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Empirical Testing of Real Option in the Real Estate Market

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Abstract

Existing researches have used real options valuation (ROV) theory to study investment in energy, oil and gas, and pharmaceutical sectors, yet little works have empirically examined ROV theory to study investment in a real estate market of EU countries that undergone severe economic crisis and now recovering. The aim of this paper is to test empirically ROV application for real estate development project with significant volatility in terms of price and cost and under strict legislation's constraints. Paper illustrates empirical testing of ROV application of the investment project "Sun Village" developed by the ABC Project Ltd Company in Latvia in 2014. We apply three ROV methods: option space matrix "Tomato Garden", Black-Scholes option pricing model and binominal option pricing model before we presented final research result. The flow chart of ROV application in real estate development projects presented in our research can serve as a "road map" for many similar projects in EU suffering real estate market bubble burst and present uncertainty.

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Keywords: real estate, real option, Black Scholes option pricing model, binominal option pricing model

1. Introduction

EU countries as Italy, Spain, France, UK etc. faced huge price decrease in real estate sector after the bubble burst. In years 2008-2010 Latvia as many other EU countries faced crisis that dramatically influenced real estate prices, as a result many investors have lost their capitals. One of the theories developed on how to address these hurdles associated with decision–making under uncertainty is that of real options. Real options theory view investments as rights but not obligations, thereby whenever real options valuation (ROV) is conducted it values the seemingly unvaluable – managerial flexibility to optimally time an investment so that its value is maximized. The energy, oil and gas, and pharmaceutical sectors are the leaders in successfully adopting the real options framework

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according to Kodukula and Papudesu (2006). However, there are few examples of ROV application in real estate business. What's more, 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". We are going to fill the gap in this paper.

Real options theory originated in 1977 with the ground-breaking idea of Stewart Myers that Black-Scholes financial option pricing model developed in 1973 can be applied to capital-budgeting, later it was proved by Folta and O'Brien (2004) and Borison (2005). Myers (1977) originally defined "real options" as: "opportunities to purchase real assets on possibly favourable terms". Since the inception of the term, it has been stretched substantially by prominent researchers as Adner and Levinthal (2004) and Reuer and Tong (2007). Gilbert (2005) argues that an option exists when company has the right, but not obligation, to perform a deal. Since there is a right to invest, but not an obligation to do so, real options theory implies that investments should be postponed in anticipation of future developments. Once additional information is received and some uncertainty resolved *then* management can make the optimal decision according to Rivoli and Salorio (1996). Dixit and Pindyck (1994) argue that real option allows measuring the ability of postponing or aborting the project after irreversible investment expense will be made.

The purpose of the real option theory in general is to attach monetary value to the managerial flexibility. Real options akin to financial options depend in general on six factors – value of the underlying, implementation costs of the option, time till expiration, volatility, risk free rate and the value lost over option's duration. While analogies between financial and real options exist, there are, as Mun (2002, p. 99) puts it, "key differences". The foremost is that in financial markets, holder of the option (at least theoretically) cannot affect its value; for real options the opposite is true argue Copeland, Koller and Murrin (2000, p. 399). While the value of real option's drivers most likely will fluctuate due to external influences, such as economic climate, inflation, rivalry or substitutes, changes in legislations, there are also internal influences according to Li, et al. (2007). The latter category refers to company's core competencies in active investment management after implementation suggested by Mauboussin (1999). To such proactive management of real options, Luehrman (1995) appositely refers to as "gardening". Managers are gardeners; they do the cultivating and eventually decide which tomato to pick and which not to. Firstly introduced by Luehrman (1995), a stylised map "Tomato Garden" is divided in a six regions framework: "invest now; maybe now; probably later; maybe later; probably never; invest never". In the 'Tomato Garden" a Black-Sholes value of European call option or deferral option is expressed as a percentage of underlying assets (discounted free cash flow of project). Luehrman's (1995) writings on real options addressed investments in real assets as European options, wherein only a single real option – *deferral*, was considered. But his approach has since been acknowledged as too simplistic and flawed by Borison (2005). In reality, most real options resemble American style options albeit with a more complex structure according to Mun (2002, p. 172).

One more approach to valuing real option is developed by Cox, Ross and Rubinstein (1979) as a Binomial options pricing model (BOPM). Gilbert (2005) mentions that binomial lattice approach is the most convenient, flexible and intuitive in valuing real options. Its advantage is that it can value both European and American real options and can also deal with multiple uncertainty sources as well as allows managing the volatility. However, BOPM main weakness is that it is hard to compute, since it requires many time steps to produce the sufficiently accurate result. In using binomial lattices, the higher the number of time-steps, the higher the level of granularity, and hence, the higher the level of accuracy according to Mun (2002, p.145). While Hull (2005, p. 355) indicated that for a financial options about thirty time steps yield good results, Kodukula and Papudesu (2006, p. 96) indicate that in ROV about *four till six* time steps commonly are sufficient for good approximations. Stepping time essentially represents the length of each time step or how much time passes between sequential nodes and is selected arbitrarily by Mun (2002, p. 144). While Binomial option pricing model faces difficulties producing accurate result due to complications in "many-step" calculation process, Black-Scholes option pricing model (BS-OPM) approach may handle this limitations. Mun (2002) mentioned that option value should be added to the net present value (NPV) calculated through DCF approach and form extended NPV value (eNPV).

Thus, we are going to integrate "Tomato Garden" map as well as both BS-OPM and BOPM methods in our conceptual model of reach before we will present research results. Since the binomial tree is recombining, we can also estimate the probability of exercising the option at the end of the option life. This can be done by using Pascal's triangle (named after the discoverer) as recommended by Kodukula and Papudesu (2006). A sensitivity analysis will show also the impact of main drivers of the option's value and will provide additional information for decision

making. Therefore, a value maximizing strategic decision on real estate development project will be our final point of destination in our research.

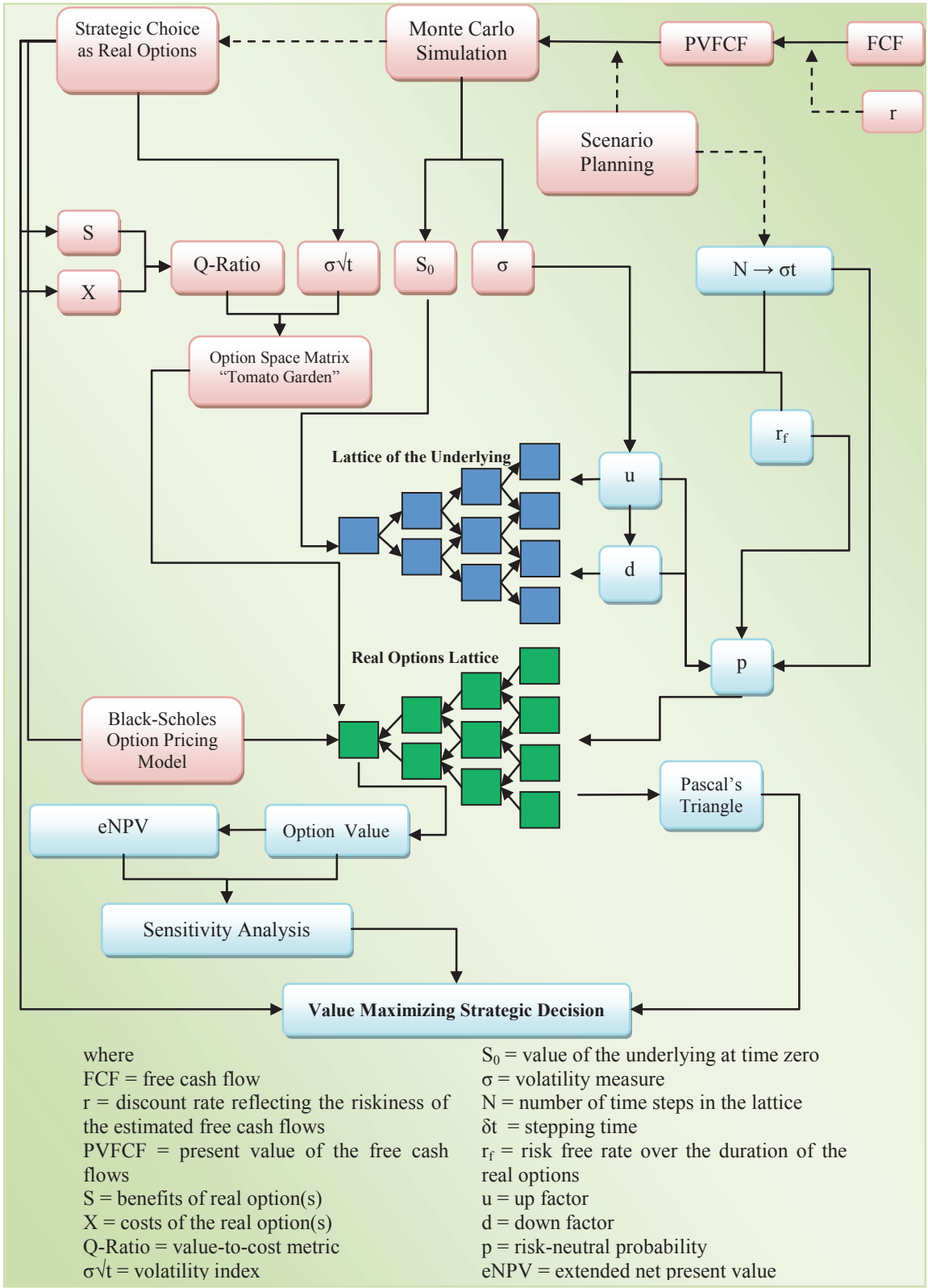
The aim of this paper is to test empirically ROV application for real estate development project with significant volatility in terms of price and strict legal regulation constraints which is changing demand. The paper empirically testing ROV application for the investment decision of ABC Project Ltd, owner of real estate development project "Sun Village" - residential construction in *Riga region* of Latvian Republic. Due to kind recommendations of companies' owners, the names of companies and the name of real estate residential project have been changed in the paper. ABC Project Ltd is considering several options concerning the project, first option is *expand option*: to finish construction and sell finished project to the buyers as soon as possible, second is *deferral option* is to wait until market conditions of real estate sector in Latvia became more clear and make investment decision later, third one is *abandon options* suggesting abandoning project to sell immediately. What we want to know is *how and to what* extent do ROV valuation can apply and thus maximize value of real estate development projects under uncertainties?

2. Description of investigation.

Paper examines the investment project in to real estate in Latvia by the ABC Project Ltd. ABC Project Ltd. has acquired property in Riga region in 2013 from other development company, which had to sell it due to its unpaid debts. There are located 15 unfinished houses which were frozen in 2009 due to economic crisis. ABC Project Ltd company has invested 237,327 € plus VAT into purchase of land and 423,833 € plus VAT in the unfinished houses purchase in 2013. Initially, company has planned to finish project and sell houses as soon as Latvian economy had been recovering. However, due to unexpected amendments in Latvian legislation on Temporary Residence Permits (TRP) for non-Schengen residents which were forced since 01.09.2014 and limited quota on TRPs, an uncertainty of future demand and volatility of prices have increased dramatically.

Therefore company decided to consider several other options concerning the project. First options is *deferral option*: to wait one year until uncertainty concerning the project will decrease and then finish construction and sell the project, second option *is abandon option*: to sell acquired property to other development company right now. Third option is *expand option*: to finish construction right now and sell. BDM Project management provided information that each house is registered in the Latvian Land Register independently what means that it can also be sold as soon as all construction works on this specific house are over. In this case company will be able to start selling houses before whole village is built, what shifts cash flows to company advantage. Investors are willing to make evaluation of each option in terms of added value. We asked research question: "How do real options affect investment decision and what option is maximizing real estate development project value"? In order to answer research question, authors will have to identify independent variables for the calculation. Most variables are provided by the ABC Project Ltd; however in order to estimate discounted free cash flows (FCF) authors will have to research prices for real estate near Riga region. It is decided to make unstructured interview with same real estate project sellers in this region in order to identify what is average price per square meter for the same houses. Thus, research question will be answered by adhering to the proceeding sequence of research activities as shown in Fig. 1:

1. identification of real options and conceptualization of their interrelations;
2. quantification of managerial assumptions in function to the FCF forecasts;
3. introduction of managerial assumptions and scenarios into Monte Carlo simulation;
4. calculation of the value of the underlying and the volatility measure via performing Monte Carlo simulation;
5. illustration of real options onto Option Space matrix: "Tomato Garden";
6. derivation of Black-Scholes option pricing (BS-OPM) formula for real option;
7. appreciation of the input parameters required for Real Options Analysis by binominal lattice;
8. calculation of binomial lattice parameters;
9. development of the lattice of the underlying;
10. creation of the real options valuation lattice via backwards induction;
11. derivation of value maximizing decisions over real option duration;
12. comparison of Options Values received by three methods: BSOP, "Tomato Garden" and binominal lattices;



where
FCF = free cash flow
r = discount rate reflecting the riskiness of the estimated free cash flows
PVFCF = present value of the free cash flows
S = benefits of real option(s)
X = costs of the real option(s)
Q-Ratio = value-to-cost metric
σ√t = volatility index
S_0 = value of the underlying at time zero
σ = volatility measure
N = number of time steps in the lattice
δt = stepping time
r_f = risk free rate over the duration of the real options
u = up factor
d = down factor
p = risk-neutral probability
eNPV = extended net present value

Fig.1. The flow chart of ROV application in real estate development project, adapted from Cirjevskis & Baduns,2015

13. determination of the probability that project will succeed by Pascal's triangle;
14. calculation of extended Net Present Value of the project;
15. conduction of sensitivity analysis;
16. decision on value maximization of real estate development project.

The flow chart of ROV application in real estate development project given in Fig. 1 and can be served as a "road map" for many similar projects in EU suffering real estate market bubble burst.

3. Data analysis and interpretation

Calculation of the real options value of a project basically starts with the computation of the underlying asset value by the traditional DCF method using a weighted average cost of capital as discount rate. Then, we will assess options values received by three methods: "Tomato Garden" map, BS-OPM and binominal lattices and will recommend value maximizing decision: choose an option type. If company choose abandon option, it means to sell unfinished houses and land right now. If company chose expand option: to start project immediately or defer option: to start project in one year, those two options will ask to finish and sell project. ABC Project Ltd management provided information that each house is registered in the Latvian Land Register independently what means that it can also be sold as soon as all construction works on this specific house are over. It will also involve company to adapt the territory in terms of electricity, roads, canalization. Moreover company will construct additional *administration house* in order to serve this property in future in terms of security, small repairs and other miscellaneous services. At this point ABC Project Ltd is considering hiring as outsource a construction company for project development in case of choosing expand option. Construction Company has also provided information on estimated construction costs. Overall investment into the project is estimated to be approximately 5 million € as given in table 1 and next explanations. In case of making investment today construction works will be finished in May 2015. Some houses may be constructed earlier in September – October 2014. Following are presented construction costs as estimated by Construction Company. All prices are presented without value added tax (VAT). Management of ABC Project Ltd also mentioned that total surface of houses constructed for sale is 4,015.55 square meters making it 992.19 € per square meter in construction costs without value added tax. Company will have approximately the same costs per square meter for each house construction. At this point direct construction costs for each type of house without administration house, beautification costs and other miscellaneous expenses are as follows: house type 1 – 828.49 € per square meter (994.38 total per sqm); house type 2 – 805.37 € per square meter (971.26 total per sqm); house type 3 – 847.59 € per square meter (1013.48 € total per sqm). The management of Construction Company also mentioned that construction prices may increase or decrease for 5.0% depending on material costs. Moreover ABC Project Ltd will pay 2.0% of net sales sum as a commission to the intermediaries and advertising expenses. Also project there will be associated with expenses in terms of salary to the management and associated taxes (administrative costs) as well as other operating expenses. Overall investment is estimated at 4,912,024.43 €. Regarding required rate of return on investment, we were informed that company founders decided to invest required for project development amount as a zero percent borrowing since investors are not demanding interest for lending money to the company. Even though, project financing is considered as hundred percent debt financing as free of interest charges, authors decided to use return available from issued in April 2014 governmental bonds as a risk free rate of return for computation of after tax cost of debt since investors could have invested this money in something else. Latvia government bonds issued in April 2014 have a 3.0 % annual return and Latvian corporate tax is at 15.0%. Thus, after tax cost of debt = 100%*3%*(1-0.15) = 2.55%. In order to estimate free cash flows it is required to identify average price per square meter in Riga region for same type of houses.

As it was mentioned previously ABC Project Ltd is considering building 15 houses available for sale. All houses will have approximately same level of luxury and therefore will have approximately the same price per square meter. In order to estimate current price per square meter it is required to find recently constructed houses available for sale in this region with following options: approximately same construction costs; terrace; well designed interior and exterior; four or more bedrooms; at least two floors; absence of unwanted objects creating loud noise, unpleasant smell, poor ecology, etc. Authors found company involved is similar project development – Realdevelopment Ltd. Realdevelopment Ltd started construction works in 2013 and have recently started selling built houses. It had planned to construct 46 houses in the Pinku village in Riga region. At this point they have constructed and registered in the land book 26 houses and provided author with information concerning their selling

prices and costs. There are five types of houses constructed by Realdevelopment Ltd. Each type has its own project; however all houses are approximately of a same level of quality and luxury with planned for construction by ABC Project company. Following are presented costs for each type of houses developed by Realdevelopment Ltd. Realdevelopment Ltd. project management is selling currently developed houses at following prices including VAT and commission fees to the intermediaries. Average selling price per square meter in Realdevelopment Ltd. is 1603,34 € with land price and 1418,90 without.

Since ABC Project Ltd purchased land for the project development for 237,327 € without VAT and is selling 4015.55 square meters of land with houses, average price per square meter is approximately 59.10 €. In this case estimated selling price per one square meter is 1418.90 € for house plus 59.10 € plus land – 1478.0 €. ABC Project Ltd management expects to sell 1 or 2 houses (10%) in 2014, 7-10 (60%) houses in 2015 and 3-7 (30%) houses in 2016. As estimated by the construction company, investment required to develop project is estimated at 3,984.176.19 €.

Table 1 – Project Sun Village construction costs provided by ABC Project Ltd.

		Nr of houses	Square meters per house	Estimated construction cost
1	House type 1	7	314	1,821, 029.59 €
2	House type 2	3	343.7	830,419.60 €
3	House type 3	5	157.29	666,587.19 €
4	Administration House	1	135.79	140,151.47 €
5	Construction site maintenance costs			31, 894.44 €
6	Beautification costs			352, 866.41 €
7	Reclamation, drainage, external networks			111,436.02 €
8	Electricity and weak currents			29,791.47 €
	Total:			3, 984,176.19 €

Moreover, company will have to invest approximately 148,000 € into administrative and operating expenses during the project life time. Additionally 2 percent of the net sales will be paid to the intermediaries and advertisement agencies making it approximately 118,699.66 €. Total investment required to obtain the asset including the currently owned property is estimated at 4,912,024 €. Present value of Free Cash Flow is 5,620,930.44 €. Thus, net present value (NPV) of investment as estimated through discounted cash flow approach is 708,906.01 €. Internal rate of return (IRR) has to be 9.21%.

We will answer research questions ""How do real options affect investment decision and what option is maximizing real estate development project value?" by estimations concerning value provided by management flexibility to postpone investment decision for *one year* till May 2015. In one year, new immigration law in Latvia will change and add certainty for decision makers. For this purpose authors apply Option space matrix "Tomato garden", then Black-Scholes option pricing model (BS-OPM), Binomial option pricing model (BOPM) and assume that all those methods will give approximately the same result. Steps required for real option valuation are presented in Figure 1. All mentioned methods require the project return volatility as an input variable; therefore authors will make scenario analysis and estimate volatility by means of Oracle Crystall Ball software. There may be optimistic and pessimistic scenario developments affecting future cash flows. Optimistic scenario assumes that prices on real estate objects will continue to grow and pessimistic that they will fall. Following is presented Latvian housing price index for the period from 2008 till 2013 by quarters taken from Latvian statistics bureau available on data.csb.gov.lv. Year 2010 is taken as a 100.0 percent. Optimistic scenario assumes that prices will continue to grow and 2010-2013 trends will continue increasing prices till the year's 2008 maximum level by the end of 2014 and will stay at this level for the next 2 years. Pessimistic scenario assumes that due to new legislation in the early 2014 and quota implementation for non resident as well as other possible sanctions against Russian citizens due to situation in Ukraine, possibility of gaining living permit in Latvia and European Union through purchase of real estate in Latvia will vanish. Authors assume that in this case demand for Real Estate will decrease and prices will fall to the year 2010 average level by the end of 2016. ABC Project Ltd management agreed to these assumptions. Average housing price index in 2010 year is 100.0 meaning that in pessimistic case prices will decrease by approximately 41.6% by the end of 2016.

Following is presented in table with price per square meter in case of pessimistic, nominal and optimistic

scenario development during years 2014-2016 developed by the authors in table 2. Author decided to use Oracle Crystal Ball (OCB) software for project return volatility estimation. Triangle distribution was used for the expected square meter price variation assumptions mentioned above. Authors decided to show only year 2014 distribution; other years are estimated in the same way.

Table 2. Price per square meter in case of pessimistic, most likely and optimistic scenario development, developed by authors.

Year	Pessimistic	Most likely	Optimistic
2014	1,273.02 €	1,478.00 €	1,624.24 €
2015	1,068.16 €	1,478.00 €	1,624.24 €
2016	863.25 €	1,478.00 €	1,624.24 €

Construction Company mentioned that construction costs may increase or decrease for approximately 5 percent depending on material costs. Authors decided to use normal distribution in the OCB software as well. ABC Project Ltd management also mentioned that in case of investing into the project there will be additional administration expenses including management salary and associated taxes as well as other operating expenses including office rent, fuel for cars and other miscellaneous expenses. ABC Project Ltd management also provided authors with data on their expectations concerning these expenses as well as possible dispersion. Authors used normal distribution for the estimated administrative expenses. Authors ran OCB software simulation 2000000 times. At each simulation OCB software has randomly took numbers in accordance with probability distribution for square meter price, construction costs, administrative and operating expenses set previously and calculated chosen by authors' parameter - free cash flows (FCF). The results of the simulation are statistics showing mean, standard deviation, coefficient of variation, etc. required for the annual volatility calculation for real options analysis. Following are presented FCF statistics received from the simulation: mean: 348,547.22 €; standard deviation: 218,616.63 €. Moreover simulation showed that project PV of FCF will be greater than zero in approximately 93.86 percent of trials. Project simulation showed 3 year estimated volatility of 62.72 percent.

First assessment of real option to wait one year for the "Sun Village" investment project has been computed with the help of Option Space matrix "Tomato Garden" metrics. Value to cost metric is calculated as follows: NPVq = S/PV = 5,620,930.44 € / 4,768,955.76 € = 1.1735 and CV (cumulative volatility) = 62.72*sqr 1 year =62.72. The "Sun Village" investment project is located in the second region "Maybe now". The "Tomato Garden" metrics second region suggests that project is very promising and its NPV is positive, however the investment decision should be considered as there is still relatively high uncertainty concerning project returns.

Even though second region suggests that it is possible to invest in the project now, there is still plenty room for improvement of investment potential. Moreover European call option pricing table showing the percentage of the underlying asset present value is shown below in table 2. Red arrows in table 2 represents crossing on NPVq – 1.17 and project estimated PVFCF volatility – 62.72 % in the option pricing table. Its value is estimated by interpolation at approximately 31.0 percent of the project underlying asset value. In this case value of the European call option to wait one year for the "Sun Village" investment project is as follows: European Call option = 5,620,930.44 €*0.31 = 1,742, 488 €.

Table 3. Black Scholes value of European call option, expressed as a percentage of underlying assets value by Luehrman (1995).

	1.06	1.08	1.10	1.12	1.14	1.16	1.17	1.18
0.60	25.8	26.6	27.3	28.1	28.8	29.5	31.0	30.2
0.6272								
0.65	27.7	28.4	29.1	29.8	30.5	31.2		31.9

In order to calculate more accurate assessment of additional value that may be provided by postponing investment decision and waiting for one year, authors decided to use next Black-Scholes option pricing model. Following input variables are required for Real Options value calculation with Black-Scholes approach. Cost of investment or exercise price (E). It is a total initial investment required to obtain the asset including the currently owned property is estimated at 4,912,024 €. Risk free rate of return*:* authors adopted the return provided by the

issued by Latvia governmental bonds in the April 2014 as a risk free rate. These bonds provide 3 percent annual return on investment. Time to expiration in years (T): since management considers postponing investment decision by one year; time of expiration is also set to this period. Present value of a project expected cash flows: as it was calculated in the first research question NPV of the project is 708,906.01 € Present value of a project to be acquired is 5,620,930.44 €. Since BSOPM and BOPM formulas in further calculation require the annual volatility of PV of FCF, author decided to convert 3 year volatility to the annual according to suggested by Kodukula & Paupudesu (2006) approach. Average annual volatility of free cash flows is estimated in Excel tables. Riskiness of the project (σ): as it was assessed with OCB software, coefficient of variation of PV FCF for 3 year period representing the standard deviation divided 0.6272, what means that volatility of project FCF is 62.72 percent. As can be observed from the table 3 in case of waiting one year before making investment decision, the value of project NPV may increase by 1,747,998.00 € according to Black-Scholes approach.

Table 4 – Black-Scholes calculation table, developed by authors.

Black-Scholes input variables	
Present value of expected cash flows(So)	5, 620, 930.44
Cost of investment or exercise price (E)	4, 912, 024.43
Risk-free rate of return (r)	3.00%
Time to expiration in years (T)	1
Volatility of PV of FCF (σ)	62.72%
d1	0.576
d2	-0.051
Value of the call option : deferral option (C)	1 ,747, 998.00 €

In order to calculate which additional value may be provided by postponing investment decision and waiting for one year, author decided to use d Binomial option pricing approaches. BOPM requires constructing binomial tree in order to identify option value. Up and down factors, time increments and risk neutral probability should be identified for this purpose. Input variables used in Black-Scholes method will be used as input variables in Binomial approach. Firstly, author has divided the time till expiration into the 5 increments for the binomial tree construction. One time increment represents is 0.2 of a year. *Up factor (u)* is used as a multiplier during one time increment step in a binomial tree. Authors used the EXP function in excel for the calculation u = 1.324.

Table 5 – Lattice of the underlying value of Sun Village project, developed by authors.

0	1	2	3	4	5
					22,850,181.13 €
				17,261,294.40 €	
			13,039,383.92 €		13,039,383.92 €
		9, 850,103.31 €		9,850,103.31 €	
	7,440,883.38 €		7,440,883.38 €		7,440,883.38 €
5,620,930.44 €		5,620,930.44 €		5,620,930.44 €	
	4,246,116.68 €		4,246,116.68 €		4,246,116.68 €
		3,207,566.26 €		3,207,566.26 €	
			2,423,033.11 €		2,423,033.11 €
				1,830,387.59 €	
					1,382,696.22 €

Authors estimated *down factor (d)* in the same way as up factor, but volatility of return is taken with minus sign, d = 0.755. *Risk neutral probability (p)* is used for calculation of expected asset value basing on its expected payoff. Authors used following formula for the calculation and made calculations with help of excel software = (exponent (risk free rate * time increment) - (down factor)/ (up factor - down factor) = 0.441. Present value of expected free

cash flows is estimated at 5,620,930.44 € and therefore is used as a starting point in binomial tree. At each time step previous tree cell is multiplies by up and down factor until 5 steps are made. At the step number 5 possible project values in one year's time are calculated and can be observed in the table 4. Then project value for each of these potential outcomes in step 5 is calculated by deducting initial investment from each of these results. In cases when there are losses, they are shown as a zero since in these cases option will not be exercised. Via backwards induction real options valuation lattice is "rolled back" on time step at a time. Accordingly, calculations begin at time step 5 and are made backwards the starting node. Author calculated values of intermediate nodes for each time step increment during this process and it can be observed in the table 6 below. Authors used Excel programme for the calculation.

Table 6 – Real option valuation lattice for Sun Village project, developed by authors.

1	2	3	4	5
				17,938,156.70 €
			12,378,653.88 €	
		8,185, 951.53 €		8,127,359.49 €
	5,139,996.26 €		4,967,462.78 €	
3,083,119.50 €		2,793,110.32 €		2,528,858.95 €
1,780, 961.21 €	1,494,136.61 €		1,108,357.67 €	
773,175.61 €		485,775.11 €		0.00 €
	212 ,907.31 €		0.00 €	
		0.00 €		0.00 €
			0.00 €	
				0.00 €

Authors calculated all intermediate values as can be observed in the table 6. Cells with zero value are situations when option will not be exercised due to its inefficiency. Option to invest is exercised at neither nodes where the option value is not zero. Zero step in the table 3 represents current period. Its value is estimated at 1,780,961.21 € what means that value of the option to wait one year before making investment decision might increase investment value till 1,780,961.21 € according to binomial option pricing model. Received with Binomial approach real option value differs from the suggested by Black-Scholes approach by approximately 1.8 percent: Black-Scholes – 1,747,998 € versus BOPM – 1,780,961.21 €. Authors assume that such difference appeared due to relatively low number of time step increments producing just 6 possible investment outcomes in BOPM as can be observed in the table 5 and 6 in the fifth step. On the other hand BOPM provide more straight forward understanding and visualizes how project uncertainty represented by volatility influences option value during its lifetime. Since the binomial tree in this example is recombining, there are many different paths leading to each node. In our case, estimation of the probability of exercising the option at the end of the option life can be done using Pascal's triangle. Therefore, the probability that the project will succeed is 16/32 = 50%. Thus, using Pascal's triangle by Kodukula and Papudesu (2006) at the end of first years, the probability of expanding the project is even at 50/50.

The option valuation shows an ROV of 1,780,961.21 € for an option to wait. Since the option value is relatively high, management may want to create a deferral option for this project. Thus, the option valuation is altering the DCF-based decision to invest at this time. Finally, authors identified that the expanded net present value (eNPV) of this project is the sum of the deterministic base case net present value 708,905 € and the strategic options value (value of option to wait) 1,747,998 € by BS-OPM making value eNPV 2,456,903 €. To provide additional insights in the real options problem, a single factor sensitivity analysis is conducted. Sensitivity analysis has been carried out by OCB software simulation. It identified the variance of free cash flows (FCF) is mostly affected by the first and second house type prices – by 60.7 % and 17.4 % consequently; construction costs variation affects FCF by 14.4%; administration and operating expense have almost no affect on FCF variation. Therefore, management may decide to keep the option of expansion open at this time to maximize value of the project significantly and exercise it when the uncertainty clears and conditions become favourable. Table 6 shows the strategic choices ABC Project Ltd company would make at different points during the option life. Our research evidences that the binomial method

makes the calculations visible and strategically flexible, so the results can be easily understood and communicated to practitioners, whereas Black- Scholes model gives higher accuracy.

Conclusion

Paper illustrates empirical ROV analysis of the investment project "Sun Village" considered by the company ABC Project Ltd. Since in case of expanding project its NPV is positive, authors decided that option to sell current project is inefficient and should not be considered. Option space metrics placed project in the second region, which means that project is very promising and should be considered; however there is still uncertainty concerning the project outcome due to high volatility level. Therefore, it was decided to identify what additional value may be provided by postponing investment decision by one year. Both Black-Scholes and Binomial approaches were used to identify the value of option to wait regarding investment decision and both methods showed approximately the same result. Finally, authors identified that the expanded net present value (eNPV) as 2,456,903 €. Moreover sensitivity analysis showed that FCF are mostly affected by first and second house type prices variation.

New immigration law in Latvia changed for the non-Schengen residents willing to get living permit since 01.09.2014 in the following way: non-resident is to buy at least one object for > 250,000 € (142,000 € before) and cadastral value > 80 000 €. Therefore, first and second house types considered by BDM Project Ltd fit all of the mentioned above criteria and such changes might have a positive affect on these houses sales by reducing competition and removing competitors whose projects are worth below 250,000 €. Other 5 houses price in case of suggested by research sq meter price is estimated at 232,000 € each. Their cadastral value will exceed 80,000 €. New Latvian legislation on Temporary Residence Permission (TRP) may pump price till 250,000 €, however new Latvian legislation amendments on private person Insolvency Law, new commercial bank policies on mortgages might diminishing price as well. Option valuation gives some idea of when it might be a good time to invest in the future, so management can plan for the investment while observing the market closely (passive learning) for the right timing. What's more, management should actively seek (active learning) to clear the uncertainty by conducting focused market surveys. As the uncertainty is resolved, ABC Project Ltd *may introduce the project anytime during* the option life. We are going to continue empirical testing of ROV application for companies strategizing in complex settings.

References

Adner, R., Levinthal, D.A., 2004. What is Not a Real Option: Considering Boundaries to Application of Real Options to Business Strategy, Academy of Management Review, 29 (1), pp. 74-84.

Black, F., Scholes, M., 1973. The pricing of Option and Corporate Liabilities, The Journal of Political Economy, Vol. 81, No.3, pp.637-654.

Borison, A., 2005. Real Options Analysis: Where are the Emperor's Clothes?, Journal of Applied Corporate Finance,17 (2), pp. 17-31.

Cirjevskis, A., Baduns, E., 2015. Valuing Managerial Flexibility: an Application of Real Option in Time of Economic Transition, International Journal of Computational Economics and Econometrics, Inderscience, Vol. 5, No. 2, pp. 143-163.

Copeland, T., Koller, T. and Murrin, J., 2000. Valuation: Measuring and Managing the Value of Companies. 3rd edition. Hoboken, New Jersey: John Wiley & Sons, Inc., pp. 339-410.

Dixit A., Pindyck, R., 1994, Investment under uncertainty, Princeton University Press, NJ, pp. 488

Folta, T. B. and O'Brien, J. P., 2004. Entry in the presence of duelling options. *Strategic Management Journal*, 25(2), pp. 121–138.

Gilbert, E., 2005. Investment Basics XLIX. An introduction to real options, Investment Analysis Journal, No 60, pp.1-4.

Cox, J.C., Ross, S.A., Rubinstein, M., 1979. Option Pricing: a simplified approach, Journal of Financial Economics, 7(3), pp. 229-263

Hull, J. C., 2005. Fundamentals of Futures and Options Markets.5th ed. Upper Saddle River, New Jersey: Pearson Education, Inc., pp. 6, 243-247, 349-255.

Kodukula, P. and Papudesu, C., 2006. Project Valuation Using Real Options: A Practitioner's Guide. Fort Lauderdale, Florida: Ross Publishing, Inc., pp. 40-48, 53-66, 72-96, 110-135.

Latvian statistics bureau data website: available on data.csb.gov.lv/en

Li, Y., James, B.E., Madhavan, R. and Mahoney, J.T., 2007. Real Options: Taking Stock and Looking Ahead, Advances in Strategic Management, 24, pp. 31-61.

Luehrman, A., 1995. Capital Projects as Real Options: An Introduction, Harvard Business School, pp.1-12.

Mauboussin, M.J., 1999. Get Real, Frontiers of Finance, Credit Suisse First Boston, Equity Research, Vol. 10.

Myers, S.C., 1977. Determinants of corporate borrowing. Journal of Financial Economics, North-Holland Publishing Company, No 5, pp.147-75.

Mun, J., 2002. Real Options Analysis: Tools and techniques for valuing strategic investments and decision, John Wiley & Sons, pp.386.

Rivoli, P. and Salorio, E., 1996. Foreign direct investment and investment under uncertainty. Journal of International Business Studies, 27(2), pp.335–357.

Tong, T.W. and Reuer, J.J., 2007. Real Options in Strategic Management, Advances in Strategic Management, Emerald Group Publishing Ltd, Vol. 24 pp.3-24.