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Real Options Mitigate the Risk of the Rejection Good Projects

The purpose of implementing projects into the business activity should be to create a solid ground for enterprise development by increasing the competitive edge.

The enormous number of defaulting projects has created the need for project evaluation not only before its implementation but over its entire life cycle. About 67% projects fail or deliver very poor results because of different issues and mistakes during implementation[3]. The failure of projects indicates deficiencies in the analytical process. The enterprises applying only DCF (Discounted Cash Flow) method are not able to recognize good projects with a good business idea and good fundamental reasoning. The Real Option Model (ROM) empowers identification of high-value projects which are frequently rejected by DCF model. This methodology helps in dissent evaluation and forecasting the com-pany value. ROM is not more difficult in application than DCF and additionally delivers added flexibility in the decision-making and management process during the project development. This article presents principles and characteristics of the real options model, and discusses the process of its application in appraisal of the projects with negative DCF with the focus on analysis of results impacted by the volatility.

Principles and Characteristics of the Real Options Model

One of many concepts offered by the finance theory, which has strong practical applicability, is the ROM. The basic concept in application of ROM for project evaluation refers to identification of the difference between the value of the project and the value of the investment or debt to undergo the project. Although this concept has some roots in the finan-

Figure 1 **Relationship between the Volatility of the Company Value and the Positive Equity**

Distribution of the Project Value

D = Debt

E = Value of the Equity
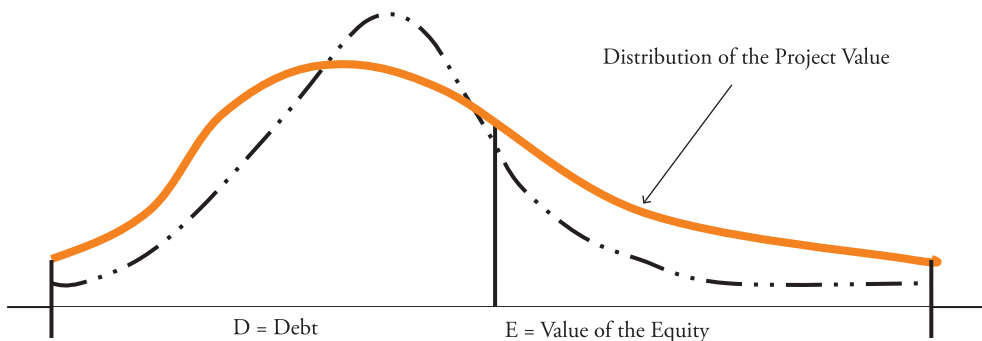
cial option model it is much different. Referring to the financial options we can label the value of the project as the value of the underlying assets and the value of the investment would be an equivalent of the exercise price. In other words, if value of the project is over the value of the investment or value of the debt, then the surplus can be called equity obtained from the project implementation. This surplus, over the invested amount funded by bank loan, is the best, at the first glance, simple measure of project effectiveness. Based on the value of this surplus investors can quickly decide whether there is a need for additional analysis. The next formula reflects the surplus generated in ROM:
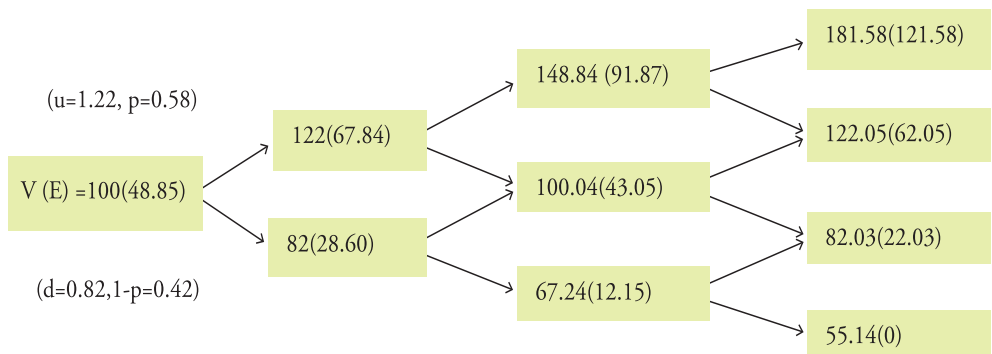
$E = V - D$

Where:

V = Value of the project,

D = Value of Debt.

The volatility or standard deviation of the project value is an essential component of ROM, which is not inherent in the DCF model. The volatility, in addition, is a function of time increasing with passage of time. The volatility in discussed concept can be perceived as a driver of the value. Figure 1 shows that the wider the distribution the higher the chance to gain positive equity or surplus resulted from project implementation.

The main purpose of this paper is to reflect how much the ROM is valuable in the appraisal of project with negative NPV as concluded by DCF model. There is high probability of the rejection good project associated with application of the DCF methodology. DCF model doesn't perceive the value arriving from the volatility component. ROM is a tool with more dimensions used in observing the project value. ROM increases the quality of the project evaluation and therefore is recommended to managers as a decision-making tool in both projects with negative and positive NPV. The most frequently used method for evaluation of the investment projects has historically been the DCF concept. There are many disadvantages of DCF assumptions versus realities to which the ROM has positive solution[4]. The ROM gains on the increasing popularity as well in the Enterprise Risk Management[5].

The ROM requests to decompose the uncertainty sources by reflecting them in the specific measures like the mean value and the standard deviation for certain risk types like change in the cost, revenue, interest rate or other value driving factors[6]. The chief benefits of using the ROM in project appraisal is its logic coherence with the business agreements signed by parties contributing to

Figure 2 **Three-period scenario of the project value and equity value**

Table 1 **DCF model of the project for startup-company**

Cash Flow Items	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	0	1	2	3	4	5	6	7	8	9	10
Quantity sold		300	323	384	410	456	487	518	557	617	713
Quantity growth rate		7.8%	18.9%	6.6%	11.3%	6.8%	6.4%	7.4%	10.9%	15.5%	11.5%
Price per unit		35.00	37.24	38.76	40.06	42.84	47.64	51.29	58.00	63.25	65.84
Price growth rate		6.4%	4.1%	3.3%	6.9%	11.2%	7.7%	13.1%	9.1%	4.1%	1.4%
Variable cost per unit		12.00	12.31	12.61	12.78	12.92	12.88	13.04	13.27	13.65	13.92
Variable cost growth		2.6%	2.5%	1.3%	1.1%	-0.3%	1.2%	1.8%	2.9%	2.0%	2.8%
Revenue		10,500	12,047	14,901	16,411	19,532	23,189	26,574	32,281	39,042	46,946
Cost of goods sold		3,600	3,981	4,849	5,236	5,889	6,269	6,754	7,384	8,428	9,928
Gross income		6,900	8,066	10,052	11,175	13,644	16,921	19,820	24,897	30,614	37,018
Sales cost		2,048	1,487	2,368	2,780	1,788	3,362	1,689	6,117	6,354	5,997
Fixed cost		250	250	250	250	250	250	250	250	250	250
EBITDA		4,602	6,329	7,434	8,145	11,606	13,308	17,881	18,530	24,010	30,771
Depreciation		4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
EBIT		602	2,329	3,434	4,145	7,606	9,308	13,881	14,530	20,010	26,771
Taxes		120	466	687	829	1,521	1,862	2,776	2,906	4,002	5,354
Net Income		481	1,863	2,747	3,316	6,084	7,447	11,105	11,624	16,008	21,417
Depreciation		4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
ΔNWC		—	(155)	(285)	(151)	(312)	(366)	(338)	(571)	(676)	(790)
Investments	40,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Free Cash Flow	(40,000)	481	1,709	2,462	3,165	5,772	7,081	10,767	11,053	15,332	20,627
PV of DCF		418	1,292	1,619	1,810	2,870	3,061	4,048	3,613	4,358	5,099
Cumulative PV of DCF		418	1,711	3,329	5,139	8,009	11,070	15,117	18,731	23,089	28,188
PV of DCF incl. RV	163,514								PV of Residual Value (RV) =		135,327
NPV incl. RV	123,514										
NPV excl. RV at Time	(40,000)	(39,582)	(38,289)	(36,671)	(34,861)	(31,991)	(28,930)	(24,883)	(21,269)	(16,911)	(11,812)

the project and the coherence with the character of the decision process. The ROM simulates optional decisions and estimates the outcomes based on different assumptions what leads to the added value[7].

Computation the Present Value of the Equity Generated by Project

In order to explain how ROM works let's assume the project which works over three years and which requested to draw D amount of bank loan. The project value evolving over time is presented on Figure 2. The initial project value, which is calculated in the DCF model, is denoted by V_0. The evolution of the value forward through following branches of the binomial tree, over the time, finally approach last stage at the end of the third year tree. At the end of the third year, the owners of the project should repay the bank loan (D). To compute the surplus generated by project, we subtract from the values of the project as shown in each node of the last stage (third stage) the value of bank loan supposed to be repaid. If the difference is positive then we put it into the node, but if it is negative we put zero into

the node. These differences can be called components of the surplus expressed in terms of the future value. After discounting each of these differences to start of the tree we obtain the present value of the surplus and this can be called as equity driven out by project.

Let's now show the how the formulas work in the example in order to compute the present value of the equity value. The example demonstrated on the Figure 2 assumes the volatility equal to $\sigma = 20\%$, and the basic time-period ($\Delta t = 1$) is equal to 1 year. Initial value of assets at time (t_0) equals to $V_0 = 100$. Value of the bank loan due to be paid at the end of the last year equals D = 60. In following periods, the changes are assuming two alternatives of jump-up or drop-down. From each node there are two routes and each following road is independent on the previous one. The time perspective assumed in that example corresponds to the 3 years (T=3), the continuous growth rate equals to r = 5%. In Figure 2, there are two numbers in each node. First number relates to project value and the second, in brackets, to the equity value in the subsequent stages of the binomial tree.

Figure 3 **Distribution of project's PV obtained from DCF model and Monte Carlo simulation**
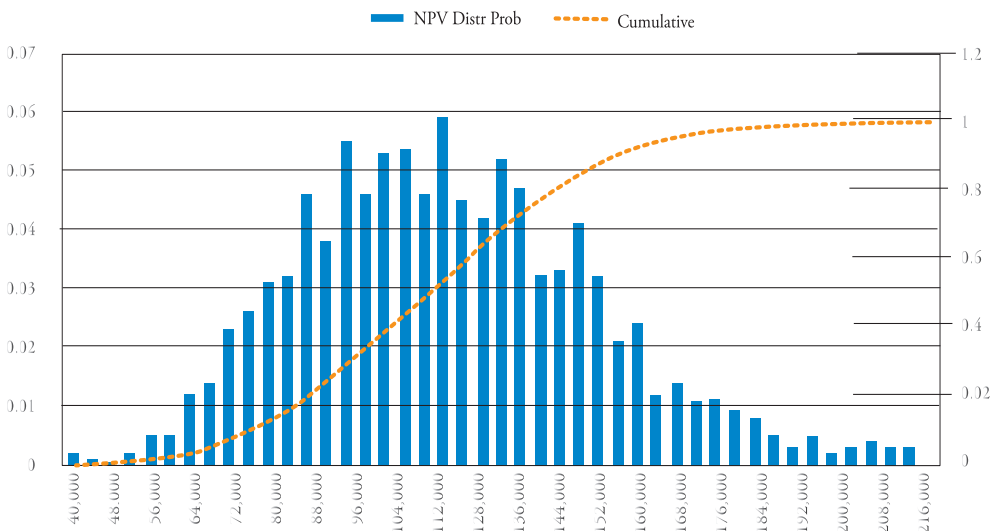
Table 2 **Assumption to the DCF model of the project for startup-company**

Source of Uncertainty	μ	σ
Quantity growth rate: R q=μ+σ N(0,1)	10.0%	7.00%
Price growth rate: R p=μ+σ N(0,1)	1.0%	4.00%
Variable cost growth per unit: Cg=μ+σ N(0,1)	3.0%	3.00%
Sales cost as a % of revenue	25.0%	5.00%
Tax rate	20.0%	
ΔNWC as a % of Δ Revenue	20.0%	
Discount rate	15.0%	

The computation of the project value utilizes following formulas:
The rate of increase in project value in each period equals: $= e^{\sigma\sqrt{\Delta t}}$,

$$u = e^{\sigma \times \sqrt{\Delta t}} = e^{0,2 \times \sqrt{1}} = 1{,}22$$

The rate of decline in project value in each period equals: $d = e^{-\sigma\sqrt{\Delta t}}$,

$$d = e^{-\sigma \sqrt{\Delta t}} = e^{-0,2 \times \sqrt{1}} = 0{,}82$$

In order to derive the present value of the equity we calculate, the so called, risk neutral probability.

Probability of increase in value equals to: $p = \dfrac{e^{r\Delta t} - d}{u - d}$, $p = \dfrac{e^{0.05 \times 1} - 0.82}{1.22 - 0.82} = 0.58$

Probability of decline in value equals to: $1 - p$, $1 - 0{,}58 = 0{,}48$.

The debt value we have to repay to the bank at the end of the third year equals to 60. Equity value in each node is the last third period equals to: most upper node 181.58-60 = 121.58; next node from the top 122.05-60 = 62.05; second node from the bottom 82.03-60 = 22.03; most bottom node 55.14-60 = 0. In the lowest node value of the equity equals to zero since the negative value of the assets doesn't exists. We calculate the value of the equity in each node for the second period by discounting the values of the equity, connected to that node, from the third period.

Value of the equity in most upper node in second period equals:

$$E_{12} = \frac{p \times E_{13} + (1-p) \times E_{23}}{e^{rt}} = \frac{0.58 \times 121.58 + 0.42 \times 62.05}{e^{0.05 \times 1}} = 91.87$$

Value of the equity in the middle node in second period equals:

$$E_{22} = \frac{p \times E_{23} + (1-p) \times E_{33}}{e^{rt}} = \frac{0.58 \times 62.05 + 0.42 \times 22.03}{e^{0.05 \times 1}} = 43.05$$

Value of the equity in the lowest node in second period equals:

$$E_{32} = \frac{p \times E_{33} + (1-p) \times E_{43}}{e^{rt}} = \frac{0.58 \times 22.03 + 0.42 \times 0}{e^{0.05 \times 1}} = 12.15$$

Table 3 **Assumptions, variable and results in the ROM in 5 year time horizon**

Assumptions, variable and results in the ROM	Symbol	Value
Share of the equity in total funding sources	We	0.2
Share of bank loan in total funding sources	Wd	0.8
Initial value of the equity	E	26.4
Value of the bank loan	D	105.6
Initial value of total funding	S	132
Bank loan at the end of the project (interest paid ongoing)	K	105.6
Annual rate of risk free government bonds	Rf	5%
Volatility of the project value	σ	30%
Period of time between two steps in ROM	Dt	0.5
Rate of increase in project value over one period	u	1.24
Rate of decline in project value over one period	d	0.81
Probability of increase in project value over one period	p	0.51
Probability of decline in project value over one period	1-p	0.49
Option value	Co	36.94
Added value (option value minus initial equity)	Co – E	10.54
Future value of the option at the end of the investment period	C10	47.43
Increase in the value of the equity	ΔE%	79.7%
Average annual nominal return on equity	ROE	11.7%
Value of the discounted cash flow	DCF	105.00
Discounted cash flow minus investment	NPV	-27.00

We calculate the equity values in nodes for first period and the present value in the similar mode like we calculated for the second period. We can finally conclude that the discussed project will generate 48.85 present value of the equity after paying the bank loan attracted for the project implementation. To start the ROM application we need to estimate two main inputs; one is the volatility and the second is the initial value of the project. There are several methods for estimating the volatility but we advise the Monte Carlo method because of its good quality and accuracy, and this method can be easily performed applying the functions available under the Excel spreadsheet[8]. In next part of the paper we present the process for estimation the volatility and the initial value of the project based on the DCF model and Monte Carlo analysis.

Computation of the Initial Value and the Volatility of the Project

Estimation of the volatility, applied in the ROM, based on the DCF and Monte Carlo simulation follows subsequent stages:
- Building the DCF model by selecting appropriate cash flow items and discount rate.
- Identifying key uncertainty sources like for example: quantity of products sold, cost of raw materials, costs of sales.

Figure 4 **Relationship between the option value and time of the project is operating**
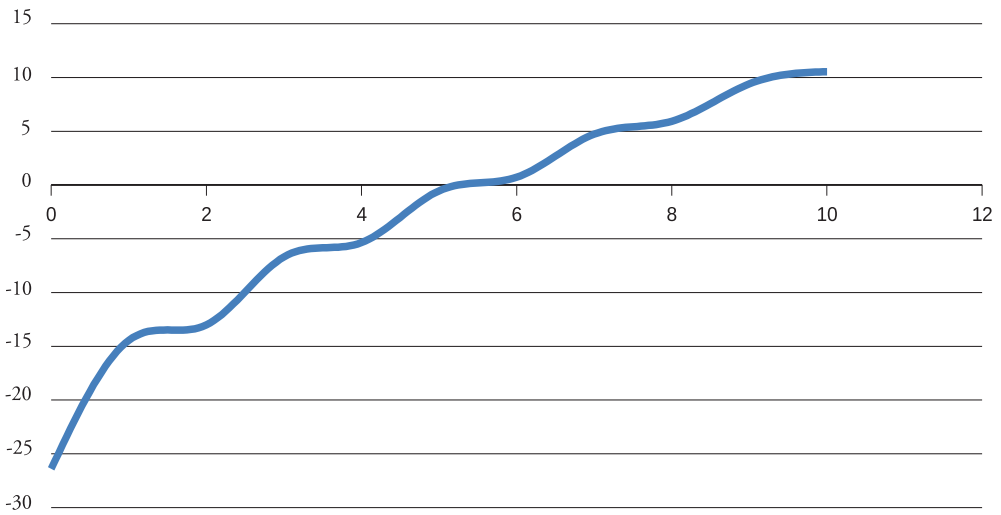
- Assigning appropriate distribution, adequate to the nature and the character of the specific risk, to each uncertainty source.
- Creating a model under Excel spread sheet simulating about 1000 different present values of cash flow coming from DCF model.
- Calculating the following basic parameters of the distribution obtained from Monte Carlo simulation: minimum value, maximum value, average value, standard deviation and the volatility (standard deviation/average value).

The above procedure will be illustrated with data presented in Table 2. Data in Table 2 are for startup-company. We presumed that the data displayed in the Table 2 adopt the project implemented over 10 years with an option to be extended for unlimited time afterwards. Assessment of the value of such an option would help to undertake early steps towards selling the company or attracting the additional investors before end of the project. Present Value (PV) of cash flow includes the Residual Value (RV). We deal with the project, which, based on the DCF model, creates after 10 years

Figure 5 **Relationship between the Return on Equity and Volatility**
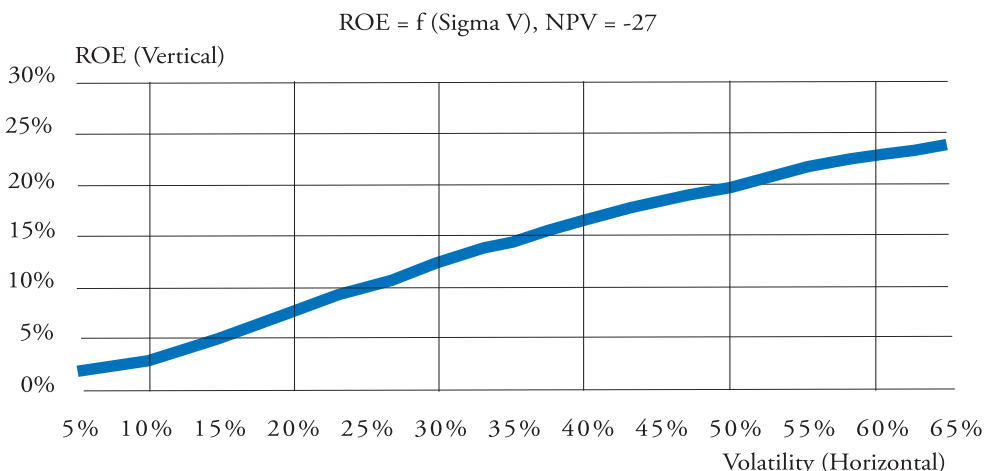
negative Net Present Value (*NPV*). These types of cases are most interesting to be processed in the ROM mainframe, and this is a kind of case, which is directly related to the main thesis of this paper. We will show sensitivity analysis, which helps to obtain positive conclusion leading to undertaking the project which initially was perceived as negative. Obtaining the answer about how project can really perform, before preparation of arguments for any future decisions helps owners in preparation of the negotiation strategy concerning the price when selling the project.

In the presented DCF model we considered four sources of uncertainties: change in quantity of sold products, change in the price of product, change in the variable cost of manufactured products driven by the changes in raw material costs, changes in the costs of sales. There are other sources of uncertainties which can be considered. The choice of uncertainty sources is by no means limited and depends only on the fundamental, business, and economic sense. For example the change in net working capital can be reflected by random characteristic measured by an average and the standard deviation in respect to change in revenue. Table 3 contains the characteristics of the selected uncertainties and assumptions about the tax- rate, discount rate and the demand for net working capital relative to the level of revenue.

First uncertainty source come from likely variations in the quantity of sold

product. We assumed that the growth rate in quantity of sold products is stochastic with an average annual growth rate of 10% and the normal distribution of random growth component with the standard deviation of 7%. In fact, for the simulation of the change in the quantity of sold product would be more adequate applying lognormal distribution instead of the normal one, since the quantity of sold products never declines below zero. The price uncertainty is characterized by steady annual growth of 1% and the standard deviation of 4%. The variable costs are uncertainly growing with the annual average of 3% and the standard deviation of 3%. The last risk item relates to sales costs which are assumed to be relative to the revenue. These costs are random with an average of 25% of revenue and the standard deviation of 5%. Performing a thousand of simulations we obtain the series of PV's facilitating creation of the distribution of PV's. Figure 3 illustrates the result of Monte Carlo simulation process. In the presented example we applied 1000 simulations. The simulation was made in the spread sheet model under Excel. The distribution, presented in Figure 3 has minimum value of 37,328; maximum value of 221,632; the mean value of 114,245; and the standard deviation equals to 31,262. Based on these numbers we can calculate the volatility as the standard deviation over the mean value.

This calculation can be given by following formula:

$$Volatility = \frac{Standard\ Deviation\ of\ Value}{Mean\ Value\ (S_0)}$$

$$\sigma = \frac{31,262}{114,245} = 27.4\% \qquad \sigma = 27.4\%;\ S = 114,245$$

At this point we approach an end of this section by concluding with output numbers of the volatility equal to, $\sigma = 27.4\%$; and the mean of present value of the project equal to $S = 114,245$.

These two numbers are the input data for the Real Option Model which will be discussed in next section.

Value-Added Sensitivity Analysis in Real Option Model

There are variety of approaches to assessment the project effectiveness depending on type of project area of the economy and goal of the projects[9]. One of the several approaches but probably most typical one will be illustrated by following case. We will present the process of financial analysis, including the sensitivity analysis, of the project effectiveness, in order to identify limits, constrains, and the conditions making the project effective. An example of the assumptions of the project characteristics are presented in the Table 4.

We consider the 5 year project with the NPV equal to -27, and this is the case which applying the DCF concept would result in rejecting the project. We would like to consider under what circumstances the project creates the value and when it can be implemented. The initial value of PV of DCF of the project equals to 105, but the project requires the funding in amount of 132 and we assume that 20% of funds are coming from the shareholders and 80% from the debt. The Monte Carlo simulation, which was presented in previous chapter, results in the volatility of project value equal to 30%. The rate of increase (u=1.24) and rate of decline (d=0.81) in the project value are computed in Table 4 based on the volatility 30%. Assuming these parameters, and applying the ROM analysis we conclude with added value of the project amounted to 10.54. The added value, presented in Table 4, is a difference between present value of initial equity and the present value of the option. It is worth to note that the assumed interval of time for steps in ROM is a half a year, and the risk free rate equals to 5%. The first conclusion at this stage is that the project became profitable with volatility of 30%, and indicating to 11.7% annual return on equity. Any increase in volatility would likely increase the project value but this rule is limited. Any decline in volatility will likely result in decline in project value.

Depending on the volatility and NPV of the project managers can observe the break-even period. In the example with NPV = -27 and Volatility = 30% the break-even period equals to 2.5 year. This relation was presented on the Figure 4. Another interesting relationship supporting the manager's decision-making process is between the ROE (Return on Equity) and the volatility with the NPV assumed constant -27. This helps managers to identify if the computed volatility enables to obtain expected return, since for each shareholder the cost of capital can be different.

The Figure 5 theoretically indicates to unlimited linear increase in return in respect to volatility, but practically we should limit this to the level of about 60% to 65%. Another important issue is to verify calculated volatility by benchmarking it against similar projects in industry, market segment or economy. There are many methods of benchmarking, but the limited scope of this paper unable to present them. Different studies show that multidimensional analysis of project performance declines the bank risk and improves credit rating of the borrowers.[10]

Conclusion

Appropriate risk management can drive the company value in the positive direction[11]. ROM helps to identify cases with values driven by risk, therefore this method looks to be promising tool for project evaluation enabling managers to explore more efficiently the company resources. Real options concept has several applications, for example enterprise default risk evaluation, which are in line of company and project effectiveness analysis[12]. The flexibility of the ROM as a tool for high quality added value decision-making creates a good potential and confidence for wider implementation of this concept into the economic activity[13]. We anticipate that the advantages and features of the real options model will impact the increasing interest for its application in all type of businesses and projects.

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