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VALUE MAXIMIZING DECISION BY THE USE OF A REAL OPTION ANALYSIS IN CURRENT ECONOMIC CLIMATE

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Abstract

Economic climate in which companies operating Latvia have to make sound capital-budgeting decisions can be noted as an archetypical example of decision-making under uncertainty. Real Options Analysis (ROA), though not applied consistently, is still well-renowned all over the globe, but apparently neglected by Latvian companies. There are few academic works on the topic, yet none of the major companies in the Latvia have publicized ROA application. Overall aim of the research is to carry out Real Options Analysis, thereby identifying value maximizing decisions regarding the Business Unit of the Latvian Company. Having used Monte Carlo simulation, 3D Option Space and sensitivity analysis – Risk-Neutral Probability-based real options analysis, authors provided a solution to the company's problem at hand. The flow chart of ROA application has been created which would be a useful "road map" as well as valuation tool for Latvian practitioners in time of economic uncertainty.

Keywords: Real Option Analysis, Monte Carlo Simulation, 3D Option Space, Risk Neutral Probability Based Analysis.

JEL Classification: G30; G31; G39.

Introduction

While the economic crisis, which started in the late-2000s is arguably past its peak, economies all over the world still demonstrate a great deal of uncertainty and instability. Not only the financial markets, but also investment prospects currently are associated with considerable risk and volatility. One of the theories developed on how to address these hurdles associated with decision–making under uncertainty is that of real options. There are few academic works on the topic, yet none of the major companies in the Latvia have publicized ROA application. ROA, though not applied consistently, is still well-renowned all over the globe, but apparently neglected by Latvian companies. However the economic climate in which companies operating Latvia have to make sound capital-budgeting decisions can be noted as an archetypical example of decision-making under uncertainty. As the Company, subject to this study, is owned by international bodies, its owners are vaguely familiar with ROA; though its application was not considered before. Still owners/managers recognize that the situation in Latvia as well as in the industry it operates in (waste management), provides a great potential to for ROA. Having identified several strategic alternatives it can initiate regarding one of its business units and developed several scenarios, Company's managers have referred to discounted cash flow to derive results. However, it is the belief of the managers of the Company that exactly ROA could help to determine such strategy, which would maximize the value of the business unit in the present volatile conditions. The first aim of this research paper is to provide a "road map" for ROA application. Second aim of the research is to carry out Real Options Analysis, thereby identifying appropriateness of application of ROA of investment project for value maximizing decisions regarding the Business Unit of the Latvian Company. Because the problem area is concerned with how to frame and integrate real options into Company's scenario planning and capital-budgeting process, the unit of analysis in the study is a real option. The research is defined as descriptive in its purpose, quantitative in its approach, deductive in its logic and applied as of its outcome. Investigation of the issue is to be carried out as a correlational field study in a non-contrived setting with minimal researcher's interference.

Theoretical background

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 as well (Folta & O'Brien, 2004; Borison, 2005). Since the inception of the term, it has been stretched substantially (Adner & Levinthal, 2004). Real options theory provides an effective foundation to deal with decision-making under uncertainty and high risk (Luehrman, 1998; Brach, 2003; Nembhard & Aktan, 2009). The risk that there are fluctuations in the value of the underlying is expressed by the volatility factor (σ) commonly measured by standard deviation. Derivation of "trustworthy" volatility measure for the underlying is one of

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the basic hindrances in the valuation of real options (Luehrman, 1995; Thurner, 2003; Kodukula &Papudesu, 2006).

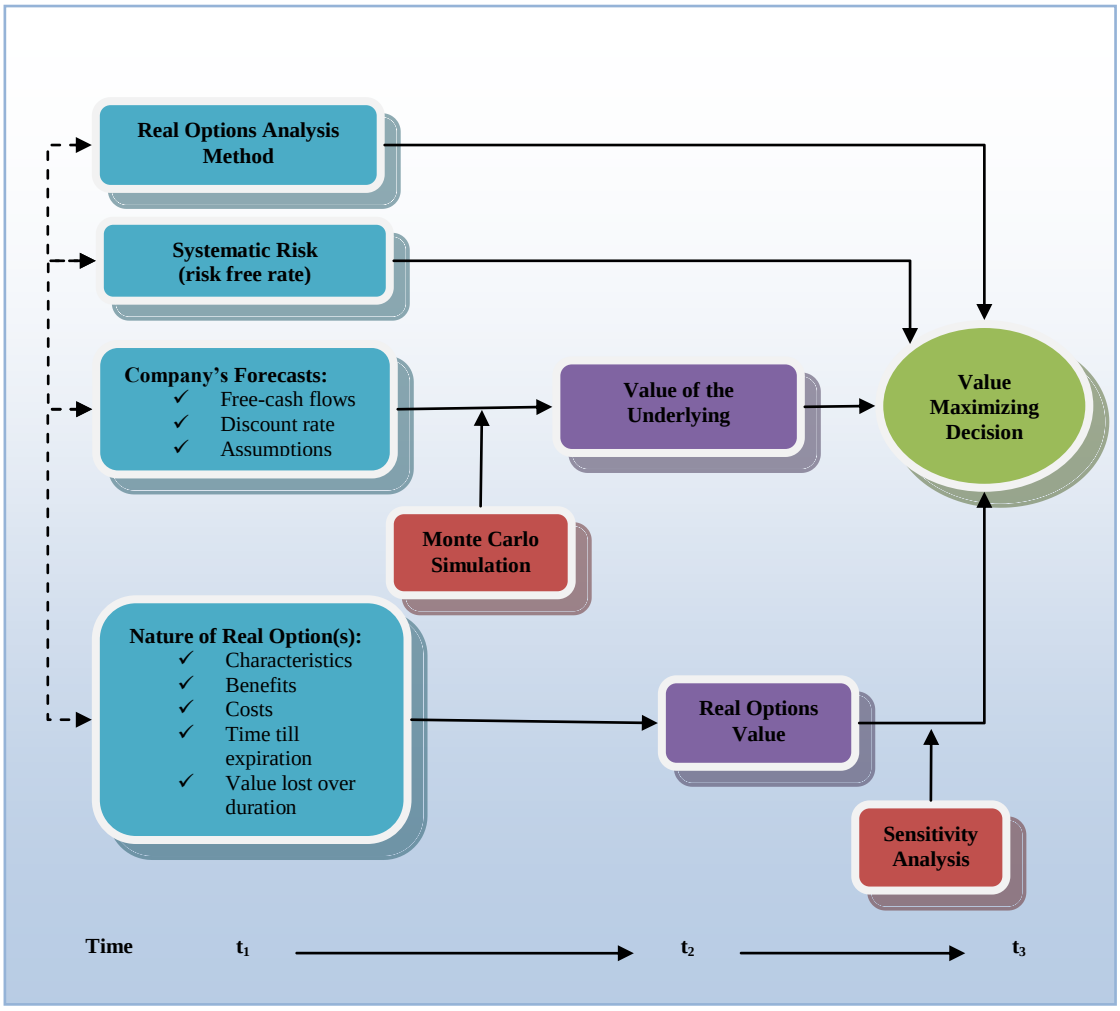

Figure 1. The flow chart of ROV application

Although not without its criticism, logarithmic present value approach (LPVA) is considered to be one of the best and hence – most often used real option volatility estimation techniques (Mun, 2002; Haahtela, 2007; Lewis *et al*., 2008). In LPVA value of sample standard deviation is the standard deviation of the natural logarithm of cash flow returns. This represents the volatility measure of the underlying or simply – volatility (σ) (Kodukula & Papudesu, 2006; Haahtela, 2007). Framing of real options refers to their illustration onto the (3D) Option Space before further analysis (Mun, 2003).Firstly introduced by Luehrman (1995), the 3D Option Space is a six region framework built on three parameters: width, height and depth (Mun, 2003; Kodukula & Papudesu, 2006). The list the mainstream ROA techniques as follows: partial differential equation (PDE), Monte Carlo Simulation (MCS) and lattices. Recombining binomial lattices are the most commonly used method to solve a real options problem (Copeland et al., 2000; Mun, 2002; Nembhard & Aktan, 2009). To derive real option value with the help of recombining binomial lattices two distinctive approaches may be applied which are based on: market-replicating portfolio (MRP) or risk-neutral probability (RNP). Most of contemporary authors resort to RNP for the analysis of a real option problem (Copeland *et al*., 2000, Brach, 2003; Nembhard & Aktan, 2009). At least two lattices are needed in RNP approach -- and more are required for compound options (Nembhard & Aktan, 2009). Firstly, the lattice of the underlying (event tree) must be constructed. Secondly, real option valuation lattice is developed and calculated in the opposite direction, back to the starting node. For descriptive appeal both may be also merged into one lattice (Mauboussin, 1999; Copeland *et al*., 2000). Once the lattice of underlying is developed for such time period, which is equal to the duration of the (longest) real option, as of the sequence presented, real option valuation lattice can be created (Bailey *et al*., 2003; Teoh & Sheblè, 2007). After

lattice of the underlying has been developed a second lattice is constructed – that of real option's valuation or decision tree (Copeland *et al*., 2000). To make a value maximizing decision it needed to compare the value of the underlying *without* any real options with the value of the underlying *with* real options exercise. To determine the monetary value of managerial flexibilities or Options Value, it is necessary to subtract the value of the underlying, which, quoting (Mun, 2002) is "the static NPV without flexibility", from the calculated eNPV derived using RNP approach, where eNPV is the PV of project or company's future profitability taking into account the embedded managerial flexibilities and contingencies. The general rule is that the difference between what was the underlying prior and after ROA, always is Options Value (Kodukula & Papudesu, 2006; Mun, 2002). Thus, two research questions (RQ's) have been developed. First research question is defined as follows: How can the managerial flexibilities Company's management has regarding its business unit be framed as real options? The first research question is concerned with the transformation of the managerial problem into a real options problem. Second research question is defined as follows: What decisions would maximize the value of the business unit over the next three years according to Real Options Analysis? It will be determined how management of the Company can proactively manage real options to maximize the value of the business unit in the future. The above-stated RQ's thus are going to be addressed in the subsequent analysis.

Research methods

To fulfill the specific aims of the study, primary data is obtained from individuals, namely Company's representatives. During several unstructured face-to-face interviews the peculiars of the problem on hand and nearly all input data necessary for ROA shall be provided. In opposition, secondary sources of data adhered to in this paper constitute those sources external and internal to the organization. Finally, during the analytical process, the data will be measured via absolute scales (i.e. differences, margins, etc.) and relative scales (i.e. ratios). BU forecasted FCF's for the next three years of operations as of 1 May 2011 (using end-of-year convention and ending 1 May 2014 are depicted as follows: in 1 year 299500 LVL (1LVL=0,7028 Euro), in 2 year 396900 LVL and in 3 year 567000 LVL. The management of the Company identified two other far less deterministic Scenarios – tentatively labeled as Slump Scenario and Recovery Scenario as well as three strategic moves it may initiate regarding the BU over the next three years, depending on the situation in the market: to expand its business; secondly, to reduce the fixed costs and thirdly to liquidate the assets. Theoretical framework of the research is presented in figure 1.Therein interaction between independent variables (blue), moderating variables (red), intervening variables (purple) and the dependent variable (green) are illustrated. Thus, first aim of our research paper has been reached. The flow chart of Real Option Value (ROV) application has can be a useful "road map" for Latvian practitioners in time of economic transition.

Result of Research

In order to provide an answer to the first research question, firstly in is necessary to view all alternative strategies the Company has regarding the BU considered through the lens of real options theory. Until spring of 2014, the Company has two real options – option to choose and option to defer. At maturity (i.e. after three years) only the chooser option will be left, thus the Company can either expand, contract, abandon or let all real options expire worthless. At maturity the deferral option would become nonexistent, since the decision to invest or disinvest can no longer be delayed. Strategic alternatives of the Company regarding the BU, viewed as real options, alongside their relations inter se are depicted in the proceeding figure 2.

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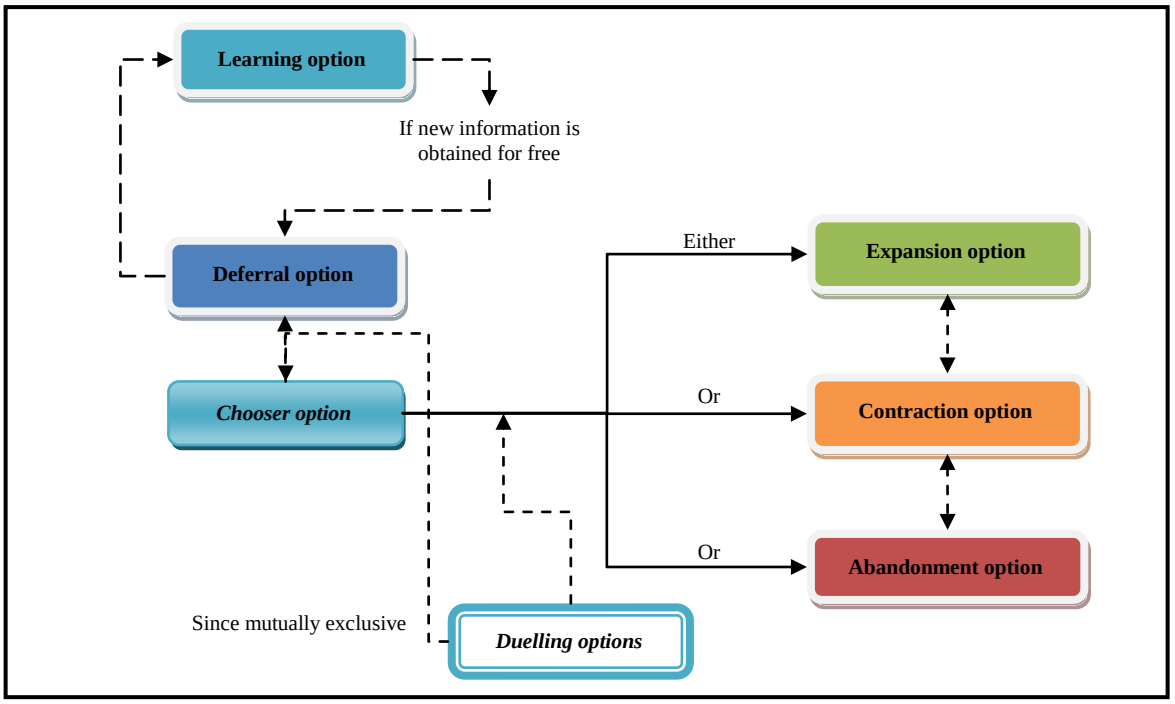

Figure 2. Portfolio of Real Options Held by the Company

At any time in the next three years the Company can choose either one of the three mutually exclusive options: a) expansion option – expand the operations of the BU by servicing new geographical regions at a cost of 145 000 LVL which would augment the FCF's generated by the BU by 25% (alternatively could be labeled as growth or investment option); b) contraction option – shrink the operations of the BU by ceasing to provide the least profitable services, thereby gaining 150 000 LVL but loosing 15% of FCF stream generated by the BU (alternatively: scale down or scope down option); c) abandonment option – liquidate the assets of the BU by selling them to another subsidiary of the parent company at 550 000 LVL (alternatively: exit or disinvestment option). Scenarios with higher probability undoubtedly are more likely to occur (i.e 50% for Base; 35% for Slump and 15% for Recovery). For the cumulative probability set to be used in conjunction MS Excel formulae, Slump scenario should be given $0 \leq p < 0{,}35$ range; Base scenario $0{,}35 \leq p < 0{,}85$ and Recovery scenario $0{,}85 \leq p < 1$. MCS is iteratively re-run 30 times and the simulated values of both S_0 and σ are noted. Afterwards arithmetic mean of these both sets is determined. Following the MCS sequence outlined, the following values are obtained: value of the underlying at time zero ($\mathbf{S_0}$) equals **880 183 LVL**; volatility factor (σ) over the duration of real options amounts to **21,28%**. The results ROV formulas for expansion option (EOV), contraction option (COV) and abandonment option (AOV) are depicted in the proceeding Tables 2 and Table 3. Once general ROV formula for each real option is determined it is possible to depict the chooser option onto 3D Option Space. Once real options are framed onto 3D Option Space, several observations can be made and presented in the subsequent Fig.3. Illustration of real options onto 3D Option Space consecutively show that only expansion option is in-the-money presently and only its exercise would augment the business unit's value. Thus, first research question has been answered. Having answered first research question, as alluded to above in this paper ROA shall be conducted by applying RNP approach answering second research question.

Table 1. Real Option Value Formula

Real Option	ROV Formulae
Expansion Option	$EOV = S - X = 0{,}25 \times S_{0_{i,j}} - 145\,000\ (LVL)$
Contraction Option	$COV = S - X = 150000 - 0{,}15 \times S_{0_{i,j}}\ (LVL)$
Abandonment Option	$AOV = S - X = 550000 - S_{0_{i,j}}\ (LVL)$

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Based on the managerial assumptions and MCS, PV of the underlying (S_0 = 880 183 LVL) and volatility (σ = 21,28%) is already determined. The last parameter to be identified thus is the risk free rate over real options duration - the fixed interest earned on a (last issued) three year bond is 5,5875%. Following the calculations of all lattice parameters, ROA by applying RNP approach can be conducted. Initially lattice of the underlying is constructed and afterwards – real options valuation lattice. Taking the value of the underlying at each node, ROV can be calculated and the value maximizing decision can be identified at that node. Identification of value maximizing decisions shall start from the terminal nodes and then the tree is "rolled back". At any node, the value maximizing decision is to be determined by weighting the value of the underlying *without* real options' exercise (or deferring the decision) against *with* real options' exercise.

Table 2. 3D Option Space Input Parameters

Real Option	**PV(S)** (LVL)	**PV(X)** (LVL)	**Q-Ratio**
Expansion Option	220 046	123 177	***1,79***
Contraction Option	103 958	132 027	***0,79***
Abandonment Option	381 178	880 183	***0,43***
Volatility Index (σ√t)			
Time Till Expiration (years)	3		
Volatility Measure (σ) (%)	21,28%		
Volatility Index (σ√t)	***0,37***		

The value of the starting node, determined via backwards induction, is calculated as 989 701 LVL. This figure represents eNPV or the total value of the BU, taking into consideration the identified real options, *if* value maximizing decisions shall be made at all instances. It is possible to determine the monetary value of the flexibilities Company's management has. From the equation above it can be determined that if managers would indeed make value maximizing decisions over the next three years, it augments the value of the *BU by 109 518 LVL or 12,44%* ([eNPV-NPV]/NPV). The results of Real Options Analysis using risk-neutral probabilities during the analysis of second research question indicate that the value of the BU the next three years is maximized if the decision currently is deferred. Finally, Sensitivity analysis is performed on eNPV or the total value of the BU whereby the major factors of ROA is altered in +/- 10%, one at the time. Sensitivity analysis points out that the underlying and expansion option predominantly affect the expanded value of the BU over the next three years which is calculated as 989 701 LVL.

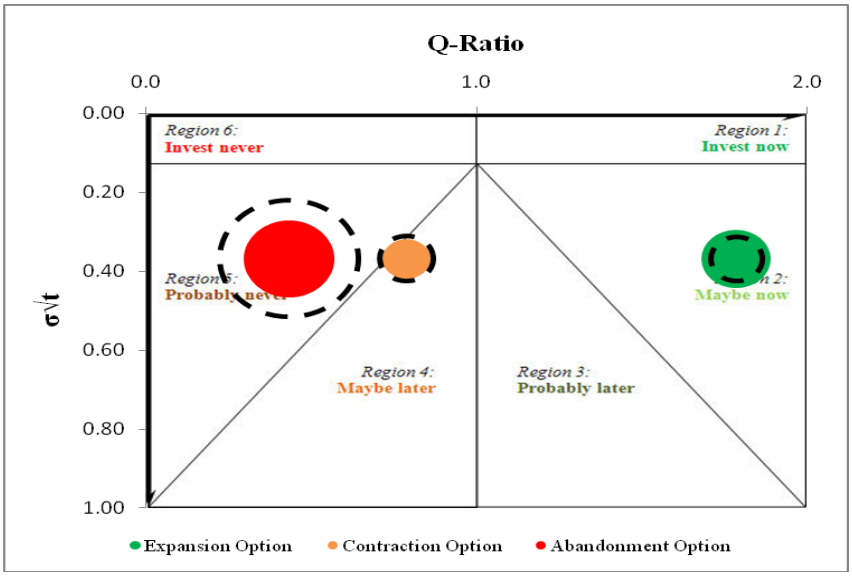

Figure 3. Real Option onto 3D Option Space

Conclusion

The aim of this research was to carry out Real Options Analysis, thereby identifying value maximizing decisions regarding the business unit of the Company over the next three years. The aim has been reached answering on two research questions. The first research question dealt with transformation of the managerial problem into a real options problem and was defined as: How can the managerial flexibilities Company's management has regarding its business unit be framed as real options? It viewed the strategic alternatives available to the Company regarding the business unit consider through the lens of real options theory. In function to the analysis made the following conclusions can be made: Strategic alternatives can be framed as real options. Real option permits the Company to either expand, contract or abandon the business unit in the next three years, each having unique benefits and costs. The most objective estimate of business unit's value over the next three years is 880 183 LVL and real options can be valued in function to this figure. The stated value can be derived on the basis of Monte Carlo simulation performed in accordance with DCF analysis as well as managerial assumptions. Volatility associated with the forecasted free cash flows generated by the business unit over the next three years is 21,28% according to Monte Carlo simulation conducted. This factor principally affects the value of real options. Expansion option is the only real option whose benefits currently exceed its costs. Other real options are out-of-the-money. The second research question was formulated as: What decisions would maximize the value of the business unit over the next three years according to Real Options Analysis?

While providing an answer to this research question, Real Options Analysis using risk-neutral probabilities was carried out. Accordingly, the proceeding conclusions can be drawn: Value maximizing decisions over real options' duration can be determined using risk-neutral probabilities in the given case, as the characteristics of real options permitted its application. Real options value formulae and identification of necessary lattice parameters allowed to contrast individual real options and thus identify value maximizing decisions at different points of time. Up till the end of second year (time t_4) expansion option, contraction options as well as abandonment option (jointly constituting chooser option) are suboptimal to realize, since value of the business unit is higher if decision is postponed. Expansion option is in-the-money at more nodes that abandonment and contraction options. While early exercise of expansion option is not preferred, given its relatively high benefit-to-cost ratio it is the most valuable real option according to risk-neutral probability approach. Currently the value maximizing decision regarding the analyzed business unit is to defer investment or disinvestment. The value of waiting (and learning) or deferral option is higher than that of a chooser option as of present. The monetary value of managerial flexibility is 109 518 LVL**,** if Company's management would make value maximizing decisions regarding its business unit at all instances. The abovementioned figure augments the value of the business unit over the next three years by 12,44%. Total value of the business unit, taking into account managerial flexibilities, over the next three years is most sensitive to changes in the value of the underlying and expansion option. These constituents predominantly shall determine the value of the business unit over the next three years. There are three categories of limitations of the research. First deals with the validity of data provided to the researchers. In case the data is subject to a change (which is most likely due to continual nature of Real Options Analysis), the analysis shall become voided. Thus the recommendations were valid only as of 1st May of 2011; any update of data after the mentioned date is beyond the scope of this paper. Secondly, the analytical approach used is subject to certain limitations. Real Options Analysis applied was that of risk-neutral probabilities – inevitably this approach has to make certain assumptions. Last but not least, it should be stressed that due to the mathematical complexity involved, real options problems are far better solved using specialist software. This paper addresses managerial problem in a relatively simple way (even for real options theory) thus financial results should be interpreted and perceived as approximations only. The study conducted may be continued in a number of directions, whereby problem analysis can be made more robust by referring to: compound and sequential compound options; game-theoretical frameworks or Option Games; non-recombining and/or multinomial lattices; Fuzzy Pay-Off Method for Real Options Valuation. It would underpin appropriateness of ROA of Investment Project in Latvian Economic Climate.

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