# Correlation of Final Consumption of Energy Used, Renewable and Biofuels, with Gross Domestic Product

**Assoc. prof. Nicolae MIHĂILESCU, PhD.** (n.mihailescu@yahoo.com)
„Hyperion” University of Bucharest

**Professor Florinel-Marian SGĂRDEA, PhD.** (sgardeafm@gmail.com)
The Bucharest Academy of Economic Studies (ASE)

**Assoc. prof. Claudia CĂPĂȚÎNĂ, PhD.** (claudiacapatana@yahoo.com)
„Hyperion” University of Bucharest

## ABSTRACT

*Energy is a current topic of priority importance for human activity. The political and economic decisions implemented by each state are rigorously based on complex analyzes to assess the level of pollution, the ability to respond to pollution limitation and the greenhouse effect. The development of human society, the socio-economic progress and the standard of living depend, first of all, on the ever-increasing consumption of energy.*

*This article presents an econometric model of the final consumption of energy used, renewable and biofuels in the 27 countries of the European Union depending on the size of the gross domestic product. The economic power of each state identified by the value of gross domestic product determines a sustainable response to finance the production and distribution of energy from renewable sources and biofuels.*

*The study was conducted on the basis of information provided by Eurostat and the International Monetary Fund for 2019.*

*Periodic review of the research on an updated statistical data system is a solution to be considered as a way of operative knowledge of the achievements related to the analyzed field.*

*The research presented applies a methodology that is rigorously grounded in statistics, econometrics and macroeconomics and can also be used as a support for applied information to develop econometric models with viability and practical utility for decision makers.*

*EViews software was used to define the econometric model.*

*The study concludes with conclusions on the viability of the econometric model of the correlation of the final consumption of renewable energy and biofuels in the European Union-27 with gross domestic product, with an indisputable utility for substantiating government decisions aimed at economic policy of monitoring and limiting pollutants.*

*The general trend at European level is the annual increase in the final consumption of renewable energy and biofuels as a result of the concerns and measures applied in the countries of the Union, both political and especially economic, organizational, scientific and technological.*
**Keywords**: *renewable energy and biofuels, econometric model.*
**JEL classification**: *C13*

## INTRODUCTION

The final consumption of energy used, renewable and biofuels is directly dependent on the economic potential of the state, the decision of the administrative and political leadership to regulate the energy field, production and distribution.

It is a generally accepted economic logic that the „Gross Domestic Product" is considered as the indicator that synthetically expresses the economic potential of a state and is, at the same time, the indicator that summarizes economic growth when its evolution is characterized by positive rhythms. By increasing the total gross domestic product and per inhabitant, the material and financial basis necessary for the fulfillment of the objectives of existence and sustainable development of all fields of economic and social life is ensured.

In order to achieve this major goal of functioning of the national economy, it is necessary to carry out studies with a viable methodological structure, with a correctly formulated economic motivation, to provide the necessary information support to identify a useful and real diagnosis of the performance of "green energy" production and consumption and the substantiation, on this basis, of some economic, budgetary, fiscal and legislative policy decisions, decisions that target both immediate time segments but also longer periods of time.

The motivational considerations presented can provide the opportunity to develop an econometric model that expresses in a synthetic (mathematical) way the correlation of the final consumption of energy used, renewable and biofuels with the gross domestic product by applying a rigorous econometric modeling methodology.

## REFERENCE LITERATURE

The analysis of the dynamics of the final consumption of renewable energy and biofuels in the states of the European Union - 27 joins the numerous econometric modeling works that have been presented in articles and specialized papers in the country and abroad.

All the studies to which we refer use a modeling methodology, rigorously based on economic theory, mathematical statistics, probability theory and statistical inference, respectively. Particular cases of analysis are treated separately by mathematical modeling of the dynamics of economic variables as well as the formation of interdependencies between variables formed in a systemic format and also provide appropriate solutions for model validation.

In this sense, the most recent works are relevant, published by Anghelache, C., Anghel, M.G., Manole, A. (2015) - "Economic, financial-banking and informatics modeling", Artifex Publishing House, Bucharest[1]; Anghel, M.G. (2014) - "Econometric Model Applied in the Analysis of the Correlation between Some of the Macroeconomic Variables", Romanian Statistical Review - Supplement/Nr. 1/2014[2]; Andrei, T., Bourbonais, R. (2008) - „Econometrics", Economic Publishing House, Bucharest[3].

In the paper elaborated by Mihăilescu, N. (2014) - "Statistics and Statistical Bases of Econometrics", Transversal Publishing House, Bucharest[4], unifactorial and multifactorial models are defined and validated, both at macroeconomic and microeconomic level, both in Romania as well as the states of the European Union.

A similar topic that refers to the complex analysis of the evolution of the money supply with the help of interdependent models is treated by Mihăilescu, N. (2019) - „Analysis of economic-financial activity - Research methodologies, case studies solved to substantiate economic-financial decisions and tests of knowledge", Transversal Publishing House, Bucharest[5].

Other reference works are: Mihăilescu, N., Căpăţână, C. (2018) - „The reversible impact of the dynamics of the gross domestic product with the imports and exports of goods and services of Romania, Romanian Statistical Review - Supplement/ Nr. 11 and No. 12/2018[6]; Pagliacci, M., Anghelache, G.V., Pocan, I.M., Marinescu, R.T., Manole, A. (2011) - "Multiple Regression - Method of Financial Performance Evaluation", ART ECO - Review of Economic Studies and Research, Publishing House Artifex, Bucharest, Vol. 2 / No.4 / 2011[7].

The mentioned works present in the context of the scientifically based methodology of econometrics, statistical legitimacies expressed by regression or trend equations that are formed to express the reality of dynamic economic processes, on quarterly and annual time segments or as interdependence between economic variables, in profile static - at a given time or representative time segment, both macroeconomically and microeconomically level. Models of demographic or social variables depending on the size of an economic variable are also presented.

## RESEARCH METHODOLOGY AND STUDY DATABASE

The research methodology of the correlation of the final consumption of energy used, renewable and biofuels, from 2019 with the gross domestic product for 27 states that make up the European Union is based on econometrics and is based on the following steps:

- Graph the correlation of the indicators in the database and choose the mathematical form of the model.
- The coefficients of the econometric model are estimated by applying the least squares method and their statistical significance is verified using „*Criterion t*",
- The viability of the model is assessed by specific tests using the following criteria: „*Criterion F*", „*Jarque-Bera Criterion*", „*Durbin-Watson Criterion*" and „*White Test*".
- It also quantifies the „power" of the model for calculating predictable levels of final consumption of energy used, renewable and biofuels using „*Theil's Irregularity/Inequality Coefficient*" as well as the relative expression „*Standard error estimation of the equation of regression*",
- Forecast levels are estimated, as a point value and as a guaranteed confidence interval with a probability of at least 95%.

The methodology used to develop and certify the viability of the models is applied using the Eviews software.

The database that is used to carry out the proposed study is provided by Eurostat and the International Monetary Fund with reference to the year 2019 and respectively to the 27 states that make up the European Union, Table 1.

**List of European Union countries - 27 after final consumption of energy used, renewable and biofuels, total and per capita, total GDP and per capita and Population (2019)**

*Table 1*

| No. | Member State | Final consumption of energy used, renewable and biofuels (thousand tons of oil equivalent) | GDP (nominal), (million US dollars)[1] | The population | Final consumption of energy used, renewable and biofuels per capita (tons of oil equivalent) | Gross domestic product per capita ($) |
|---|---|---|---|---|---|---|
| 1 | Germany | 16,618.056 | 4,000,386 | 84,052,061 | 0.197711 | 47,594.15 |
| 2 | France | 14,836.710 | 2,775,252 | 65,418,030 | 0.226798 | 42,423.35 |
| 3 | Italy | 10,912.230 | 2,072,201 | 60,776,531 | 0.179547 | 34,095.41 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | Spain | 7,202.379 | 1,425,865 | 46,770,000 | 0.153996 | 30,486.74 |
| 5 | Poland | 6,418.452 | 586,015 | 38,511,824 | 0.166662 | 15,216.50 |
| 6 | Romania | 3,831.610 | 239,851 | 20,121,641 | 0.190422 | 11,920.05 |
| 7 | Lower Countries | 1,988.634 | 912,899 | 16,787,689 | 0.118458 | 54,379.08 |
| 8 | Greece | 1,701.095 | 219,097 | 11,350,118 | 0.149875 | 19,303.50 |
| 9 | Belgium | 1,948.804 | 533,153 | 11,071,483 | 0.176020 | 48,155.52 |
| 10 | Portugal | 2,904.002 | 238,510 | 10,562,178 | 0.274943 | 22,581.52 |
| 11 | Czech Republic | 3,242.387 | 242,052 | 10,436,560 | 0.310676 | 23,192.70 |
| 12 | Hungary | 1,846.200 | 155,703 | 9,906,000 | 0.186372 | 15,718.05 |
| 13 | Sweden | 8,210.396 | 551,135 | 9,573,466 | 0.857620 | 57,569.01 |
| 14 | Austria | 4,110.477 | 457,637 | 8,602,112 | 0.477845 | 53,200.54 |
| 15 | Bulgaria | 1,424.833 | 64,963 | 7,351,234 | 0.193822 | **8,837.020** |
| 16 | Denmark | 1,675.684 | 350,874 | 5,580,516 | 0.300274 | 62,874.83 |
| 17 | Finland | 6,763.272 | 275,321 | 5,421,827 | **1.247416** | 50,780.12 |
| 18 | Slovakia | 1,236.644 | 106,585 | 5,414,937 | 0.228376 | 19,683.52 |
| 19 | Ireland | 487.697 | 424,635 | 4,588,252 | 0.106293 | 92,548.32 |
| 20 | Croatia | 1,151.904 | 60,688 | 4,290,612 | 0.268471 | 14,144.37 |
| 21 | Lithuania | 723.309 | 53,323 | 3,043,429 | 0.237663 | 17,520.70 |
| 22 | Latvia | 1,037.812 | 34,881 | 2,217,000 | 0.468115 | 15,733.42 |
| 23 | Slovenia | 641.394 | 54,242 | 2,062,455 | 0.310986 | 26,299.73 |
| 24 | Estonia | 442.860 | 30,312 | 1,294,455 | 0.342121 | 23,416.80 |
| 25 | Cyprus | 197.276 | 24,492 | 838,916 | 0.235156 | 29,194.82 |
| 26 | Luxembourg | 161.030 | 68,770 | 537,853 | 0.299394 | **127,860.2** |
| 27 | Malta | 31.875 | 14,505 | 452,515 | **0.070440** | 32,054.19 |

*Source: Eurostat,[1] Data provided by the International Monetary Fund (2019)*

The final consumption of energy used, renewable and biofuels of 27 component states of the EU, in 2019, clearly highlights the existence of a state of pronounced heterogeneity of European states assessed on the basis of the size of the coefficient of variation. Finland has the highest per capita consumption, 1.247416 tons of oil equivalent and Malta the lowest level 0.070440. This state of affairs is described in detail and edifying by appropriate statistical indicators systematized in Table 2 for total values (column 1) and for values per capita (column 2 - solution adopted to ensure the comparability of consumption size). It is clear that the information on this energy consumption raises the question of meeting the challenge of greater involvement of European states in coordinating policies to support the rapprochement of achieving the desired result, reducing environmental pollution.

The situation of the 27 states that make up the European Union in terms of the degree of homogeneity / heterogeneity in terms of the size of the gross domestic product per capita, Table 2 (column 3) is also attested with a pronounced heterogeneity based on the coefficient of variation which is 72.4579%, much higher compared to a sufficiently restrictive limit of 10%.

**Statistical description of the set of values for the final consumption of energy used, renewable and biofuels, total și per capita și GDP per capita of 27 EU states. in 2019**

*Table 2*

| Statistical indicators | Final consumption of energy used, renewable and biofuels (thousand tons of oil equivalent) | Final consumption of energy used, renewable and biofuels per capita (tons of oil equivalent) | GDP per capita (nominal), ($) |
|---|---|---|---|
| 0 | 1 | 2 | 3 |
| **Mean** | 3,768.408 | 0.295388 | 36,917.93 |
| Median | Hungary: 1,846.200 | Slovakia: 0.228376 | Cyprus: 29,194.82 |
| Maximum | Finlanda: 16,618.06 | Finlanda: 1.247416 | Luxemburg: 127,860.2 |
| Minimum | Malta: 31.87500 | Malta: 0.070440 | Bulgaria: 8,837.020 |
| Std. Dev. | 4,441.705 | 0.244274 | 26,749.96 |
| Coefficient of variation (%´) = (Std. Dev/Mean) 100 | 117.87% | 82.696% | 72.4579% |
| Skewness | 1.625991 | 2.719834 | 1.758785 |
| Kurtosis | 4.794893 | 10.43553 | 6.334543 |
| Jarque-Bera | 15.52166 | 95.48672 | 26.42903 |
| Probability (*J-B*) | 0.000426 | 0.000000 | 0.000002 |
| Sum | 101,747.0 | 7.975471 | 996,784.2 |
| Sum Sq. Dev. | (5.13E+08) | 1.551411 | (1.86E+10) |
| Observations | 27 | 27 | 27 |

As mentioned, the statistical series of values on the final consumption of energy used, renewable and biofuels, per inhabitant, shows a pronounced asymmetric arrangement. Table 3 identifies a group of 12 states that report a final consumption of energy used, renewable and biofuels, per capita up to 0.2 tons of oil equivalent and another 11 states have a consumption of between 0.2 and 0.4. These two groups represent 85.19% of the total states.

The states with a final consumption of energy used, renewable and biofuels, per capita, exceeding 0.4 tons of oil equivalent are 4, Finland (1.247416), Sweden (0.857620), Austria (0.477845) and Latvia (0.468115), with an overall proportion of 14.81%.

The graphical representation in Figure 1 illustrates the situation in Table 3 with the obvious asymmetry that characterizes the disposition of the 27 states of the European Union after the final consumption of energy used, renewable and biofuels, per inhabitant.

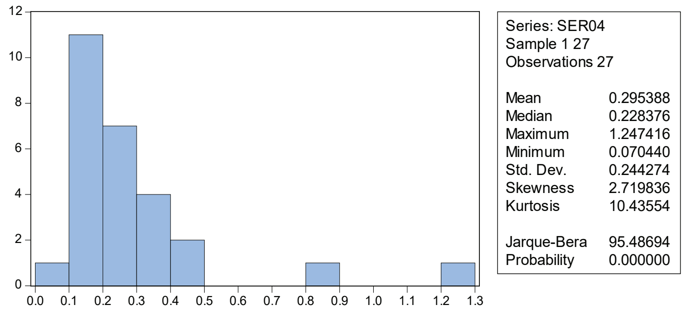
**Grouping the statistical series of values regarding the final consumption of energy used, renewable and biofuels, per capita, of 27 EU states in 2019 (tons of oil equivalent)**

*Table 3*

| Sample: 1 - 27: Number of observations: n = 27: Number of groups: 5 | | | | |
|---|---|---|---|---|
| Value (tons of oil equivalent) | Count | Percent | Cumulative Count | Cumulative Percent |
| [0.0 – 0.2) | 12 | 44.44 | 12 | 44.44 |
| [0.2 – 0.4) | 11 | 40.74 | 23 | 85.19 |
| [0.4 – 0.6) | 2 | 7.41 | 25 | 92.59 |
| [0.8 – 1.0) | 1 | 3.70 | 26 | 96.30 |
| [1.2 – 1.4) | 1 | 3.70 | 27 | 100.00 |
| Total | 27 | 100.00 | 27 | 100.00 |

**Graphical representation of the statistical series of values on final consumption of energy used, renewable and biofuels, per capita, of 27 EU states in 2019, (tons of oil equivalent)**

*Figure 1*

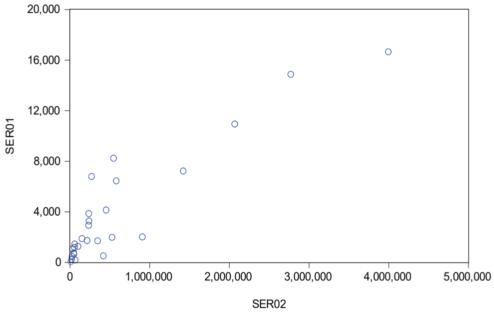



**Defining the econometric model of the correlation of the final consumption of energy used, renewable and biofuels, with the gross domestic product, calculating the indicators of econometric representation, testing their statistical significance and comments**

The analysis of the graphical representation of the correlation between the two variables (Figure 2) shows that as the gross domestic product increases, so does the final consumption of energy used, renewable and biofuels, which confirms a direct link, and the points tend to grouped around a line, which justifies the option for a linear function. Under these conditions, the regression equation $\hat{y} = a + bx$ will represent the estimated levels of the endogenous variable ($y$) as a function of the exogenous variable ($x$) and the equation that exposes synthetically to the real levels is: $y = a + bx + u$ where $u$ is the residual variable.

**Correlogram of final consumption of energy used, renewable and biofuels expressed in thousand tons of oil equivalent (SER01) by gross domestic product - million US dollars (SER02), for 27 countries of the European Union, in 2019**

*Figure 2*




The indicators that ensure an analytical and at the same time complex characterization of the econometric model (estimated regression equation) are presented in Table 4.

**Synoptic table of the system of econometric representation indicators for the model of the correlation of the final consumption of energy used, renewable and biofuels with the gross domestic product**

*Table 4*

| | | | | |
|---|---|---|---|---|
| Dependent Variable: ***y* = Final consumption of energy used, renewable and biofuels** (thousand tons of oil equivalent) | | | | |
| Method: Least Squares | | | | |
| Sample: 1-27; Included observations: *n* = 27 | | | | |
| The regression equation: y = a + b · x + u; y = 1,232.346 + 0.004287 · x + u | | | | |
| Variable | Coefficient | Std. Error | *t*-Statistic | Prob. |
| x = GDP - nominal (million US dollars) „b” | 0.004287 | 0.000386 | 11.11208 | 0.0000 |
| C = model constant „a” | 1,232.346 | 424.3097 | 2.904356 | 0.0076 |
| *R*-squared | **0.831625** | Mean dependent var: $\bar{y}$ | | 3,768.408 |
| Adjusted *R*-squared | 0.824890 | S.D. dependent var | | 4,441.705 |
| S.E. of regression | **1,858.682** | Jarque-Bera | | 4.634458 |
| Sum squared resid | 86,367,436 | Prob. (*J-B*) | | **0.098546** |
| Correlation ratio: R=$\sqrt{R^2}$ | **0,911935** | Hannan-Quinn criter. | | 17.99285 |
| *F*-statistic | 123.4782 | Durbin-Watson stat | | 1.848242 |
| Prob (*F*-statistic) | 0.000000 | *Theil Inequality Coefficient* | | **15.9134 %** |
| Heteroskedasticity Test: White | | | | |
| *F*-statistic = 0.680581; | | Prob. *F* (2, 24) | | 0.5158 |
| $n \cdot R^2 = \chi^2 -$ statistic = 1.449121; | | Prob. Chi-Square (2) | | 0.4845 |

Figure 3 provides visual information on how the three components defining the model (actual and estimated endogenous variable data and residues, respectively) are located for each of the 27 states in 2019. The graphical form confirms the status of the results in Table 5.

It can also be estimated that the size of the residue does not exceed the estimate of the limit error ( $\hat{\Delta}$ ), resulting from the product of the critical value of $t_{table} = \pm 2.060$, for a probability of 95% (significance threshold of 5% is arranged bilaterally) and 25 degrees of freedom (based on the Law of Student Distribution), $f = n - k = 27 - 2 = 25$, with the estimation of the standard error of the regression equation, $\hat{\sigma}_{y,\hat{y}} = \pm 1,858.682$, graphically presented situation in the last column of Table 5, except Sweden and Finland. These statistical findings support with sufficient confidence the viability of the model of correct representation of reality.

( $\hat{\Delta} = 2.060 \cdot 1,858.682 = \pm 3,828.885$ thousand tons of oil equivalent)

**Graphical presentation of residues (Residual), real levels - calculation basis - (Current) and estimated levels (Fitted) based on the linear regression equation of the correlation of the final consumption of energy used, renewable and biofuels, with the gross domestic product**

*Figure 3*

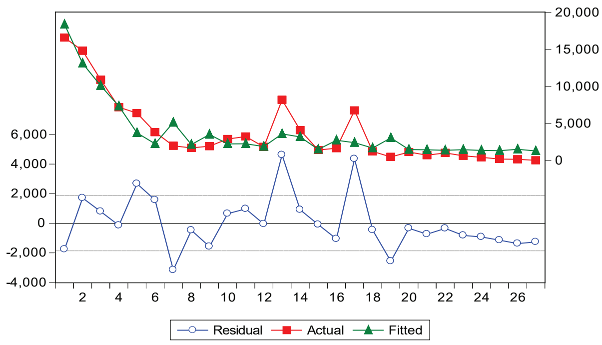



Table 5 shows the actual levels of the dynamics of final consumption of energy used, renewable and biofuels, the estimated levels based on the simple linear regression equation, and the series of error term levels. The range of residues in the last column of the table gives the image of a corresponding alternative arrangement of the error term compared to the zero size. This confirms, in graphical form, the existence of the state of non-autocorrelation of the values of the error term, identified as a numerical dimension by the size of the Durbin-Watson statistical coefficient (DW = 1.848242) and consequently it is estimated that the model is correctly developed.

**Series of real levels (calculation basis), of the levels estimated on the basis of the regression equation, regarding the correlation of the final consumption of energy used, renewable and biofuels, with the gross domestic product and the residual term range - (Linear unifactorial econometric model) (thousand tons of oil equivalent)**

*Table 5*

| No. | Member State | Actual (thousand tons of oil equivalent) $y$ | Fitted (thousand tons of oil equivalent) $\hat{y}$ | Residual $u = y - \hat{y}$ | Residual plot $\pm\hat{\sigma}_{y,\hat{y}} = \pm 1{,}858.682$ $-\hat{\sigma}_{y,\hat{y}}$ $+\hat{\sigma}_{y,\hat{y}}$ |
|---|---|---|---|---|---|
| 1 | Germany | 16.618,1 | 18.381,0 | -1.762,93 | * . |
| 2 | France | 14.836,7 | 13.129,1 | 1.707,57 | . *. |
| 3 | Italy | 10.912,2 | 10.115,3 | 796,886 | . * . |
| 4 | Spain | 7.202,38 | 7.344,67 | -142,287 | . * . |
| 5 | Poland | 6.418,45 | 3.744,44 | 2.674,01 | . . * |
| 6 | Romania | 3.831,61 | 2.260,53 | 1.571,08 | . *. |
| 7 | Lower Countries | 1.988,63 | 5.145,71 | -3.157,08 | * . . |
| 8 | Greece | 1.701,10 | 2.171,56 | -470,464 | . * . |
| 9 | Belgium | 1.948,80 | 3.517,84 | -1.569,03 | .* . |
| 10 | Portuga | 2.904,00 | 2.254,78 | 649,224 | . * . |
| 11 | Czech Republic | 3.242,39 | 2.269,96 | 972,425 | . * . |
| 12 | Hungary | 1.846,20 | 1.899,81 | -53,6055 | . * . |
| 13 | Sweden | 8.210,40 | 3.594,92 | **4.615,47** | . . * |
| 14 | Austria | 4.110,48 | 3.194,12 | 916,357 | . * . |
| 15 | Bulgaria | 1.424,83 | 1.510,83 | -85,9932 | . * . |
| 16 | Denmark | 1.675,68 | 2.736,45 | -1 060,77 | . * . |
| 17 | Finland | 6.763,27 | 2.412,58 | **4.350,69** | . . * |
| 18 | Slovakia | 1.236,64 | 1.689,25 | -452,605 | . * . |
| 19 | Ireland | 487,697 | 3.052,65 | -2.564,95 | * . . |
| 20 | Croatia | 1.151,90 | 1.492,50 | -340,596 | . * . |
| 21 | Lithuania | 723,309 | 1.460,93 | -737,620 | . * . |
| 22 | Latvia | 1.037,81 | 1.381,87 | -344,060 | . * . |
| 23 | Slovenia | 641,394 | 1.464,87 | -823,474 | . * . |
| 24 | Estonia | 442,860 | 1.362,29 | -919,426 | . * . |
| 25 | Cyprus | 197,276 | 1.337,34 | -1.140,06 | . * . |
| 26 | Luxembourg | 161,030 | 1.527,15 | -1.366,12 | . * . |
| 27 | Malta | 31,8750 | 1.294,53 | -1.262,65 | . * . |
| | Sum | 101.747,0 | 101.747,0 | 0,000 | |

**Conclusions on the significance of the indicators of econometric representation and the assessment of the viability of the econometric model of the final consumption of energy used, renewable and biofuels according to the gross domestic product**

The linear one-factor econometric model of final consumption of energy used, renewable and biofuels according to the gross domestic product of the 27 states that make up the European Union, $y = 1{,}232.346 + 0.004287 \cdot x + u$, is appreciated as a model with reserved viability because not all statistical testing conditions are met to justify a full viability conclusion:

- the correlation ratio ($R$ = 0.911935) has a size very close to the unit, which confirms the existence of a very strong correlation of the final consumption of energy used, renewable and biofuels depending on the gross domestic product. Also, the size of the coefficient of determination ($R^2$ = 0.831625) offers the possibility to specify that 83.1625% of the change in final consumption of energy used, renewable and biofuels is explained by the change in gross domestic product, the difference up to 100% is the influence residual component or the influence of other factors, not included in the model;

- in the case of the studied correlation, $F_{-statistic}$ = 123.4782 and it is found that this quantity exceeds to a significant extent the tabular value which is 4.24 ($F_{-tabular}$ = 4.24). From the table with the values of the Fisher distribution function is extracted $F_{-tabular}$, which corresponds to a probability of 95% and respectively the number of degrees of freedom, $f_1 = k - 1 = 2 - 1 = 1$ and $f_2 = n - k = 27 - 2 = 25$.

It is thus attested, with sufficient confidence, that the correlation ratio and the coefficient of determination are significantly different from zero or, in other words, the existence of a real correlation between the variables of the studied system is validated.

- the parameters of the regression equation „*a*" and „*b*" are significantly different from zero (for these parameters the null hypothesis is rejected), based on the „*Criterion t*" with significance thresholds of 0.76% and 0.00% respectively, below the maximum limit of 5% (Table 4). Under these conditions, the independent (exogenous) variable, the gross domestic product ensures a significant influence on the final consumption of energy used, renewable and biofuels;

- the econometric model shows, by the size of the regression coefficient „*b*", that an increase by one unit (one million US dollars) of the value of the gross domestic product increases the final consumption of energy used, renewable and biofuels by 0.004287 units (thousand tons of oil equivalent);

- the „*Durbin-Watson statistical coefficient*" ($DW$ = 1.848242) has a size that is in the range 1.469 <1.848242 <4 - 1.469 = 2.531 and we can appreciate with sufficient confidence that the variants of the error term do not autocorrelate, this being a complementary condition to confirm the viability of the regression equation, the model has a correct construction. The conclusion is attested based on the Durbin-Watson distribution for a significance threshold, $q$ = 5%, the number of exogenous variables, $k$ ,= 1 and the number of observations, $n$ = 27 by taking into account the inequality $d_2 < DW < 4 - d_2$;

- the relative expression of the standard error estimate of the regression equation,

$$\hat{V}_{y,\hat{y}} = (1{,}858.682 / 3{,}768.408) \cdot 100 = 49.3227\%$$

provides information that does not support the viability of the model (regression equation) for an extrapolation calculation because it is larger than the acceptable limit of 10%;

- a statistical significance similar to that presented by the estimation of the relative standard error of the regression equation is obtained by calculating and interpreting „*Theil Inequality Coefficient*" (*Th* = 15.9134%). This coefficient can be between zero and one (100) and is considered to be a very good size to assess the viability of the model when it does not exceed the 5% limit;

- the statistical description of the error term series is made by the asymmetry coefficient (Skewness = 0.933389), the vault-flattening coefficient (Kurtosis = 3.796657), the Jarque-Bera statistical coefficient (*J-B* = 4.634458), which follows the distribution law $\chi^2$ with 2 degrees of freedom, and the probability related to the *J-B* coefficient (9.8546%). This information underlies the rejection of the assumption of the error term values according to the law of normal distribution (*conclusion provided by the normality test of the residual variable distribution*), because the probability associated with the *J-B* coefficient is less than the critical limit of 60%. In this situation, the non-confirmation of the hypothesis of normality of the error term distribution, the quality of the parameters of the regression equation to be of maximum probability as well as the calculation of the confidence intervals is obviously affected;

- the heteroscedasticity error test confirms the homoscedasticity property of the final consumption model of energy used, renewable and biofuels, according to the gross domestic product, based on the two statistical criteria applied, „*Criterion F"* and „*Criterion* $\chi^2$ " respectively on the equation of auxiliary regression of the square of the residual levels according to the gross domestic product. Under these conditions, the following assessments can be made:

- the dispersion of errors is constant;

- the application of "*Criterion t*" to verify the significance of the parameters of the regression equation provides fully conclusive statistical information

The size of the final consumption of energy used, renewable and biofuels depending on the size of the gross domestic product is a legitimacy that has been confirmed econometrically as a linear unifactorial model but must be supported both by policy decisions (Mina-Raiu et al., 2021) and by implementing sustainable economic measures to achieve outstanding results, quantified by high efficiency in order to reach the standards of good governance (Raiu, 2015). Achieving this goal is possible only through the simultaneous action of all EU Member States - 27, individually but also through the implementation of coordinated mutual support programs (Mina-

Raiu, 2014), as a necessary and rapid response to environmental degradation, the phenomenon of global warming through pollution.

The results obtained in this field have a transitory value and the support of the final consumption of energy used, renewable and biofuels through the economic development of all the states must be continued with an intensity inscribed on an ascending trend. A decisive role is played by scientific research with an indisputable contribution to the development and improvement of technological solutions with a support inscribed both in the national budgets and in the Union budget.

Gradually reducing the level of pollution and ensuring the health of the living environment is the beneficial solution to the prosperity of all nations.

**Selective Bibliography**


1. **Andrei, T., Bourbonais, R.** (2008) - „*Econometrics*", Economic Publishing House, Bucharest.
2. **Anghel, M.G.** (2014) - "*Econometric Model Applied in the Analysis of the Correlation between Some of the Macroeconomic Variables*", Romanian Statistical Review - Supplement / Nr. 1/2014, pp. 88–94, Bucharest.
3. **Anghelache, C., Anghel, M.G., Manole, A**. (2015) - "*Economic, financial-banking and informatics modeling"*, Artifex Publishing House, Bucharest.
4. **Mihăilescu, N.** (2021) - „*Statistics and Statistical Basics of Econometrics*", Transversal Publishing House, Bucharest.
5. **Mihăilescu, N.** (2019) - „*Analysis of economic-financial activity - Research methodologies, case studies solved to substantiate economic-financial decisions and knowledge tests*", Transversal Publishing House, Bucharest.
6. **Mihăilescu, N., Căpăţînă, C.** (2018) - „*The reversible impact of the dynamics of the gross domestic product with the imports and exports of goods and services of Romania*", Romanian Statistical Review - Supplement / Nr. 11 and No. 12/2018, Bucharest.
7. **Mina-Raiu, L.** (2014) – "*Public-private partnership impact on local economic development. evidence from Romanian counties*", Economic Sociology, Human Resource Management and Organizational Dynamics, pp. 211-229, Editura ASE, București.
8. **Mina-Raiu, Laura, Bucura, Isabelle-Alexandra, Raiu, Cătălin Valentin** (2021), "*Transposing good practices in the field of Quality Management in Japan, within Romanian Public Administration*", Romanian Statistical Review, nr. 2/2021, ISSN/ eISSN: 1018-046X / 1844-7694, pp. 62-74.
9. **Raiu, Cătălin-Valentin** (2015), „*An Ontology of Good Governance. A Political Theory Approach*." Romanian Journal of Economics 40, no. 1 (49) (2015): 128-143.
10. **Pagliacci, M., Anghelache, G.V., Poca**n, **I.M., Marinescu, R.T., Manole, A.** (2011) - "*Multiple Regression - Method of Financial Performance Evaluation"*, ART ECO - Review of Economic Studies and Research, Editura Artifex, Vol.2/ No.4/2011, Bucharest.
11. **Stancu, S., Andrei, T., Iacob, A.I., Tușa, E.** (2008) - „*Introduction to econometrics using EViews*", Economic Publishing House, Bucharest.