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SUSTAINABLE POSITION OF EUROPEAN COUNTRIES BASED ON LIFE EXPECTANCY AT BIRTH AND THE RISK OF POVERTY

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Abstract

The level and growth of GDP per capita has a role and effect in all areas of life in society. Life expectancy at birth for each person and the risk of poverty or social inclusion are dependent on the economic strength of the State expressed by GDP per capita. Under these circumstances, practical utility for explicit reasons and justification of economic policy decisions, an analysis of the interdependence between life expectancy and the risk of poverty with GDP per capita, by applying a rigorous econometric modeling methodologies.

Key words**:** *econometric model, GDP per capita, life expectancy at birth, poverty risk, social inclusion*

INTRODUCTION

Economic potential and level of economic development of a country is the synthetic form of measuring the total gross domestic product and per capita.

The potential effects of level and GDP growth are found in all areas of the company's [5]. In the context of this economic logic states that: life expectancy at birth of each person is dependent on economic potential of the state expressed by GDP per 1 inhabitant [12].

It is believed that a certain level of economic development creates the material conditions necessary for life expectancy reflects this potential [11]; the risk of poverty or social inclusion is a direct relationship determining the value of gross domestic product. A certain lower level of economic development will inevitably produce a proportional phenomenon of poverty [10].

In the framework of interdependent variables defining system presents analysis of life expectancy and risk of poverty according to GDP per capita, by applying a rigorous econometric modeling methodology.

This can provide the opportunity for econometric study support to obtain the information necessary to allow substantiation of macroeconomic decisions to promote a real and sustainable economic progress.

Note: It is noted that life expectancy at birth is defined as the average number of years a person will live if subjected rest of his life to the current mortality conditions.

The indicator that expresses social inclusion or poverty risk refers to the people who are at risk of poverty or living in households with very low work intensity.

Risk of poverty is affected by people with a disposable income below the risk equivalent of poverty, which is set at 60% of the national median equivalent disposable income (after social transfers).

The Europe 2020 strategy promotes social inclusion, in particular through the reduction of poverty. The aim of the strategy is to decrease by at least 20 million people affected by the risk of poverty and social exclusion.

MATERIALS AND METHODS

The methods used to process the data contained in Table 1 are able to provide the resulting analytical indices and relevant information about the interdependence of life expectancy and the risk of poverty with GDP per capita.

To achieve the objective using appropriate methods of statistical modeling and verification of sustainability models based on the data presented in Table 1 which covers 30 European countries in 2013.

Table 1. Life expectancy, poverty risk, GDP per capita in 2013 for 30 European countries

No.	Country	Life expectancy y_1	Poverty risk y_2	GDP/ capita x
1	Belgium	63.7	20.8	33,500
2	Bulgaria	66.6	48	5,200
3	Czech Republic	64.2	14.6	15,000
4	Denmark	59.1	18.9	43,000
5	Germany	57	20.3	32,800
6	Estonia	57.1	23.5	12,800
7	Ireland	68	29.5	37,600
8	Greece	65.1	35.7	16,800
9	Spain	63.9	27.3	22,300
10	France	64.4	18.1	31,200
11	Croatia	60.4	29.9	10,200
12	Italy	60.9	28.4	25,400
13	Cyprus	65	27.8	20,500
14	Latvia	54.2	35.1	10,000
15	Lithuania	61.6	30.8	10,800
16	Luxembourg	62.9	19	77,100
17	Hungary	60.1	33.5	10,100
18	Malta	72.7	24	16,800
19	Netherlands	57.5	15.9	37,600
20	Austria	60.2	18.8	36,100
21	Poland	62.7	25.8	10,100
22	Portugal	62.2	27.5	16,000
23	Romania	57.9	40.4	6,700
24	Slovenia	59.5	20.4	17,100
25	Slovakia	54.3	19.8	13,100
26	Sweden	66	16.4	39,800
27	United Kingdom	64.8	24.8	29,500
28	Iceland	66.7	13	33,100
29	Norway	68.6	14.1	66,600
30	Switzerland	58.4	16.3	56,900

Source: calculus on data from www.eurostat.ro

RESULTS AND DISCUSSIONS

Econometric studies of the system variables listed in Table 1 envisage the elaboration of the following models: a model of interdependence life expectancy with GDP per capita and a model of interdependence risk of poverty with GDP per capita [3].

The graphical representation of the correlation between variables system under study, Fig. 1 and Fig. 2 by the arrangement of the point cloud on form interdependence both between Y1 - life expectancy at birth; x - GDP per capita and between Y2 - the risk of poverty; x - GDP per capita allows us to appreciate that there is a significant gap between the two forms graphs [8].

The graph in Fig. 1 point cloud does not formalizes, obviously, a certain statistical regularity because the points are distributed in whole representation and they have a high dispersion.

Fig. 2 suggests a certain group of points in a hyperbole shape.

In those circumstances opting for two regression equations simple simultaneous with the same independent variable (exogenous) [1], GDP per capita, which formed different general: $\hat{y}_1 = a + bx$ to express the correlation between life expectancy at birth and GDP per capita respectively $\hat{y}_2 = a + b/x$ to express the correlation between risk of poverty and GDP per capita.

The linear model of interdependence life expectancy at birth with GDP per capita

The graphical representation of the correlation between endogenous variable $\hat{y}_1$ - life expectancy at birth, with exogenous variables, x - GDP per capita in Fig. 1 by the arrangement of the point cloud can be justified option for a simple linear regression equation that has the general form: $\hat{y}_1 = a + bx$. It is obvious that this model has minimal support for full visual but building statistical representation calculate key indicators and econometric will appreciate, therefore, the viability of the model.

The results presented in a synoptic picture of econometric representation indicators (Table 2) do not support, in statistical terms, that there is a real dependence between life expectancy at birth and GDP per capita [2].

The bases for this conclusion are the following results:

-*Correlation report*

($R = \sqrt{R^2} = \sqrt{0.033664} = 0.183477$) by its size close to zero attests that the variables studied system does not form a real interdependence.

This conclusion is supported statistically by "Criterion F" which denies the significance of the correlation ratio as zero, with a significance level of 33.1787%;

- *Parameter estimator "b"* of simple linear model is not confirmed as significant in statistical terms, based on "t criteria" (Student), with a significance threshold of 33.18% [7].

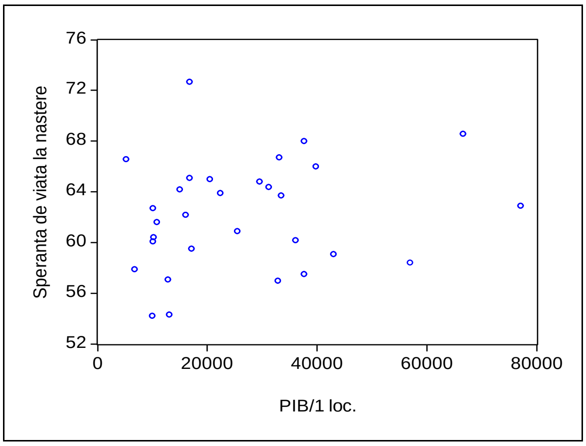

Fig.1. Life expectancy and GDP per capita correlogram
Source: author calculus

The results and conclusions confirm the theoretical support that the life expectancy at birth is likely to be higher as the economic strength of a country is higher.

Table 2. Synoptic table of results that attest viability of simple linear model for correlation between life expectancy and GDP per capita

Dependent Variable: **Life expectancy** ($\hat{y}_1$)				
Method: Least Squares				
Sample: 1 – 30; Included observations: 30				
$\hat{y}_1 = a + bx \rightarrow$ $\hat{y}_1 = 61.00907 + 0.0000446 \cdot x$				
Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
PIB/1 loc. *„b"*	4.46E-05	4.52E-05	0.987640	0.3318
C *„a"*	61.00907	1.432797	42.58041	0.0000
R-squared (R^2)	0.033664	Mean dependent var		62.19000
Adjusted *R*-squared	-0.000848	S.D. dependent var		4.321985
S.E. of regression - $\hat{\sigma}_{y_2;\hat{y}_2}$	4.323816	Akaike info criterion		5.830494
Sum squared resid	523.4709	Schwarz criterion		5.923908
Log likelihood	-85.45742	*F*-statistic		0.975434
Durbin-Watson stat	2.000752	Prob (*F*-statistic)		0.331787

Note: These indicators are obtained using Eviews software.
Source**:** author calculus

This logic is based on the size of financial and material potential for social protection and assistance and therefore a certain life expectancy at birth.

Data provided by the statistics on life expectancy at birth for the 30 European countries, can be inconclusive in terms of production methodology in these conditions and econometric study results are marked by infidelity.

Invalidation developed model does not cancel, but real possibility of a relationship between two general causal variables. In these circumstances it may recommend reconsideration observation data and statistical modeling procedures replay.

Hyperbolic model for risk of poverty and GDP per capita

Correlogram correlation between endogenous variable $\hat{y}_2$ - the risk of poverty, with exogenous variables, x - GDP per capita in Fig. 2 by the arrangement of the point cloud is justifying the option for a simple regression equation hyperbolic which has the general form: $\hat{y}_2 = a + b \cdot 1/x$.

It is noted that as GDP per capita increases the risk of poverty is reduced by an obvious tendency to stabilize at a level as low.

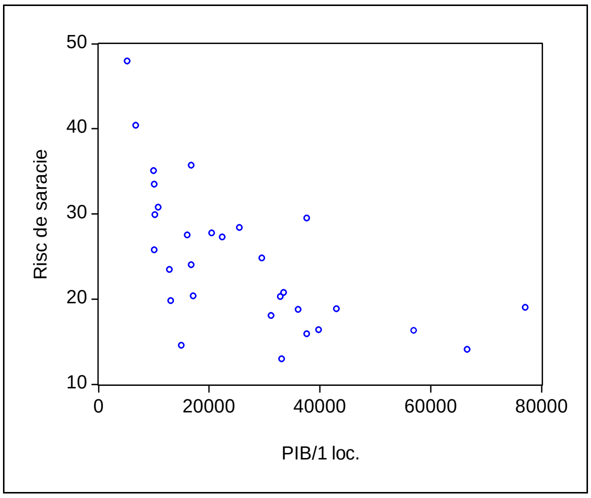

Fig. 2. Correlogram for poverty risk and GDP per capita
Source: author calculus

Estimated parameters of simple hyperbolic regression equation regarded as interdependent system studied are performed using least squares and results following system of equations:

$$\begin{cases} \Sigma y_2 = n \cdot a + b \cdot \Sigma 1/x \\ \Sigma y_2 \cdot 1/x = a \cdot \Sigma x + b \cdot \Sigma 1/x^2 \end{cases}$$

After solving the system of equations econometric model is obtained,

$$\hat{y}_2 = 15.16229 - 161492.4/x$$

Table 3. Synoptic table that attest viability of simple hyperbolic model for poverty risk and GDP per capita

Dependent Variable: **Poverty risk (** $\hat{y}_2$ **)**				
Method: Least Squares				
Sample: 1 – 30; Included observations: 30				
$\hat{y}_2 = a + b/x \quad \rightarrow$ $\hat{y}_2 = 15.16229 - 161492.4/x$				
Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
PIB/1 loc. „*b*”	161492.4	22520.04	7.171053	0.0000
C „*a*”	15.16229	1.606907	9.435699	0.0000
R-squared - ($R^2_{y_2.x}$)	0.647462	Mean dependent var		24.61333
Adjusted *R*-squared	0.634871	S.D. dependent var		8.333180
S.E. of regression - $\hat{\sigma}_{y_2;\hat{y}_2}$	5.035399	Akaike info criterion		6.135203
Sum squared resid	709.9467	Schwarz criterion		6.228616
Log likelihood	-90.02804	*F*-statistic		51.42400
Durbin-Watson stat	1.485043	Prob (*F*-statistic)		0.000000

Note: These indicators are obtained using Eviews software.
Source: author calculus

The estimated values of the parameters defining the unifactorial hyperbolic model for risk of poverty according to GDP per capita and the main results of information econometric are shown in "synoptic table of econometric indicators" (Table 3), allowing attesting to assess the viability of the econometric model.

Actual levels (y_2) and the estimated ($\hat{y}_2$) for risk of poverty obtained by applying simple hyperbolic regression equation, residues series and their arrangement are presented in Table 4.

The residue graph from the last column of the table, provide a picture for alternation between them in relation to the origin, which confirms the status non autocorrelation.

Statistical coefficient Durbin Watson (DW = 1.485043 - in Table 3) confirms this conclusion because it considered appropriate positions within the range 1.4 - 2.6, to accept the hypothesis of non-correlation residues.

Through this statistical finding it is considered that the efficiency parameter regression equation is appropriate [6].

It notes also that residues do not exceed framing admitted, in statistical terms, expressed the estimates by ±2.048 standard error of regression equation

$$(\pm t_{q=0.05;\ f=n-k=30-2} \cdot \hat{\sigma}_{y_2;\hat{y}_2} = \pm 2.048 \cdot 5.035399)$$

under the law of Student distribution for a significance level of 5%, bilateral, and 28 degrees of freedom.

This finding is able to justify the formation of the belief that the econometric model of the risk of poverty formalized through a regression equation simple hyperbolic shown a construction math correct reality of statistics and therefore has utility practice to substantiate and implement economic policy measures and by taking into account social exogenous variable GDP per capita.

The plots presented in Fig. 3 and Fig. 4 shall be evidence of the viewing position of the series of values related to the risk of poverty [4], actual and fitted, and residues in Table 4.

Table 4. Actual values, fitted values for dependent variable (poverty risk) based on GDP per capita using a uni factorial hyperbolic model; residual values and residual plot

<table>
<tr><th>No.</th><th>Country</th><th>Actual</th><th>Fitted</th><th>Residual</th><th>Residual Plot</th></tr>
<tr><td>1</td><td>Belgium</td><td>20.8000</td><td>19.9830</td><td>0.81704</td><td>| . |* . |</td></tr>
<tr><td>2</td><td>Bulgaria</td><td>48.0000</td><td>46.2185</td><td>1.78148</td><td>| . | * . |</td></tr>
<tr><td>3</td><td>Czech Republic</td><td>14.6000</td><td>25.9284</td><td>-11.3284</td><td>|* . | . |</td></tr>
<tr><td>4</td><td>Denmark</td><td>18.9000</td><td>18.9179</td><td>-0.01793</td><td>| . * . |</td></tr>
<tr><td>5</td><td>Germany</td><td>20.3000</td><td>20.0858</td><td>0.21416</td><td>| . * . |</td></tr>
<tr><td>6</td><td>Estonia</td><td>23.5000</td><td>27.7789</td><td>-4.27888</td><td>| * | . |</td></tr>
<tr><td>7</td><td>Ireland</td><td>29.5000</td><td>19.4573</td><td>10.0427</td><td>| . | . * |</td></tr>
<tr><td>8</td><td>Greece</td><td>35.7000</td><td>24.7749</td><td>10.9251</td><td>| . | . *|</td></tr>
<tr><td>9</td><td>Spain</td><td>27.3000</td><td>22.4041</td><td>4.89590</td><td>| . | * |</td></tr>
<tr><td>10</td><td>France</td><td>18.1000</td><td>20.3383</td><td>-2.23833</td><td>| . *| . |</td></tr>
<tr><td>11</td><td>Croatia</td><td>29.9000</td><td>30.9949</td><td>-1.09488</td><td>| . *| . |</td></tr>
<tr><td>12</td><td>Italy</td><td>28.4000</td><td>21.5203</td><td>6.87974</td><td>| . | . * |</td></tr>
<tr><td>13</td><td>Cyprus</td><td>27.8000</td><td>23.0400</td><td>4.76003</td><td>| . | * |</td></tr>
<tr><td>14</td><td>Latvia</td><td>35.1000</td><td>31.3115</td><td>3.78847</td><td>| . | *. |</td></tr>
<tr><td>15</td><td>Lithuania</td><td>30.8000</td><td>30.1153</td><td>0.68471</td><td>| . |* . |</td></tr>
<tr><td>16</td><td>Luxembourg</td><td>19.0000</td><td>17.2569</td><td>1.74313</td><td>| . | * . |</td></tr>
<tr><td>17</td><td>Hungary</td><td>33.5000</td><td>31.1516</td><td>2.34837</td><td>| . | * . |</td></tr>
<tr><td>18</td><td>Malta</td><td>24.0000</td><td>24.7749</td><td>-0.77493</td><td>| . *| . |</td></tr>
<tr><td>19</td><td>Netherlands</td><td>15.9000</td><td>19.4573</td><td>-3.55730</td><td>| .* | . |</td></tr>
<tr><td>20</td><td>Austria</td><td>18.8000</td><td>19.6358</td><td>-0.83576</td><td>| . *| . |</td></tr>
<tr><td>21</td><td>Poland</td><td>25.8000</td><td>31.1516</td><td>-5.35163</td><td>| *. | . |</td></tr>
<tr><td>22</td><td>Portugal</td><td>27.5000</td><td>25.2556</td><td>2.24444</td><td>| . | * . |</td></tr>
<tr><td>23</td><td>Romania</td><td>40.4000</td><td>39.2656</td><td>1.13437</td><td>| . |* . |</td></tr>
<tr><td>24</td><td>Slovenia</td><td>20.4000</td><td>24.6063</td><td>-4.20629</td><td>| .* | . |</td></tr>
<tr><td>25</td><td>Slovakia</td><td>19.8000</td><td>27.4900</td><td>-7.68995</td><td>| * . | . |</td></tr>
<tr><td>26</td><td>Sweden</td><td>16.4000</td><td>19.2199</td><td>-2.81989</td><td>| . * | . |</td></tr>
<tr><td>27</td><td>United Kingdom</td><td>24.8000</td><td>20.6366</td><td>4.16339</td><td>| . | *. |</td></tr>
<tr><td>28</td><td>Iceland</td><td>13.0000</td><td>20.0412</td><td>-7.04121</td><td>| * . | . |</td></tr>
<tr><td>29</td><td>Norway</td><td>14.1000</td><td>17.5871</td><td>-3.48710</td><td>| .* | . |</td></tr>
<tr><td>30</td><td>Switzerland</td><td>16.3000</td><td>18.0005</td><td>-1.70047</td><td>| . * | . |</td></tr>
</table>

Source: author calculus

Normality test of the distribution of the residual variable, Jarque-Bera leads to a secure acceptance of this hypothesis because coefficient JB = 0.070358 is associated with an acceptance probability P = 96.5432% under the law of division hi square with two degrees of freedom (Figure 5).

Obviously, in this case we have to accept statistical basis normality assumption which

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confirms good efficacy estimators simple regression equation hyperbolic.

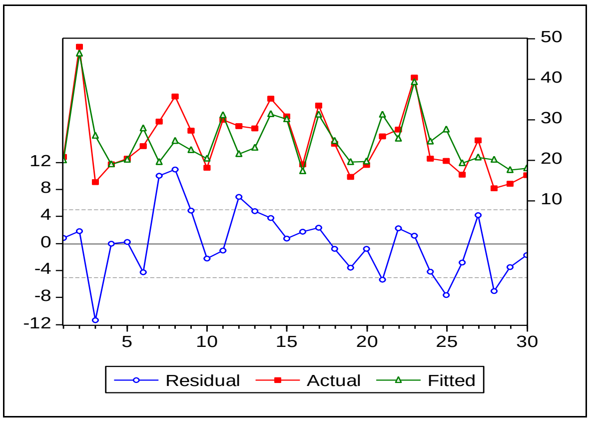

Fig. 3. Graphical representation of Residual, Actual and Fitted values for poverty risk based on GDP per capita
Source: author calculus

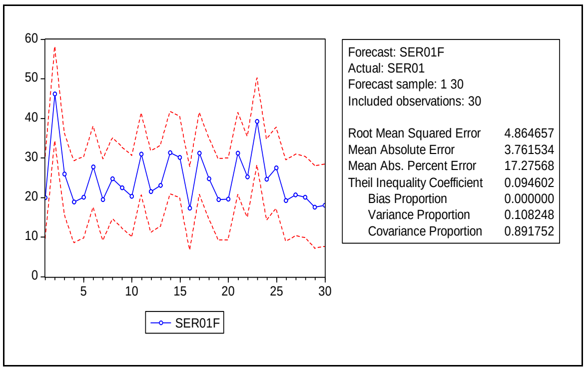

Fig. 4. Graphical representation of fitted values for poverty risk based on GDP per capita (SER01F) and ± 2.048 estimation for errors on simple hyperbolic regression equation with 5% threshold and 28 freedom degrees;
Source: author calculus

„F Criteria",

$$F-statistic = 0.909824 < F-tabelar = F_{q=0.05;\ f_1=k-1=3-1=2;\ f_2=n-k=30-3=27} = 3.35$$

„ χ^2 Criteria",

$$n \cdot R^2 = 30 \cdot 0.063139 = 1.894175 <$$

$$\chi^2 - tabelar = \chi^2_{q=0,05,\ f=k-1=3-1=2} = 5.99$$

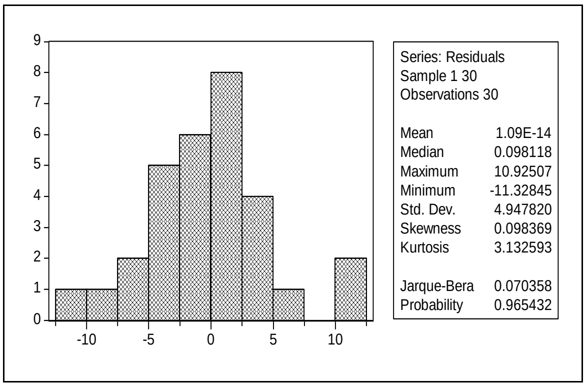

Fig. 5. Statistics and normality test for residual variable based on Jarque-Bera Criteria
Source: author calculus

Verification of the hypothesis of heteroscedasticity of residual variable for the correlation between risk of poverty and GDP per capita (econometric model unifactorial hyperbolic) is performed using "Test White", which consists of applying two statistical criteria for verifying hypotheses "criterion F" and "χ^2 criteria".

This test is based on statistical characteristics of the equation squared residual variable auxiliary according to the independent variable and the results are shown in Table 5. In the case of the poverty risk is assumed statistical basis needed to be refuted hypothesis of heteroscedasticity and thus, the model is homoscedastic, the error term has a value equal to the scattering with respect to the independent variable (x).

Table 5. Synoptic table for "White test" for simple unifactorial hyperbolic model for poverty risk based on GDP per capita

F-statistic	0.909824	Probability		0.414585
Obs**R*-squared	1.894175	Probability		0.387869
Test Equation: Dependent Variable: RESID^2 Auxiliary regression equation: $u^2 = (y_2 - \hat{y}_2)^2 = z = a + b/x + c/x^2$				
Method: Least Squares				
Sample: 1 – 30; Included observations: 30				
Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
C „*a*"	8.696374	18.13529	0.479528	0.6354
(1/x) „*b*"	564997.1	506822.2	1.114784	0.2748
$(1/x)^2$ „*c*"	-3.55E+09	2.74E+09	-1.295774	0.2060
R-squared	0.063139	Mean dependent var		23.66489
Adjusted *R*-squared	-0.006258	S.D. dependent var		35.14958
S.E. of regression	35.25939	Akaike info criterion		10.05798
Sum squared resid	33567.06	Schwarz criterion		10.19810
Log likelihood	-147.8697	*F*-statistic		0.909824
Durbin-Watson stat	1.513376	Prob (*F*-statistic)		0.414585

Source: author calculus

CONCLUSIONS

Analysis of the results in Table 3 and based on other tests and statistical calculations performed provides an opportunity to make the following conclusions:
- Correlation between risk of poverty and GDP per capita registered in 30 European countries in 2013 is hyperbolic regression equation expressed by: $\hat{y}_2 = 15.16229 - 161492.4/x$;
- Between system variables correlation study, the risk of poverty and GDP per capita is interrelated significant in statistical terms, and strong intensity, since the ratio of correlation has a size positioned at the lower limit 0.8-1, $R_{y_2.x} = 0.80465$ and is significantly different from zero, meaning "Criterion F" in this case, is very close to zero.
- Coefficient of determination $R^2_{y_2.x} = 0.620533$, certifies that 62.0533% of the variance of the endogenous variable - Y_2 - (risk of poverty) is explained by the variation of exogenous variable - x - (GDP per capita), the difference up to a hundred percent is the proportion of residual components or the proportion determined by the influence of other factors not considered in the analysis studied the correlation system;
- Two estimators of the model parameters, "a" and "b" are significantly different from zero, meaning "Criterion t" because the threshold of significance of the test statistics of these is close to zero (Table 3);
- "Durbin-Watson statistic coefficient" DW = 1.485043, of a size large enough to appreciate it confirms the non-existence of autocorrelation between levels of the error term (residual). The information obtained is attested by the arrangement residues plot showing some alternation to the original (residues in Table 4). In these circumstances it is considered that the model is sufficiently viable model ensures good efficiency parameters to be used in calculations by extrapolation or interpolation;
- Residues within the permitted maximum estimates ± 2.048 of error average regression equation based on the law of distribution Student arrangement of bilateral materiality threshold of 5% and 28 degrees of freedom, which confirms the correct statistical modeling system correlation studied by simple hyperbolic regression equation;
- Description of the error term statistical series (residual) is shown graphically (histogram in Fig. 5) and by indicators: mean, median, maximum, minimum, standard deviation, the coefficient of asymmetry (Skewness), Bolt flattening coefficient (Kurtosis), Jarque-Bera statistic coefficient (JB = 0.070358) which will form the laws of distribution χ^2 with 2 degrees of freedom and probability coefficient related JB (P = 96.5432%). This information underlying hypothesis acceptance of the values of the error term disposition under the law of normal distribution, a finding necessary to ensure good efficiency econometric model;
- The results shown in the picture synopsis of "White Heteroskedasticity Test" (Table 5) confirms that the residual variable is homoscedastic, the error term shows an equal dispersal relative values of the independent variable (x), ensures the possibility to conclude that viable model to calculate the estimate of the risk of poverty if they produce expected changes in GDP per capita [9];

The conclusion of the study is based on the results of calculations and it certifies the sustainability of the equation hyperbolic shape modeling statistical correlation between risk of poverty and GDP per capita. Economic growth and the economic potential of a state dimensioned by GDP per capita ensure durable and sustainable support to minimize the risk of poverty.

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