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ANALYSIS OF THE INTERDEPENDENCE BETWEEN GROSS DOMESTIC PRODUCT (GDP), STEEL PRODUCTION AND IRON PRODUCTION (10 STATES OF EUROPEAN UNION)

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Given the intensification of the world economy globalization, the production represents one of the factors characterizing the development of a country and its performance. In this context, this paper aims to establish and analyze the influence of the crude steel production and blast furnace iron production on the gross domestic product, using the multiple linear regression model. Data subject to the study are related to the period 2004 – 2014, and the research refers to the first ten countries producing crude steel and blast furnace iron, members of the European Union.

Key words: gross domestic product, crude steel, blast furnace iron, production, economic increase

INTRODUCTION

After the economic crisis started at the end of 2008, at the level of the European Union (EU) member countries, the activities of the metallurgic industry recorded a significant decrease, with lasting implications on the production capacities and jobs within the metallurgic units [1]. It is considered essential for the EU to remain a steel-producing region, taking into account the importance of the metallurgic industry for economy, society, environment and security of supply [2]. Thus the purpose of this paper is to establish, using the multifactorial regression model, the interdependence between GDP and independent variables: crude steel production (CSP) and blast furnace iron (BFI) production, at the level of the first ten countries producing raw material for the metallurgic industry, EU member countries. The study also propose to establish the extent to which the model can be used for determining the further value of the GDP for a certain region or period, using the amount of CSP and BFI.

USED METHOD AND DATA BASIS

The paper aims to analyze the interdependence between the GDP, CSP and BFI from: Belgium, Czech Republic, Germany, Spain, France, Italy, Netherlands, Austria, Poland and United Kingdom using the linear regression model [3]. In the analysis we start from a set of data including, as dependent variable, the value of the GDP (y_i) and as independent variables: CSP (x_1) and BFI (x_2).

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Statistical data underlying the study come from the Eurostat data basis [4] and from the online data basis and Steel Statistical Yearbooks of World Steel Association [5], and the used reports were the quarterly ones related to the studies period (2004 – 2014).

For establishing how the independent variables influence the value of GDP, the used research method implied 440 observations (n), processed with SPSS [6].

USING THE MULTIPLE REGRESSION MODEL FOR ANALYZING THE INTERDEPENDENCE BETWEEN THE GDP, CSP AND BFI

In order to achieve the multifactorial linear model, the analysis aimed the tendency line of the GDP, expressed in billions of euros (Be) depending on CSP and BFI separately taken and expressed in millions of tones (Mt), building, for this purpose, unifactorial linear econometric models (Figure 1 and Figure 2).

From the analysis of the tendency line we can notice that the value of the multiple determination coefficient (R^2) shows that, in proportion of 59,3 %, GDP is influenced by the amount of CSP.

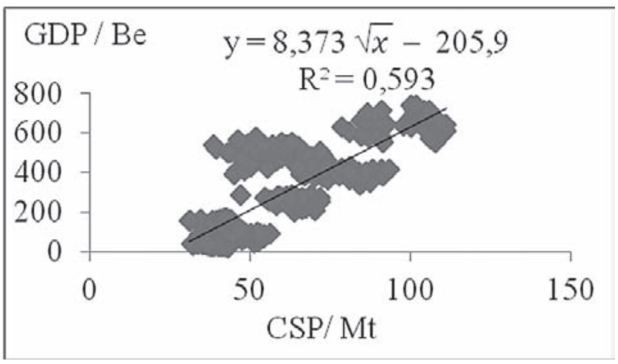

Figure 1 GDP evolution depending on CSP (2004 – 2014) [4, 5]

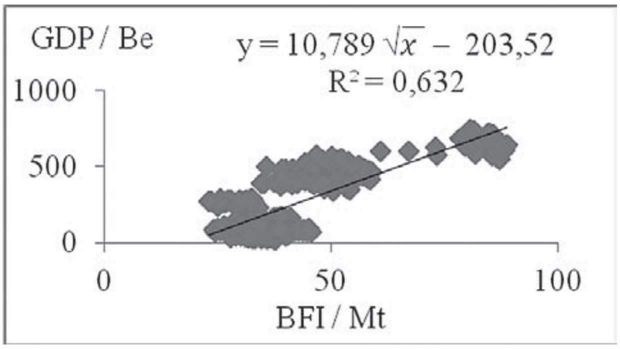

Figure 2 GDP evolution depending on BFI (2004 – 2014) [4, 5]

From the analysis of the tendency line depending on the second variable, we can notice that the value of the R^2 shows that GDP is influenced by the amount of the iron production in a proportion of 63,2 %.

It results the following structure of the multifactorial regression model:

$$y_i = \beta_0 + \Sigma\beta_i \sqrt{x} + \varepsilon \qquad (1)$$

where: β_0, β_i represent the model parameters, and e represents a random variable.

The presence of the random variable is important, because in economy there are many factors influencing GDP.

TESTING THE FORECAST OF THE GROSS GDP ON CSP AND BFI

In order to measure the interdependence and also the intensity between the resultative variable and the factorial variables, we shall calculate the coefficients of multiple correlations (R), and for determining the percentage with which CSP and BFI influences the GDP some coefficients of determination shall be established – Table 1.

Table 1 **Statistics of the regression / 2004 – 2014 [4, 5]**

R	R^2	Adjusted R^2	Se	DW
0,824	0,678	0,677	118,503	1,818

From the analysis of data displayed by the SPSS it results that the value of R is rather high, respectively 0,824, value showing that there is a rather intense connection between GDP, CSP and BFI. The analysis of the connection between variables using the R^2 highlights that 67,7 % of GDP was influenced by the CSP and BFI, and 32,3 % of GDP is influenced by other random factors, while the standard error (Se) of the model is 118,503.

In order to verify the hypothesis of error independence, the study aimed the calculation of the Durbin – Watson (DW) whose value is 1,850. The size of the variable is compared with the critical values DW_1 = 1,838 and DW_u = 1,848, noticing that the calculated value is lower than d_1, which denote a positive self-correlation of errors. We reject the null hypothesis in the favor of alternative one, and the chosen model is significantly statistical. For testing the validity of the model (M), the research aimed to conduct the analysis based on the ANOVA table (Table 2) for regression (Rg).

Table 2 **Analysis based on the ANOVA table / 2004 – 2014 [4, 5]**

ANOVA				
M	Sum of Squares	Mean Square	F	Sig. F
Rg	12,93 x 10^6	0,64 x 10^6	460,485	0,00

From the analysis of the obtained data, by using test F, based on the theoretical repartition Fisher – Snedecor (F), correlated with the values of F_{tabled} = 3,85, it results that $F_{tabled} < F_{calculated}$ = 460,485 reason for which in the null hypothesis it is rejected in the favor of the alternative one, and the chosen model is considered as significant from the statistical point of view. The model validity and the strong connection between the variables is also supported by threshold of significance (Sig. F) Significance F < 0,01.

The study also aimed (Table 3) to establish the coefficients of the proposed model, to verify the statistical safety of the coefficients value, to establish the ranged from which they take values and, not the least, the colinearity between the two independent variables.

After the analysis of variance we may appreciate that the value of the GDP is significantly influenced by the CSP and BFI.

Due to the fact that the coefficients value is higher than zero, it result that y is positively influenced by x_1 and x_2. But, the BFI has the highest influence on the value of the GDP, because the value of the coefficient related to this variable (6,763) is higher than for CSP (3,977). Thus, an econometric model may be built, where the resulative values may be estimated by the following relation:

$$\hat{y}_1 = -252,976 + 3,977\sqrt{x_1} + 6,763\sqrt{x_2} \qquad (2)$$

It results that for each coefficient there is a standard error, which, for the constancy, is of 18,259, for CSP it is of 0,504, and for BFI it is of 0,630. From the interpretation of the coefficients of the proposed model, it results that for a variation with a unit of CSP, a change of GDP occurred with 3,977 units, and at a change with one unit of BFI there is a variation of the value of GDP product with 6,763 units.

The conducted research proposed to test the model and by means of test t, taking into account the statistical safety comparing the values of t with the theoretical ones. The null hypothesis was rejected, because $t_{calculated}$ for the coefficient of x_1 is of 7,884, respectively 10,743 for the variable x_2, it has the value higher than $t_{theoretical}$ = 1,645.

The same can be noticed if we analyze the ranges from which both the free term and the coefficients corresponding to the independent variables take values, where the null value is not included within these ranges.

Table 3 **Value of the model coefficients and the analysis of the threshold of significance / 2004 – 2014 [4, 5]**

Coefficients				
M	Unstandardized Coefficients		t	Sig.
	Value	Se		
β_0	– 252,976	18,259	– 13,855	0,000
β_1	3,977	0,504	7,884	0,000
β_2	6,763	0,630	10,743	0,000
M	95,0 % Confidence Interval for B		Collinearity Statistics	
	Lower Bound	Upper Bound	Tolerance	VIF
β_0	– 288,862	– 217,090		
β_1	2,986	4,969	0,342	2,924
β_2	5,526	8,001	0,342	2,924

Thus β_0 takes values from the range [– 288,862; – 217,090], β_1 from the range [2,986; 4,969], and β_2 from the range [5,526; 8,001]. We may notice that the threshold of significance (Sig.), for each coefficient, it is lower than 0,01 showing that they are statistically significant and not just by chance.

After the verification of the multicollinearity between the independent variables, we found that the value of the variance inflation factor (VIF) is of 2,924, lower than 5 [7], leading to the conclusion that between x_1 and x_2 there is no direct connection, these variables not influence each other, and we may build a model. A particular importance shall be given to the residues (Rs) showing (Table 4) the minimum (Min.) value and the maximum (Max.) value of standard deviations (Sd).

Table 4 **Statistics of the residues for the model / 2004 – 2014 [4, 5]**

M	Min.	Max.	Mean	Sd
PV	45,599	782,751	270,950	171,641
Re	– 213,548	340,737	0,000	118,233

The analysis highlights the predicted value (PV) of GDP, knowing CSP and BFI, is of 270,950 with a minimum of 45,599 and a maximum of 782,751. It results that the deviation from the model is in minus with 213,548 Be and in plus with 340,737 Be. The average and the Sd of this variables is rather high ± 118,233 respectively ± 171,641.

CONCLUSIONS AND SUBSEQUENT DEVELOPMENTS

The value of the coefficients, demonstrated that between the dependent variable and the two independent variables considered, there is a strong and direct connection. The proposed model can be used for determining the further value of the gross domestic product for a certain region and period, knowing the amount of the steel production and iron production.

We shall take into account that the value of the standard error is rather high, which demonstrates that the gross domestic product, at the level of a country, is also influenced by other factors. From the economic point of view, it is correct, because in the real economy there are many factors influencing the economic increase, which is demonstrated also by the higher value of the free term, which is of 252,97. The calculated deviation, rather high, may be explained by the fact that the amount of the steel and iron production, by their consumption in terms of raw material in the production process, we shall take into account that the econometric modeling is based on the hypothesis that the interest variables are random, meaning that the values they shall take in the future are uncertain.

This paper represents a first step in the approach to show the extent to which the amount of the products productions in the metallurgic industry influences the gross domestic product, the main indicator of the economic development of a country.

The model may be improved by including in the analysis sphere a higher number of metallurgic products, as independent variables, and the study may be extended by determining the influence of the activity from the metallurgic industry on the goods production, products which having as destination the final consumption or investments.

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