THE ISSUE OF INCOME FROM OPERATING UKRAINE COAL DEEP MINES

PROBLEMATIKA HOSPODÁŘSKÉHO VÝSLEDKU HLUBINNÝCH UHELNÝCH DOLŮ UKRAJINY

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Abstract

This paper focuses on looking for factors that influence the income of deep coal mining operations in Ukraine. The method of discriminate analysis was employed for assessing economic success of the operations. It could be concluded that mining-geological conditions are the most significant cause of influence; the human factor is of lesser importance.

Abstrakt

Příspěvek se zabývá hledáním faktorů, které ovlivňují dosažení kladného nebo záporného hospodářského výsledku hlubinných uhelných dolů Ukrajiny. Je použitá metoda diskriminační analýzy. Dochází se k závěru, že nejvýznamnější příčinou jsou důlně-geologické podmínky, v menší míře pak vliv lidského činitele.

Key words: coal deep mines, Ukraine, profitable and loss-making mines

1 INTRODUCTION

Ukraine takes the seventh position as regards the world total coal reserves. Until 1989, in analogy to other Comecon countries, the country collieries were owned and operated by the state. The coal was taken as a strategic raw material whose extraction economy was of less importance. The financing of actual mining operations took advantage of redistributing income between open cast and deep mines. The loss-making operation of some collieries was taken for granted and the appropriate planning provisions were made. The mine workers' status and their wages were superior compared to other blue-collar workers.

The progress of restructuring mining industries after 1989 was faster in the Czech Republic than in Ukraine. The restructuring was characterised by privatisation of the industries concurrently with restriction of their activity. At the same time, state subsidy and income redistribution schemes were abolished. The causes of the restructuring consisted in reduced priority of heavy industries, loss of strategic status for many minerals, the need of which could be met by import, and environmental concerns, and other factors inclusive those of politics. The restricted mining industry activities were concentrated and specialised on extracting of choice resources. The mining industry organisational structures simplified.

In such situation, the importance of profitability of individual mining enterprises increased, as loss-making pits were being closed down.

2 INCOME FROM OPERATING COAL DEEP MINES

An economic result of a company, as a difference between revenues and expenses, is a complex indicator of successful or unsuccessful operations. Considering the conditions of deep mine operations, this indicator is influenced by many factors that can be summarized as follows:

- **Natural factors**: Useful seam thickness; seam bedding depth and its dip; coal gas capacity; threats of quakes, coal and gas outbursts; seam tectonics; etc.,

- **Human factors**: Workforce provision as regards quantity and miners' qualification structures; their age, health, work moral, etc.,

- **Economic factors**: Prices of products and production process inputs, ratio of inside and outside capital resources, production quantities, etc.,

- **Organisation and management factors**: Management experience and motivation, mining legislation of work and safety at work, etc.

These factors influence the economic results and cash flows of individual collieries. If it is obvious that factors of negative influence are beyond redress, the colliery is closed down.

Such analyses and processes affected coal (but also other mineral) extraction industries in the Czech Republic in the nineties of the past century. The result was that only half of total production was reached in comparison to a historical maximum. The Ukrainian coal mining industries are at the beginning of the process. The ratio of the state owned and run collieries is still quite high and a lot of them operate in the red.

It is a question, which factors promote chances of success or failure. Obviously, the answer depends on how many factors of the above mentioned items are at disposal for the analysis.

This case investigation took into account monthly statistics of 12 coal deep mines of the Donetsk Region in Ukraine. The input data covered operations between 2000 and 2005. (Kochura, 2012). In this period, all collieries were in the hands of the state. The monthly statistics presented the following variables:

- Coal production [ton/month]

- Direct costs of extraction [Hryvnia/ton]

- Production loss caused by gas capacity[ton/1000 tons of production]

- Production loss caused by geological conditions[ton/1000 tons of extraction]

- Production loss caused by disrupted flows of material supplies [ton/1000 tons of production]

- Workforce provision ratio [ratio to 1, i.e. to full workforce provision rate]

- Workers of basic qualification ratio, i.e. workmen without secondary or higher education [ratio to 1]

- Human factor implied loss of production, i.e. infringement of work safety regulations [tons/1000 tons of production]

- Production loss due to equipment breakdowns [ton/1000 tons of production]

- Increase of production input costs in the last 5 years [%]

- Trading income of the colliery [thousand Hryvnias/month]

The production losses caused by natural and organisational/management factors, as well as a human factor were identified by periods in which the production was disrupted by any of the mentioned factors.

Comparing daily production capacities with the periods of discontinued production, the losses were established in tons per month, which were adapted to 1000 tons of production so as to provide for comparison with other collieries. The input data files were structured into 2 groups, namely: (i) profitable collieries, and (ii) pits operating in the red. The individual indicator (variable) averages of these groups are given in Tab. 1. This table also provides for assessments of statistical significance as regards differences in averages of profitable and loss-making collieries. This statistical significance was evaluated by the Student's t-test at the $\alpha=0.05$ level. (Hindls, 2007). Each group of collieries comprised 32 figures.

The discriminate analysis was used for identifying those variables that are significant for classifying businesses as profitable or loss-making.

Tab. 1 Indicator (variable) averages and statistical significance of their differences

Variable	Average		Difference significance
	Profitable	Unprofitable	
Actual production	63 383.03	25 019.63	Significant difference
Actual direct costs	90.02	136.55	Insignificant difference
Production loss due to coal gas	0.36	1.77	Insignificant difference
Production loss due to geological conditions	6.32	42.35	Insignificant difference
Production loss due to material supply deficiencies	8.33	13.36	Insignificant difference
Workforce qualification structure ratio	0.80	0.81	Insignificant difference
Workforce basic qualification ratio	0.74	0.71	Insignificant difference
Production loss due to human factor	0.71	3.69	Insignificant difference
Production loss due to equipment breakdowns	76.52	90.89	Insignificant difference
Cost increases of material inputs, 5-year period	4.98	8.65	Insignificant difference
Income	+ 685.00	-1259.00	Significant difference

3   DISCRIMINATE ANALYSIS METHOD

3.1 The Method

The discriminate analysis of classification statistically investigates relations between a group of independent attributes, m – discriminators, and a single dependant qualitative variable. The simplest case is represented by a binary variable output of 0 (zero) value if an object belongs to Class I. If an object belongs to Class II, the binary variable output has a value of 1. The objective is to develop a prediction model that would provide for classification of new objects.

The application of the method starts with two classes of objects. Each of them is characterised by its discriminator value, m. The first class comprises objects, n_1, and can be described by an input matrix, $n_1 \ x \ m$. The matrix's lines are formed by discriminator values of specific objects; the columns provide for values of specific discriminators for different objects. The second class comprises objects, n_2, and can be described by an input matrix, $n_2 \ x \ m$. Sample averages, $\bar{x}_1$ and $\bar{x}_2$, are calculated for individual classes. These are vectors, the constituents of which are calculated as discriminator values averages.

Further, a common covariance matrix is formed:

$$S = \frac{(n_1 - 1)S_1 + (n_2 - 1)S_2}{n_1 + n_2 - 2} , \qquad (1)$$

where:

S_1, S_2 – covariance matrices of individual classes.

With the aid of the sample averages, $\bar{x}_1$ a $\bar{x}_2$, and the inversion matrix, S^{-1}, as related to the common covariance matrix, S, the vector, a, is calculated (the constituents, of which are the linear discriminate function coefficients), and a coefficient,

$$b = -\frac{1}{2}a^T(\bar{x}_1 - \bar{x}_2) - ln(\frac{\pi_1}{\pi_2}),$$ (2)

where:

π_1, π_2 - a priori probabilities that an object pertains to the first or second class.

The simplest assumption is: $\pi_1 = \pi_2 = 0,5$

If new objects, x_0, are classified, the rule is applied that an object is classified as belonging to class I. if $a^T x_0 + b > 0$ (Meloun&Militký, 2004). (3)

3.2 Discriminate analysis application

The linear discriminate analysis was applied to a file, n_1, of profitable collieries, and file, n_2, of loss-making pits. Each colliery is characterised by a set of discriminators, m. The objective is to find a discriminate function that would provide for classifying a specific colliery as profitable or operating in the red. If Class I (profitable pits, n_1) is characterised by mean value vectors,

$x_1 = (x_{11}, x_{12}, \ldots, x_{1m})$ and a covariance matrix, S_1

and Class II. (unprofitable pits, n_2) by mean value vectors,

$x_2 = (x_{21}, x_{22}, \ldots, x_{2m})$ and a covariance matrix, S_2,

than the coefficients, $a_1, a_2, \ldots, a_m$ of the discriminate function,

$$f_i = a_1 x_{i1} + a_2 x_{i2} + \cdots + a_m x_{im},$$ (4)

are calculated by the formula,

$$a = S^{-1}(\bar{x}_1 - \bar{x}_2)$$ (Hebák et al., 2004). (5)

If average value vectors of Classes I and II are substituted in the discriminate function equation, we can calculate average values, $\bar{Z}_1$ and $\bar{Z}_2$.

The optimal threshold value, C, which determines objects as belonging to Class I or Class II, can be calculated:

$$C = \frac{(\bar{Z}_1 + \bar{Z}_2)}{2}.$$ (6)

A non-classified colliery, whose linear discriminate function value is in excess of C, can be put in Class I of profitably operating pits. If the linear discriminate function value is less than C, the pit should be qualified unprofitable and as such belongs to Class II. The model efficiency can be assessed by a feedback classification of collieries – or any company for that matter – that provided for the input data files of the model provision, and whose economic performance is known.

The relative significance of individual discriminators can be established by means of standardised discriminate coefficients. The standardized discriminate coefficients can be calculated if the discriminate function coefficients, a_i, are multiplied by standard deviations, s_i, of the respective discriminators. Irrespective of their negative or positive signs, each standardized coefficient represents a relative contribution of its discriminator to the linear discriminate function. The discriminators with standardized coefficients of relatively high values contribute to the linear discriminate function more than those of the lesser values. The negative or positive sign only means that discriminators contribute positively or negatively.

3.3 Discriminate analysis results

The results of the discriminate analysis in a form of standardized discriminate coefficients are provided by Tab. 2.

Tab. 2 Standardized discriminate coefficients

Variable	Value
Actual production	2.460
Actual direct costs	-0.680
Production loss due to coal gas	0.349
Production loss due to geological conditions	-0.499
Production loss due to material supply deficiencies	0.546
Workforce qualification structure ratio	0.228
Workforce basic qualification ratio	1.707
Production loss due to human factor	0.228
Production loss due to equipment breakdowns	-1.215
Cost increases of material inputs, 5 years period	-0.389

As evidenced by Tab. 2, Class I of profitably operating pits is particularly influenced by actual production volumes, and the ratio of the basic qualification workforce. Conversely to this fact, the negative ranking of the Class II of collieries operating in the red is mostly caused by production breakdowns.

By utilising the linear discriminate function – as a result of discriminate analysis application – and the individual pit discriminator values in the respective months of the analysis, a feedback classification was performed, having regarded the input data files of profitable or in the red operating collieries. The ratio of successfully classified pits to their total number in the group (i.e. 32) is a measure of classification success. Concerning 32 profitable and 32 in the red operating pits of each group, the success rate was 93.75 %, and 90.63 % respectively.

4 DISCUSSION

The individual discriminator averages, their quantitative levels, and statistical significance of differences of discriminator averages between profitable and loss-making pits provide for the following characteristic of profitable collieries:

They are clearly major producers of coal, they operate with lower direct costs, and production losses that would be caused by breakdowns, coal gas and geological adversities, as well as increases of input material costs in the last five years are also less significant. The discriminator average differences, as regards production losses due to breakdowns and input material cost increases, are of little statistical consequence. The differences of the other three discriminators are statistically significant.

The variable of actual production can be considered as a factor of major importance. High levels of direct costs – mine pumping-out and ventilation, lighting, and maintenance – are concurrent to any mining operations. If a monthly coal production output is low, the ratio of the actual direct costs per one ton of coal produced can be pretty high. Direct costs further increases due to the fast rise of material input costs. Collieries operating in the red also have higher rates of production losses caused by geological conditions of mining, and production equipment breakdowns. The latter two influences might be considered in their unity, as the equipment breakdowns can be also affected by natural conditions of the equipment operation.

These specific conditions of mining operations imply factors of major significance for classifying the individual pits as profitable or loss-making. Higher production rates not only influence the actual direct costs (fixed cost constituent ratio) but also imply increases of income from coal sales. A rather surprising factor of influence is that of workforce basic qualification ratio. It can be assumed that workers of this category are directly involved in the coal extraction activities so that their higher ratio affect positively the rates of production. The negative effect of equipment breakdowns is easy to grasp – the breakdowns that cause stoppage of the fully mechanised extraction working are clearly of a major impact on the overall coal production because of the production capacities implied in the mechanised working.

5   CONCLUSION

The individual discriminators values of profitable and loss-making collieries of the original input files provide for the following conclusions:

- Lower production losses due to better geological conditions of mining mean that the pits operate in more favourable natural environment.

- Favourable conditions of operation enable utilizing the equipment and machinery both of a larger number and capacity, which reduces a risk of production losses by breakdowns.

- Utilization of the large-capacity equipment and a lesser breakdown risk imply increased production rates, which lowers the ratio of fixed costs per one ton of coal extracted and consequently leads to a reduction of direct costs. These costs may be negatively affected by less favourable geological conditions under which loss-making collieries operate.

- Concerning collieries that operate in the red, the direct costs further increase by the faster growth of material input costs. The material inputs for operating more or less the same levels of machinery are approximately the same. Different material input needs for operating relatively the same machinery signify deficiencies of organization and management of the supply processes. There is a theoretical assumption that low production pits cannot take advantage of bulk discounts, as they buy less and it is more difficult for them to negotiate individual delivery prices.

It can certainly be assumed that natural conditions of mining dominate, concerning profitability of mining. The human factor influence is of lesser importance. Such assumption is in full accordance with the experience of deep mine operations in the Czech Republic, where the process of restructuring was started by closing down pits of adverse natural condition of operation.

Nevertheless, this analysis input data files are not large enough. Their amplification might provide for thoroughgoing investigation of factors that cause or influence the profitability of the Ukraine coal deep mines.

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RESUMÉ

Restrukturalizace uhelného průmyslu České republiky předcházela těmto procesům v podmínkách Ukrajiny, kde stále zůstává značný podíl hlubinných uhelných dolů v rukou státu. Privatizační procesy a ekonomické změny země se sedmými největšími zásobami uhlí na světě zvyšují význam dosahovaných hospodářských výsledků.

Hospodářský výsledek, tedy zisk nebo ztráta hlubinných uhelných dolů je ovlivňován řadou faktorů – přírodními, lidskými, ekonomickými faktory a faktory organizace a řízení. K analýze vlivu konkrétních faktorů jsme použili výchozí soubor 32 údajů měsíčních hodnot ziskových dolů a 32 údajů měsíčních hodnot ztrátových dolů Doněcké oblasti. Každý měsíční údaj byl charakterizován 10 proměnnými (diskriminátory) zahrnující těžbu uhlí, přírodní, ekonomické a lidské faktory. Dále byl k dispozici údaj o dosaženém hospodářském výsledku. Pro zjištění diskriminátorů, které jsou nejvýznamnější pro zatřídění do skupiny ziskových nebo ztrátových dolů, byla použita diskriminační analýza.

Výsledky ukázaly, že zařazení mezi ziskové doly je nejvíce pozitivně ovlivněno objemem těžby a podílem dělníků se základní kvalifikací. Zařazení mezi ztrátové doly je nejvíce ovlivňováno ztrátami těžby vlivem havárie zařízení.

S ohledem na hodnoty diskriminátorů v obou skupinách dolů, absolutní hodnoty těchto diskriminátorů a statistickou významnost rozdílů průměrných hodnot diskriminátorů mezi ziskovými a ztrátovými doly lze

předpokládat, že dominantní vliv na ztrátovost dolů budou mít přírodní podmínky, v menší míře pak lidský činitel.

Rozšíření vstupních souborů a zvýšení počtu diskriminátorů by umožnilo hlubší zkoumání příčin ztrátovosti resp. ziskovosti hlubinných uhelných dolů Ukrajiny.