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ANALYSIS OF ANALYSIS OF SUSTAINABLE ECONOMIC GROWTH POSITION OF EUROPEAN COUNTRIES BY ECONOMETRIC MODELING

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Abstract

The economic potential of a country is consistently a primary goal of existence and sustainable development. To achieve this major goal is necessary to undertake strict complex studies to formulate a correct diagnosis and real economic situation and the rationale, on this basis, decisions economic policy and legislative decisions aimed at both time horizons immediate and for longer periods of time. In this context the significance and importance of GDP per capita as synthetic macroeconomic indicator is developed a multifactorial econometric model that includes two exogenous variables, the employment rate over 55 and resource productivity.

Key words**:** *GDP per capita, employment rate over 55, EU-28, resource productivity, econometric model*

INTRODUCTION

The growth of economic potential of a state [7] is a synthetic form of measuring the total GDP and GDP per capita. An intake defining the size and dynamics of gross domestic product it holds, from a certain point of view, the employment rate for workers aged 55+ and internal material resource productivity in the economy [11]. In the context of this economic logic states that: workers aged over 55 are considered to possess undoubted quality yield by recognized expertise and manifested in the economic process by helping to achieve economic outturn dimensioned as gross domestic product and productivity of resources built in internal gross domestic product figure measure their recovery and influence the dynamics of GDP [9].
In this context the definition of interdependent systems of variable analysis present gross domestic product per capita according to the employment rate of the population that has more than 55 years and that the productivity of resources used in the economy by applying a rigorous methodology of econometric modeling.
This can provide support for opportunity of econometric study to obtain the information necessary to allow substantiation of macroeconomic decisions to foster real economic progress and reinforced [10].

MATERIALS AND METHODS

The methods used to process the data contained in Table 1 are able to provide, by synthetic and analytical obtained indices, relevant information on 28 European countries on GDP per capita, rate of employment over 55 years, resource productivity, but also the mathematical relationship that expresses the interdependence of these variables. To achieve goals we are using grouping method, the relative size of the structure method, statistical modeling and viability checking method and of the model.

Table 1. GDP per capita, employment rate over 55, resource productivity in 2014 for 28 European countries

No. crt.	Country	GDP per capita SER 01 = y (euro)	Employment rate over 55 SER 02 = x_1	Resource productivity SER 03 = x_2
1	Belgium	33800	42.7	2.3896
2	Bulgaria	5400	50	0.2912
3	Czech Republic	15200	54	1.0018
4	Denmark	43300	63.2	2.1037
5	Germany	33200	65.6	2.0896
6	Estonia	13200	64	0.4226
7	Ireland	39500	53	1.4873
8	Greece	17000	34	1.4004
9	Spain	22700	44.3	2.7244
10	France	31100	47	2.601
11	Croatia	10200	36.2	1.0906
12	Italy	25300	46.2	2.8886
13	Cyprus	20200	46.9	1.3121
14	Latvia	10400	56.4	0.4934
15	Lithuania	11200	56.2	0.6505
16	Luxembourg	79500	42.5	4.0119
17	Hungary	10500	41.7	0.8873
18	Malta	17200	37.7	1.3444
19	Netherlands	37900	59.9	3.8225
20	Austria	36000	45.1	1.7102
21	Poland	10500	42.5	0.6125
22	Portugal	16300	47.8	1.141
23	Romania	6900	43.1	0.3217
24	Slovenia	17600	35.4	1.4331
25	Slovakia	13400	44.8	1.1966
26	Finland	34100	59.1	1.0029
27	Sweden	40400	74	1.7159
28	United Kingdom	30100	61	3.2409

Source: calculus on data from www.insse.ro

RESULTS AND DISCUSSIONS

Based on statistical data from Table 1 we conduct a systematic distribution of European states after the three indicators considered as a group at the level of 2014.

First was drawn the group listed in Table 2 which highlights four groups of countries based on GDP per capita. Of the 28 countries included in the group, 50.00% (14 countries) have a level of GDP per capita between 0 and 20,000 euro, 39.29% (11 countries) representing states that have a GDP per capita between 20,000 and 40,000 euros and 3 states (10.71%) have a GDP per capita exceeding 40,000 euro [8].

Romania is positioned in Group 1 with a GDP per capita of 6,900 euros while Luxembourg has the highest rate of 79,500 euro.

Statistical description of the series of distribution of the 28 EU countries, the indicators presented in Table 2 highlights the significant degree of asymmetry of the series and also by the size indicator Jarque-Bera in Table 5 refuted likeness law normal distribution [4].

The average level of GDP per capita was at the end of 2014 of EUR 24,360.71 characterized by a coefficient of variation of 64.7979%. These results attest that statistical series of 28 European countries in Table 1, in terms of GDP per capita has a high degree of heterogeneity and warns that the average value is affected by non-representatively [3].

Table 2. Grouping of 28 EU states by GDP per capita in 2014

Tabulation of SER01 (**PIB/1 loc.)**				
Sample: 1 28; Included observations: 28				
Number of categories: 4			Cumulative	Cumulative
Value	Count	Percent	Count	Percent
[0, 20000)	14	50.00	14	50.00
[20000, 40000)	11	39.29	25	89.29
[40000, 60000)	2	7.14	27	96.43
[60000, 80000)	1	3.57	28	100.00
Total	28	100.00	28	100.00

Source: author calculus

Regarding the employment rate of people who are aged over 55 years, the group of 28 European countries in Table 3 highlights the following: grouping identifies five types of qualitative states; the largest group is the 40-50 range is stated in the employment rate over 55 years is 42.86% (12 countries) from a total of 28 European countries; the second group in importance is entered in the range of 50-60 employment rate over 55, which includes seven states (25.00%); groups included in the intervals 30-40 and 60-70 respectively of employment rates over 55 years, equal proportions of 14.29% each, by 7 states; one country, Sweden has an employment rate of people aged over 55 have the size stated

within 70-80 respectively 74. Statistical description of the series distribution of the 28 EU countries, the indicators presented Table 3 highlights the significant degree of asymmetry of the series and also Jarque-Bera indicator of the size of Table 5 refuted likeness normal distribution law. The average employment rate of people aged over 55 years has been the end of 2014 of 49.79643 characterized by a coefficient of variation of 20.4841%. These results attest that the statistical series of the 28 European countries in Table 1, the size of the employment rate over 55 has a relatively acceptable homogeneity and warns that the average value has a degree of representativeness diminished significantly as it approaches the level of Reference 30% limit considered as acceptance of homogeneity series.

Table 3. Grouping of 28 EU states by employment rate over 55 years in 2014

Tabulation of SER02 (**Rata de angajare peste 55 ani)**				
Sample: 1 – 28; Included observations: 28				
Number of categories: 5			Cumulative	Cumulative
Value	Count	Percent	Count	Percent
[30, 40)	4	14.29	4	14.29
[40, 50)	12	42.86	16	57.14
[50, 60)	7	25.00	23	82.14
[60, 70)	4	14.29	27	96.43
[70, 80)	1	3.57	28	100.00
Total	28	100.00	28	100.00

Source: author calculus

Data presented in Table 4 systematize community of 28 European countries on five groups, depending on resource productivity. Such notice may, in summary, the following: the group is part of resource productivity 1.0-2.0 range comprises 42.86% of the total states and 12 countries; 0.0-1.0 and 2.0-3.0 group of resource productivity group has close proportions, 25.00% (7 countries) and 21.43% (6 states); groups with a significantly higher resource productivity include only three states, two states are in the range 3.0-4.0 (Netherlands and the UK) and a state within the range 4.0-5.0 (Luxembourg).

Clearly, this group also (Table 4) highlights the significance of asymmetry of the series and also Jarque-Bera through size indicator in Table 5, refuted the likeness of the normal distribution law [5]. The coefficient of variation of this series is 63.29% distribution and explains non-representatively average value, according to information provided Jarque-Bera statistic coefficient [6].

Table 4. Grouping of 28 EU states by resource productivity in 2014

Tabulation of SER03 **(Productivitatea resurselor)**				
Sample: 1 – 28; Included observations: 28				
Number of categories: 5			Cumulative	Cumulative
Value	Count	Percent	Count	Percent
[0, 1)	7	25.00	7	25.00
[1, 2)	12	42.86	19	67.86
[2, 3)	6	21.43	25	89.29
[3, 4)	2	7.14	27	96.43
[4, 5)	1	3.57	28	100.00
Total	28	100.00	28	100.00

Source: author calculus

Table 5. Main statistics that describe EU-28 series for GDP per capita, employment rate over 55 and resource productivity in 2014

Statistics	GDP per capita	Employment rate over 55	Resource productivity
Mean	24,360.71	49.79643	1.620989
Median	18,900.00	46.95000	1.372400
Maximum	79,500.00	74.00000	4.011900
Minimum	5,400.000	34.00000	0.291200
Std. Dev.	15,785.23	10.20034	1.026042
Skewness	1.520698	0.484404	0.791441
Kurtosis	6.200206	2.461715	2.801389
Jarque-Bera	22.73997	1.433064	2.969125
Probability	0.000012	0.488443	0.226601
Observations	28	28	28

Source: author calculus

Correlation analysis of GDP per capita, employment rate over 55 years, and resource productivity by applying a methodological support of an econometric nature, shall be based on data presented in Table 1, which covers 28 European countries.

The graphical representation of the correlation between variables system under study, Figure 1 and Figure 2 provides information suggestive by the arrangement of the point cloud on form interdependence both between SER 01 = y and SER 02 = x_1 and between SER 01 = y and SER 03 = x_2. In those circumstances we opted for a multiple linear regression equation that has the general form: $\hat{y} = a + bx_1 + cx_2$.

By determining the equation [2] analytically formalize dependence gross domestic product per capita according to the rate of employment over 55 years, and that the resource productivity by eliminating the

influence of other factors that are considered non-essential.

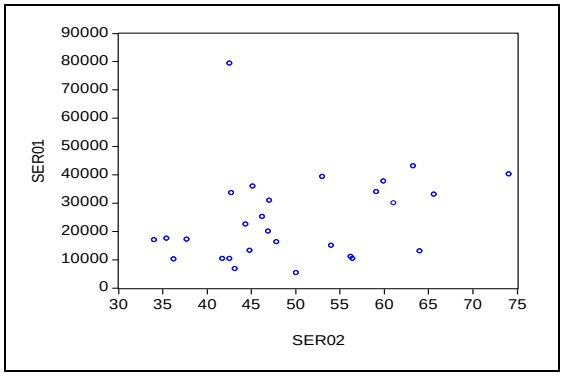

Fig. 1. GDP per capita and employment rate over 55 years cloud
Source**:** author calculus

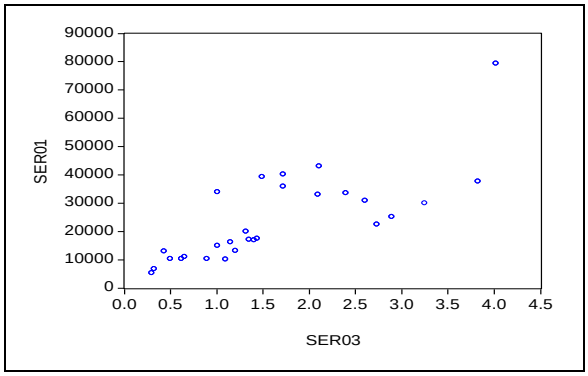

Figure 2. GDP per capita and resource productivity cloud
Source: author calculus

Parameter estimation of linear multiple regression equation regarded as analytical form interdependent system studied is performed using least squares method and results following system of equations [1]:

$$\begin{cases} \Sigma y = na + b\Sigma x_1 + c\Sigma x_2 \\ \Sigma x_1 y = a\Sigma x_1 + b\Sigma x_1^2 + c\Sigma x_1 x_2 \\ \Sigma x_2 y = a\Sigma x_2 + b\Sigma x_1 x_2 + c\Sigma x_2^2 \end{cases}$$

After solving the system of equations econometric model is obtained,

$$\hat{y} = -9354.584 + 302.7674x_1 + 11498.27x_2$$

The estimated values of the parameters that define the multifactor model linear gross domestic product per capita and other results information econometric are shown in "synoptic table of econometric representation indicators" that allow to appreciate the level of evidence of the viability of the econometric model, (table 6).

Table 6. Synoptic table of results that attests viability of linear multifactorial model of correlation between GDP per capita and employment rate over 55 and resource productivity

Dependent Variable: **PIB/1 loc.**				
Method: Least Squares				
$\hat{y} = a + bx_1 + cx_2 \rightarrow$ $\hat{y} = -9354.584 + 302.7674x_1 + 11498.27x_2$				
Sample: 1 – 28; Included observations: 28				
Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
Employment rate over 55 years „*b*"	302.7674	191.2845	1.582812	0.1260
Resource productivity „*c*"	11498.27	1901.644	6.046487	0.0000
C „*a*"	-9354.584	9956.308	-0.939564	0.3564
R-squared (R^2)	0.620533	Mean dependent var		24360.71
Adjusted *R*-squared	0.590176	S.D. dependent var		15785.23
S.E. of regression ($\hat{\sigma}_{y;\hat{y}}$)	10105.31	Akaike info criterion		21.38047
Sum squared resid	2.55E+09	Schwarz criterion		21.52320
Log likelihood	-296.3265	*F*-statistic		20.44096
Durbin-Watson stat	2.211362	Prob (*F*-statistic)		0.000005

Source: author calculus
Note: These indicators were obtained by using Eviews.

Actual levels (y) and the estimated ($\hat{y}$) of GDP per capita obtained by applying multiple linear regression equation, residues series and their displacement is shown in Table 7. The graph of residue from the last column of the table provides a picture of their alternation in relation to the origin, which confirms the status non correlation. Statistical coefficient Durbin Watson (DW = 2.211362 - Table 6) confirms this conclusion because is positioned between 1.4 and 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. It notes also that residues do not exceed framing admitted, in statistical terms, expressed by ±2.060 estimates of standard error of regression equation

$$(\pm t_{q=0.05;\, f=n-k=28-3} \cdot \hat{\sigma}_{y;\hat{y}} = \pm 2.060 \cdot 10105.31)$$

under the law of Student distribution for a significance bilateral level of 5% and 25 degrees of freedom. This finding is able to justify the formation of the belief that the econometric model of the gross domestic product per capita formalized by an equation of linear multiple regression shows a construction math correct reality of statistics and therefore has utility practice to substantiate and implement measures

economic growth by considering the two exogenous variables (employment rate for those over 55 years and resource productivity).

Table 7. Actual and estimate values for GDP per capita based on employment rate over 55 years and resource productivity based on a multifactorial linear model including residual plot

Obs.	Actual	Fitted	Residual	Residual Plot
1	33800.0	31049.8	2750.16	. |* . |
2	5400.00	9132.08	-3732.08	. *| . |
3	15200.0	18513.8	-3313.82	. *| . |
4	43300.0	33969.2	9330.79	. | * |
5	33200.0	34533.7	-1333.73	. *| . |
6	13200.0	14881.7	-1681.69	. *| . |
7	39500.0	23793.5	15706.5	. | . * |
8	17000.0	17041.7	-41.6773	. * . |
9	22700.0	35383.9	-12683.9	*. | . |
10	31100.0	34782.5	-3682.47	. *| . |
11	10200.0	14145.6	-3945.60	. *| . |
12	25300.0	37847.2	-12547.2	*. | . |
13	20200.0	19932.1	267.921	. * . |
14	10400.0	13394.7	-2994.74	. *| . |
15	11200.0	15140.6	-3940.56	. *| . |
16	79500.0	49642.9	29857.1	. | . *|
17	10500.0	13473.2	-2973.23	. *| . |
18	17200.0	17518.0	-318.014	. * . |
19	37900.0	52733.3	-14833.3	*. | . |
20	36000.0	23964.6	12035.4	. | .* |
21	10500.0	10555.7	-55.7164	. * . |
22	16300.0	18237.2	-1937.22	. *| . |
23	6900.00	7393.68	-493.681	. * . |
24	17600.0	17841.5	-241.545	. * . |
25	13400.0	17968.2	-4568.22	. *| . |
26	34100.0	20070.6	14029.4	. | . * |
27	40400.0	32780.1	7619.93	. | *. |
28	30100.0	46379.0	-16279.0	* . | . |

Source: author calculus

Graphic representations in Figure 3 and 4 visual attests the values of GDP per capita (real and estimate) and also residue values in Table 7.

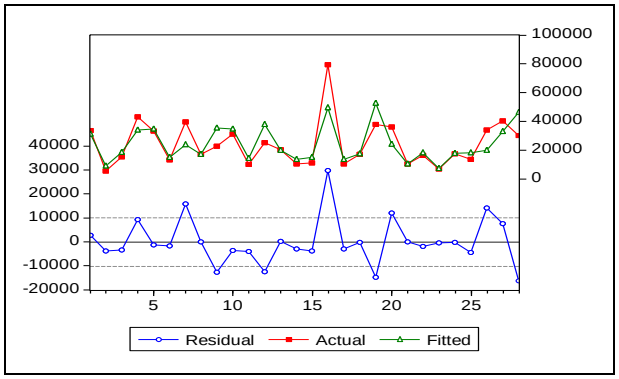

Fig. 3. Graphical representation of residual, real and estimate values for GDP per capita based on employment rate over 55 years and resource productivity
Source: author calculus

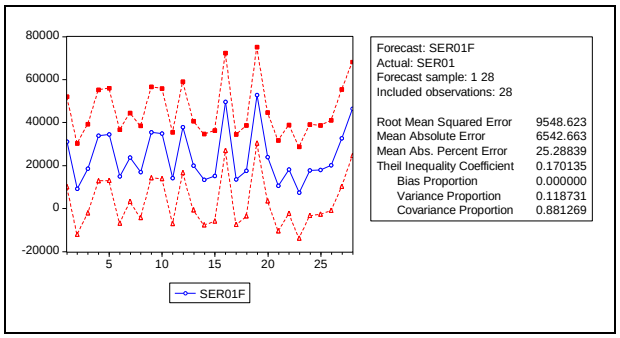

Fig. 4. Graphical representation of estimate values of GDP per capita based on employment rate over 55 years and resource productivity in the limit of ± 2.060 estimation of average error for multiple linear equation (Student repartition with significance of 5% and 25 freedom degrees)
Source: author calculus
Note: SER01F is estimate value for GDP per capita based on employment rate over 55 years and resource productivity

$$(\pm t_{q=0.05;\, f=n-k=28-3} \cdot \hat{\sigma}_{y;\hat{y}} = \pm 2.060 \cdot 10105.31)$$

Test normality of the distribution of the residual variable, Jarque-Bera leads to a rejection of this hypothesis because coefficient JB (JB = 8.045334) is associated with a very low probability of acceptance (P = 1.7905%) under the law hi square distribution with two degrees of freedom (Figure 5). It is obvious that this statistical test justify the recommendation to increase the number of observations for better efficiency multifactorial linear regression model.

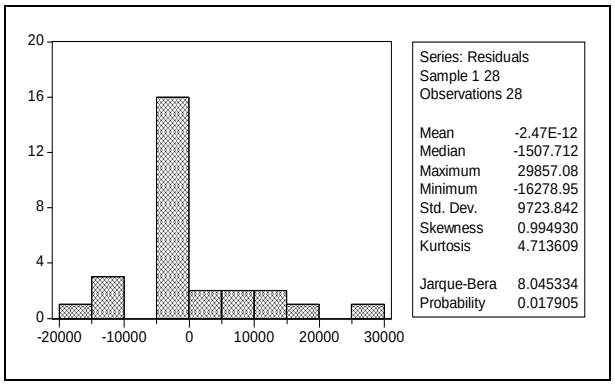

Fig. 5. Statistical description and normality test for residue variable based on Jarque-Bera criteria
Source: author calculus

To test the heteroscedasticity / homoscedasticity of residue we will use White test. The results entered in the Synoptic picture "White Heteroscedasticity Test"

(Table 8) was obtained by applying the software Eviews and attests that the residual variable is heteroscedastic. The conclusion is validated both under "F Criteria" and the "χ^2 Criteria" thresholds of significance of 0.000025% and 0.001315% of, reasons for accepting the hypothesis of heteroscedasticity as not exceed a maximum of 5%, considered acceptance threshold.

Based on the results shown in "White Heteroscedasticity Test" (Table 8) we concluded that the residual variable is heteroscedastic and it is assumed that between the square residual variable and exogenous variables (employment rate over 55 and resource productivity) is formed a significant interdependency relationship, confirmed statistically, and under these conditions the residual variable dispersion is not constant because:

„ F Criteria"

$$F-statistic > F-tabelar = F_{q=0.05;\, f_1=k-1=6-1=5;\, f_2=n-k=28-6=22} = 2.66$$

$$F-statistic = 10.77632 > F-tabelar = 2.66$$

$$F-statistic = \frac{\dfrac{\sum_i (\hat{z}_i - \bar{z})^2}{k-1}}{\dfrac{\sum_i (z_i - \hat{z}_i)^2}{n-k}} = 10.77632$$

„ χ^2 Criteria"

$$n \cdot R^2 > \chi^2 - tabelar = \chi^2_{q=0,05,\ f=k-1=6-1=5} \rightarrow 28 \cdot 0.710075 = 19.88209 > 11.1$$

Table 8. Synoptic picture of „White Heteroscedasticity Test" for linear multifactorial model of GDP per capita

White Heteroskedasticity Test:				
F-statistic	10.77632	Probability		0.000025
Obs*R-squared	19.88209	Probability		0.001315
Test Equation: Dependent Variable: RESID^2				
$u^2 = z = a + b \cdot SER02 + c \cdot SER02^2 + d \cdot SER02 \cdot SER03 + e \cdot SER03 + f \cdot SER03^2$ $u^2 = z = a + b \cdot x_1 + c \cdot x_1^2 + d \cdot x_1 \cdot x_2 + e \cdot x_2 + f \cdot x_2^2$				
Method: Least Squares				
Sample: 1 – 28; Included observations: 28, (n = 28)				
Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
C „a"	-2.55E+08	5.46E+08	-0.466298	0.6456
SER02: x_1 „b"	3664964.	20001778	0.183232	0.8563
SER02^2 : x_1^2 „c"	60923.29	192180.0	0.317012	0.7542
SER02*SER03: $x_1 \cdot x_2$ „d"	-6532731.	2463894.	-2.651385	0.0146
SER03: x_2 „e"	1.87E+08	1.53E+08	1.222709	0.2344
SER03^2: x_2^2 „f"	64808196	19242230	3.368019	0.0028
R-squared (R^2)	0.710075	Mean dependent var		91176203
Adjusted *R*-squared	0.644182	S.D. dependent var		1.79E+08
S.E. of regression	1.07E+08	Akaike info criterion		39.99693
Sum squared resid	2.51E+17	Schwarz criterion		40.28240
Log likelihood	-553.9570	*F*-statistic		10.77632
Durbin-Watson stat	2.092041	Prob (*F*-statistic)		0.000025

Source: author calculus

CONCLUSIONS

The econometric model of GDP per capita based on employment rate over 55 years and resource productivity is shaped mathematical as regression equation

$$\hat{y} = -9354.584 + 302.7674x_1 + 11498.27x_2,$$

and is certified as a model with a limited viability as criteria for statistical testing does not confirm in all cases that the model is fully viable.

Viability interpretation is based on the following findings:

-Multiple coefficient of determination $R^2_{y.x_1,x_2} = 0.620533$, by size, allows us to appreciate that 62.05% of GDP per capita changes is explained by employment rate over 55 and resource productivity, the gap to 100% is the influence of other variables not included in the model, or residual variable influence;

-Correlation ratio has a very high value ($R_{y.x_1,x_2} = 0.787739$) which confirms a strong positive correlation between the model's variables.

Econometric model studied confirm the statistical significance of the correlation ratio using "F Criteria". Under this criterion we compared $F_{statistic} = 20.44096$ with $F_{table} = 3.39$ and we found that calculated value significantly exceeds the table value. From the table of Fisher we extract distribution function F_{table}, which corresponds to a probability of 95% and the number of degrees of freedom $f_1 = k-1 = 3-1 = 2$ and $f_2 = n-k = 28-3 = 25$

$F_{statistic} = 20.44096 > F_{table} = 3.39$

$$F_{table} = F_{P;f_1=k-1;f_2=n-k} = F_{P;f_1=3-1=2;f_2=28-3=25} = 3.39$$

It is attested, with reasonable confidence, that correlation ratio is significantly different from zero or, in other words, the ratio validates real correlation between studied variables;

- Parameter estimator "b" (b = 302.7674) is not significantly different from zero (for this parameter accepts null hypothesis), under "t Criteria" with the threshold of 12.60%. In these circumstances the independent variable (exogenous) x_1 – employment rate over 55 years, offers statistical information that it propagates an insignificant influence on the size of GDP per capita;

- Parameter estimator "c" (c = 11498.27) has a statistically significant different from zero, under "t Criteria". It thus provides statistical information that the variable resource productivity has a significant role in the formation and change in GDP per capita;

- Regression coefficient "c" compared with the estimator parameter "b" also allows noting the priority order applied when policy makers will apply measures to increase GDP per capita. First will be considered and implemented measures that lead to increased resource productivity;

- Econometric model highlights the size of the regression coefficient "b" that an increase by one unit for employment rates over 55 years produces an increase in GDP per capita by 302.7674 units and an increase of one unit for resource productivity will increase GDP per capita with 11,498.27 units;

- Heteroscedasticity of residual variable is statistically confirmed and in these circumstances the "t Criteria" for the significance of the regression equation parameters is not fully conclusive and the dispersion of the residue values is not constant;

- Durbin-Watson statistic coefficient (DW = 2.211362) has a value which is positioned in the range from 1.4 to 2.6 and we appreciate that the error term are not auto correlated, as a condition for confirming the viability complementary regression equation if used in the calculations of extrapolation. When using the table of Durbin Watson distribution, non-auto correlation residue hypothesis is confirmed for both a significance threshold of 1% and for a significance threshold of 5%, for a total of 28 observation and 2 exogenous variables;

- Relative expression to estimate the standard error of the regression equation, compared with the average value of the dependent variable (GDP per capita), 41.482%, offers information not sustain the viability of the model (regression equation) to calculate extrapolation because it has a size exceeding

the limit of 10% deemed appropriate. A statistical significance similar to that which presents the estimate of the relative standard error of the regression equation is obtained by calculating and interpreting "irregularity coefficient (inequality) of Theil" (Th = 17.0135%) - Figure 4. Irregularity coefficient (inequality) Theil's can take a value between zero and one (100), and is considered as a very good size for assessing the viability of the model when Th does not exceed 5%. This involves statistical unconfirmed conclusion of invalidity of the model to be used to calculate the extrapolation of estimates;

- Statistical description of the error term statistical series (residual) is shown graphically (histogram in Figure 5) as well as indicators: mean, median, maximum, minimum, standard deviation, the asymmetry coefficient (skewness), bolt-flattening coefficient (Kurtosis), Jarque-Bera statistic coefficient (JB = 8.045334) which will form the χ^2 laws of distribution with 2 degrees of freedom and probability coefficient related JB (1.7905%). This information underlying the rejection of the hypothesis of disposition values of the error term under the law of normal distribution (test for normality of the distribution of the residual variable) because the probability associated coefficient JB is less than the critical limit of 60%, as a necessary conclusion to ensure good efficiency econometric model. Obviously testing statistical distribution of the error term, the conclusion that induces to improve the quality model, it is recommended increasing the number of observations;

In conclusion we may consider the multifactor model linear GDP per capita according to the rate of employment of persons who are aged 55+ and resource productivity has limited viability especially when intended to be carried out calculations extrapolating or interpolation. The model can be retained and is a solution of mathematical formalization of statistical regularities between variables included in the model as a source of justification of economic policy decisions.

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