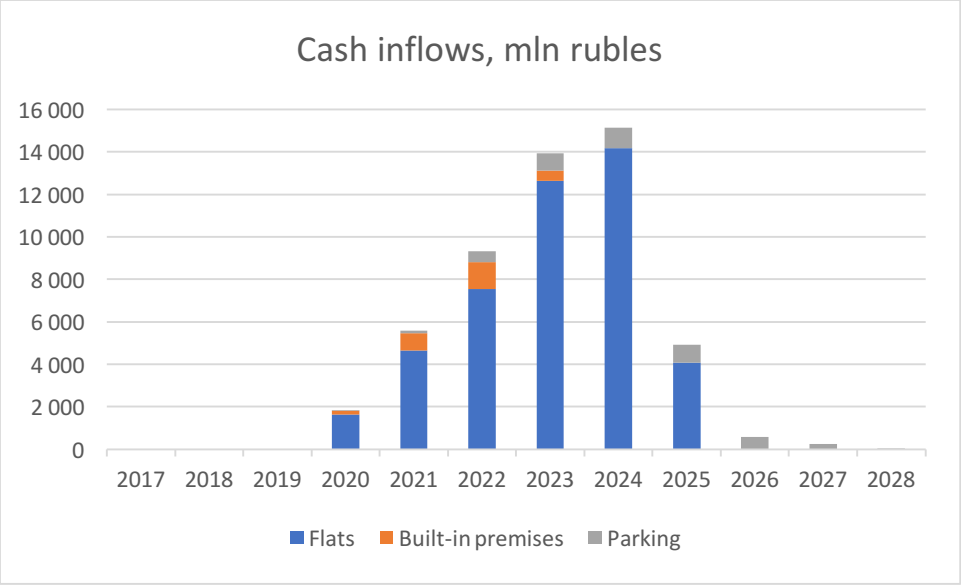

Figure 7. *Project cash inflows*

Cash outflows

Cash outflows consist of the following categories:

- Land acquisition costs
- Construction and assembly activities
- FEED activities
- Utility networks
- Administrative costs
- Commercial costs
- And other costs

Each of the categories will be presented further in detail.

Land acquisition costs

The project implies that the developer is to acquire two allied land plots of 12 and 4 hectares respectively which are owned by two independent legal entities. There are no any paper enhancements which could add premium to the market price. The possible price of the given piece of land has not been disclosed to the author, thus it should be evaluated. However, general background information about the land market is to be provided in advance.

Any real estate project is developed on a land plot which could be either leased or acquired by the company. In Russian residential construction, the latter option is far more popular. The land plots could be publically or privately owned. The state used to be an active player on the land market until 2013, then, Smolniy stopped selling land for two years. In 2015, the Property Fund of Saint-Petersburg, which is in charge of state-base land auctions, decided to reenter the market in order to support city budget during the crisis (Kovtun, 2016). Nevertheless,

developers are not very interested in state auctions, because the land plots, which are presented there, usually have poor location, no documentation, technical conditions, and permits[4]. Besides, Property Fund of Saint-Petersburg is known for charging unreasonably high prices, which could be 10-15% higher than the market value of given land plots (Kovtun, 2016). That is why, the main source of land is private owners.

Developers, operating in Saint-Petersburg, constantly complain on scarcity of land which could be efficiently used for residential construction projects. There are almost no green fields within the city, while majority of redevelopment projects are still economically unattractive due to high construction costs and administrative issues. The scarcity of developable land keeps the prices on the very high level and empowers land owners with great market power over developers (Zaretskiy, 2016). In accordance with KPMG (2017) report, devoted to construction costs in Russia, the cost of land as a portion of total project costs in Saint-Petersburg is twice higher than in Moscow Metropolitan region.

The price on a given piece of land depends on many factors such as:

- Location (Social infrastructure, ecology, proximity, transport accessibility)
- Maximum developable area (total m^2 of selling space which could be built in accordance with rules of use and development)
- Availability of utility networks
- Availability of paper enhancements (project design, technical conditions, permits)
- Future infrastructure development plans in the region
- Overall land market conditions (supply and demand)
- Scheme of payment
- Competitive factors (proximity of other projects of the same class)

The are several approaches to evaluate the land plot: income method, costs method, method of comparables, expert opinions and so on. The choice of the method depends on a particular object and availability of relevant information. The easiest approach is the method of comparables which uses the information about previous transactions of the similar objects. It is actively used in Western countries where the data about transactions is usually publically available. In Russia, only state-based auctions results are disclosed, while information about private deals is closed. Since the Property Fund of Saint-Petersburg plays a minor role on the land market today, there is no needed information for implementation of this approach. Other listed above methods have been used by the author to evaluate the potential price of a given piece of land.

[4] Structured interviews with industry experts (Appendix 3)

Income approach is the most common way of land pricing by its owners. The landlord assesses how much revenue could be generated by a developer on a given piece of land. Then, all the costs associated with the project development and developer's required return are subtracted. Since any land acquisition is a complicated process of negotiations, the most discussible part of the equitation above is definitely the return of a developer.

$$Land\ price = Potential\ revenues - Total\ construciton\ costs - Developer's\ return \quad (15)$$

Costs approach is based on industry average estimate of land price as a percentage of total costs. In Saint-Petersburg, it moves in a range of 16%-18% over the last three years (KPMG, 2017).

Expert opinions have been gathered though a series of structured interviews with top industry experts from leading construction firms. Based on the data provided by Etalon and performed calculations, they assessed probable market price of the land plot, taking into account main object features.

The obtained results have been weighted in accordance with accuracy of the estimates. The final land price value is defined as 4 288 836 306 rubles. It should be mentioned, that land acquisition costs are not treated as cash outflow in DCF model. They are rather stated as initial investment.

It is important to highlight that for the sake of simplicity, the payment is decided to be paid immediately. This assumption is a simplification, because in real business practice, very few land plots are acquired by cash and in one payment. Usually, sophisticated payment conditions are negotiated, when the land owner receives only part of the sum in cash (about 30%) immediately, and the rest of the sum is paid out from the sales of flats or other property which is planned to be developed.

Construction and assembly costs

This group of costs consists of expenditures associated with construction itself, construction materials, and assembly works. C&A is the biggest cost category in any development project, thus they should be carefully assessed during feasibility study, because even small percentage change in C&A costs could dramatically affect the bottom-line of the projects. The most popular and accurate approach to identify and assess those risks and uncertainties is to use expert opinion. Etalon representatives provided the author with their initial estimates of the project C&A costs. However, having interviewed several industry experts, including ones from the Etalon company, it has been inferred that initial C&A cost estimates usually fluctuates in a range of -5% to +10% thanks to the factors which have been presented in the first chapter of the Thesis. In order to incorporate the experts' opinions, triangle distribution

for C&A costs has been applied. As a result, total construction and assembly costs are evaluated as 24 407 594 533 rubles.

Front-end engineering costs

The FEED activities are performed during pre-development stage and include design and construction documents preparation as well as engineering investigations and surveys. The costs associated with project design inspection and other permissions are also included in this category. FEED costs could increase substantially in case of any project change, especially after inspection, because all the process has to be repeated. In the analyzed project, the assumption is made that the project concept will not be changed over time and all FEED costs will be as planned. Total FEED costs are 1 175 497 318 rubles.

Utility networks

This group of costs depend on the land plot location and its access to city's utility networks. Developer must receive technical conditions from utility companies (the process and its challenges are described in the first chapter of the Thesis) at first to get a building permit. After that, utility installation activities could be started. Total utility network costs are 2 985 322 969 rubles

Administrative costs

Administrative costs are usually assessed as a percentage of total construction costs. Etalon representatives advised to evaluate them as follows:

$$Administrative\ costs = 4\% * (C\&A + FEED + Utility\ networks) \quad (16)$$

As a result, total administrative costs are 1 142 736 593 rubles.

Commercial costs

The company uses both own distribution channels and special agencies. Even though, Etalon tends to refuse from external parties' services due to their low efficiency[5], the commissions of real estate agencies is still comparatively big portion of selling and marketing costs of the Group. Total commercial costs come out at 1 546 098 676 rubles or 3% of total cash inflows.

Other costs

This category comprises other overhead costs which could not be attributed to a particular cost group listed above. Total other costs, based on data provided by Etalon, is 262 905 875 rubles.

Total annual distribution of cash outflows is presented below (Figure 8).

[5] Unstructured interview with Dmitriy Speranskiy (Chief sales officer of LenSpecSMU)

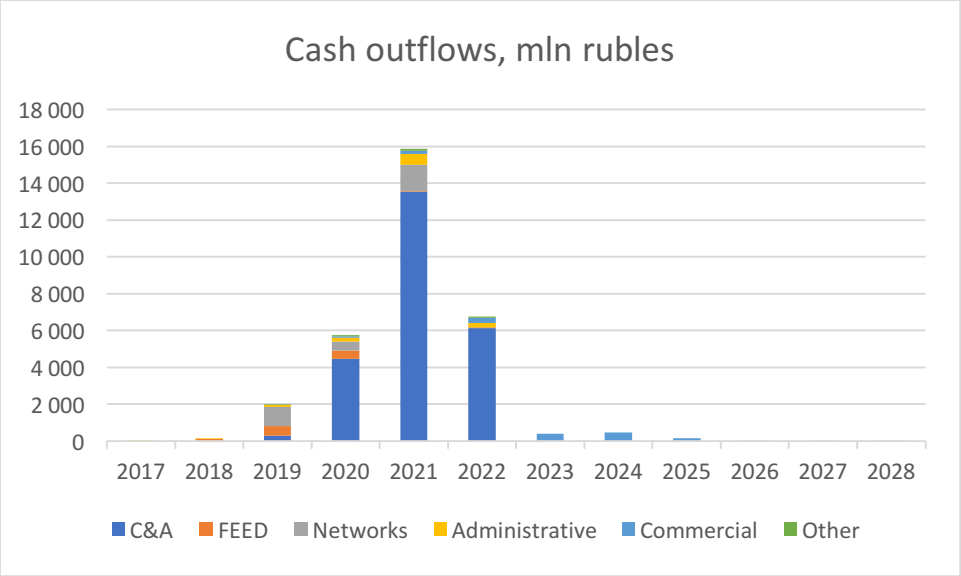

Figure 8. *Project cash outflows*

Having defined cash inflows and outflows, one could move on to free cash flows calculations.

Free cash flows

Previously obtained cash flows enable us to calculate EBIT or earnings before interest and tax (Figure 9).

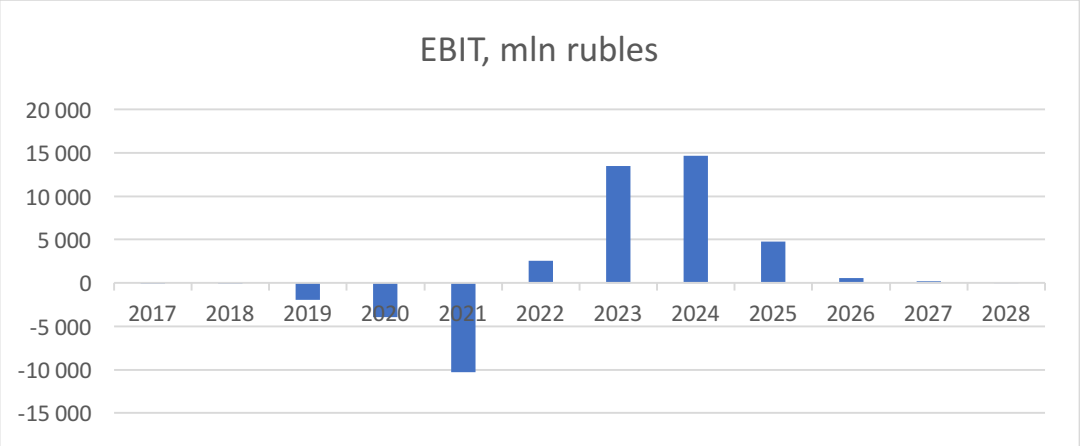

Figure 9. *Project EBIT*

As could be inferred from the diagram, positive operating income appears only after 5 years from the start of the project. It is caused by the fact that most capital-intense activities such C&A, FEED, utility networks implementation occur at the first stages of the project, when property sales are either not started or not active yet. Since Etalon does not provide any discounts at the early construction stages, clients are not incentivized to purchase flats earlier, hence, the most significant flow of customers is expected during later stages of project development.

In order to calculate free cash flows, the tax payments are to be subtracted from the earnings before tax. Since Etalon group builds the projects under 214 Federal law, it should not pay VAT, so all the tax expenditures are the income tax.

As a result, we can calculate free cash flows for every particular time period (Figure 10).

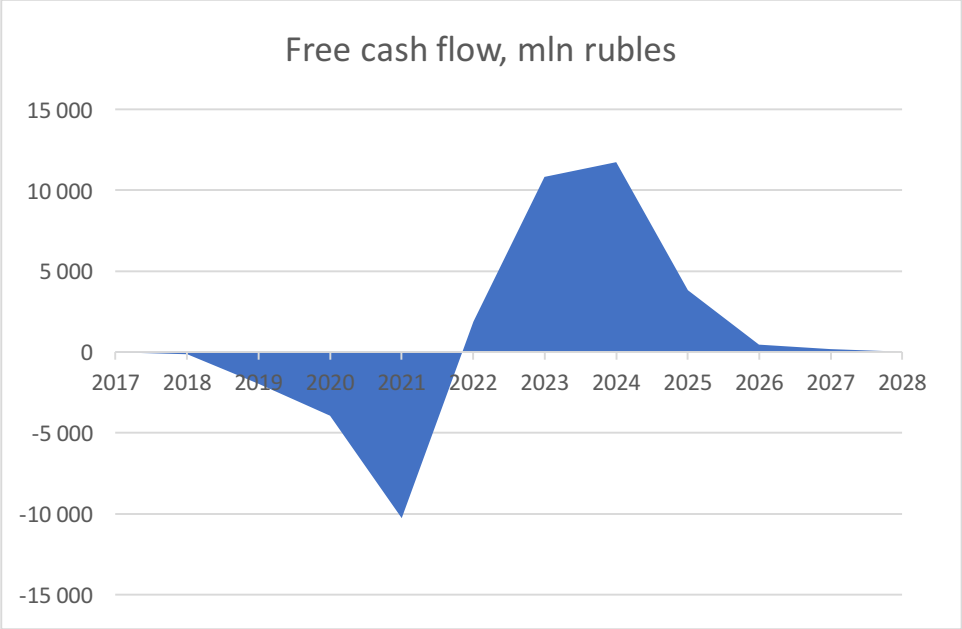

Figure 10. *Project free cash flows*

The next step is to discount these free cash flows at an appropriate risk-adjusted discount rate. Etalon assesses this rate as weighted average cost of capital, but the exact figure could not be disclosed due to NDA, thus the author calculated it on his own. The basic formula for the company which does not have preferred stocks is the following:

$$WACC = k_d w_d (1 - T_c) + k_e w_e \quad (17)$$

Where:

k_d – cost of debt;

w_d – weight of debt in the project's financing structure;

k_e – cost of equity;

w_d – weight of equity in the project's financing structure.

Cost of capital is defined using capital asset pricing model (CAPM), cost of debt – through current Etalon Group corporate bonds, which comprises almost all the long-term borrowings of the company. It should be mentioned that the financing structure could differ among various projects. For instance, development projects which are situated in Moscow region

are significantly more leveraged, than Saint-Petersburg ones[6]. As a result, WACC for the given project is estimated as 12.61%. The detailed calculations are presented in the Appendix 5.

Now discounted free cash flows distribution over the project period could be designed (Figure 11).

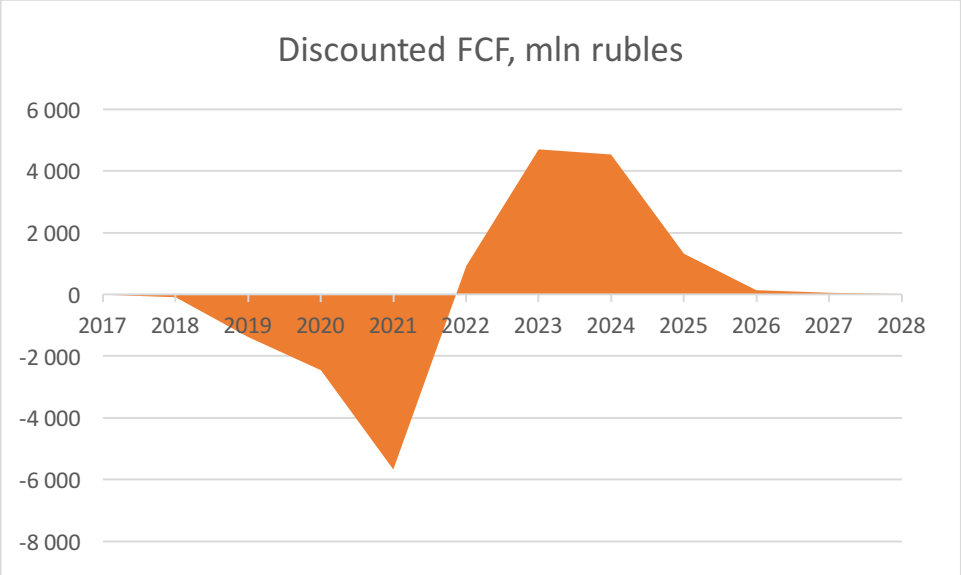

Figure 11. *Discounted free cash flows*

Summing up all the present values of future free cash flows and subtracting initial investments, which are defined as the land plot acquisition, net present value could be obtained. The project NPV is – 1 943 913 305 rubles. Negative NPV means that the project should be rejected by the company's top management.

Even though total cash inflows exceed outflows, including initial investments in land, by 6.2 billion rubles, discounting turn the NPV into negative. Thus, it is extremely important to use discounting methods in order to make relevant investing decisions. Nevertheless, many developers do not use these tools, as has been concluded in the first chapter of the Thesis. On the graph below, one could notice how discounting affect the free cash flows and how significantly reduces long-term cash flows.

[6] Unstructured interview with Etalon's manager

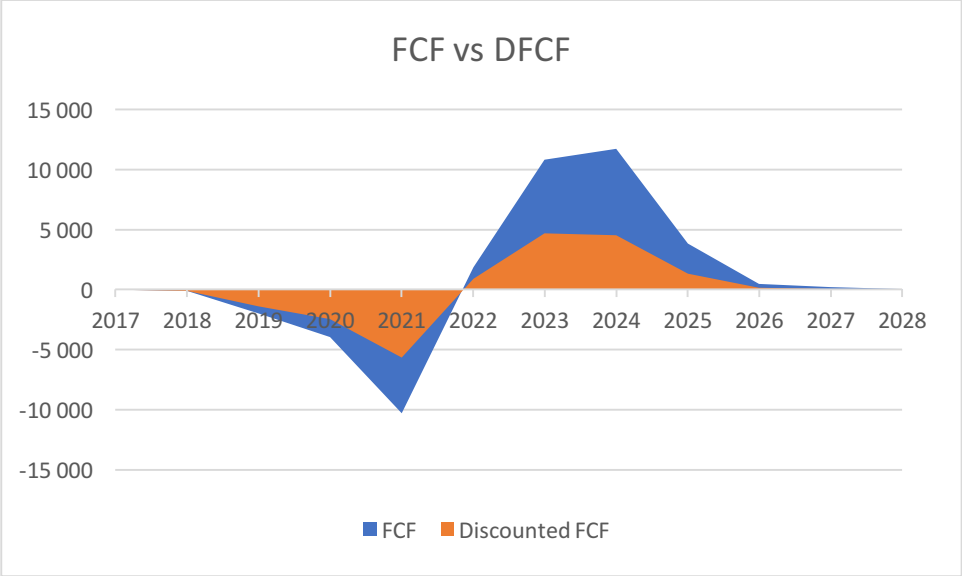

Figure 12. *Comparison of FCFs and discounted FCFs*

Monte Carlo simulation

Since the base case NPV analysis is static, because it employs only one scenario of future state of implied variables, it is useful to include Monte Carlo simulation of net present value of a particular project. As has been mentioned earlier, there are two main underlying uncertainties in the model – price and C&A costs. Prices are simulated, using ARIMA (0,1,1) model, while C&A costs – using triangle distribution within specified range.

Result of 10,000 simulations with help of @Risk statistical toolkit are presented below. As could be inferred from the histogram, in 92.4% of scenarios, the project NPV is below zero. Such distribution proves that the project should be rejected under conventional net present value analysis.

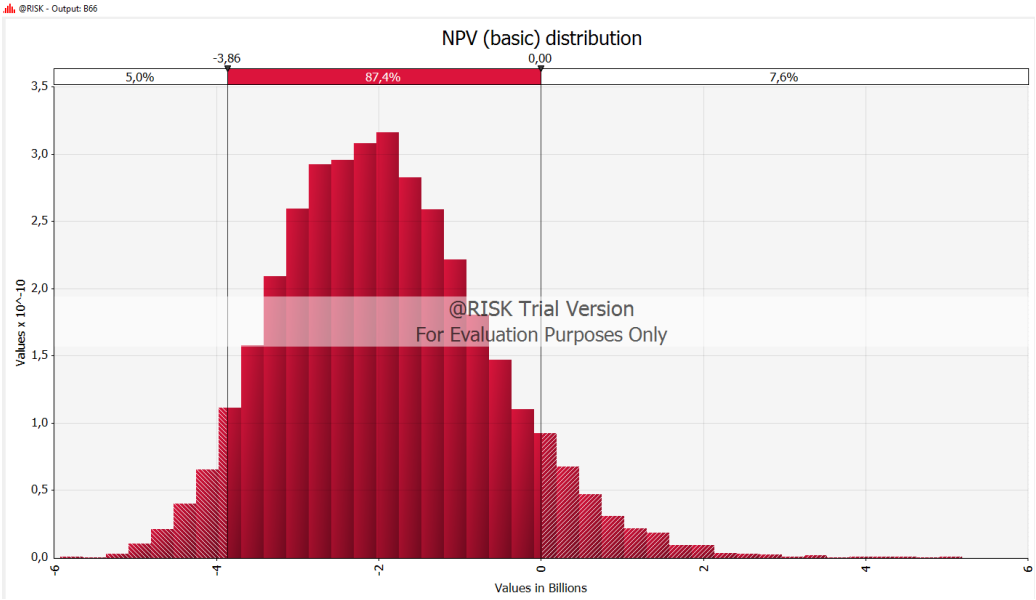

Figure 13. *NPV distribution*

Real options framing

In order to define which real options could be applied to the project, the author would refer to the results of real options analysis conducted in the second chapter. Since Etalon is a leading residential developer in the region, listed on the London Stock Exchange, which works in accordance with 214 Federal Low, its managerial flexibility is rather limited. Besides, the project is located in the city in Primorskiy region which is already well-developed in terms of social and transport infrastructure. The project, as it is common for big financially sustainable firms, is not planned to be developed in consecutive stages. As a result, the only valid strategic option that could be incorporated into project valuation is option to abandon.

Abandoning option has been comprehensively analyzed in previous chapter. In multi-family residential construction, developer may smoothly quit the project only before the start of sales which could be initiated right after getting the building permit. Thus, the time to expiration of this put option is defined as 2.3 years.

Real options modeling and analysis

In the second chapter of the Thesis, binominal option pricing model has been chosen as the most suitable for real options valuation in Russian residential real estate industry. This model is employed through several steps:

1. Implied volatility of logarithmic returns of future cash flows estimation, using Monte Carlo simulation;
2. Design of binominal lattice for project cash flows;
3. Design of binominal lattice for project NPV;
4. Salvage value calculation at every node of the NPV lattice;
5. Design of option valuation lattice and calculation of the option value;

Implied volatility calculation

For volatility estimation, logarithmic present value approach has been chosen which is actively used by Mun (2002), whose real options process framework is employed in the Thesis. This was introduced by Tom Copeland (2001). The model collapses all future cash flow estimates into two sets of present values, one for the first time period and another for the present time. Then, the following formula is applied:

$$\mathrm{X} = ln\left(\frac{\sum_{i=1}^{n} \mathrm{PVCF}_i}{\sum_{i=0}^{n} \mathrm{PVCF}_i}\right) \quad (18)$$

Where $\mathrm{PVCF_i}$ is the present value of future cash flows at a different time periods *i.*

Using the X value, one can perform Monte Carlo simulation on the discounted cash flow model to obtain the distribution of X values. The standard deviation of the forecast distribution

of X is the volatility estimated that could be used in real options valuation (Mun, Real option analysis – Tools and Technics for valuing strategic Investments and Decisions, 2002).

Since the approach is based on logarithms, the value of $PVCF_i$ could not be negative. Nevertheless, the approach is widely used in textbooks and articles devoted to real options analysis. The thing is that majority of authors who investigate the topic of real options prefer to use projects with positive forecasted cash flows, thus there is a lack of papers where the opposite situation is analyzed.

Since the cash flows of real estate project are usually negative during the first half of the project life-span, and the case project is not an exception, it was decided to take away C&A costs from FCF calculations and discount them to a period 0 and add to the land purchase price as capex costs. Such move enables us to obtain purely positive cash flows which could be used for further volatility estimation.

Having performed 10,000 simulations, the author obtained distribution of X values with standard deviation equals to 14.15% per quarter or 28.3% in annual terms. The distribution of values is presented in the Appendix 6.

Binominal lattice of present value of future cash flows

The time to expiration of the option is already defined as two years and three months. The next important point in lattice design is to determine the time-step of the tree. The greater number of time intervals in the lattice, the more accurate is valuation result. However, we should not forget that strategic decisions such as abandoning of multi billion rubles project are not made every day in contrast to financial market where options could be easily exercised at any time during the trading session. In Etalon Group, all the most important strategic decisions are made at shareholders' meetings which occurs once per quarter. Hence, the time step for the lattice is also defined as three months.

Obtained implied volatility enables us to calculate up (u) and down (d) factors, using formulas presented in the second chapter.

$$u = e^{\sigma \times \sqrt{dt}} = e^{0.1415 \times \sqrt{1}} = 1.152 \quad (19)$$

$$d = \frac{1}{u} = 0.868 \quad (20)$$

The present value of future cash flows, which are used in volatility estimation, is equal to 17 703 844 967 rubles. This value is used as a starting point for the lattice. Multiplying by up and down factors, we design the tree which consists of 9 steps. The lattice is presented in Appendix 8.

Binominal lattice of the net present value of future cash flows

Since we have used only cash flows without capital expenditures associated with the land plot acquisition and C&A activities, now these costs are to be incorporated in the lattice. In order to do that accordingly, capex expenditures should be adjusted to each node, using quarter risk-free rate at as a factor. For example, in the 8th node, present value of capex expenditures are to be calculated as follows:

$$Capex_8 = Capex_0 * (1 + r_f)^8 \quad (21)$$

Having subtracted capex expenditures at every node of the lattice, the new tree with NPV values could be obtained. This tree is also presented in Appendix 9.

Salvage value of abandonment

The idea of the option to abandon is that the company can quit the property development project by selling the land and improvements to a third party at its salvage value. Since the land, as an asset, is not depreciated, its price is defined solely by the market conditions and degree of its development or "packaging", because the packaged land could be sold with additional premium.

Land pricing is a fairly difficult task since any given land plot is unique. In order to define the possible selling price of the land plot at every node of the lattice, the author asked industry experts from leading construction firms for help. Salvage value estimation has been conducted through three steps:

1. The market value of land for each node of the NPV tree has been calculated;
2. Packaging premium factor for each node has been assessed;
3. Having multiplied the market value by the premium factor, total salvage value of the project at each node has been defined.

Each step results in a lattice, all of them are presented in Appendix (10,11,12). There are several main ideas behind the values which are presented there.

Since the market value of land is mainly defined by the net value of property which could be developed there, the lower the expected NPV of potential project, the lower the land price. Nevertheless, the undeveloped land price has another driver – scarcity of land supply in the market. Unless redevelopment projects become less constrained by administrative and financial barriers, the supply of land for multifamily housing within the city will narrow down year by year. This factor will not allow the land prices to drop dramatically even during severe crises.

The significant decrease in the land value in the worst possible scenario could be explained by the fact that even though the market price of land could not drop substantially, its liquidity will be harmed for sure. One can assume that if the land could not be sold at its intrinsic price, it should be kept till better days and then either sold or developed by the company itself.

However, Etalon prefer to sell out all the land plots which could not be developed by the company. Etalon already used that strategy during the crisis of 2008-2009. Hence, liquidity discount is applied to the salvage value during the crisis period. As a result, the land price is estimated to be almost twice cheaper than in basic scenario.

Another topic to be discussed is packaging premium. During the pre-development stage, the company invests in FEED activities, receives technical conditions, starts utility networks implementation, gets the building permit. All that, mainly paper, enhancements indeed add value to the land, because all the design and permission procedures require significant administrative, time, and capital resources. In the previous chapters, it has been broadly described how tough these processes are and how difficult for Etalon's smaller peers to complete those tasks. According to the interviews with industry experts, the premium for packaged land could reach 100% to the market value of undeveloped land. However, the worse the economic situation and perspectives of the project, the lower the premium will be. As could be inferred from the lattice (Appendix 11), in worst scenarios there are no expected premiums at all, because under those scenarios, the land will not likely to be developed by the new owner immediately. Hence, many permissions will have to be renewed, since the have quite tight expiration deadlines. Besides, the project is designed as comfort plus and business class complex. These two segments are the most exposed to negative demand shifts during the crises (Glebov-Zelinskiy, 2015). Consequently, the project designs are probably to be redone towards more affordable flats of smaller size.

Option valuation lattice

Design of option valuation lattice proceeds in two steps, which are the valuation of the terminal nodes and the valuation of the intermediate nodes, using a process known as backward induction. In the first lattice (present value of future cash flows), the values have been calculated using a forward multiplication of up and down factors, from left to right. However, for option valuation lattice, the calculations are to be performed in a backward manner, starting from the terminal nodes, the nodes which are at the end of the lattice (Mun, 2002).

The value of the terminal node is obtained through the value maximization of abandonment versus continuation. This function could be represented as follows:

$$V_n = \max(K_n; S_n) \tag{22}$$

Where V is a maximized or current value, K is a strike price or salvage value, S is a net present value of future cash flows, and n is a node.

This procedure is performed for all the eight terminal nodes. Then, intermediate nodes' values are calculated. In order to do that, risk-neutral probabilities have to be calculated.

$$p = \frac{e^{r_f \times dt} - d}{u - d}; \tag{23}$$

Where, r_f is a quarter risk free rate, δt is a time step, u and d are up and down factors.

After that, the values are weighed by risk-neutral probabilities and calculated backwards, discounting at a risk-free rate.

$$V_{J,i} = \frac{p \times V_{j+1,i+1} + (1-p) \times V_{j+1,i-1}}{e^{r_f \times dt}}; \quad (24)$$

Where p is a risk-neutral probability, V is a current value of a terminal node, j - index of time; i - index for state at time.

Obtained values are compared with salvage value at the respective node. As a result, maximized value for the intermediate nodes could be derived. The maximized or current value of the first, the most left, node is nothing else, but the net present value of the project with the abandonment option or so called extended NPV.

$$Extended\ NPV = NPV\ basic + option\ value \quad (25)$$

In the case project, this value is 5 314 897 882 rubles (Appendix 13). Consequently, the project indeed creates value for Etalon's shareholders and the decision, which would be made in accordance with basic NPV calculation, is wrong.

If we subtract the base case NPV from the extended NPV, we will obtain the option value. In the given project, this value is 7 258 811 187 rubles. Such a high option value is caused by the nature of the project which has negative NPV in most of the scenarios. Thus, the opportunity to quit the project before making heavy investments in C&A and other activities is extremely valuable, because it enables Etalon to hedge against unfavorable external factors. In other words, using terminology of financial markets, the company limits possible downside movement of the underlying asset and keep the unlimited upside potential.

The strategy tree, presented in the Appendix 14, demonstrates a clear strategic management toolkit for Etalon's management regarding when and under what circumstances the company should either proceed with the project or abandon it.

Conclusion

The third chapter of the Thesis has been devoted to practical implementation of the real options analysis to real business case. The analyzed project has been recently evaluated by the company and rejected due to its negative net present value.

Since Etalon employs conventional valuation tools which do not take managerial flexibility into account, incorporation of real options in the valuation process could improve the project results and even turn the NPV of the project into positive, changing the optimal investing decision.

Having performed real options analysis, the author concluded that the project indeed creates value to the shareholders of Etalon group and decision to reject it, which has been based on static valuation, was incorrect.

Thus, the real options analysis is proved to be a powerful valuation tool which enhances efficiency of investing decision making thanks to more precise evaluation of potential projects, which are frequently rejected due to underestimated results of static valuation methods. Consequently, this methodology is to be applied in residential real estate project valuation.

Conclusion

The main goal of the Thesis is to evaluate the investment attractiveness of the real residential construction project, using the ROA approach. Although the goal is formulated as a purely practical one, it has required significant research and analysis of the topic in order to provide comprehensive results.

First of all, the industry specific valuation and risk identification tools have been analyzed from both practical and theoretical perspective. The analysis has led to valuable insights thanks to primary data usage. It has been inferred that residential real estate developers primarily use technics, which simplify the real business environment and undermine effectiveness of investing decision-making. The author has identified two main concerns within the topic: managerial flexibility and uncertainty.

Companies ignore the value of managerial flexibility that leads to underestimation of potential projects profitability and wrong investing strategies. Their valuation based on static forecasts and sometimes even does not take into account such fundamentals as the time value of money.

The risks are assessed mainly qualitatively, using expert opinions. Firms treat uncertainties only from negative perspective, creating significant contingency reserves, which lead to projects underestimation.

As a result, real option analysis, as a more advanced valuation and risk management tool, which enables management to look at feasibility study from new viewpoint and assess potential projects more precisely, improving corporate investing decisions, has been introduced.

The second part of the Thesis has been devoted to the practical side of real options theory with respect to residential construction industry. Main real options described in the literature have been analyzed and challenged by Russian industry specifics in order to define the most applicable strategic options. Then, they have been classified by types of projects and market players. Finally, real options process framework has been introduced and adjusted to real estate industry. The findings of this part could be summarized in several statements:

- The real options literature considers residential real estate industry more flexible than it is;
- Option to abandon is the only real option which could be applied in most of the residential real estate projects on the Russian market;
- Big, publically traded firms, operating in the city have the least possible managerial flexibility in contrast to cottage developers;

- Binominal lattice method is the most applicable for real options valuation in real estate projects.

The final part has presented the practical implementation of the real options analysis to real business case. The project's net present value, evaluated with the help of standard valuation tools, was negative that spurred Etalon managers to reject that investment initiative. Application of real options analysis framework, described in the second part of the Thesis, has incorporated the strategic option to abandon into the valuation that turned the project's net present value into positive and, as a result, completely changed the investing decision. In other words, the case project has proved that real options approach improves the accuracy of valuation results and enables managers to craft indeed value-maximizing strategies.

To sum up, it could be stated that the Thesis brings significant value in both theoretical and practical fields. The research, which is based on primary data and the industry insights, helps to fill the gap in modern Russian scientific literature devoted to the topic. At the same time, application of ROA to the real business case provides solid evidences of its efficiency and viability.

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Appendix

Appendix 1. Valuation tools survey

1. Which valuation method is used in your company?
    a) Dynamic method (valuation based on discounting of future project cash flows at a risk-adjusted discounting rate)
    b) Static method (valuation method does not reflect time value of money)
    c) Expert judgment method
2. Which tools from listed below are used in your company?
    a) Net present value (NPV)
    b) Internal rate of return (IRR)
    c) Profitability index (PI)
    d) Payback period (PP)
    e) Modified internal rate of return (MIRR)
    f) Discounted payback period (DPP)
    g) Accounting rate of return (ARR)

Appendix 2. Risk assessment and management tools survey

1. Which tools from listed below are used in your company?
    a) Expertise estimation
    b) Sensitivity analysis
    c) Scenario analysis
    d) Simulation
    e) Real options

Appendix 3. Structured interview with industry experts

1. How do total construction costs vary over time (on average)? What are the main variables?

2. Could companies purchase a land plot and do not start its development, waiting for better market conditions? Have you used this option in your company?

3. How do social burdens restrict your ability to defer the start?

4. How do you assess the liquidity of land market in Saint-Petersburg? To what extent could it be decreased during a crisis?

5. What is the market-average premium for packaged land? Are there any packaging developers on the market?

6. Have your company faced with a situation when it is more economically reasonable to sell already packaged land, than to develop it on your own? Would you prefer to sell the problematic asset or wait till better time?

7. Could you also develop horizontal infrastructure to enhance the land value?

8. Why do developers freeze their projects? In what cases could it be done?

9. Do you use the cash flows from selling the project flats for financing or the budget is comprised in advance?

10. How big is your leverage? Does it differ among the projects portfolio?

11. Could you develop fewer stages/phases as it has been planned?

12. Could you modify the project concept during the pre-development phase?

13. How do you acquire land plots? Who are the main landlords in the city?

14. How has the industry regulation changed over last several years? What changes are anticipated? How do they influence on your planning and budgeting activities?

Appendix 4. Projects location map

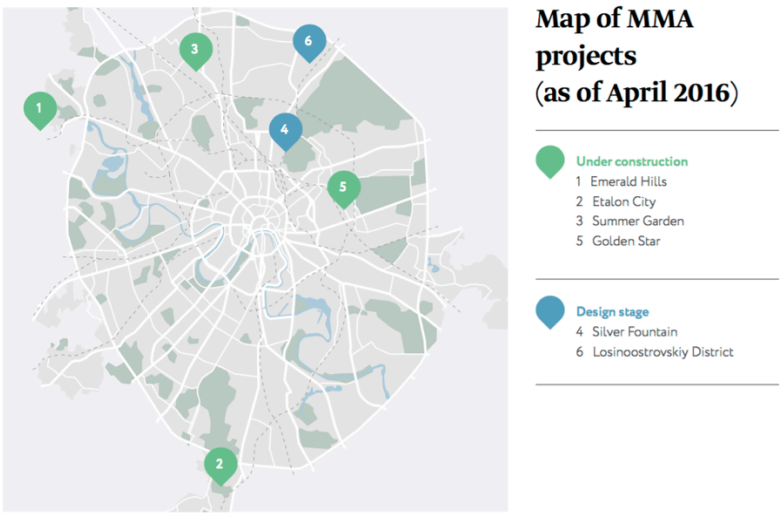

Figure 14. *Moscow Metropolitan Area projects*

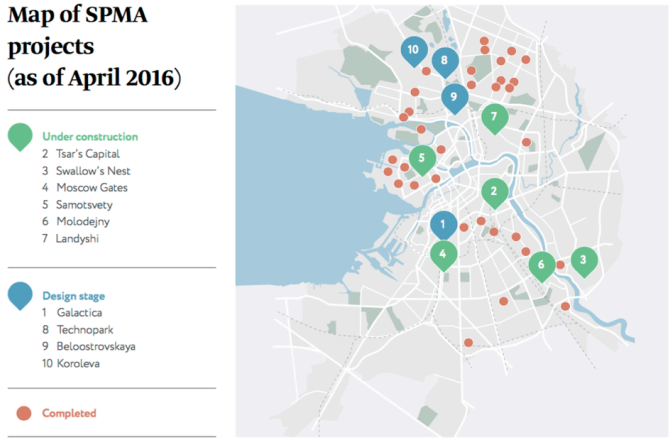

Figure 15. *St. Petersburg Metropolitan Area projects*

Appendix 5. WACC calculation

Table 6. WACC calculation

Title	**Unit**	
Risk-free rate [1]	%	8,02%
Unlevered Beta (Real estate development) [2]		0,57
Levered Beta (Real estate development)		0,68
Income tax	%	20%
Equity risk premium [3]	%	9,24%
Cost of equity	%	**13,29%**
Cost of Debt	%	**12,38%**
WACC	%	12,61%
WACC quart		3,01%
Average capital structure	**Unit**	
Equity	%	80,00%
Debt	%	20,00%
[1] 10-years Government bond yield (ОФЗ)		
[2] New York University's Stern School of Business (source: http://www.damodaran.com), unlevered beta for real estate development in emerging countries		
[3] New York University Leonard N. Stern School of Business. Total equity risk premium Russia 2017 г. (source: http://www.damodaran.com).		
4 weighted average return on issued bonds		
Облигация (Issued corporate bonds)	**Объем выпуска**	**Ставка (Interest rate)**
Облигация 4-02-17644-J	5	11,85%
Облигация 4B02-01-17644-J-001P	5	12,90%

Appendix 6. Implied volatility of PVCF estimation

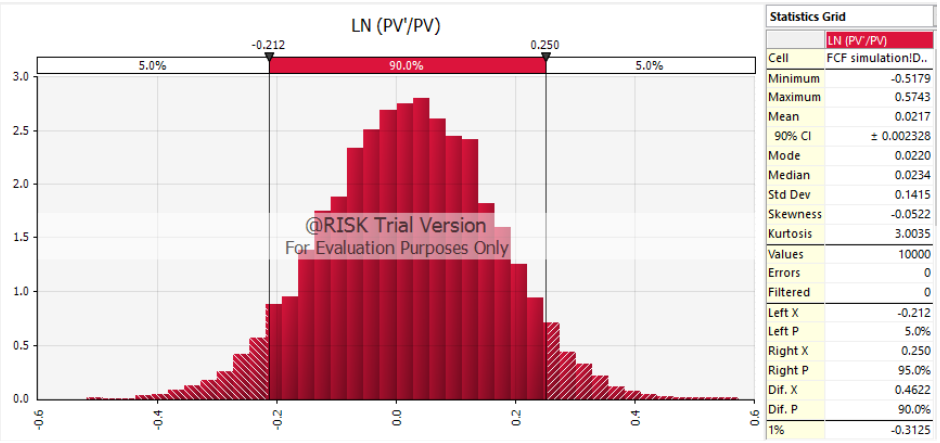

Figure 16. *Implied volatility of PVCF estimation*

Appendix 7. Case project's activities timeline

Project activities	*Residential + built-in I phase*	*Underground parking, I phase.*	*Kinder garden I phase*	*Residential + built-in II phase*	*Underground parking, II phase.*	*Kinder garden II phase*	*Residential + built-in III phase*	*Underground parking, III phase.*	*Aboveground parking, III phase.*	*Kinder garden III phase*	*School III phase*
Land acquisition	*Jul 17*	*Jul 17*	*Jul 17*	*Jul 17*	*Jul 17*	*Jul 17*	*Jul 17*	*Jul 17*	*Jul 17*	*Jul 17*	*Jul 17*
Site plan confirmation	*Nov 18*	*Nov 18*	*Nov 18*	*Nov 18*	*Nov 18*	*Nov 18*	*Nov 18*	*Nov 18*	*Nov 18*	*Nov 18*	*Nov 18*
Project design approval	*Sep 19*	*Sep 19*	*Sep 19*	*Sep 19*	*Sep 19*	*Sep 19*	*Sep 19*	*Sep 19*	*Sep 19*	*Sep 19*	*Sep 19*
Building permit receiving	*Oct 19*	*Oct 19*	*Oct 19*	*Oct 19*	*Oct 19*	*Oct 19*	*Oct 19*	*Oct 19*	*Oct 19*	*Oct 19*	*Oct 19*
Start of construction activities	*Jan 20*	*Jan 20*	*Feb 20*	*Mar 20*	*Mar 20*	*May 20*	*Feb 20*	*Jul 20*	*Jul 20*	*Jul 20*	*Jul 20*
Putting the project inti operation	*Dec 21*	*Dec 21*	*Dec 21*	*Jun 22*	*Jun 22*	*Jun 22*	*Dec 22*	*Dec 22*	*Dec 22*	*Dec 22*	*Dec 22*
Sales start	*Mar 20*	*Sep 20*	*-*	*Sep-20*	*Sep-21*		*Dec-20*	*Sep-21*	*Sep-21*		
End of sales	*Nov 24*	*Jan 25*	*-*	*May-25*	*Sep-26*		*Dec-25*	*Sep-26*	*Jan-26*		
Transferring of social objects to the state			*Aug-22*			*Aug-22*				*Aug-23*	*Aug-23*

Appendix 8. Present value of future free cash flows, binominal tree

Quarter	0	1	2	3	4	5	6	7	8	9
PV CF, rub	17 703 844 967	20 394 838 329	23 494 864 040	27 066 095 221	31 180 155 343	35 919 554 678	41 379 345 102	47 669 026 424	54 914 742 478	63 261 811 026
		15 367 914 251	17 703 844 967	20 394 838 329	23 494 864 040	27 066 095 221	31 180 155 343	35 919 554 678	41 379 345 102	47 669 026 424
			13 340 197 504	15 367 914 251	17 703 844 967	20 394 838 329	23 494 864 040	27 066 095 221	31 180 155 343	35 919 554 678
				11 580 027 487	13 340 197 504	15 367 914 251	17 703 844 967	20 394 838 329	23 494 864 040	27 066 095 221
					10 052 102 793	11 580 027 487	13 340 197 504	15 367 914 251	17 703 844 967	20 394 838 329
						8 725 779 855	10 052 102 793	11 580 027 487	13 340 197 504	15 367 914 251
							7 574 458 364	8 725 779 855	10 052 102 793	11 580 027 487
								6 575 047 785	7 574 458 364	8 725 779 855
									5 707 504 260	6 575 047 785
										4 954 428 612

Appendix 9. Net present value of future free cash flows, binominal tree

Quarter	0	1	2	3	4	5	6	7	8	9
NPV, rub	- 1 943 913 305,01	364 464 734,82	3 074 424 171,65	6 247 993 030,75	9 956 646 857,89	14 282 745 121,64	19 321 185 956,90	25 181 312 437,71	31 989 108 612,05	39 889 729 342,76
		- 4 662 459 343,17	- 2 716 594 901,08	- 423 263 861,21	2 271 355 554,30	5 429 285 664,50	9 121 996 197,82	13 431 840 692,20	18 453 711 236,43	24 296 944 740,68
			- 7 080 242 364,25	- 5 450 187 939,20	- 3 519 663 518,43	- 1 241 971 227,46	1 436 704 894,23	4 578 381 235,07	8 254 521 477,36	12 547 472 995,18
				- 9 238 074 704,04	- 7 883 310 981,60	- 6 268 895 305,45	- 4 354 314 178,50	- 2 092 875 656,90	569 230 173,76	3 694 013 538,04
					- 11 171 405 692,35	- 10 056 782 070,29	- 8 717 961 641,67	- 7 119 799 734,89	- 5 221 788 898,97	- 2 977 243 353,92
						- 12 911 029 701,76	- 12 006 056 352,42	- 10 907 686 499,72	- 9 585 436 362,14	- 8 004 167 431,91
							- 14 483 700 781,32	- 13 761 934 131,20	- 12 873 531 072,88	- 11 792 054 196,75
								- 15 912 666 200,96	- 15 351 175 501,78	- 14 646 301 828,22
									- 17 218 129 606,24	- 16 797 033 897,99
										- 18 417 653 070,94

Appendix 10. Unpackaged land price

Quarter	0	1	2	3	4	5	6	7	8	9
Unpackaged land price	4 288 836 306	4 460 389 758	4 638 805 349	4 824 357 563	5 017 331 865	5 218 025 140	5 426 746 145	5 643 815 991	5 869 568 631	6 104 351 376
		3 945 729 402	4 103 558 578	4 267 700 921	4 438 408 958	4 615 945 316	4 800 583 129	4 992 606 454	5 192 310 712	5 400 003 140
			3 630 071 050	3 775 273 892	3 926 284 847	4 083 336 241	4 246 669 691	4 416 536 478	4 593 197 938	4 776 925 855
				3 339 665 366	3 473 251 980	3 612 182 059	3 756 669 342	3 906 936 116	4 063 213 560	4 225 742 103
					3 072 492 136	3 195 391 822	3 323 207 495	3 456 135 794	3 594 381 226	3 738 156 475
						2 826 692 765	2 939 760 476	3 057 350 895	3 179 644 931	3 306 830 728
							2 600 557 344	2 704 579 638	2 812 762 824	2 925 273 336
								2 392 512 757	2 488 213 267	2 587 741 798
									2 201 111 736	2 289 156 206
										2 025 022 797

Appendix 11. Land packaging premium factors

Quarter	0	1	2	3	4	5	6	7	8	9
Prmium factor	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,20	1,44	1,87
		1,00	1,00	1,00	1,00	1,00	1,00	1,15	1,38	1,79
			1,00	1,00	1,00	1,00	1,00	1,10	1,32	1,72
				1,00	1,00	1,00	1,00	1,05	1,26	1,64
					1,00	1,00	1,00	1,05	1,26	1,64
						1,00	1,00	1,00	1,00	1,00
							1,00	1,00	1,00	1,00
								1,00	1,00	1,00
									1,00	1,00
										1,00

Appendix 12. Project salvage value

Quarter	0	1	2	3	4	5	6	7	8	9
Salvage value, rub	4 288 836 306	4 460 389 758	4 638 805 349	4 824 357 563	5 017 331 865	5 218 025 140	5 426 746 145	6 772 579 190	8 452 178 829	11 427 345 776
		3 945 729 402	4 103 558 578	4 267 700 921	4 438 408 958	4 615 945 316	4 800 583 129	5 741 497 422	7 165 388 783	9 687 605 634
			3 630 071 050	3 775 273 892	3 926 284 847	4 083 336 241	4 246 669 691	4 858 190 126	6 063 021 278	8 197 204 767
				3 339 665 366	3 473 251 980	3 612 182 059	3 756 669 342	4 102 282 921	5 119 649 086	6 921 765 564
					3 072 492 136	3 195 391 822	3 323 207 495	3 628 942 584	4 528 920 345	6 123 100 307
						2 826 692 765	2 939 760 476	3 057 350 895	3 179 644 931	3 306 830 728
							2 600 557 344	2 704 579 638	2 812 762 824	2 925 273 336
								2 392 512 757	2 488 213 267	2 587 741 798
									2 201 111 736	2 289 156 206
										2 025 022 797

Appendix 13. Option valuation lattice

Quarter	0	1	2	3	4	5	6	7	8	9
Current value, rub	5 314 897 882	6 374 224 802	7 781 314 155	9 635 468 020	12 087 212 784	15 341 713 246	19 641 786 871	25 189 729 678	31 993 399 591	39 889 729 343
		4 325 542 069	5 031 154 515	5 985 438 080	7 233 200 053	8 868 722 015	11 062 688 883	14 114 586 376	18 458 002 216	24 296 944 741
			3 699 671 932	4 150 168 624	4 808 495 595	5 664 670 933	6 729 423 481	8 033 080 441	9 734 131 066	12 547 472 995
				3 339 665 366	3 571 071 095	4 030 511 805	4 683 857 325	5 519 836 505	6 423 228 485	6 921 765 564
					3 072 492 136	3 195 391 822	3 452 072 533	3 923 752 195	4 717 773 115	6 123 100 307
						2 826 692 765	2 939 760 476	3 057 350 895	3 179 644 931	3 306 830 728
							2 600 557 344	2 704 579 638	2 812 762 824	2 925 273 336
								2 392 512 757	2 488 213 267	2 587 741 798
									2 201 111 736	2 289 156 206
										2 025 022 797

Appendix 14. Strategic decision binominal tree

Quarter	0	1	2	3	4	5	6	7	8	9
Decision	Develop	Develop	Develop	Develop	Develop	Develop	Develop	Develop	Develop	Develop
		Develop	Develop	Develop	Develop	Develop	Develop	Develop	Develop	Develop
			Develop	Develop	Develop	Develop	Develop	Develop	Develop	Develop
				Abandon	Develop	Develop	Develop	Develop	Develop	**Abandon**
					Abandon	**Abandon**	Develop	Develop	Develop	**Abandon**
						Abandon	**Abandon**	**Abandon**	**Abandon**	**Abandon**
							Abandon	**Abandon**	**Abandon**	**Abandon**
								Abandon	**Abandon**	**Abandon**
									Abandon	**Abandon**
										Abandon