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ALTERNATIVE COSTS OF EQUITY OF COAL MINING COMPANIES TAKING INTO ACCOUNT A CONTEXT OF THE RUSSIAN INVASION INTO UKRAINE

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Abstract. The aim of work was to evaluate the alternative costs of equity of mining companies in the Czech Republic from 2011 to 2021 and to predict the development of costs structure of equity in the following five years. The calculation of Capital Asset Pricing Model (CAMP) model was selected to deal with the issue of alternative costs of equity in the monitored period and multi-layer perceptron networks were selected for the prediction of development. The achieved results clearly demonstrate the ratio of capital structure and its prediction in the future. The research is useful for energy enterprises and a possibility to use it in another sector is obvious.

Keywords: alternative costs; debt capital; CAMP; neural networks

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JEL Classifications: E37, D24, L72

1. Introduction

The military conflict caused by Russia already began in 2014 by fighting over the control of Crimea and it incites the current incident. Russia is critically dependent on the income from gas export to Ukraine and the European Union, Ukrainian energy deposits and pipelines are potentially a direct competitive threat to Russian energy export (Johannesson & Clowes, 2022). The current situation in Russia and Ukraine is enhanced by the events from two previous years of pandemic and the consequences are the oscillations of economy in the whole world influencing all segments (Dutta & Saikia, 2022). There occurs a documentation of negative relation between the Ukraine-Russian war and the profits of global share markets (Boungou & Yatie, 2022). Not only does the war enormously affect the global supplies of natural gas, but also food industry, which results in the rise of food prices, supply chains, it affects production processes and dealing with import and the logistics of import from Ukraine (Jagtap et al., 2022). The military conflict therefore results in increased monitoring and analysing fuel supplies. The current crisis affects the issues of intensive research and the possibilities of alternative fuel supplies, including independence from other countries, oil supply and necessary raw materials. For example, biofuels may

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become clean and affordable energy in the post-war era (Esfandabadi et al., 2022). The lack of natural gas brings about the revaluation of other possible energy sources, as the limitation of gas supplies from Russia results in the rise in demand for other sources of energy and heat, the value of which increases (Halser & Paraschiv, 2022). This situation is also relevant to mining companies as the price of energy influences every entity in the world and therefore it is important to determine two key factors, i.e. the overall demand for a product and final consumption (Baratsas et al., 2021; Polishchuk et al. 2021; Hyránek et al. 2021).

The prices in the international coal trade depend on the largest coal exporters and users (Guo et al, 2021; Pitukhina & Urbański, 2021; Škare et al., 2021; Přívara, 2021). A small change in coal mining significantly affects the volume of trade in the international market. The European market has not set the trends in the international coal markets for many years, but it is influenced by general trends (Stala-Szlugaj & Grudzinski, 2021; Ulewicz et al. 2022; Čermáková et al. 2022). The price of coal deviates three times from the basic price ant it is determined by the beginning and the end of certain events, such as oil price shocks and financial recession (Khan et al., 2021; Přívara, 2019a, 2019b; Kabir, 2021). Therefore, mining companies face significant changes. The structure of sources of mining companies is reflected in the ability of the company to fulfil the golden and the silver rule of balance sheet. The degree of the return of company assets differs and it is influenced by the oscillation of coal prices in various phases of market and by the ability to pay off debts (Sierpinska, 2021; Grumstrup et al., 2021; Vaněk et al. 2021). The current situation is a mere imaginary acceleration of the sequence of events with exploitable sources, which is going to happen in the near future, and the present measures will be manifested. Coal will remain the main source of energy in the country in compliance with the state energy policy despite the increase of using nuclear energy and natural gas (Cablik et al., 2019; Sahoo & Pradhan, 2021; Magdich et al., 2021). The slowdown of global economy and the change of global value chains is necessary in the long-term horizon with regard to the results of historic approaches. It is important to avoid historic dangerous paths that could result in unnecessary outcomes (Mariotti, 2022; Masood et al., 2017). The risks of economic cycle also influence the speed of adapting the capital structure of society (Korzh et al., 2017; Štefančík et al., 2021; Qin et al., 2021; Škare and Porada-Rochon, 2022). Adapting is slower in the presence of macroeconomic risk and companies adjust their capital structure faster than in developed countries (Mursalim et al., 2017; Gan et al., 2021; Belas et al., 2019). The digital methods of managing financial resources optimise a capital structure and increase the value of company (Panfilova et al., 2019; Krajčík, 2021; Bilan et al., 2017). The complexity of capital structure relates to the need for debt capital: an access to debt markets and capacity for additional loans. Each of these derivates bears a unique influence on the complexity of the structure (Orlova et al., 2020; Gavurova et al., 2017, 2020). The achieved results may be useful for all experts who deal with the own costs of companies, alternative costs of equity, mining companies, CAMP method and neural networks.

The aim of research is to evaluate the alternative costs of equity of mining companies in the Czech Republic from 2011 to 2021 with regard to coronavirus crisis, the war between Russia and Ukraine and the prediction of developing the costs structure of equity in the following five years.

Capital structure is a dynamic process that changes in time in dependence on variables that influence the overall development of economy, specific sector or society (Nenu et al., 2018; Privara et al., 2018). Optimal capital structure is a key presumption of business activities and it is a hard task to determine it as there is not a universal model of the structure (Belas et al., 2018). In accordance with the findings (Mohd Azhari et al., 2022; Přívara & Rievajová, 2021; Vorobeva & Dana, 2021) among publically traded companies, the maximal debt was higher before the COVID-19 period, the short term debts negligibly decreased in the course of pandemic, however, the long term debts increased negligibly.
RQ1: How did the costs structure of equity develop in mining companies operating in the Czech Republic from 2011 to 2021?

The current situation of post-COVID period and the development of military conflict bring about the adaptation of capital structures in business environment. The risks of economic cycle influence the speed of adapting the capital structure of company. The adjustment of capital structure is slower in the presence of a macroeconomic risk. Companies adjust their capital structure in good macroeconomic states faster in contrast to bad economic countries (Gan et al., 2021).
RQ2: What is the way of developing the structure of own costs in mining companies in next 5 years?

2. Literature Review

An entity should have a flexible structure or should have the possibility to borrow funds if needed (Savina, 2020). (Martati et al., 2018) state that the ratio of indebtedness and debt to equity influences the profitability of manufacturing companies. The calculations carried out by Royer (2019) show that the rate of return on equity leads to higher costs of equity and confirm that the costs of equity are higher than debt capital. The precise value of return on equity cannot be determined because some parameters need to be estimated and can include errors in measurements (Situm, 2021). Business valuation methods usually explicitly do not include the effects that the costs of company bankruptcy could have on the costs of capital. Kambourova et al. (2019) argue that the aim is to demonstrate the resulting financial vulnerability by adjusting capital costs using various methods. One of the methods is the calculation of weighted average costs of capital. The values of average weighted costs of capital can change depending on the structure of investment resources, revenues, and profitability (Bunkovsky & Yastrebinsky, 2018). This method is used to determine the value of the overall capital structure of a company, and is particularly suitable for choosing a healthy investment project. Rodica et al. (2019) performed an analysis of the neutrality of financial policy and average costs using linear regression model where the dependent variable is WACC and independent variable is the financial structure that represents financial influence. In the research on calculating WACC, Kubenka (2020) uses various methods for their determining and CAMP where the key method is the result of the calculation of weighted average costs. The standard model of valuation of capital assets is not valid if the risk-free asset ceases to exist or if the barrier-free borrowing and lending rates differ (Mondal & Selvaraju, 2019). In this consumption-based model, the value premium grows non-linearly with the degree of discounting and affects the cross-section of returns (Hens & Schindler, 2020). If the company has zero hedging costs, it uses the contingent capital asset valuation model (Hasler & Martineau, b.r.,2022). For determining the value of investment capital, Potashnik et al. (2018) used the model of valuation of capital assets and Hamada equation with regard to financial risks and risks associated with investment decisions. This model enables to assess the risk factor of financial assets based on their correlation with market portfolio using beta coefficient. The method assumes the relationship of the static risk and revenue. The estimated risks are time-varying and are not stable over time (Nurjannah et al., 2018). The CAPM model assumes that investors are risk averse (Levy, 2022), which is also confirmed by (Mohanty, 2019). The performance of the CAPM seems to be quite sensitive to the selected weight matrix (Shi, 2022). In developed countries, the CAPM model is the most commonly used model for determining the costs of equity; on the other hand, there is no consensus concerning the selection of the most suitable model that would be easily applicable for estimating the costs of equity (Momcilovic et al., 2017). The decision on investment and consumption in several periods exposes a company to time-varying risks related to economic cycles and market volatility. Based on the method of capital asset valuation, (Barinov et al., 2020) conclude that macroeconomic factors significantly influence the revenues of insurers.

In economic practice, there are several models and methods used for the quantification of costs of equity. Depicting the most suitable evaluation method can be achieved by using comparative analysis of the costs of equity using present and past market information. If uncertainty prevails, financial anomalies increase the complexity of financial decisions. The use of mathematical programming can reduce the degree of complexity in planning both internal and external financing and investing (Eldomiaty et al., 2018). The causal effect of arbitrage limits on asset pricing anomalies using SHO regulation program is weakened for portfolios created using pilot

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stocks (Chu et al., 2020). Gao et al. (2019) examine the validity and utility of hybrid valuation models that generalize residual income valuation model. The authors state that the internal value of hybrid models are more precise and the implied costs of equity better capture the systematic risks and expected returns. Baines & Hager (2020) come up with the statement that any model of stock market must consider geographic inequalities and ongoing national diversities in the capital development. Estimating the future probability distribution of the time series considering its history is the key factor for optimizing business processes. (Salinas et al., 2020) propose a method based on training auto-regressive neural network model on a large number of related time series.

Vidya & Prabheesh (2020) conducted research on predicted future development of trade using the analysis of business networks and artificial neural networks. In their comparative analysis of methods for empirical asset valuation, Gu et al.(2020) measure risk premium of assets, identifying decision trees and neural networks as the most efficient methods and trace their predictive gains, which enable non-linear predictor interactions not considered in other methods. Ratih (2021) agrees that the method of neural networks is more efficient, even when accounting for the transction costs. Recurrent neural networks are becoming popular not only due to their accuracy but they can be used even for non-expert users, since they are robust, effective, and automatic (Hewamalage et al., 2021). Algorithms based on machine and deep learning represent new approaches in solving problems related to time series forecasting. These methods provide more accurate results than conventional regression-based modelling. LSTM layer is suitable for modelling time information on irregular trends of time series components. The proposed method achieves nearly perfect prediction output (Kim & Cho, 2019). Multivariate time series data forecasting has a number of valuable applications. However, this is hindered by complex and non-linear interdependencies between time series and time steps. For accurate prediction, it is essential to model the long-term dependency on time series data, which can be achieved through recurrent neural networks with attention mechanisms (Shih et al., 2019). Qualitative content analysis is a research method performed either in inductive or deductive way. The inductive approach is based on the data collected in order to be able to start the research. The deductive (directed) approach is based on the existing theory to set up the categories that guide the research (Kibiswa, 2019). The method of qualitative analysis of data from content analysis is applicable in analysing a wide range of data sources including textual, image and audio datasets (Kleinheksel et al., 2020). Research methods and analytical approaches supporting research must constantly respond to changes in research methods and technologies of data collection and data analysis in current research frameworks (Serafini & Reid, b.r. 2019). Anastasiei & Georgescu (2020) argue that automated qualitative analysis is dependent on the accuracy of the tool used, which can be verified using manual qualitative analysis. On the basis of data collected in the form of internal company statements, annual reports and final balance sheets of companies, internal documents of a company are analysed and subsequently evaluated and compared across the whole industry. The most suitable method of predicting the development of costs is time series forecasting, whose task is to predict the future values of a given sequence using historical data (Sagheer & Kotb, 2019).

Teo et al. (2022) carry out the testing of network scheme feasibility using a three-layer deep neural network for achieving maximum accuracy. Paul & Sarkar (2018) compare the results of the most commonly used multilayer perceptron and multilayer convolutional neural network. Deep convolutional neural network is universal if the depth of the neural network is sufficient (Zhou, 2020). A data-driven prediction can be achieved by the combination of deep convolutional neural network and deep multilayer perceptron (MLP) (Sekar et al., 2019).

Content analysis will be used for data collection and analysis for both research questions. In order to be able to respond the first research question, CAPM will be used. The second formulated research question will be answered using multilayer perceptron neural networks.

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3. Methodological approach

3.1 Data

Data on risk-free rate of return or risk-free values for the monitored period 2011–2021 are available on the websites of the Czech National Bank, specifically in the database of time series ARAD, yield on ten-year government bond (ČNB,2022). Data on beta coefficient will be obtained from Excel in Damodaran data, section archived data, European section Levered and Unlevered Betas by Industry for individual years. To obtain the values of risk premium, Damodaran online data will be used as well, specifically data item: Risk Premium for Other Markets for specific monitored period (Adamodar, 2022). For the purposes of predicting time series, Excel file will be created containing monthly time data from January 2022 to December 2026.

3.2 Methods

The data will be processed using the calculation of the CAPM model according to the formula below (Levy et al., 1999):

$$E(r_i) = R_f + \beta_i \, (E\,(R_m) - R_f) \tag{1}$$

where $E(r_i)$ represents the expected return rate of the i-th investment instrument,
R_f risk-free rate of return,
β_i beta coefficient of i-th instrument considering systematic risk,
$E\,(R_m)$ expected rate of return of the market portfolio.

The result will be calculated according to the above formula for each month of the monitored period. The individual resulting values will then be graphically represented in order to provide a faster and clear overview of the development of the monitored changes. This method thus enables obtaining answer to the first research question.
MLP is one of the most commonly used type of neural networks. It is a network with one or more hidden layers of neurons between the input and the output layer. The neuron in the input layer sends the signal to all neurons of the hidden layer. The outputs of the hidden layers transmitted to the inputs of each neuron in the higher layers and are multiplied by relevant weights. The output of the k-th neuron in an n-th hidden or output layer of multilayer neural network can be calculated as follows:

$$y_k^n = f\,(w_{0,k}^n + \textstyle\sum_{i=1}^{m} y_i^{n-1} \,.\, x \, w_{i,k}^n) \tag{2}$$

where $f(x)$ represents the transfer function in neuron,
$w_{0,k}^n$ bias in neuron,
m number of weights of neurons.

For processing the data to answer the second research question, program Mathematica, version 13.1 will be used. The data analysis will be performed using the method of neural networks, specifically time series analysis. The first variable is the date; the second variable are the results of $E(r_i)$ calculated using CAPM. The dataset is then imported into the program using functions Drop and Flatten with the specified input data. In the program, only the values in the first place in the table are displayed in the first step (a). This is followed by another command: display the values from the second place (b). In the third step, these values are combined using the function Thread (a→b). Based on these three steps, the program displays the individual months assigned to the individual values of $E(r_i)$ from Excel.

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In the next step, the second Excel file with one prepared variable, future data from 1 January 2022 to 31 December 2026 in monthly intervals, is imported. Other commands entered using the functions Predict, NeuralNetwork, PerformanceGoal, and data prediction will generate multilayer perceptron networks, which will show the prediction of the future development of $E(r_i)$ in the next 5 years and thus provide the answer to the second research question.

4. Results

4.1 CAPM

Figure 1 shows an overview of values in the past monitored period 2011-2021.

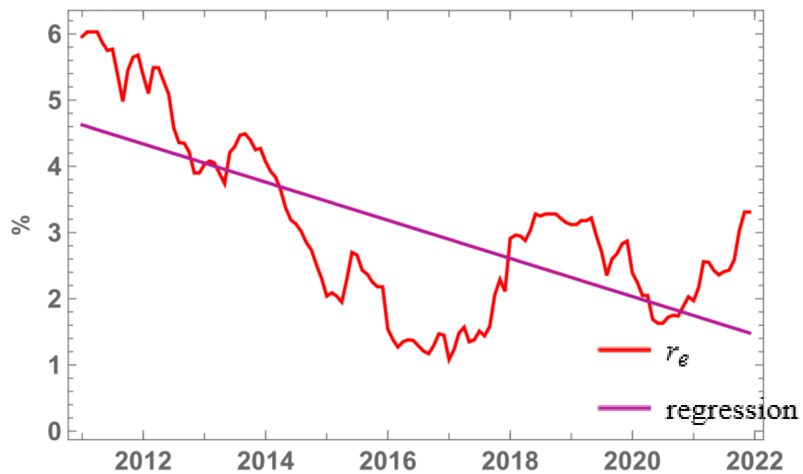

Figure 1. Values until 2021

Source: Authors

The x-axis shows the time values from 2011 to 2022. The y-axis shows the values from 0 to 6. This limit is suitable and sufficient for the purposes of this research. The course is thus given by individual values obtained by substituting individual results from the above formula for the calculation of CAPM from the above resources. It can be also seen that the individual values change over time, showing an upward or downward trend. The cross-section of the image is represented by a line with a downward trend.

4.2 MLP

Figure 2 shows the values of predicted future development of the values of alternative costs of equity.

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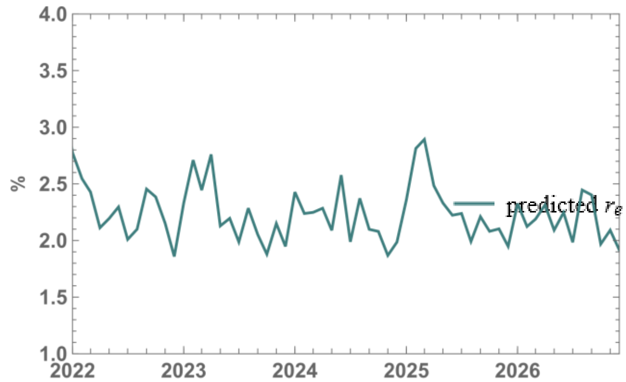

Figure 2. Prediction of future development

Source: Authors

The x-axis represents the years 2022-2026, while the y-axis sows the values from 1 to 4, which is sufficient for this purpose. Individual values are interlinked according to the predefined rules. Furthermore, on the basis of the calculations, it can be concluded that the course will change but will not achieve values higher than 4 and will not contain any other extreme values.

In Figure 3, Figures 1 and 2 are combined into one timeline.

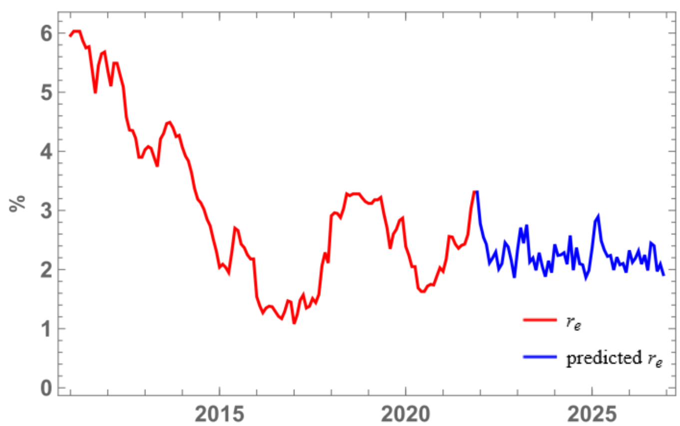

Figure 3. Development of alternative costs of equity until 2026

Source: Authors

The future prediction shows a half of the period for which the preceding values were analysed. Yet, it shows that the values will be more stable, without major fluctuations, but as pronounced as in the first part of the analysed period.

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5. Discussion of results

RQ1: How did the costs structure of equity develop in mining companies operating in the Czech Republic from 2011 to 2021?

At the beginning of the monitored period, the share of alternative costs of equity accounted for about 57.19 % of the total costs of equity. Over the years, the individual values changed and fluctuated significantly, not only as a result of the economic situation in the Czech Republic and in the world. At the end of the monitored period, the values were significantly lower than at its beginning, with a 26.54 decrease. The minimum value in the monitored period was recorded in the first month of the year 2017, achieving 10.77 %, while the maximum value of the alternative costs of equity was 60.34 % recorded in March 2011. The biggest difference was thus 49.57 %. The overall average value of percentage share of alternative costs of equity for the monitored period was thus 30.56 %. According to Momcilovic et al. (2017), CAPM is one of the best methods for calculating alternative costs of equity, which is also confirmed by the results obtained within this research. This approach can be used for the mining industry but also for any selected sector in the Czech Republic and abroad, but only provided that the necessary input data for the calculation are available and traceable.

RQ2: What is the way of developing the structure of own costs in mining companies in next 5 years?

Based on the obtained results for the past monitored period 2011-2021, using neural networks, it is possible to predict the possible future development. The monitored development was for the half of the period than the previous one. Due to the uncertainty concerning the war conflict between Ukraine and Russia and other circumstances, it is impossible to predict the future development precisely. Prediction thus do not always correspond to the actual development. In terms of forecasting the development of costs of equity, Sagheer & Kotb (2019) state that time series forecasting is one of the best methods to predict the values for given sequences using historical data, which can be also confirmed based on the results obtained within this research. Sekar et al (2019) predict the future development of values using neural networks and deep multilayer perceptron, which also proved to be useful for the purposes of the research submitted. As stated by Siami-Namini et al. (2019), this method provides more accurate results than conventional regression-based modelling. Based on the results of the calculations performed for the purposes of the research, this conclusion can be also confirmed. Individual predictions, however, cannot be perceived as certain, as other unexpected circumstances and factors can emerge that could disrupt the course of the development, as confirmed in the past years. This forecasting method can be used for predicting the development of costs of equity, but can be used for any other time series with a given history in the analysed time series.

6. Conclusions

The goal of the research was to evaluate the alternative costs of equity in mining companies in the Czech Republic between 2011-2021 with regard to the COVID-19 pandemic and the conflict between Russia and Ukraine, as well as to forecast the development of the structure of costs of equity in the next five years. The goal was achieved using the method of capital asset valuation, CAPM, while the development was predicted using time series and multilayer neural networks. The goal was thus achieved. The discussion of results indicates that even when considering the events in the past two years, when the world was facing the global COVID-19 pandemic, the structure of alternative costs of equity of mining companies has not been significantly affected. It has been found that it is not possible to determine the ideal capital structure, as it changes over the years for every company or the whole industry. In general, it can be stated that it is recommendable to use debt capital rather than equity to certain extent. The risk the company takes through its capital structure is different for every industry and changes over time. The degree to which it is recommendable to used debt capital can be determined by tax shield and accounting rules.

Forecasting the structure of equity of a company is useful mainly for company owners and investors (not only) in energy companies. The expected capital structure of energy companies in the future indicates that the structure of the costs of equity will fluctuate depending slightly on external factors. It is also necessary to consider the extreme values of individual companies, which might slightly distort the data in the overall overview of companies.

In the monitored period, equity of energy companies achieved the highest values at the beginning of the year 2011 until 2016 when it showed the lowest values. In this period, the companies could use the possibility of financing through debt capital rather than through equity. Between 2017 and 2019, the values fluctuated again, with an initial increase in the value of equity. In this period, the companies used financing through debt capital. An important thing is not to exceed a specific amount of debt capital, otherwise the profit of energy companies becomes risky. In the year 2020, owners of energy companies use debt capital to a larger extent, which is profitable and acceptable for them in this monitored period. At the beginning of 2021, the values of equity grow again, and the companies should prefer debt capital to equity. The values grow until the end of the year. Major fluctuations were assumed in the years 2020-2022 due to the COVID-19 pandemic. In 2025, it is expected that the values of equity will be higher than in the remaining years of the monitored period. Therefore, the companies should prefer debt capital over equity. For investors, forecasting the development of capital structure is of great importance. Indebtedness of energy companies grows in individual years, which indicates a suitable investment opportunity. According to the prediction, the year 2025 will be the least favourable year for investment decisions concerning investment in companies. The comparison of other years of the monitored period shows that the second least favourable period for investments is the first half of the year 2023. In 2024 and 2026, the values slightly fluctuate and it cannot be excluded that the investment will be inefficient.

No regularity or cycle is observed in the monitored or predicted period. Energy companies try to avoid heavy indebtedness in order to be able to maintain their stable position in the market. Overall, from the perspective of energy companies´ owners, the development of their capital structure in the Czech Republic is evaluated as positive.

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