

RISK-ORIENTED INVESTMENT IN MANAGEMENT OF OIL AND GAS COMPANY VALUE

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ABSTRACT

Capital-intensive investment projects with high level of risk are the driver of the company's value growth, but under certain conditions they may lead to a default. The financial cycle specifics of the projects in oil and gas industry related to the need for significant initial investment, as well as structural specifics of raising capital, determine the necessity of an integrated and comprehensive assessment of investment risks.

The article offers the author's approach to assessing the impact of investments on the value of oil and gas business, based on RAROC (risk-adjusted return on capital) indicator. A method of an investment project-risk assessment is devised taking into account modern approaches to risk management in the industry. Proposed is a selective algorithm for making an investment decision on the basis of a double criterion index of efficiency, with due regard to the taken risks and comparison of target and unacceptable solvency. The practical focus of the research is shown on the example of investment portfolio analysis of an oil and gas company. The results of the research can be used in the process of financial decision making by management of oil and gas companies, and by investors and analysts.

Keywords: economic capital, investment risks, investments, oil and gas company, RAROC model, selection of investment projects, unacceptable risk, value management.

1 INTRODUCTION

Defining a modern model of the world economic development, the oil and gas business is characterized by the presence of a significant number of risks, that have a negative impact on the performance of companies in the industry. At the same time, at implementation of investment projects of oil and gas companies associated with the construction of new or modernization of existing facilities, there appear further complications related to high-capital intensity and long payback period of investments. These factors create a contradiction in making objective investment decisions, hinder the industry development and determine the main challenges facing an oil and gas company.

These tasks shall be solved by the development of an approach, which will allow a comprehensive evaluation not only of the efficiency of an oil and gas company as a whole, but also of each of its subsidiaries, as well as identifying, with the account of the industry specifics, those of them that are unprofitable and lower the economic value of the company.

The result of this research is the author's approach to assessing the value of oil and gas companies, based on the RAROC model, which allows evaluating the investment effectiveness in various areas of business and types of risk, and developing a program of the company cost management.

In the future, the use of such tools must become the basis of making strategic management decisions related to the optimization of oil and gas companies.

2 VALUATION OF OIL AND GAS COMPANY

Valuation of business pursues a variety of goals, both strategic and operational in nature, and related to the decisions of owners and top management of a corporation. In this article, the main purpose of the valuation of oil and gas companies means not only assessing the level of efficiency of the business as a whole and its individual areas, but also the development on this basis of a cost management mechanism for oil and gas companies based on the quality of managerial decisions.

The original concept of company valuation based on the method of economic value added (EVA), as proposed in the 80s of twentieth century by Stern Stewart & Co consulting company, was further developed in the framework of RAROC models. This model allows accounting of the existing risks in the company as a whole and in its individual units, applying the basic principles of the theory of economic capital.

Under this approach, the value of the business is being transformed on the basis of profitability, adjusted for the level of accepted risks as shown in eqn (1):

$$EP = (RAROC - HR) * ECAP \quad (1)$$

where EP - economic profit, which characterizes the added value of a business; RAROC - risk-adjusted return on capital; HR - hurdle rate, which characterizes the required profitability of the stock capital, assessed through CAPM model; ECAP - value of economic capital.

Given the RAROC transformation into economic profits, it is easy to show, which investments create value and which ones destroy it, based on the comparison of RAROC and HR. If the value of RAROC exceeds the hurdle rate, the investment value is created, if $RAROC < HR$, the value is destroyed [1].

2.1 Specificity of RAROC model in valuation of a company

In the economic literature, the acronym RAROC means risk-adjusted return on capital, which represents a financial indicator of return on equity, adjusted for risk.

The RAROC model includes a set of methodologies and facilitates the development of new opportunities for the support of decision-making process and development of applications on valuation of economic capital and calculation of profits from economic capital, risk based on the level of the whole company and its individual units [2]. The method is based on finding common factors between existing risk, capital and company value.

In broader terms, the RAROC method makes it possible to evaluate all the risks assumed by the company, and measures the economic capital on the basis of each single risk, as well as their correlation. This method enables solving a various range of tasks: from measuring of profitability to capital management and capital investment strategies. This method makes it possible to manage capital, clearly aware of how much money is required to ensure all risks of the enterprise, where it is invested and what the return on this expense will be achieved, while taking into account the contribution of each of the risk types to economic capital by finding independent distribution for each component type of risk and synthesis of these components and combining the correlations between the risks.

The basic stages for estimating RAROC lie in resolving of certain particular problems, as follows:

1. Calculation of the capital required to cover all company risks (economic capital);
2. Determination of the most effective ways of company capital investment;
3. Comparison of income with the account of risk in various areas of company business; and
4. Identification of prospects for the transfer of existing risks.

2.2 Application of RAROC-model in assessment of an oil and gas company value

The RAROC model offers a direct method of comparing the results of various activities of the company, taking into account the existing risks. This method involves the adjustment of returns with the account of capital, spent on this type of activity. The RAROC factor is usually calculated on the basis of annual savings by eqn (2) [3]:

$$RAROC = \frac{NI - EL}{ECAP} \quad (2)$$

where *RAROC* - risk-adjusted return on capital; *NI* – net income; *EL* – expected losses as a consequence of risk realization; *ECAP* – value of economic capital.

In this model, the estimate of net income is made according to eqn (3) [3]:

$$NI = D*(1 - EL) - F*(1 - ECAP) - C \quad (3)$$

where *D* – return from the activity in which the investment was made; *F* – funding costs of the activities in which the investment was made; *C* – general administrative expenses.

3 ECONOMIC CAPITAL MODEL IN THE VALUATION OF OIL AND GAS COMPANY

In the framework of the presented approach to the assessment and management of oil and gas company value, an integral part is the model, making it possible to estimate the economic capital of a company as a whole and specific to individual areas of its activities. In the concept of risk management, economic capital is the capital needed by an enterprise to cover the risks it faces in trying to maintain a certain standard of solvency or in the event of default [4, 5]. Otherwise, it is the amount of capital that a company needs for the purpose of covering losses arising from the realization of risk. The economic capital enables a company to protect its operations in case of losses caused by realization of risks [5].

3.1 Basic components of the economic capital model

The basic components of the model of economic capital and the methods of their evaluation are considered in detail by the authors in previous papers [5, 6]. These include [6–10]:

PD – the probability of default. It is the main indicator of the level of risk of a project, reflecting the probability of default on an investment project.

LGD (loss given default) – the level of losses in case of default is the expected average relative size of losses born by the company in case of default of an investment project.

EAD (exposure at default) – the position at risk. It characterizes an absolute value of the sum of an investment project and is determined by its full actual or estimated cost of the investment, current and other expenses.

M (maturity) is the effective term. This is an average time during which the position remains at risk. It is determined by the period of investment phase of the project.

3.2 Specificity of the rating model assessment of investment projects default probability

In the framework of oil and gas companies cost management, the assessment of emerging investment risks on proposed implementation projects is based on the use of the *logit* - model [6]. It implies logical transformations to the prediction of data based on the method of maximum likelihood [7].

General view of the *logit* - model is presented in eqn (4) [6]:

$$PD = (y_i = 1) = \frac{1}{1 + e^{-z}} \quad (4)$$

Where PD – the probability of default of an investment project; $(y_i = 1)$ – the case when an investment project is declared as a default one; parameter $z = (b_0 + b_1 * X_{i1} + b_2 * X_{i2} + \dots + b_n * X_{in})$; X_{in} – the value of the j -th financial indicator for the i -th investment project; b_j – the value estimation of the j -th coefficient.

The final investment projects ranking depending on their default probability is a result of the *logit*-model application.

3.2.1 Application of rating models in oil and gas company

The earlier studies [6] based on a survey of leading managers in the oil and gas industry helped to specify the z -parameter for the *logit* - model applied for Russian oil and gas companies.

An updated parameter z for eqn (4) takes the following form as presented in eqn (5) [5]:

$$z = 0,5578 + 1,0012 * X_{i1} + 0,8794 * X_{i2} + 0,1478 * X_{i3} + 0,9841 * X_{i4} + 0,5878 * X_{i5} + 0,6587 * X_{i6} + 1,0231 * X_{i7} + 0,1495 * X_{i8} \quad (5)$$

The factors used in estimating the parameter z in eqn (5) include the figures mentioned in Table 1.

4 THE METHOD OF INVESTMENT PROJECTS PORTFOLIO SELECTION BASED ON THE CONCEPT OF UNACCEPTABLE RISK

The authors' method of formation of investment projects portfolio is based on the concept of unacceptable risk, which provides the determination by the shareholders of target credit rating, which an oil and gas company seeks to achieve to ensure the necessary level of strategic stability and investment attractiveness, and of unacceptable credit rating, which the shareholders consider inappropriate. Depending on the forecast horizon, one can set a certain level of probability of default for both target and unacceptable credit rating. One of the variants of the rating and probability of default conformance is presented in Table 2 [11,12].

The PD determines a confidence level that is required to calculate the unexpected losses and economic capital of an oil and gas company, which is calculated by eqn (6):

$$\gamma = 1 - PD \quad (6)$$

Table 1: The main risk factors of investment projects.

Factor	Description
Financial indicators	
DSCR (Fin1)	Average DSCR indicator for the planning period of an investment project.
Share of own capital in the project (Fin2)	Characterizes the share of investment budget, funded from the business owners' means.
IRR (Fin3)	Internal rate of return, characterizes the discount rate, at which Net Present Value = 0
DPP (Fin4)	The discount period of an investment project payback period (years).
FS (Fin5)	Project sustainability to stress-inducing changes of price. Related to high volatility of prices on the oil market. Evaluated is the oil price reduction % laid in the project, at which Net Present Value becomes equal to 0.1 – over 15%, 0 – less than 15%.
Institutional Indicators	
Project type (Inst1, Inst2, Inst3, Inst4)	Characterizes the type of realized investment project from the point of view of the type of reproductive performance. It is implemented by means of dummy variables: Inst1 – repair, Inst2 – modernization, Inst 3 – reconstruction, Inst4 – new construction
Market risk level (Inst5, Inst 6, Inst 7)	Related to the risk of failure in achieving by the project of planned indices due to unfavorable sales opportunities. The indicator is established by way of expert opinions in the form of a score: Inst5 = 1 low risk, characterized by an expected growth of demand on a target market, a low competition and an opportunity to reorient to other markets Inst6 = 1 average risk, stable demand, availability of several big competitors, possible difficulties in the sales of product Inst7 = 1 high risk, reduction of demand, availability of strong market leaders, impossibility of product sale on other markets/ presence of entrance barriers
Experience of similar projects implementation (Inst 8, Inst9, Inst10)	Inst8 = 1 – implemented more than 3 similar projects Inst9 = 1 – implemented from 1 to 3 similar projects Inst10 = 1 – similar projects were never implemented

where γ – confidence level, identifying the non-collapse probability, PD – the level of default probability corresponding to the target credit rating.

Let the default probability corresponding to the target credit rating amount to PD_{TARGET} , and $PD_{UNACCEPT}$, then, for determination of economic capital of the target and unacceptable level of credit rating, confidence levels as shown in eqns (7) and (8), respectively, may be used:

Table 2: Conformance between probability of default and credit rating.

Rating	1-Y PD %	3-Y PD %	5-Y PD %
AAA	0,008	0,03	0,1
AA	0,04	0,16	0,28
A	0,16	0,4	0,58
BBB	0,3	1,4	3
BB	1,15	8,6	15
B	5,8	15,4	32,6
CCC or lower	26,57	45,5	60

$$\gamma_{TARGET} = 1 - PD_{TARGET} \quad (7)$$

$$\gamma_{UNACCEPT} = 1 - PD_{UNACCEPT} \quad (8)$$

$ECAP_{TARGET}$ and $ECAP_{UNACCEPT}$ values of economic capital correspond to these confidence levels. The unacceptable risk level will be characterized by losses from investment projects implementation, which are determined by the difference of the economic capital values in eqn (9):

$$ECAP_{CRA} = ECAP_{TARGET} - ECAP_{UNACCEPT} \quad (9)$$

where $ECAP_{CRA}$ – economic (risk) capital of accepted credit risk.

The algorithm of decision making on formation of investment projects portfolio will include the following stages:

1. The evaluation of the magnitude of unacceptable level of losses characterized by the difference of economic capital of the target and unacceptable ratings.
2. The calculation of investment projects economic capital. As a method of economic capital assessment, the Merton-Vasicek model is used. In this model, the reliability parameter is set at the level of 99.97%, which corresponds to a target credit rating of BBB. The calculation of the company risk capital is carried out according to eqn (10) [6]:

$$ECAP = EAD * LGD * \left(N * \left(\frac{N^{-1}(PD) + \sqrt{R} * N^{-1}(a)}{\sqrt{1-R}} \right) \right) - PD \quad (10)$$

where $ECAP$ – the risk-capital, N – function of standard normal distribution, R – the correlation coefficient of the indicators of a project (company) the general economic situation, α - reliability level.

The model of Merton-Vasicek involves the determination of the macroeconomic factor, which can be estimated based on the oil and gas industry statistics and on general economic market indicators.

3. Determination of the economic capital amount for all investment projects portfolio combinations. While evaluating the total economic capital of a projects portfolio, one cannot

ignore the effect of correlations, which is able to reduce the amount of risk capital, compared to a simple summation of the indicators of risk capital, as the correlation of defaults of investment project in reality will be less than 1 (because the default of one project will definitely not result in the default of all other projects). The correlation can be evaluated by standard statistical methods of retrospective data, at that, in the absence of data, information of analogue projects can be used. Given that the risk of default of the projects largely depends on market factors (for example, the decline in oil prices may cause a loss of revenue, a drop in Debt Service Coverage Ratio (DSCR) and payment default under the investment project), it is possible to put the level of project risk derived from the volatility, in this connection, for the purpose of risk correlation accounting, the model of Markowitz can be used as eqn (11):

$$ECAP_T = \sqrt{\sum_{i=1}^n ECAP_i + 2 * \sum_{i=1}^{n-1} \sum_{j=i+1}^n ECAP_i * ECAP_j * p_{ij}} \quad (11)$$

where $ECAP_T$ – cumulative economic capital of an investment projects portfolio, $ECAP_i$ – economic capital of the i -th investment project, p_{ij} – correlations between the risks of investment projects.

4. Selection of portfolio combinations maximizing the value of the business, from the point of view of the general level of risks, eqn (12):

$$\begin{cases} RAROC \rightarrow \max \\ ECAP_T < ECAP_{CRA} \end{cases} \quad (12)$$

5 THE MODEL APPLICATION FOR AN OIL AND GAS COMPANY INVESTMENT PROJECTS PORTFOLIO FORMATION

Let's consider a model, using the following example [6]. The investment program of an oil company includes five investment projects with the initial parameters, as presented in Table 3.

The LGD distributions resulted in Table 4 with the assessment of statistically different LGD key parameters for each type of investment projects [6].

The calculation of economic capital and matrix correlations of the investment projects are presented in Tables 5 and 6, respectively.

Assume that budget constraints allow implementing only two of the three investment projects. On the basis of eqn (11), various combinations of investment portfolio by level of ECAP and RAROC were calculated, as presented in Table 7.

Table 3: Main parameters of realized investment projects.

No	Projects	Full price, \$ mln.	Period of project implementation, years	Default probability, %
1	Modernization of oil-trunk pipeline	45	2	8.1
2	Construction of oil storage	35	2	8.5
3	Reconstruction of filling stations network	30	2	5.4

Table 4: LGD estimates for main types of investment projects.

	Overhaul repair (%)	Modernization (%)	New construction (%)
Short term	12	45	65
Long term	30	58	80

Table 5: Calculation of investment projects economic capital.

Projects	<i>EAD</i>	<i>T</i>	<i>PD</i>	<i>LGD</i>	<i>R</i>	<i>ECAP</i> _{BBB}	<i>NI-EL</i>
Modernization of oil-trunk pipeline	45	2	0.081	0.58	0.25	10.26	8
Construction of oil storage	35	2	0.085	0.65	0.2	8.46	6
Reconstruction of filling stations network	30	2	0.054	0.58	0.62	5.95	5

Table 6: Investment projects correlations matrix.

Project	Modernization of oil-trunk pipeline	Construction of oil storage	Reconstruction of filling stations network
Modernization of oil-trunk pipeline	–		
Construction of oil storage	0.46	–	
Reconstruction of filling stations network	0.8	0.35	–

Table 7: Correlation of investment projects defaults matrix.

ECAP/RAROC	Modernization of oil-trunk pipeline (%)	Construction of oil storage (%)	Reconstruction of filling stations network
Modernization of oil-trunk pipeline	–	–	–
Construction of oil storage	9.9 / 34.3	–	–
reconstruction of filling stations network	10.7 / 28	4.6 / 65.2	–

The RAROC analysis shows that all the projects are cost-effective in terms of the risks taken and lead to an increase in the value of business. Despite this, a combination of low-risk investment projects provide a higher level of profitability, taking into account the risks, even with the lower net income in absolute terms. In the present example, given the low default risk of projects, all RAROC indicators are positive, but an opposite situation is also possible when the projects have a negative RAROC, destroy the value of the business and do not correspond to the interests of shareholders. Also, an important factor is determined by the company risk appetite. Assuming that in the example above, the risk appetite is limited at the level of \$10 million, the best, in terms of maximizing the business value of the portfolio, will be the project of oil storage building and reconstruction of the network of filling stations.

6 CONCLUSIONS

The key objective of the company's activities, and investing as a necessary part of it, is to increase the value and maximize the shareholders' well-being. Given the essentiality of capital expenditures, it is appropriate to compare the financial effect of the implementation of projects with the magnitude of the risk. Risky projects, in case of substantial deviations from the business plan, can lead to the violation of obligations to investors and lenders and the default of entire business, or its loss in the event of registration of all property as collateral for loans or recourse of recourse to other lines of business. In this connection, mapping of efficiency and the level of risks becomes a priority in taking investment decisions.

As a methodology for the risk-based profitability evaluation, the RAROC method may be used. The author's approach to taking investment risks is based on a measure of profitability, adjusted for risk; RAROC, as the ratio of economic benefits from the project and risks taken, acts as the main indicator of efficiency. The method allows for the selection of a portfolio of investment projects, taking into account the risk appetite and budgetary constraints to maximize the business value.

The methodological approach to selection of an investment projects portfolio proves its effectiveness and ease of use, however, a number of modeling directions are prospective in nature. In particular, it is necessary to develop an approach to evaluating the correlation of investment projects with the general state of the economy that involves the construction of a multifactor indicator, which enables to identify the general economic trends and their impact on investment activity. Also important is the development of methods for the assessment of total capital portfolio of investment projects, elaboration of a research mechanism of the correlation of defaults of individual projects with each other.

ACKNOWLEDGEMENT

The work was supported by Act 211 Government of the Russian Federation, contract No 02. A03.21.0006.

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