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ESTIMATING THE COST OF EQUITY USING A MINING BUILD-UP MODEL

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Abstract

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Among other methods, build-up models have been used to value equity. However, the build-up models are usually general models to appraise business and financial risks, and thus cannot fully mirror the special characteristics of different industries. The article presents a new model called 'Mining Build-up Model' to assess the risks of mining companies. The model has four modules of risks (A – Business risks, B – Financial risks, C – Mining risks, and D – Module of a mining company), altogether roofing 12 areas of different risks. To demonstrate its usefulness, the Mining Build-up Model was applied on a mining company called OKD, a.s. – a member of the mining group New World Resources (NWR) in the Czech Republic. For the different areas of risks, we quantified the components of risk, which became the starting points to determine the final risk premium. The quantification of the components of risks relies on expert evaluations of the degree of risk of the different components of risk in the risk modules. The weighs of the components of risks were determined using Saaty's method (the Analytic Hierarchy Process – AHP). We found that in OKD, a. s. – a member of the mining group NWR – the risk premium of cost of equity reached the value of 12.52 % in 2013. As we worked with the risk-free rate of return at a value of 2.83 %, the cost of equity for OKD, a. s. – a member of the mining group NWR, amounted to 15.35 %. The weighted average cost of capital of NWR Plc was calculated as 12.34 %.

Keywords: risk, modular method, cost of equity, risk premium, build-up model

INTRODUCTION

Taking into account all kinds of turbulences of the business environment, the success of corporations depends on timely anticipation of market opportunities, identification of threats and dealing with possible problems of strategic nature (Chuchrová *et al*., 2016; Geissler and Krys, 2013; Chakravarthy, 1997). Accordingly, investment decision-making pertains to the activities that may have a major impact on the future performance of a business. It is, thus, necessary to make decisions on the basis of studies and investment models that assess possible options from a variety of viewpoints.

Feasibility studies are crucial in the assessment process. An integral part of the assessment process is the evaluation of investment efficiency based on static and dynamic methods. In practice, a Net Present Value (NPV) method is common. Pursuant to this method, an investor may decide to invest if the net present value is higher than zero. This happens if the sum of the present value of discounted cash flow of each year of utilizing the investment is higher than the investment cost. Besides this fundamental 'zero rule', Ross (1995) stresses that taking on investment may be recommended only if other conditions are also met, e.g. environmental, social, cultural, etc. (Ross, 1995).

To calculate NPV it is crucial to choose an appropriate discount rate. The correct discount rate should assess the impact of risk associated with the investment and inflation effects. An improperly set value of the discount rate can lead to an incorrect decision regarding the acceptance or rejection of an investment (Brealey, 1996). The discount rate is most often determined based on the capital cost of a company, which is defined as the *Weighted Average Cost of Capital* (WACC). For the sake of simplicity, it is possible to omit the cost of loan capital r_d, which

is usually associated with the cost of credit and other components. Subsequently, the whole issue reduces itself to determining the cost of equity r_e, thus the rate of return required by the investor. According to Brunet (1998) "the costs should be investor's anticipated internal rate of return on future cash flows associated with each of capital" (Brunet, 1998).

Literature review

The issue of determining the cost of capital and valuation of different risks in companies has been of interest of not only investors but also scholars. This is evidenced by a number of publications dealing with the valuation of capital and risks. However, the focus of many publications is the determination of the cost of capital and risk premium quantification in the context of CAPM model (Capital Asset Prising Model), for example by Amiram *et al.*, 2017; Chen and Zhang, 2017; Bora *et al.*, 2015; Rajhans, 2015; Harris and Marston, 2013, etc. An interesting study by Alam and Peng (2014) examines the relationship between research and development expenditures and risk premiums implied in the costs of equity capital. Despite the clear dominance of CAPM model in the determination of the cost of capital in expert publications, there are also studies pointing at alternative approaches, e.g. the build-up models (Van Bulck, 2007; Michalak, 2014).

Although the most common approaches to determining the cost of equity r_e are the so-called income methods, modular (build-up) approaches have become good complements to these methods. Analysts have, for example, estimated the equity rate of return using build-up approaches in small businesses (Boudreaux *et al.*, 2011). For small businesses that are not listed on the stock market, it can thus be an alternative to income methods.

Nowadays, several build-up methods are used. According to Michalak (2014), the build-up approach is based on considering particular elements of risks that constitute the discount rate in a company (Michalak, 2014). The models are based on adding risk factors to the base created by a risk-free rate. According to Boudreaux *et al.* (2011), build-up models start with a risk-free rate. Next, one or more factors based on the risk of the equity instrument are added (Boudreaux *et al.*, 2011). Also, the model by Sorin (2009) involves a risk-free rate (R_f) and other risk premiums: market risk premium (RP_m), RP_s represents size premium, and RP_u stands for unsystematic specific risk (Sorin, 2009).

Boudreaux and his team of authors suggest another model. They use the following premiums: R_f – risk-free rate, RP_m – equity risk premium for market (general market equity risk premium), RP_s – size premium, Rp_u – specific company premium (stands for unsystematic risk), Rp_i – country risk premium (international investing), and O – other adjustments. Summing-up these extras, the expected equity return, or the cost of equity capital (Ke) are achieved (Boudreaux et al., 2011).

Under the conditions prevailing in the Czech Republic, a modular method by Neumaierova (2002) is often used. Also, there is the so-called *Complex Modular Method* or *Complex Build-up Method* (CBM) by Mařík and Maříková, hereinafter referred to as "M&M", which is the application of a model by Garnett and Hill (G&H), an American appraisal company, to Czech conditions.

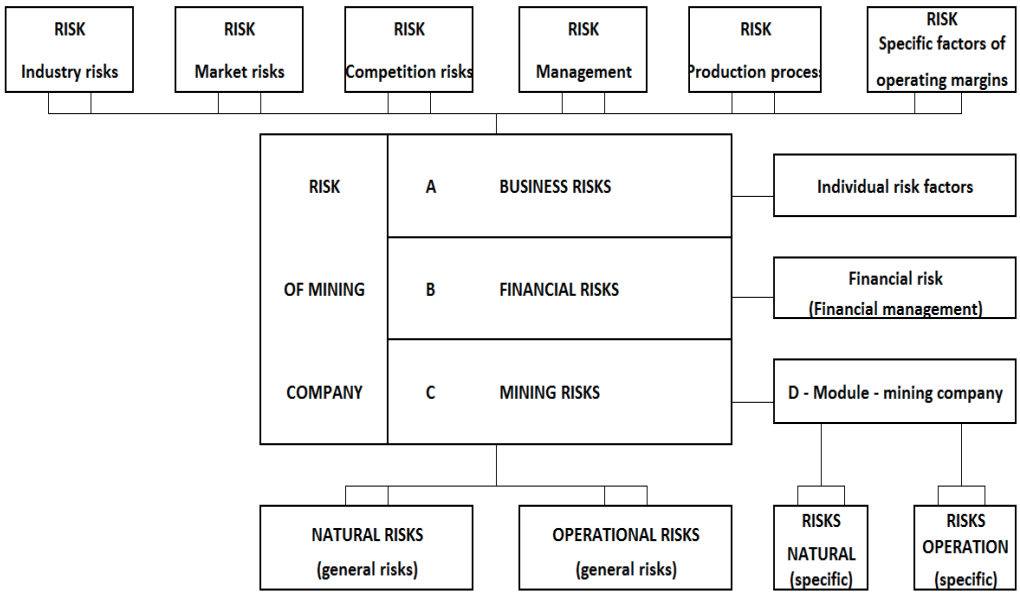
G&H build-up model defines a total of 36 factors (inquiries) to be assessed, subdivided into four groups of business (commercial) risk and a group of factors of financial risk. The factors of business risk consist of market risk (twelve factors), production risk (six factors), industry risk (four factors), and management risk (six factors). The factors of financial risk consist of eight sub-factors (Mařík et al., 2007).

A common feature of G&H and M&M models is the fact that the risk premium for the cost of equity is determined based on a certain number of factors which in total characterize a degree of risk rate of business activities of an evaluated company. It is true, however, that these two models are rather general. To determine the risks more precisely, build-up method may include specific risks of different lines of business, or of the company itself whose discount rate is to be determined.

For a risk premium to be objectively informative, it is crucial to construct a build-up model of risks so that it reflected the general business and financial risks as well as it was able to anticipate specific risks. Despite the fact that mining and processing of mineral resources is a standard business activity, we cannot ignore the particularities and specific nature of the industry/ business. (Vaněk *et al.*, 2011). The specific risks for mining and mineral processing are, for example, the risk of rock bursts, the risk of methane occurrence, irruptions of water, fluctuations in the quality of the mineral, complexity of the geological conditions, abrasiveness of the surrounding rocks, etc.

This paper, therefore, does not deal with the general quantification of risk premiums, but focuses on the domain of mining industry or mining companies, particularly companies exploiting hard coal. Thus, to quantify the risk premiums in the conditions of hard-coal mining companies objectively, we constructed a build-up model called "*Mining Build-up Model*" (MBM). In addition, to test the new build-up model, it is applied to assess a selected mining company – OKD, a. s., which is a member of the mining group New World Resources (NWR).

The aim of the article is to introduce this method and demonstrate its practical application on a particular mining company. The risk premium is determined using MBM and the cost of capital of the selected mining company is determined by WACC. This model, which is able to consider a variety of risks, may also be applicable to asses



1: *Fig. 1 The structure of risk areas of the company according to the proposed MBM*

other mining companies in order to learn about the risks and to determine their discount rate.

MATERIALS AND METHODS

The risks in the mining company OKD, a. s. – a member of the mining group NWR, were assessed using the "*Mining Build-up Model*" (MBM), see Fig. 1.

MBM comprises four basic modules that deal with the basic risk factors. Module A focuses on business risks, module B concentrates on financial risks, module C deals with general risks in the mining industry, and module D considers the specific risks in a particular mining company.

MBM model was prepared by Bora (2014) in his dissertation, one of the authors of this article. MBM builds on the existing G&H model and M & M model by Mařík et al. (2007), and modifies them. The modifications lie in adding specific risk factors to the business and financial risks (A and B modules) that are specific to businesses engaged in the exploitation of mineral deposits. Completely new parts of MBM, namely general mining risks (C module) and specific risks of a particular mining company (D module), can be regarded as the most significant changes to M&M method (Bora, 2014).

Fig. 1 implies that module C of MBM describes the natural and operational mining risks. The mining module D in MBM represents the types of raw materials (energy raw materials, non-metalliferous minerals, construction materials, ore minerals) and the method of their extraction (open mining, deep mining, mining using drilling, chemical mining method, mining of cohesive raw materials, mining of non-cohesive raw materials) in a particular mining company (Bora, 2014).

The risks and the levels of own costs using MBM are determined via the steps below:

1. Compilation of a risk catalogue with the risk factors of a mining business – mining risks;
2. Expert appraisal of the intensity of each risk;
3. Determination of weights for given groups of risks using Saaty's method (the Analytic Hierarchy Process – AHP);
4. Transformation of the determined intensity of risk into the risk premium;
5. Determination of the cost of equity r_e and of the risk premium.

Supposing investors wish to make qualified and responsible decisions on their investment, they should consider all the risks involved. Investors (managers) are assumed to act with due managerial care and diligence. MBM is made up from a set of identifiable risks in the form of the so-called catalogue of risks. The catalogue of risks is used as the basis for qualified assessment of risk factors in MBM. The catalogue is designed in order to allow its users to evaluate different areas of risk within relevant parts of the model (A, B, C, and D). The users can choose which parts of the risk assessment will be activated (Bora, 2014).

The catalogue of risks (Bora, 2014) contains 125 questions that may be answered using a 5-point scale differentiating the intensity of risk:

1. Minimum risk;
2. Low risk;
3. Adequate risk;
4. Increased risk;
5. High risk.

For a better idea what kind of information the catalogue of risks includes, below we extract a part of the catalogue, namely from module

I: *An extract from the catalogue of risks (Bora, 2014)*

	C. Business Risk	
	1. Phases of company life cycle in relation to future strategic decisions	**Intensity of risk**
a)	**Phase of stabilisation** – the company has reached its optimal size and there is no need for further expansion investment; on the other hand, the company must implement the so-called reproduction investment that is equal to the sum of depreciation, in order to maintain its position on the market.	Minimum
b)	**Phase of growth** – this phase is characterised by a growing cash flow that is not too high due to extensive investments. Outside sources are predominantly used for financing, including external investment too.	Low
c)	**Phase of establishment** – this phase is labelled as the "period of hunger". Cash flow is negative as the company invests and expects return on investment in the future. Financing comes from outside sources, with predominant own resources as it is very difficult to persuade investors about reasonable appreciation of their capital.	Adequate
d)	**Phase of recession** – the company has problems with sales, the earning assets are falling, along with the decreasing profit and cash flow, which may cause insolvency problems leading to dissolution.	Increased
e)	**Phase of crisis management** – the company cannot deal with the crisis, the loss is enormous, the business is coming to its end.	High
	D. Module - specific risks of a particular mining company	
	4. Deposit with a hazardous occurrence of outbursts of gas and coal in relation to the extraction of balance reserves	**Intensity of risk**
a)	Deposit with no occurrence of outbursts of gas and coal	Minimum
b)	Deposit with minimum occurrence of outbursts of gas and coal	Low
c)	Deposit with about 50 % seams classified as outburst-prone	Adequate
d)	Deposit with about 75 % seams classified as outburst-prone	Increased
e)	Deposit with only outburst-prone seams	High

Note: OKD, a. s. – a member of the mining group NWR, extracts hard coal, which mirrored in the manner how the catalogue of risks was compiled.

A (business risks) and module D (specific risks of a particular mining company) – see Tab. I.

According to Hlaváček (2005), the basis for build-up approaches is the expert quantification of risks (Hlaváček, 2005). The nature of such approaches is analogous to the expert assessment of risks using the Failure Mode and Effect Analysis (FMEA). According to Janíček (2013), an ideal expert team should have 5 – 7 members, and should include respondents from various levels of the company management. During the expert appraisal of risks in OKD, a. s. we addressed six experts, among whom four were managers from various levels of the company management in question, and two were researchers specialising in underground mining.

Having answered the questions in the risk catalogue, the component risks within modules A, B, C, and D were added together. In order to prevent the dependence of the results on the number of examined factors in each group, it is necessary to determine weights for all groups of risk factors expressing the importance of the risk category. The weights of the criteria are a subjective expression of an expert's opinion, based on their viewpoint. Therefore, it is appropriate for the criteria's weights to be determined by more evaluators (Fotr and Souček, 2005).

In order to determine the weights, the authors decided to use AHP. Unlike the method of pairwise comparison, where one criterion from the pair is simply preferred, AHP also specifies the magnitude of this preference. The magnitude is expressed by a number of points from a predetermined scale according to Saaty (2001).

The actual weight values of criteria are determined using geometric means of the rows of the Saaty's matrix, which are then normalized by Equation (1). This way, we obtained the normalized weights of the set of criteria of the MBM model.

$$v_i = \frac{G_i}{\sum_{i=1}^{n} G_i} \tag{1}$$

where:
v_i.... normalized weight of the i-th criterion,
G_i... geometric mean of the i-th criterion,
n.... number of criteria (Saaty, 2008).

In this case, the criteria represent the different component risk factors.

If we know the weights of the different component risk factors as well the number of evaluated specific risk factors, we may calculate the weighted number of risk factors (specific and component). The weighted number is determined via Equation 2 below:

$$N_v = \mathrm{N} \cdot \mathrm{v}_i \tag{2}$$

where:
N_v.. weighted number of risk factors;
N ... number of specific risk factors;
v_i.... normalized weight of the i-th criterion.

In order to determine the risk premium of a specific risk factor, or of a component risk factor, first we need to calculate the risk premiums for the different degrees of risk. The starting point for the calculation is *a*, which is the main risk rate (Mařík *et al.*, 2007).

$$a = \sqrt[x]{\frac{r_{e\,max}}{r_f}} \tag{3}$$

where:
a .....constant a;
$r_{e\,max}$ ....maximum cost of equity;
r_f.....risk-free rate.

The determination of parameters of a power function a^x results from the assumption that for a completely risk-free company with the level of risk equal to 0, it applies that $a^0 = 1$. The power expresses the degree of risk. If we assume, in this case, that the risk premium is 0 times the risk-free rate of return, the multiple may be expressed as a^0 1 (Mařík, 2011).

The risk premium of cost of equity r_e is calculated by multiplying the risk-free rate of return r_f by the coefficient of the risk premium *Z*, where *Z* is defined by the expression $(a^x - 1)$, see Equations (4) and (5). Their following functional relationship is then the prerequisite for the transfer of the risk value to the risk premium:

$$\mathrm{RP} = \mathrm{r_f} \cdot \mathrm{Z} \tag{4}$$

$$\mathrm{RP} = \mathrm{r_f} \cdot \left(\mathrm{a}^{\mathrm{x}} - 1\right) \tag{5}$$

where:
RP .... risk premium;
r_f ..... risk-free rate of return;
Z..... coefficient of risk premium;
a ..... constant a;
x ..... degree of risk.

As we cannot assume to have only one risk factor, it is vital to consider a complex N of risk factors. Calculating the risk premium, in line with Equation (6) we first determine the component risk premium for one factor and later add up all the N of component risk premiums in line with Equation (6).

$$RP_{1F} = \mathrm{Z} \cdot \frac{r_f}{N_v} \tag{6}$$

where:
RP_{1F} ....risk premium for 1 component risk factor;
r_f .....risk-free rate of return;
Z.....coefficient of risk premium;
Nv.....weighted number of risk factors.

To calculate the total risk premium, the weighted arithmetic sum of the risk premiums is used. The cost of equity of the company r_e shall be calculated according to Equation (7).

$$\mathrm{r_e} = \sum_{\mathrm{i}=1}^{\mathrm{N}} \mathrm{RP_{1Fi}} + \mathrm{r_f} \tag{7}$$

where:
r_e.....cost of equity capital;
RP_{1Fi}....risk premium of the i-th risk group;
r_f .....risk-free rate of return.

Equation (7) may also be simplified as follows in Equation (8). This modification is characteristic of build-up approaches.

$$\mathrm{r_e} = \mathrm{r_f} + \mathrm{OR} + \mathrm{FR} + \mathrm{TR} + \mathrm{other\ premiums} \tag{8}$$

where:
r_f ..... risk-free rate of return;
OR ... risk premium for business activity;
TR .... risk premium for mining risks;
FR .... risk premium for financial activity.

II: *The input values for MBM*

INPUT VALUES - MINING BUILD-UP MODEL		
Risk-free rate of return	r_f	2.83%
Maximum risk level of company evaluated using $r_{e\,max}$	$r_{e\,max}$	30.00%
Constant a	$a = (r_{e\,max} / r_f)^{1/5}$	1.603

III: *Calculation of the risk premium*

	Level of risk	$a = a^x$	$Z = (a^x - 1)$	Risk premium
x = 0	Minimum risk	1.000	0.000	0.00%
x = 1	Low risk	1.603	0.603	0.16%
x = 2	Adequate risk	2.571	1.571	0.43%
x = 3	Increased risk	4.123	3.123	0.85%
x = 4	High risk	6.611	5.611	1.53%

Basis for calculation

To use MBM, the assumption of a creditor risk indicator at a value of 30 % was selected (Mařík *et al.*, 2007). The prerequisite supposing that a company reaches the debt-to-equity ratio at a value of about 70/30 gives a signal to creditors that the company is in an utmost risky situation for the creditor. According to this prerequisite, the interval of the MBM result is defined.

The risk-free rate r_f was determined from the return of 10-year UK government bond which was 2.83 %. The minimum value of the MBM result will therefore equal the risk-free rate of return r_f = 2.83 %. The maximum value of the risk premium of the cost of equity can reach 30 %.

For clarity, the input values to calculate risks through MBM are shown in Tab. II.

RESULTS

This section presents the results obtained from the MBM model in an aggregate form. The basis to calculate the risk premium of discount rate, resulting from the filled-in risk catalogue, is the intensity of risk, see Tab. III.

The next step leading to the determination of risk premium and cost of equity was to determine the weights for particular areas of risk evaluated by the expert team. In total, there were 12 areas of risk: Industry risks (k_1), Market risks (k_2), Competition risks (k_3), Risk of management (k_4), Risk of production process (k_5), Risk of specific factors of operating profit margins(k_6), Factors of financial risk (Risk of financial management) (k_7), Financial and stock market risks (k_8), Operational risks (general risk) (k_9), Natural conditions (general risk) (k_{10}), Operational risks (specific risk) (k_{11}), and Natural conditions (specific risk) (k_{12}).

We determined the weights for each particular area of risk by means of Saaty's method, see Tab IV. The discrete areas of risk are referred to as criterion in the table below.

The preferences of the particular areas of risk were determined in the course of a brainstorming discussion attended by the authors of this article and experts who evaluated the different areas in the catalogue of risks. The preferences of significance of particular areas of risk (k_1 to k_2) were determined based on AHP methodology.

We are fully aware of the problematic nature of the preferences due to the high value of the Consistency Ratio (0.57) determined in compliance with the methodology. As the preferences were determined via experts' statements, we decided to undervalue the condition of consistency and work with the preferences determined by experts. Considering the number of areas of risk, we consider this simplification as rational.

The catalogue of risks is very complex and thus contains too much data for this article. The readers may find the complete catalogue of risks in Bora's dissertation (2014).

The numeric distribution of the different intensity of risk in the scale, see Tab. V, depends on the expert's frequency of choosing an answer related to a particular intensity of risk in the catalogue of risks. Answering the question determines the intensity of risk arising in the different assessed areas of the catalogue of risks based on its division into categories and questions contained therein.

Component risks calculated via MBM are shown in Tab. V.

The total risk premium and the cost of equity may be determined based on the knowledge of risk of the particular MBM modules, see Tab. VI.

It is apparent from Tab. VI that in 2013 the risk premium of cost of equity (RP_{re}) reached the value of 12.52 % in OKD, a. s. – a member of the mining group NWR. As we worked with the risk-free rate of return at a value of 2.83%, the value of the cost

IV: *Determination of weights using Saaty's method*

Criterion	k_1	k_2	k_3	k_4	k_5	k_6	k_7	k_8	k_9	k_{10}	k_{11}	k_{12}	Geometric average	Standardized weight
k_1	**1**	3	1/5	3	3	7	1/9	1/7	1/7	1/9	1/7	1/5	0.5045	0.028965
k_2	1/3	**1**	7	7	9	9	1	1/5	1/5	5	1/7	1/7	1.1509	0.066071
k_3	5	1/7	**1**	5	3	1/5	1/5	1/7	1/5	1/3	1/5	1/5	0.4835	0.027758
k_4	1/3	1/7	1/5	**1**	3	1/3	1/5	7	1/7	1/5	1/9	1/9	0.3598	0.020654
k_5	1/3	1/9	1/3	1/3	**1**	1/5	1/3	1/7	1/7	1/7	1/9	1/9	0.2152	0.012355
k_6	1/7	1/9	5	3	5	**1**	1/5	1/5	1/7	1/7	1/9	1/9	0.3890	0.022331
k_7	9	1	5	5	3	5	**1**	1/9	1/3	1/3	1/5	1/5	1.0435	0.059905
k_8	7	5	7	1/7	7	5	9	**1**	1	5	3	3	2.9829	0.171241
k_9	7	5	5	7	7	7	3	1	**1**	5	1/3	3	3.1347	0.179961
k_{10}	9	1/5	3	5	7	7	3	1/5	1/5	**1**	5	1/3	1.5918	0.091382
k_{11}	7	7	5	9	9	9	5	1/3	3	1/5	**1**	5	3.1326	0.179838
k_{12}	5	7	5	9	9	9	5	1/3	1/3	3	1/5	**1**	2.4306	0.139539
												Σ	**17.4190**	1

of equity for OKD, a. s. – a member of the mining group NWR amounted to 15.35%. This value was reached as the sum of RP_{re} and r_f.

DISCUSSION

In the event that the management decides to finance corporate investments only out of equity capital, the result of r_e from MBM can be regarded as the discount rate determined in an expert manner. Likewise, RP_{re} can be considered as the risk premium of the discount rate (RP_d).

Besides significant exact elements in build-up approaches, MBM is a method based on expert knowledge. The validity of the results is affected by subjective views of selected experts, so it is necessary to pay due attention to the choice of unbiased experts. Provided that the respondents/experts

V: *Tab. V Calculation of risk via MBM*

Module	MINING BUILD-UP MODEL	RP = (z . rf/n)	Number	Weights	Weight number	Risk premium of risk area (RP × weight number)
	BUSINESS RISK		**62**		**2.364**	**0.94%**
	I. Industry risk		**13**		**0.377**	**0.19%**
	Minimum risk	0.000%	1	0.02896	0.029	0.00%
	Low risk	0.165%	3	0.02896	0.087	0.01%
	Adequate risk	0.428%	5	0.02896	0.145	0.06%
	Increased risk	0.851%	3	0.02896	0.087	0.07%
	High risk	1.530%	1	0.02896	0.029	0.04%
	II. Market risk		**21**		**1.387**	**0.52%**
	Minimum risk	0.000%	10	0.06607	0.661	0.00%
	Low risk	0.165%	0	0.06607	0.000	0.00%
	Adequate risk	0.428%	5	0.06607	0.330	0.14%
	Increased risk	0.851%	5	0.06607	0.330	0.28%
	High risk	1.530%	1	0.06607	0.066	0.10%
	III. Competition risk		**8**		**0.222**	**0.14%**
	Minimum risk	0.000%	1	0.02776	0.028	0.00%
	Low risk	0.165%	1	0.02776	0.028	0.00%
	Adequate risk	0.428%	4	0.02776	0.111	0.05%
	Increased risk	0.851%	0	0.02776	0.000	0.00%
A	High risk	1.530%	2	0.02776	0.056	0.08%
	IV. Management		**11**		**0.227**	**0.05%**
	Minimum risk	0.000%	6	0.02065	0.124	0.00%
	Low risk	0.165%	4	0.02065	0.083	0.01%
	Adequate risk	0.428%	0	0.02065	0.000	0.00%
	Increased risk	0.851%	0	0.02065	0.000	0.00%
	High risk	1.530%	1	0.02065	0.021	0.03%
	V. Production process		**5**		**0.062**	**0.01%**
	Minimum risk	0.000%	1	0.01236	0.012	0.00%
	Low risk	0.165%	2	0.01236	0.025	0.00%
	Adequate risk	0.428%	2	0.01236	0.025	0.01%
	Increased risk	0.851%	0	0.01236	0.000	0.00%
	High risk	1.530%	0	0.01236	0.000	0.00%
	VI. Specific factors of operating profit margins		**4**		**0.089**	**0.02%**
	Minimum risk	0.000%	2	0.02233	0.045	0.00%
	Low risk	0.165%	1	0.02233	0.022	0.00%
	Adequate risk	0.428%	0	0.02233	0.000	0.00%
	Increased risk	0.851%	1	0.02233	0.022	0.02%
	High risk	1.530%	0	0.02233	0.000	0.00%

Module	MINING BUILD-UP MODEL	RP = (z . rf/n)	Number	Weights	Weight number	Risk premium of risk area (RP × weight number)
	FINANCIAL RISK		**34**		**3.484**	**4.12%**
	I. Factors of financial risk		**21**		**1.258**	**0.72%**
	Minimum risk	0,000%	2	0.05991	0.120	0.00%
	Low risk	0.165%	8	0.05991	0.479	0.08%
	Adequate risk	0.428%	5	0.05991	0.300	0.13%
	Increased risk	0.851%	1	0.05991	0.060	0.05%
B	High risk	1.530%	5	0.05991	0.300	0.46%
	II. Financial and stock market risk		**13**		**2.226**	**3.41%**
	Minimum risk	0.000%	0	0.17124	0.000	0.00%
	Low risk	0.165%	0	0.17124	0.000	0.00%
	Adequate risk	0.428%	0	0.17124	0.000	0.00%
	Increased risk	0.851%	0	0.17124	0.000	0.00%
	High risk	1.530%	13	0.17124	2.226	3.41%
	MINING RISK - mining company		**9**		**1.177**	**4.22%**
	I. Operational risk (general risk)		**4**		**0.720**	**1.31%**
	Minimum risk	0.000%	0	0.17996	0.000	0.00%
	Low risk	0.165%	0	0.17996	0.000	0.00%
	Adequate risk	0.428%	0	0.17996	0.000	0.00%
	Increased risk	0.851%	1	0.17996	0.180	0.20%
C	High risk	1.530%	3	0.17996	0.540	1.10%
	II. Natural conditions (general risk)		**5**		**0.457**	**2.91%**
	Minimum risk	0.000%	0	0.09138	0.000	0.00%
	Low risk	0.165%	0	0.09138	0.000	0.00%
	Adequate risk	0.428%	1	0.09138	0.091	0.28%
	Increased risk	0.851%	3	0.09138	0.274	1.65%
	High risk	1.530%	1	0.09138	0.091	0.99%
	MODULE FOR SPECIFIC RISKS IN A MINING COMPANY		**20**		**3.355**	**3.24%**
	I. Operational risk (specific risk)		**14**		**2.518**	**2.47%**
	Minimum risk	0.000%	3	0.17984	0.540	0.00%
	Low risk	0.165%	1	0.17984	0.180	0.05%
	Adequate risk	0.428%	5	0.17984	0.899	0.67%
	Increased risk	0.851%	3	0.17984	0.540	0.80%
D	High risk	1.530%	2	0.17984	0.360	0.95%
	II. Natural conditions (specific risk)		**6**		**0.837**	**0.77%**
	Minimum risk	0.000%	0	0.13954	0.000	0.00%
	Low risk	0.165%	2	0.13954	0.279	0.10%
	Adequate risk	0.428%	3	0.13954	0.419	0.40%
	Increased risk	0.851%	1	0.13954	0.140	0.27%
	High risk	1.530%	0	0.13954	0.000	0.00%

maintain objectivity in their expert assessments, their answers should logically more or less coincide because they have identical input information.

An already existing Capital Asset Pricing Model (CAPM) can be used for equity risk evaluation for mining companies listed on the stock exchange (Bora *et al.*, 2015). However, in the Czech Republic as well as in other countries, many joint stock companies have no shares traded on the stock market; therefore, an alternative is to base the decisions on modular methods. MBM is an expert approach, for which the effort was exerted to maximize the objectivity of the output data. The Mining Build-up Model has the ambition to be included in the existing Build-up methods.

VI: *Calculation of risk premium and r_e - the cost of equity for OKD, a. s. – a member of the mining group NWR*

Module	Result
BUSINESS RISK	0.94%
FINANCIAL RISK	4.12%
MINING RISK - mining company	4.22%
Module for specific risks in a mining company	3.24%
RP_{re} – Risk premium in total	12.52%
Risk-free rate of return	2.83%
r_e – Cost of equity	15.35%

VII: *Calculation of WACC from MBM data*

Calculation of WACC from MBM data		
D – debt (net)	1,009,147,000 EUR	NWR_{2013}
E – equity (market value)	463, 762,543 EUR	NWR_{2013}
r_f – current risk free rate of return UK	2.83%	
RP_{re} – from MBM	12.52%	NWR_{2013}
r_e – from MBM ($r_f + RP_{re}$)	15.35%	NWR_{2013}
r_d – cost of debt	13.70%	NWR_{2013}
t_c – corporate tax Netherlands	20.00%	NWR_{2013}
Determinants of capital structure for cost of equity – E/(D+E)	0.3149	NWR_{2013}
Determinants of capital structure for cost of debt – D/(D+E)	0.6851	NWR_{2013}
($1 - t_c$)	80%	
WACC – discount rate of NWR Plc	12.34%	

The expert assessment through MBM shows that the cost of equity r_e of the mining company OKD, a. s. – a member of the mining group NWR, reaches a value of 12.52%. The risk premium of cost of equity, which also evaluates an unsystematic risk, amounts to 15.35%.

The measured risk of the company determined via the costs of own capital (r_e) reaches almost the maximum of the interval <2.83 to 30%>. This interval reflects the set-up of the mathematical model MBM when transferring the experts' assessment of risk into the exact form.

Although Damodaran's statistics (2017) claim that the degree of risk in mining companies fluctuates around 9.87 % in the long-term, this Fig. does not correlate with our results. In case r_e identified by means of MBM is used to calculate WACC, we may find that the discount rate calculated under the influence of NWR's capital structure determinants was 16.75%,[1] see Tab. VII.

Admittedly, the value of such calculated discount rate is higher than the average in the mining industry determined by Damodaran (cost of capital = 7.77%) (Damodaran, 2017). It must be pointed out, however, that in 2013 OKD, a. s. – a member of the mining group NWR, was regarded as a highly risky business by many experts in the field and stock exchange investors.

This may be documented by the information from the London Stock Exchange, where in 2014, 2015 and 2016 the NWR securities were at their annual minimums. Finally, the securities were suspended due to the force of circumstances and their almost zero value. Naturally, the information was also known to the experts participating in this research, the result of which is the proposed method of risk assessment called MBM and its subsequent application.

In the light of calculating WACC taking into account the determinants of capital structure, amounting to 12.34%, and the real financial conditions of OKD, a. s. – a member of the mining group NWR, the value of the discount rate manifested in its full intensity as late as 2016, when the company filed for insolvency. The numbers and facts only confirm that OKD, a. s. – a member of the mining group NWR, faced high risks already back in 2013. Based on the above mentioned, we perceive the research results as relevant.

Our findings contribute to the discussion on the importance of risk assessment, especially in connection with investments (Hull, 1980; Benaroch, 2002). If investment projects are assessed using

1 The information on the determination of the discount rate for NWR in 2013 is available in the monograph Risk premium and cost of capital: application in mining industry by Bora, Vaněk and Špakovská (2015).

a discount rate lower than a rate reflecting its objective risks, the investment project undertaken may fail. The investment may fail to generate profit, or it need not be paid off.

Because we do not know the discount rate according to which the investment projects in OKD, a. s. – a member of the mining group NWR, had been assessed, we cannot rigorously declare whether the discount rate used in the company in question reflected the objective level of risk or not. Nevertheless, due to the fact OKD, a. s. – a member of the mining group NWR, has gone bankrupt, we may assume that the company management had underestimated the risks.

CONCLUSION

The introduced model herein, the Mining Build-up Model (MBM), was prepared for the needs of the mining and processing industry. Later on, it was applied to determine the risks in the mining company OKD, a. s. – a member of the mining group NWR.

The risk premiums in the basic modules were as follows: business risk = 0.94%, financial risk = 4.12%, mining risk = 4.22 %, and specific risk of a mining company = 3.24%. The total risk premium was determined having added up the different premiums and it reached 12.52%. As we worked with the risk-free rate of return at a value of 2.83%, the cost of equity for OKD, a. s. – a member of the mining group NWR, amounted to 15.35%. The weighted average cost of capital of NWR Plc was calculated as 12.34%.

The MBM model we created is a valuable contribution to the group of modular methods. Its advantage is that apart from general considerations, it takes into account specificities of the mining industry. Although the mining company is a standard business from many perspectives, the line of business – exploitation and processing of minerals – includes a number of specific risks that the models used so far do not quantify. Therefore, a decision based on the results from MBM can better reflect these specific features, which will positively affect the quality of an investment decision of any mining company.

The Mining Build-up Model allows managers, or mining company management, to quantify the cost of equity with regard to a fair amount of risk, to which the company is exposed. The variability, with which risks can be viewed, and the ability of a plastic view of the risk of the mining company are an indisputable advantage of the MBM architecture. Although MBM cannot substitute the risk management and especially risk analysis, the provided details are important from the perspective of the acceptance or rejection of an investment project. In addition, MBM can also have significant benefits for mining companies that cannot use other methods to determine r_e based on market income methods.

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