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Study on factors influencing the level of capital expenditure spent in mining

Introduction

The importance of investment expenditure for the development of production activity is enormous. This is true for any economic entity, but is particularly important in relation to the extraction activity of mining plants. The reason for this is that mining is recognised as one of the most asset-intensive areas of economic activity, and the process of transforming investment expenditures in mining into the fixed asset components is particularly long--lasting. The fixed capital resources generated as a result of the investment activity, next to such factors as human labour expenditures, essentially determines the production effects achieved during the exploitation of the mining plant.

Currently as most investors represent private entities as the state generally does not undertake any investment activity in this area it is essential to asses factors which encourage investors to make capital investments in mining. Due to the fact that the investment process constitutes an extremely complex activity, it is not only important to determine the factors influencing such decisions but also the level of their importance for making such decisions. In order to determine the impact of the most important factors on the level of investment expenditure incurred, it is possible to use statistical data acquired by mining plants in the past, aggregated from the entire mining sector. This can be described using the functional relationship as the econometric model after having estimated the structural parameters of such a model. Once such a model is determined to be relevant, i.e. if it is found to reliably

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describe the relationships studied, the model can be used to study the tendencies of such relationships in the future.

In cases where two basic factors determining production effects are taken into account namely the capital resources generated as a result of the investment processes and the human labour expenditure the importance of the first factor grows with economic development since wealthy communities have relatively easier access to cheap capital, whereas human labour is relatively expensive under such conditions. However, these general tendencies may be reversed, for instance, during an economic downturn when access to cheap sources of investment capital is more difficult and people more readily accept work under more difficult conditions for lower remuneration.

1. Determining the factors influencing the propensity to invest in mining

As mentioned, many factors may influence the propensity of investors to make capital expenditures within a specific sphere of economic activity which are often complex and difficult to quantify. These factors can be generally classified as macroeconomic and microeconomic factors. The macroeconomic factors arise from the condition of the economy of the whole country and they constitute external factors for particular economic entities. Although the impact of a mining plant on their level is insignificant, they may substantially influence the investment decisions made in mining.

According to economic theory, among circumstances encouraging investment in a specific area of economic activity, the following factors are most commonly listed (Oyrzanowski 1997):

— the level of fixed capital existing in the country and the level of its use,
— investment profitability i.e. the rate of return achieved by the investor in relation to the funds invested,
— interest rates applicable in the market of a particular country as investment is profitable and will be undertaken only if its profitability is higher than the current interest rate.

The scale of the existing resources of fixed assets as well as the quality and advancement of individual facilities of these assets represent the most important factors determining economic growth and development. Expenditures on investment activity always represent a limited value, and in the case of the Polish mining industry, they are also not readily available. Accordingly, the underlying problem of rational management is not only the investment stream but also its effective and targeted utilisation. The increase in production size also depends on the mechanism of allocating resources among the following structures: spatial, departmental and sectoral, generic, and functional and objective (Kosieradzka 1998; Franik 2007).

This study considered factors directly related to the mining sector the internal factors in addition to external factors. These factors are referred to as the microeconomic factors. They

do not represent a single mining plant, but rather aggregate of such plants constituting the industrial sector called "mining and extraction" according to the Polish Classification of Activity (PKD). Studies on changes in the levels of investment streams and the factors affecting those changes are of fundamental cognitive importance, contributing to proper decision making within management.

Determining the relationship between the changes in the level of investment expenditure and the factors analysed is a fundamental issue for assessing developmental activity in mining plants. A relatively precise determination of these relationships which describes the importance of individual factors as a formalised function irrespective of their aggregate category (a coal mine, a mining company, the trade, the industrial sector) allows for an objective assessment of prior investment and production activity (Gawlik 2008).

This examination has attempted to determine the impact of selected factors on the propensity to invest in the mining industry. A set of such potential factors was established and an attempt made to asses the significance of such factors based on their impact on the level of investment expenditure.

These relationships were studied using statistical figures for the national economy and the mining industry from 2000–2010, applying mathematical statistics and econometric modelling methods. The value of investment expenditure in mining was treated as a dependent variable, y, while the macro- and microeconomic factors studied are the successive, independent variables from x_1 to x_9.

The list of the factors considered (including their symbols) is as follows:

1) gross domestic product, [M PLN], x_1,
2) gross value of fixed assets in the country, [M PLN], x_2,
3) real interest rate, [%], x_3,
4) gross value of fixed assets in mining, [M PLN], x_4,
5) net value of fixed assets in mining, [M PLN], x_5,
6) gross added value generated by mining, [M PLN], x_6,
7) gross value of fixed assets liquidated in mining, [M PLN], x_7,
8) level of consumption of fixed asset components in mining, [M PLN], x_8,
9) average remuneration in mining, [M PLN], x_9.

The third factor, the real interest rate, was based on the market interest rate, after accounting for inflation. The nominal values in the statistics, those expressed in current prices for a specific year, were converted to real values, i.e. expressed in fixed priceswhich applied the average indicator of changes in production and service prices. The real values are expressed under market conditions for the year 2010. This refers to all variable factors excluding the real interest rate and the level of consumption of fixed asset components.

The set of input data for analysis, prepared as described above, is presented in Tables 1 and 2.

TABLE 1

Real values of investment expenditure and the economic factors studied

TABELA 1

Realne wielkości nakładów inwestycyjnych oraz badanych czynników ekonomicznych

Years	y_t	Independent variables				
		x_{1t}	x_{2t}	x_{3t}	x_{4t}	x_{5t}
	[M PLN]	[M PLN]	[M PLN]	[%]	[M PLN]	[M PLN]
2000	2 627.5	975 492.6	1 893 386.9	8.15	52 150.6	18 657.4
2001	2 981.1	968 344.2	1 892 002.6	8.93	51 973.5	19 630.2
2002	2 813.3	985 656.8	1 957 499.4	6.38	51 351.6	18 633.0
2003	2 782.7	1 019 650.2	2 026 009.9	5.08	44 968.8	20 890.5
2004	2 909.4	1 035 018.0	2 042 287.0	2.58	44 346.6	20 814.4
2005	3 786.8	1 084 072.4	2 090 709.1	3.05	45 541.3	20 693.0
2006	4 135.7	1 201 271.4	2 167 935.5	3.13	48 326.5	21 785.5
2007	4 877.2	1 254 172.0	2 278 532.5	2.13	53 322.7	24 088.5
2008	5 832.7	1 319 539.7	2 362 999.3	1.34	54 908.8	23 106.9
2009	5 250.1	1 377 248.4	2 436 330.7	0.38	58 540.8	25 522.5
2010	4 880.0	1 415 362.0	2 520 940.0	2.50	53 296.0	23 126.0

Source: own study based on (Statistical Yearbooks 2000–2011)

TABLE 2

Real values of investment expenditure and the economic factors studied (cont.)

TABELA 2

Realne wielkości nakładów inwestycyjnych oraz badanych czynników ekonomicznych (c.d.)

Years	y_t	Independent variables			
		x_{6t}	x_{7t}	x_{8t}	x_{9t}
	[M PLN]	[M PLN]	[M PLN]	[%]	[M PLN]
2000	2 627.5	20 891.7	2 349.7	64.2	4 307.55
2001	2 981.1	19 605.0	1 270.4	62.2	4 438.24
2002	2 813.3	18 847.0	1 298.4	63.7	4 573.69
2003	2 782.7	18 969.5	668.8	53.5	4 726.04
2004	2 909.4	24 669.1	763.0	53.1	4 728.64
2005	3 786.8	25 131.0	655.7	54.6	4 934.65
2006	4 135.7	25 477.0	852.1	54.9	5 121.47
2007	4 877.2	25 614.0	856.7	54.8	5 264.07
2008	5 832.7	29 213.3	888.0	57.9	5 901.65
2009	5 250.1	26 583.4	1 026.0	56.4	5 829.18
2010	4 880.0	27 651.0	1 137.0	56.6	5 817.81

Source: own study based on (Statistical Yearbooks 2000–2011)

2. Determining the relationship between the investment expenditure and the factors studied

Measurement and modelling of economic phenomena, including their interdependency, is the underlying objective of econometrics. The research tools developed in this area may allow for the construction of econometric models which, as J. Dziechciarz states: "…constitute the set of equations (functions) approximating, at a certain precision accepted by the user, the processes (relationships) between the economic variables and other variables – recognised (hypothetically) as reasons (decision making instruments) or as symptoms. It is usually determined additionally that the equations (relationships) are of stochastic nature" (Dziechciarz 2002). The function determining the level of investment expenditures spent in mining, in relation to variable factors which may hypothetically affect their level, may represent a certain mathematical model of the investment process in mining. The analytical determination of such relationships is of significant importance for studies on the productivity of a factor such as capital expenditure and its impact on the effectiveness of mining management. Studies on these relationships in the mining sector are of particular importance due to:

— the specific character of mining demonstrated in this case by the significant role of investment, which is associated with the repeated relocation of the longwall face,
— the restructuring process carried out over several dozen years, with the aim of enhancement of the effectiveness of the sector.

In the studies conducted, the following econometric formula was considered:

$$y = f(x_1, x_2, \ldots, x_m, \varepsilon) \tag{1}$$

For a linear function, the model takes the following form:

$$y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \ldots + \alpha_m x_m + \varepsilon \tag{2}$$

where:

y – level of investment expenditure (dependent variable), M PLN,
$x_1, x_2, \ldots, x_m$ – factors studied (independent variables, $m = 9$),
$\alpha_0, \alpha_1, \ldots, \alpha_m$ – parameters of the model (estimated based on data),
ε – random component of the model.

Prior to determining the structural parameters of the model containing all the factors studied, the parameters of the linear models capturing single, independent variables were specified. This approach was aimed at confirming whether or not such a relationship exists, i.e. whether the variable studied significantly affects the level of investment expenditure and, if so, what is the general form of such a function. The nature of relationships between the variables, described by the linear regression function, is evaluated with the application

of the r linear correlation coefficient. The value of this coefficient may facilitate the adjustment of independent variables for the full econometric model containing all independent variables affecting the dependent variable. The estimated structural parameters of regression models for individual independent variables and the values of correlation coefficients are summarised in Table 3.

TABLE 3

Linear models of investment expenditure for the independent variables studied and the values of correlation coefficients

TABELA 3

Liniowe modele nakładów inwestycyjnych dla badanych zmiennych objaśniających oraz wartości współczynników korelacji

Independent variables	Linear expenditure model	Correlation coefficient
x_1	$y = -3420.3 + 0.0064 \cdot x_1$	0.936
x_2	$y = -6448.6 + 0.0048 \cdot x_2$	0.911
x_3	$y = 5202.2 - 328.69 \cdot x_3$	–0.792
x_4	$y = -4343.3 + 0.1622 \cdot x_4$	0.630
x_5	$y = -5958.1 + 0.4575 \cdot x_5$	0.879
x_6	$y = -2763.7 + 0.279 \cdot x_6$	0.883
x_7	$y = 4770.0 - 0.8154 \cdot x_7$	–0.337
x_8	$y = 9202.5 - 92.342 \cdot x_8$	–0.324
x_9	$y = -5769.3 + 1.9111 \cdot x_9$	0.954

Source: own study

The linear relationships and the level of correlation coefficients presented table 3 justify the claim that the majority of the studied variables of the factors show strong correlation with investment expenditure. If the threshold value of the correlation coefficient is adopted at the level of 0.5, the dependency of all factors on investment expenditure is considerably higher than this level except for two factors namely, the x_7 factor (gross value of fixed assets liquidated in mining), and x_8 factor (level of consumption of fixed asset components in mining). The poor correlation between the investment expenditure and the gross value of liquidated fixed assets, which is not typical from an economic point of view, certainly results from the circumstances of property restructuring in this sector. These were mainly reforms in hard coal mining conducted during the post-communist economic transformation when many mining plants were liquidated. Further investment expenditure was incurred in the plants where mining activity continued.

Among various factors, the only one which indicates negative correlation with investment expenditure is the level of the real interest rate. This phenomenon is justified from

economic point of view as the tendency toward an increase in capital investment on account of material investment grows with the increase in this rate.

The strongest expenditure correlation in mining is observed between remuneration and the value of the gross domestic product, which also results from the general economic principle stating that alongside the increase in a country's wealth, there is growth in the share of savings in GDP allocated for investment, including investment in mining.

Figure 1 shows an example of the relationship between the level of investment expenditure and the value of the gross domestic product. Figure 2 shows a similar dependency on the level of the real interest rate.

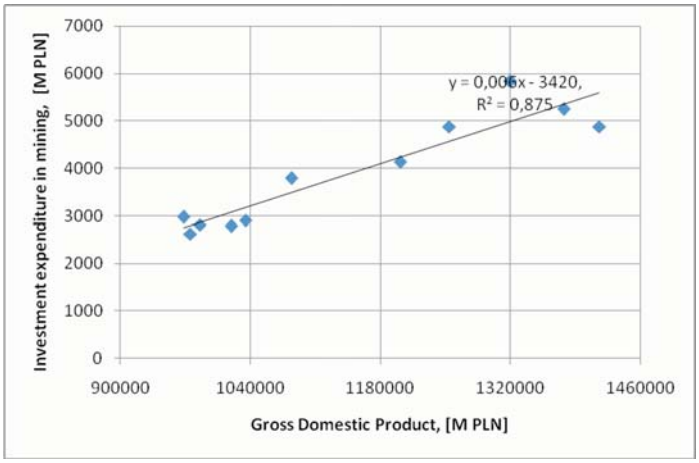

Fig 1. Relationship between investment expenditure spent in mining on the GDP

Rys. 1. Zależność nakładów inwestycyjnych wydatkowanych w górnictwie od PKB

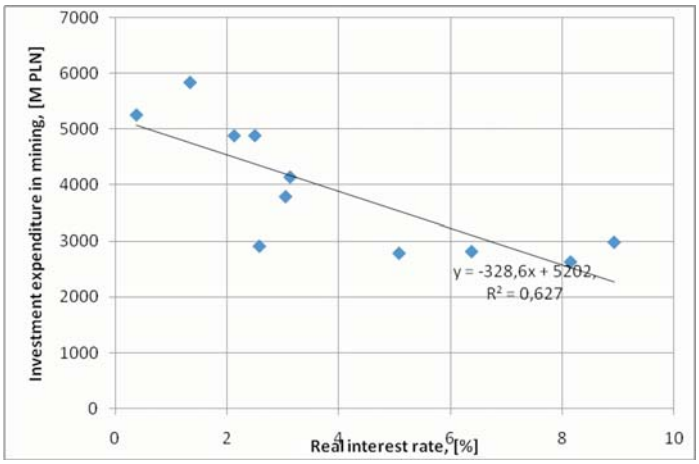

Fig 2. Relationship between investment expenditure spent in mining on the real interest rate

Rys. 2. Zależność nakładów inwestycyjnych wydatkowanych w górnictwie od wartości realnej stopy procentowej

3. Correlations of the factors studied and the standard linear model of investment expenditure

The set of values of the factors considered prepared previously made it possible to determine the structural parameters for the assumed form of the linear model of investment expenditure spent in mining, i.e. the value of the absolute term and the parameters standing at each variable. At the first stage, the parameters of the model were determined considering all the independent variables taken into account, although some of them show mutual correlations. The computer programme model used for the estimation also allows for calculating many other values useful for the evaluation of the model itself as well as the significance of the variables used in it.

The estimated value of the investment expenditure (dependent variable) may be determined based on the relationship:

$$\hat{y} = -196\ 594 - 0.0066x_1 - 0.00347x_2 + 142.42x_3 - 2.96x_4 + 6.93x_5 + \tag{3}$$

$$+ 0.11x_6 + 0.63x_7 + 3\ 349.81x_8 + 4.00x_9$$

The econometric model determined preliminarily should undergo verification, mainly in the scope of assessment of its significance in representing the modelled reality and its usefulness in the process of economic decision making based on it. The information capacity of individual variables building the model is also important as well as their role in the

TABLE 4

Correlation matrix of the dependent variable and the independent variables

TABELA 4

Macierz korelacji zmiennej objaśnianej i zmiennych objaśniających

	y	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9
y	1.000									
x_1	0.936	1.000								
x_2	0.911	0.990	1.000							
x_3	–0.792	–0.808	–0.838	1.000						
x_4	0.630	0.596	0.534	–0.197	1.000					
x_5	0.879	0.904	0.900	–0.855	0.522	1.000				
x_6	0.883	0.862	0.851	–0.853	0.351	0.771	1.000			
x_7	–0.337	–0.293	–0.357	0.627	0.356	–0.456	–0.352	1.000		
x_8	–0.324	–0.385	–0.441	0.722	0.412	–0.561	–0.482	0.830	1.000	
x_9	0.954	0.973	0.976	–0.849	0.553	0.890	0.870	–0.399	–0.413	1.000

Source: own study

estimation of the investment expenditure based on the model built. Within the process of building the econometric model containing many independent variables, the selection of adequate variables from the set of potential variables is one of the most important issues. The correlation matrix plays an important role in this case, as the variables considered in the model should be as strongly correlated with the dependent variable as possible and as weekly correlated with each other as possible. Table 4 presents the correlation coefficients, both the mutual ones and between the individual factors and the level of investment expenditure. The correlation matrix is the symmetrical matrix against the main diagonal (Franik 2011).

The correlation matrix serves for building of the so-called extended correlation matrix which subsequently allows for calculating the coefficient of multiple correlations. Such a coefficient is the basic measure determining the quality of a model, i.e. the strength of the relationship between the dependent variable and the linear combination of independent variables.

Another measure of the quality of the approximated model of the investment expenditure function is the φ^2 coefficient of association, computed according to the formula:

$$\varphi^2 = \frac{\sum_{t=1}^{n} (y_t - \hat{y}_t)^2}{\sum_{t=1}^{n} (y_t - \bar{y})^2} \tag{4}$$

where:

$\hat{y}_t$ – value of investment expenditure estimated based on the model,
$\bar{y}$ – average value of investment expenditure,
n – number of years.

The value of the coefficient of association should be contained in the range from zero to one, and the lower its level is, the better the estimated model reflects the economic process studied. In the case analysed, the value of the coefficient of association is 0.00775 for the investment expenditure model containing all the factors taken into consideration. The value of this coefficient is relatively low in this case, which confirms the fact that the econometric model presented reflects the correlation studied in sufficiently detailed way.

4. Adjustment of the independent variables to the linear model of capital expenditure spent in mining

The independent variables used for building the model (variable economic factors) affect the dependent variable to a different extent since their "information capacity" is different.

At the macroeconomic scale, under high aggregation of these variables, they usually result from the impact of other variable factors. In the linear econometric model, the independent variables should be the non-randomised values and they should be independent and free from co-linearity, i.e. no precise linear correlation should occur between them. In practice, many techniques are used for adjustment of variables to the model, such as: the method of all models possible, *a priori* elimination, *a posteriori* elimination, stepwise regression, gradual regression or the method of capacity of information carriers (Dziechciarz 2002). All these techniques use, to a certain extent, the correlation matrix for performing the assessment.

In the final version of the model it is often sufficient to include only these independent variables which contribute the most essential information on the independent variable. It often simplifies the final form of the model, without simultaneous limiting of its importance in explaining the economic phenomenon studied and the possibilities of its practical application. In such verification of the model, understood as the ultimate adjustment of significant independent variables, the method of information capacity indicators was used (Bartosiewicz 1989; Nowak 1990).

In this method, all the potential independent variables serve as the information carrier. If m independent variables occur, $2^m - 1$ of possible combinations of independent variables exist. The following expression is called the individual capacity of each combination of the information carriers:

$$h_{kj} = \frac{r_j^{\,2}}{\sum_{l=1}^{m_k} |r_{lj}|}, \qquad (j = 1, 2, ..., m_k) \tag{5}$$

where:

- k – number of the combination,
- m_k – number of variables in k-th combination,
- j – number of variable in the combination considered,
- r_j – correlation coefficient between the potential independent variable and the dependent variable,
- r_{lj} – correlation coefficient between the j-th and the l-th potential independent variable.

The above figure is the measure of the size of information contributed by x_j variable on the dependent variable.

Based on the value of the individual capacity of the information carriers, the capacity of the integral combination of these carriers is calculated. It makes the sum of the individual capacities of the information carriers, included in the particular combination of independent variables:

$$H_k = \sum_{j=1}^{m_k} h_{kj}, \qquad (k = 1, 2, ..., 2^m - 1) \tag{6}$$

The integral capacity constitutes the criterion of selection of the relevant set of independent variables – such combination of variables for which the H_k value is the maximum shall be selected.

As a result of the calculations of the integral coefficients of information capacity, in the final version of the investment expenditure model, five variable factors were left among the originally considered, i.e., the x_2, x_3, x_7 and x_8 variables were eliminated. Poor correlation of these variables with the dependent variable confirms the legitimacy of the claim of their limited importance for explaining their impact on the dependent variable (variable x_2 is strongly correlated with variable x_1). In the method of adjustment of variables for the model using the method of correlation coefficients analysis (Nowak 1990), such variables are eliminated from the model, for whom the absolute value of the correlation coefficient of this variable with the dependent variable is lower than the critical value. The critical value of the correlation coefficient is calculated based on a relevant formula. This value depends on the statistical value which, for the adopted significance level, is derived from the tables of *t*-Student test and the number of the degrees of freedom. In the case considered here, the critical value of the correlation coefficient is 0.399 adopting the significance at the level of 0.05 and 0.584 – at the significance level of 0.01.

The combination of variables introduced for further considerations allowed for reassessment of the structural parameters of the linear model. Its final form is as follows:

$$\hat{y} = -8\,212.6 - 0.003x_1 + 0.062x_4 + 0.093x_5 + 0.117x_6 + 1.385x_9 \tag{7}$$

In table 5 the most important information concerning the estimated model is included, namely, its structural parameters (value of the absolute term and the values of coefficients for each of the independent variables analysed), values of standard error for these parameters estimation and the value of *t*-Student statistics.

Despite, that the coefficients of equation are on border of significance (apart from free word) the equation is essential with regard on very high value of coefficient of multiple correlation, higher from critical value.

Due to limiting the number of independent variables captured in model (7) the basic indicators aimed at the model quality assessment became deteriorated to a certain extent. The value of the coefficient of association increased to the level of 0.0427, whereas the multiple correlation coefficient decreased from the level of 0.996 characteristic of the model containing 9 variables to the value of 0.978 in case of the model containing 5 independent variables. However, deterioration of the values of these measures is so negligible that it may be considered as totally insignificant for the process of further application of the model estimated. The values quoted confirm that fact that the linear investment expenditure model

TABLE 5

Structural parameters of the model, standard error of their estimation and *t* statistics value

TABELA 5

Parametry strukturalne modelu, błąd standardowy ich oszacowania oraz wartość statystyki *t*

Independent variables	Estimated parameters of model	Standard error of the estimation	*t* value
Wraz wolny	–8 212.6	1 916.335	–4.28557
x_1	–0.00245	0.003169	–0.77465
x_4	0.061676	0.032491	1.898227
x_5	0.092648	0.114071	0.812201
x_6	0.116997	0.064997	1.800047
x_9	1.385401	0.836208	1.656766

Source: own study

developed reflects the nature of the economic reality studied in the adequate way and at sufficient level of precision.

One of the methods for assessment of the quality of the model presented is the graphical comparison of the value of the dependent variable observed in reality with the values calculated based on the model developed. In the scope of verification of reliability of the model, many other methods are used, mainly based on studies of the level and distribution of deviations of the observed values of the independent variable against its value estimated based on the theoretical model.

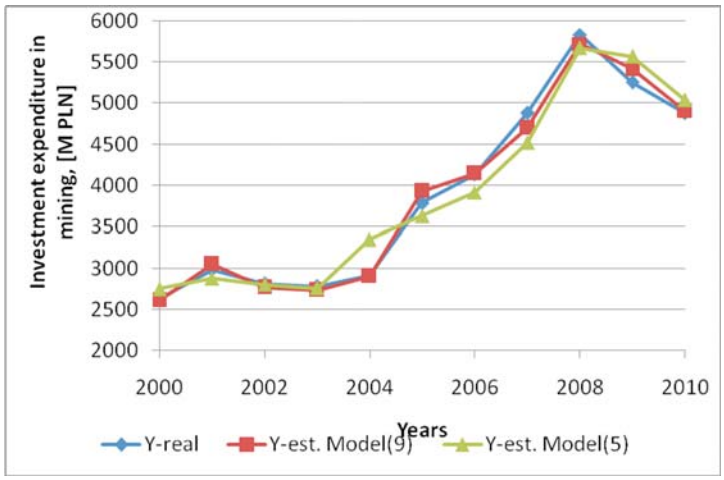

Fig. 3. The values of investment expenditure spent in mining in the years 2000–2010 and their values estimated based on the models considering 9 and 5 independent variables

Rys. 3. Wielkość nakładów inwestycyjnych wydatkowanych w górnictwie w latach 2000–2010 oraz ich wielkości oszacowane na podstawie modeli uwzględniających 9 oraz 5 zmiennych objaśniających

Figure 3 presents the developments in the real values of investment expenditure spent in mining in the period studied and the values of expenditure estimated based on the approximated econometric models, both for the model containing 9 independent variables (formula 3) and for the model with the reduced number of independent variables (formula 7).

It is obvious that the quality of the investment expenditure model depends on including the set of appropriate factors which may influence the level of the expenditure, but also on the quality and scope of the input date characterising these factors. In this analysis, it was deliberately decided to limit the set of such data to the recent 11 years, mainly in order to eliminate, at least to a certain extent, the impact of the extensive restructuring processes carried out at an enormous scale in mining, although not only in this sector. Radical changes in the economy are more difficult to illustrate with the use of the models. However, at the same time, as it can be observed in Figure 3, it is clearly visible that, by applying the theoretical correlation, it is possible to reflect the decreased level of investment expenditure in the Polish mining, caused by the economic downturn in the years 2001–2002 (the first crisis) and the beginning of the second world crisis in the years 2008–2010.

Considering the substantial decrease of the number of the mining plants in the leading sector of the Polish mining, i.e. the hard coal mining, it should be stated that the dynamics of growth of the level of investment expenditure spent in the years 2003–2008 was very high, although the restructuring processes and difficulties in the access to effective sources of capital considerably limited the investment front in mining. In real terms, the level of annual investment expenditure in this period increased from about PLN 2.8 billion in 2003 to PLN 5.8 billion in 2008. Since this year, the decrease in investment expenditure has been observed, which undoubtedly results from the global economic situation, the effects of which are transferred to the economics of the Polish mining. However, due to the importance of coal in providing the energy safety of the country, for the purpose of maintaining the current production level, it is necessary to allocate considerable investment resources for preparing and making the new levels and exploitation fields available.

Summary

Interrelations between the value of investment expenditure spent in the Polish mining and other economic values are usually very complicated and multilateral. The level of expenditure is usually affected by many factors, both of economic and extra-economic nature. As usual, when the phenomenon is considerably complicated, multilateral cause correlations of many variables occur, and the relevant relationships usually do not occur in clear form, being disrupted by the impact of side factors, including those incidental and insignificant. It is practically impossible to consider all the correlations in the model developed. Thus, the econometric model should capture only such relationships between the factors considered which are permanent, not incidental, and only those whose impact is strong enough.

Structural parameters of a function specifying the level of investment expenditure can be determined based on statistical data, appropriately processed, so that the model constructed reflects the economic process studied in relevant way.

Such a model is not free of defects typical for statistical models, however, it simultaneously enables to obtain a lot of valuable information concerning the impact of the factors studied on the value of such expenditure, and the theoretical possibilities to exchange the specific quantity of one factor by another factor.

The model presented can be mainly used for determining the forecast concerning the tendency of future level of investment expenditure, depending on the variables of the factors. The investment expenditure whose spending results in the development of the resources of capital assets of the mining plant principally determine the management effectiveness. It particularly refers to fixed assets which constitute the underlying component of assets of the coal mines, and whose resources are relatively difficult to increase due to the limited access to investment capital, high capital intensity of the mining production and the high risk associated with implementation of investment in mining.

The adequately developed econometric model should also make it possible to find out the level of dependency between the increased productivity of fixed assets and effects of factors independent of the enterprise and of the intentional activity of the enterprise. Analysis of such a function provides for obtaining the information concerning changes in the level of value and effectiveness of fixed assets in comparable periods, especially in the dynamics of such changes. A possibility is also important to obtain information on the accuracy of the econometric methods applied as compared to the deterministic methods used in the analysis of an enterprise of an industrial sector.

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BADANIE CZYNNIKÓW WPŁYWAJĄCYCH NA WYSOKOŚĆ NAKŁADÓW INWESTYCYJNYCH WYDATKOWANYCH W GÓRNICTWIE

S ł o w a k l u c z o w e

Przemysł wydobywczy, inwestycje, model ekonometryczny, skłonność do inwestowania

S t r e s z c z e n i e

W artykule przedstawiono wyniki badań dotyczących oceny istotności najważniejszych czynników makro- i mikroekonomicznych wpływających na skłonność inwestorów do inwestowania w górnictwie. W górnictwie polskim w okresie ostatnich kilkunastu lat były intensywnie przeprowadzane procesy restrukturyzacyjne, które w dużym stopniu wpłynęły na stan aktywów trwałych, niezbędnych w eksploatacji kopalin użytecznych. Dla właściwego zarządzania środkami technicznymi w zakładach górniczych niezbędna jest znajomość znaczenia poszczególnych zmiennych czynników, wpływających na skłonność inwestorów do ponoszenia określonych nakładów w celu poprawy efektywności gospodarowania. W analizie wykorzystano metody statystyki matematycznej i modelowania ekonometrycznego dla określenia charakteru związków między badanymi wielkościami, a także dla oceny istotności tych zależności. W badaniach wykorzystano dane statystyczne dotyczące badanych czynników uzyskiwanych przez podmioty gospodarcze w latach 2000–2010. Przedstawiono liniowy model ekonometryczny zależności nakładów inwestycyjnych wydatkowanych w górnictwie od takich wielkości jak wartość majątku trwałego, PKB, realna stopa procentowa, stopień zużycia trwałych składników majątkowych w górnictwie oraz innych czynników. Określenia parametrów strukturalnych funkcji określającej wielkość nakładów inwestycyjnych, można dokonać za pomocą metod ekonometrycznych na podstawie danych statystycznych odpowiednio przetworzonych, tak aby skonstruowany model odzwierciedlał w sposób właściwy badany proces ekonomiczny.

Model taki nie jest pozbawiony wad, typowych dla modeli statystycznych, ale jednocześnie umożliwia uzyskanie wielu cennych informacji o wpływie badanych czynników na wielkość tych nakładów oraz teoretycznych możliwościach wymiany określonej ilości jednego czynnika na drugi. W ostatecznej wersji modelu często wystarczy ująć jedynie te zmienne objaśniające, które wnoszą najistotniejsze informacje o zmiennej objaśniającej. Upraszcza to często końcową postać modelu, nie ograniczając jednocześnie jego znaczenia w wyjaśnianiu badanego zjawiska ekonomicznego oraz możliwości jego praktycznego wykorzystania. W ostatecznym doborze istotnych zmiennych objaśniających ujętych w modelu wykorzystano metodę wskaźników pojemności informacyjnej.

Key words

Mining industry, investment, econometric model, propensity to invest

Abstract

This article presents the results of studies assesing the significance of the most important macro- and microeconomic factors affecting investors' propensity to invest in mining. The Polish mining industry in recent years has seen intensive restructuring processes which have considerably affected the status of fixed assets required for the exploitation of useful minerals. In order to efectively manage technological progress in mining plants, it is necessary to understand the role of individual, variable factors influencing investors' propensity to make specific expenditures. In the analysis, mathematical statistics and econometric modelling methods were applied to determine the nature of correlations between the values studied and their significance. This examination applied statistical data accumulated by economic entities from 2000–2010. A linear econometric model was presented illustrating the relationship between capital expenditure in mining and such indicators as fixed assets value, GDP, real interest rate, consumption levels of fixed asset components in mining, and various other factors. Structural parameters of a function specifying the level of investment expenditure can be determined based on statistical data which has been appropriately processed so that the model constructed reflects the economic process studied in relevant way.

Such a model is not free of defects typical in statistical models; however, it simultaneously enables one to obtain valuable information concerning the impact of the factors studied on the value of such expenditure, and the theoretical possibilities to exchange the specific quantity of one factor for another factor. In the final version of the model, it is often sufficient to include only these independent variables which contribute the most essential information to the independent variable. This often simplifies the final form of the model without simultaneous limiting of its importance in explaining the economic phenomenon studied and the possibilities of its practical application. In the final selection of significant variables captured in the model, the method of information capacity indicators was used.