ORIGINAL PAPER

STATISTICAL ANALYSIS OF THE ECONOMETRIC INDICATORS IN THE FIELD OF TAX ADMINISTRATION IN SEVEN STATES OF EUROPEAN UNION

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Abstract. *The mathematical analysis presented in this study identifies models of the dynamics of total tax collections and social contributions per inhabitant according to the gross domestic product per inhabitant from 2009 to 2018 for seven states in Eastern Europe by linear regression equations. The models are statistically confirmed as viable models because the required conditions for formulating this assessment are met. This study has the value and usefulness of preventive information for the correction and substantiation of individual governmental and community decisions, in order to homogenize both from the point of view of the fiscal behavior of each state and the point of view of economic development, in correlation with a financial and budgetary policy to maintain macroeconomic balances and economic stability.*

Keywords: *total tax collections and social contributions per inhabitant; gross domestic product per inhabitant; econometric model; the regression equation.*

1. INTRODUCTION

Taxes are the obligatory fees paid by individuals or companies to the government [1]. Taxation has the raise to increase public revenues, in order to stabilize the economy, to exceed spending and contribute to the economic growth of each state [2]. The total receipts from taxes and social contributions per inhabitant give the measure of the functional performance of the tax administration but also of the economic potential of which each inhabitant is capable [3]. The economic and financial power of the individual, in general, is conventionally represented by the gross domestic product per inhabitant and constitutes the defining variable that can explain or influence the size of the income tax and social contributions per inhabitant, as sources of forming the centralized funds of the individual state.

It is thus mentioned that the sum of the total receipts from taxes and social contributions per inhabitant is determined first of all by the size of the gross domestic product that returns to an inhabitant [4], and from the point of view of the coordinates adopted regarding the government is determined by the normative taxation policy and respectively of

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calculating social contributions [5] and not least of the level of fiscal evasion[6], of the power of administrative and legal actions to limit the functioning of the economy that is avoided from fulfilling the legal obligations[7]. Many studies on taxes and social contribution have focused on the decision of individuals to declare the income generating these taxes [6,8] and on the motivation to pay these taxes [9-11]. The fiscal literature mentions several factors, both economic and social, regarding the non-payment of taxes and duties, among which we mention the fines for non-payment [12], the tax burden [13], the age and the type of taxpayers [14].

This research has a different aim, the dynamics analysis of the total collections of taxes and social contributions per inhabitant will be carried out in interdependence with the dynamics of the gross domestic product per inhabitant and will be structured on customized studies at the level of the seven states of the European Union geographically positioned in the east of Europe: Romania, Poland, Greece, Bulgaria, Slovenia, Slovakia, and Hungary, considered to have historical, economic and political features that ensure a certain homogeneity, based on the statistical information provided by Eurostat. The sum of the total receipts from taxes and social contributions per inhabitant has, in general, a level customized to each state of the European Union and is positioned on a trajectory with strong historical, traditional valences, which manifested with a certain constancy disturbed only by events that they have caused major changes in the economic situation such as war, natural calamity, economic crisis, widespread pandemic, revolution or coup.

Public finances and the macroeconomic analysis of fiscal policies emphasize the theoretical importance of taxation as a determining factor in economic decision-making. The benefits of macroeconomic modeling in the collection of taxes and social security contributions are important in light of important ongoing political debates on the implications of significant fiscal policy changes ~ such as fiscal harmonization and fiscal convergence in the European Union [15].

The results and the conclusions of appreciation regarding the performance of the tax administrations in the respective states will be an argumentative support to specify their comparative position, the level of collecting taxes and social contributions per inhabitant as well as the mathematical expression of the statistical legality for their dynamics from 2009 - 2018 according to the dynamics of the gross domestic product per inhabitant.

2. MATERIALS AND METHODS

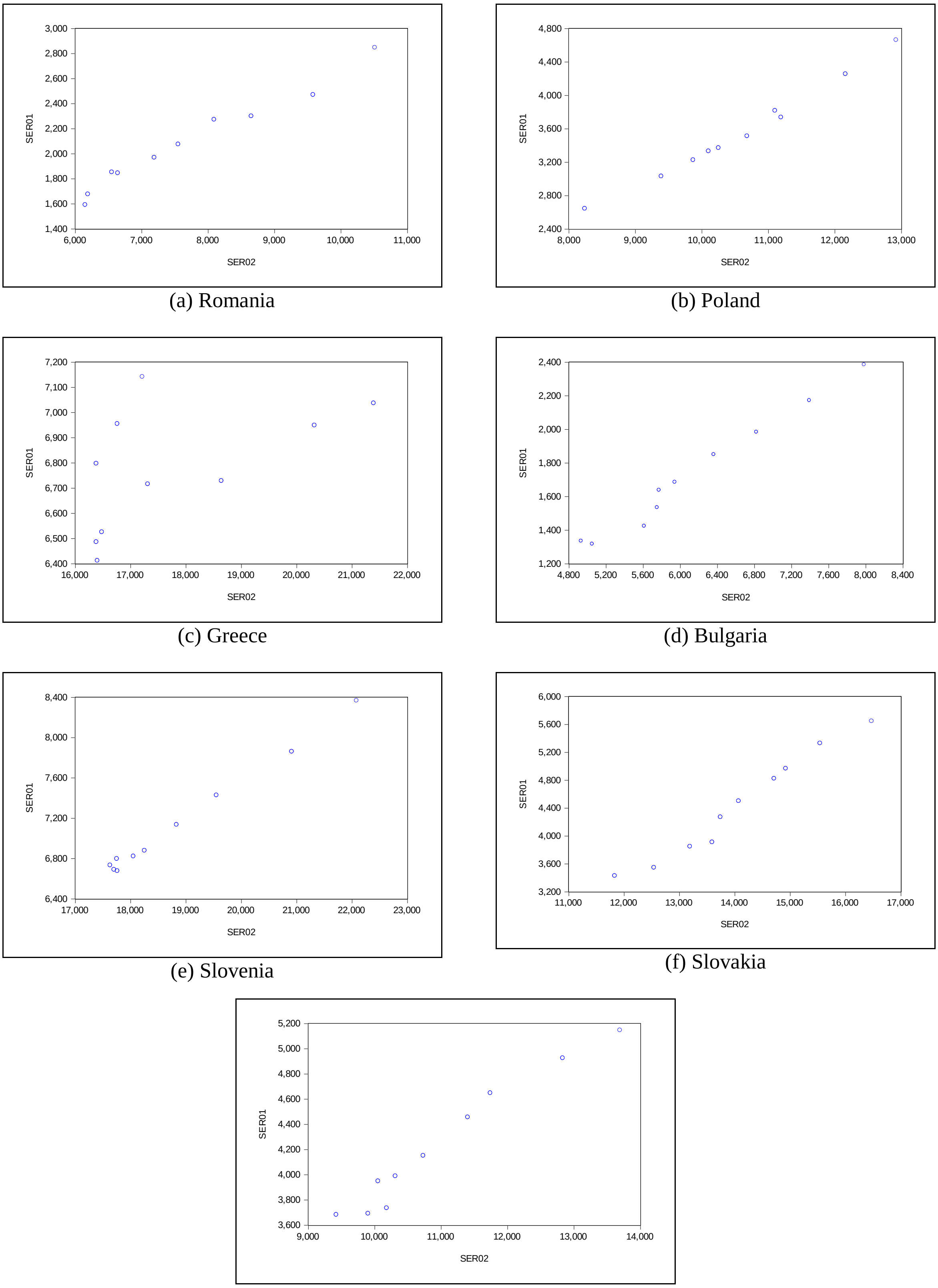
From a methodological point of view, the analysis respects the consecrated stages of the econometric modeling based on which a regression equation will be defined as a mathematical form of the interdependence of the indicator in the field of tax administration (the sum of the total tax receipts and social contributions per inhabitant) with an independent or exogenous variable, the gross domestic product per inhabitant for each of the seven states included in the research, concerning to the period 2009 - 2018, with the following procedural structure: a. Mathematical definition of econometric models; b. Calculation of the econometric representation indicators; c. Certification of the significance of the econometric representation indicators; d. Conclusions regarding the validation of the models; e. Estimates regarding the forecasts under the conditions of possible scenarios for estimating the level of the endogenous variable in the following time segments.

The data needed to carry out the proposed comparative study are presented in Table 1 and the representation of the graphical dynamic to the total amount of taxes and social contributions per inhabitant, according to the dynamics of the gross domestic product per inhabitant, in the seven states analyzed are presented in Fig. 1.

Table 1. Sum of total tax receipts and social contributions1) per inhabitant (euro) and gross domestic product per inhabitant (euro) in the seven state analised: Romania, Poland, Greece, Bulgaria, Slovenia, Slovakia, and Hungary - from the period 2009 – 2018.

The year	The total amount of taxes and social contributions per inhabitant (euro) $ser01 = y$							Gross domestic product per inhabitant - market prices - (euro) $ser02 = x$						
	Romania	Poland	Greece	Bulgaria	Slovenia	Slovakia	Hungary	Romania	Poland	Greece	Bulgaria	Slovenia	Slovakia	Hungary
2009	1,592.85	2,645.04	7,037.31	1,336.03	6,677.76	3,430.70	3,683.22	6,150	8,240	21,390	4,930	17,760	11,830	9,420
2010	1,677.49	3,032.97	6,949.44	1,318.05	6,798.25	3,548.82	3,692.70	6,190	9,390	20,320	5,050	17,750	12,540	9,900
2011	1,853.65	3,227.49	6,729.04	1,424.94	6,822.90	3,851.48	3,736.06	6,550	9,870	18,640	5,610	18,050	13,190	10,180
2012	1,845.92	3,333.00	6,716.28	1,535.25	6,734.66	3,913.92	3,949.65	6,640	10,100	17,310	5,750	17,630	13,590	10,050
2013	1,970.06	3,372.25	6,526.08	1,638.68	6,690.60	4,273.14	3,989.97	7,190	10,250	16,480	5,770	17,700	13,740	10,310
2014	2,076.25	3,513.72	6,412.40	1,686.96	6,880.25	4,502.40	4,152.51	7,550	10,680	16,400	5,940	18,250	14,070	10,730
2015	2,273.29	3,737.46	6,486.48	1,850.76	7,136.57	4,824.88	4,457.40	8,090	11,190	16,380	6,360	18,830	14,710	11,400
2016	2,300.90	3,818.40	6,797.70	1,984.62	7,429.00	4,968.36	4,649.04	8,650	11,100	16,380	6,820	19,550	14,920	11,740
2017	2,471.64	4,256.00	6,955.40	2,172.66	7,862.16	5,330.22	4,926.72	9,580	12,160	16,760	7,390	20,910	15,540	12,830
2018	2,848.21	4,664.12	7,142.15	2,386.02	8,368.32	5,649.21	5,147.44	10,510	12,920	17,210	7,980	22,080	16,470	13,690

Data source: http://ec.europa.eu/eurostat and data processed by the author
Note: 1) refers to "The sum of the total receipts from taxes and social contributions", after deduction of the established amounts, but unlikely to be collected, according to the specification formulated by Eurostat.



(a) Romania (b) Poland

(c) Greece (d) Bulgaria

(e) Slovenia (f) Slovakia

(g) Hungary

Figure 1. Graphical representation of the dynamics of the total amount of taxes and social contributions per inhabitant (euro) -ser01, according to the dynamics of the gross domestic product per inhabitant (euro) -ser02, in the seven state analised: Romania, Poland, Greece, Bulgaria, Slovenia, Slovakia, and Hungary Romania - from the period 2009 – 2018.

3. RESULTS AND DISCUSSION

3.1. DEFINING MODELS, CALCULATING ECONOMETRIC REPRESENTATION INDICATORS AND COMMENTS

The statistical situation of the seven states of Eastern Europe (Romania, Poland, Greece, Bulgaria, Slovenia, Slovakia, and Hungary) included in the research, regarding the period 2009-2018, regarding the total collections of taxes and social contributions per inhabitant and the gross domestic product per inhabitant is shown in Table 2 and highlights the following aspects:

Table 2. The indicators of general statistical representation of the seven states of Europe regarding the total collections of taxes and social contributions per inhabitant and the gross domestic product per inhabitant, from the period 2009 – 2018

Statistical indicators	**Total receipts from taxes and social contributions per inhabitant (euro)**	**Gross domestic product per inhabitant - market prices - (euro)**
Annual average (simple arithmetic mean)	**4,281.075**	**12,303.29**
Median	3,931.785	11,570.00
Maximum value: x_{max}	8,368.320 (Slovenia in 2018)	22,080.00 (Slovenia in 2018)
Minimum value: x_{min}	1,318.050 (Bulgaria in 2010)	4,930.00 (Bulgaria in 2009)
Absolute amplitude of the variation: $A = x_{max} - x_{min}$	7,050.270	17,150.00
The relative amplitude of the variation (relative to the average value)	164.68%	139.39%
Standard deviation estimate (E.A.S.)	2,011.163	4,690.589
Coefficient of variation (*V*): $V = (E.A.S./Mean) * 100$ - The panel is not homogeneous for the point of view of the two variables considered as a criterion of appreciation	**46.98%**	**38.12%**
Jarque-Bera	4.831730	3.844585
Prob. *J-B*	8.929%	14.627%
- the variables are not distributed asymptotically normal -		
Number of observations	**70**	**70**

The panel of 7 states, to which we refer, is not homogeneous from the point of view of the two variables considered, considering the coefficients of variation recorded, 46.98% and 38.12%. The size of this indicator of variation is above a level considered reasonable by 30% and warns of the existence of important discrepancies between these 7 states.

Slovenia has the highest levels in 2018, both in terms of the total amount of taxes and social contributions per inhabitant and for the gross domestic product per inhabitant expressed in market prices, 8,368.320 euros, and 22,080.00 respectively euros.

Bulgaria records, for the two variables, in 2010 (1,318.050 euros total receipts from taxes and social contributions) and 2009 (4,930.00 euros gross domestic product per inhabitant), the lowest levels.

The absolute difference between the maximum and the minimum value is 7,050,270 euros for the total collection of taxes and social contributions per inhabitant and 17,150.00 euros for the gross domestic product per inhabitant.

For the point of view of the total receipts from taxes and social contributions per inhabitant, each state deviates on average from the average value, plus or minus, with 2,011.163 euros and for the point of view of the gross domestic product on 4,690.589 euros per inhabitant, giving the measure of essential differences between states.

Romania, with an annual average amount of total tax and social contributions per inhabitant of 2,091.026 euros, is lower by 2,190.049 euros compared to the general average of the seven states, of 4,281.075 euros, registered in period 2009 - 2018.

The gross domestic product per inhabitant of Romania in 2018 was 10,510.00 euros, lower than the average level of the seven states included in the research by 1,793.29 euros.

The mathematical form of the econometric model of the total income from taxes and social contributions per inhabitant, according to the gross domestic product per inhabitant, for each state, can be decided after analyzing the graphical representations that give the form of the correlation between the variables of the system under study (Figure 1- a, b, d, e, f, and g). The way the "point cloud" is distributed in the graph gives sufficiently convincing information about the type of interdependence of the two variables. Under these conditions, a simple linear regression equation is chosen which has the general form of representing the real levels: $y = a + b * x + u$, where y is the endogenous variable (dependent) - the total income from taxes and social contributions per inhabitant, x is the exogenous variable (independent) - the gross domestic product per inhabitant, and u is the residual variable. The parameters of the regression equation are estimated using the least squares method. Mathematical models based on the simple regression equation were used in interpreting the relationships between e-commerce and influencing factors [16, 17], in evaluating employee performance [18], companies financial performance [19] or to identify the correlations between the number of employees and the financial performance indicators [20].

An individual situation considered as an exception is identified in the case of Greece, for which a model has not been outlined that can be appreciated as expressing certain statistical legality. Greece is facing, during the period under analysis, a disorderly state in the behavior of the tax administration; the dynamics of the total tax collections and social contributions per inhabitant does not unfold according to the dynamics of the gross domestic product per inhabitant. After 2015, however, there are some indications of overcoming the state marked by macroeconomic imbalances.

The way "the point cloud" is plotted in the graph (Figure 1.c) does not provide sufficiently convincing information about the form of the interdependence of the two variables. In these conditions, four variants of models (linear, parabolic, third-degree polynomial and hyperbolic) have been elaborated and by exclusion one can opt for a simple hyperbolic regression equation, as an approximate form of information, which gives a general representation of the real levels: $y = a + b * (1/x) + u$, where y is the endogenous variable (dependent) - the total income from taxes and social contributions per inhabitant, x is the exogenous variable (independent) - the gross domestic product per inhabitant, and u is the residual variable. In all four models, the correlation ratio is not significantly different from zero, based on "Criterion F" following a Fisher distribution law. Thus it is not confirmed, statistically, that a real correlation is formed between those two variables.

The support of the choice of the hyperbolic model has a theoretical content of priority representation of the evolution of the next years because, for a longer time, it can be justified that the evolution will have a normal linear growth configuration. These assessments are outlined in the last three years of the analyzed period.

Also, it can be considered that the analysis carried out is based on a volume of observations located at a relatively low level (n = 10), which may affect the safety and significance of the assessments but, nevertheless, provide useful informational support for a comparative image. The econometric models for the states included in the research and the econometric representation indicators are presented in Tables 3-4.

Table 3. Comparative synoptic table of the indicators of econometric representation regarding the unifactorial model of the total receipts from taxes and social contributions per inhabitant (y) according to the gross domestic product per inhabitant (x)

Indicators of econometric representation	Romania	Poland	Greece
The econometric model The regression equation of the estimated levels of the endogenous variable (ŷ) as a function of the exogenous variable (x)	Unifactorial linear $\hat{y} = a + b * x$	Unifactorial linear $\hat{y} = a + b * x$	
Model estimators "a" Probability (significance threshold) % "b" Probability (significance threshold) %	111.9188 36.37% 0.256694 0.00%	-1,033.973 0.04% 0.433807 0.00%	No viable econometric model is identified. A larger number of observations is required
Period subject to analysis:	2009 – 2018, (n = 10)	2009 – 2018, (n = 10)	2009 – 2018, (n = 10)
Correlation report: $R = \sqrt{R^2}$	0.986916	0.99394	
Coefficient of determination: R^2 (%)	97.4003%	98.7917%	
Durbin-Watson coefficient Range of acceptance of the residual non-correlation hypothesis, based on the Durbin-Watson distribution: $1001 < DW < 2999$, for $q = 1\%$; n =10; k` = 1 $1320 < DW < 2680$, for $q = 5\%$; n =10; k` = 1	1.557644	0.963430	
Theil inequality coefficient (%)	1.3934%	0.8515%	
Estimation of the average error of the regression equation - the absolute expression: (euro), $\hat{\sigma}_{y*\hat{y}}$	± 66.13384	± 68.60413	
Estimation of the average error of the regression equation - relative expression (%): $\hat{V}_{y*\hat{y}} = \frac{\hat{\sigma}_{y*\hat{y}}}{\bar{y}} * 100$	3.16275%	1.9271%	
Jarque-Bera Probability J-B (%). Based on the distribution X^2 for 2 degrees of freedom	0.741004 69.0388%	0.496261 78.0258%	
F-statistic	299.7334	654.0924	
F-theoretical: $F_{p=0.95}$; $f_1 = k - 1$; $f_2 = n - k$; k = 2; n = 10	5.32	5.32	
Probability (F-statistic) (%)	0.00%	0.00%	
Heteroskedasticity Test: White	Homoskedastic model	Homoskedastic model	
Number of observations (n)	10	10	10
Proportion of total receipts from taxes and social contributions in gross domestic product (%), in 2018	27.1%	36.1%	41.5%
Gross domestic product per inhabitant (euro), in 2018	10,510[p]	12,920	17,210

Note: p = predicted

Table 4. Comparative synoptic table of the indicators of econometric representation regarding the unifactorial model of the total receipts from taxes and social contributions per inhabitant (y) according to the gross domestic product per inhabitant (x)

Indicators of econometric representation	Bulgaria	Slovenia	Slovakia	Hungary
The econometric model The regression equation of the estimated levels of the endogenous variable (ŷ) as a function of the exogenous variable (x)	Unifactorial linear $\hat{y} = a + b * x$	Unifactorial linear $\hat{y} = a + b * x$	Unifactorial linear $\hat{y} = a + b * x$	Unifactorial linear $\hat{y} = a + b * x$
Model estimators "a" Probability (significance threshold) % "b" Probability (significance threshold) %	-503,3332 0,20% 0,363106 0,00%	121,9353 52,12% 0,372294 0,00%	-3.076,306 0,02% 0,533828 0,00%	80,94155 78,73% 0,377100 0,00%
Period subject to analysis:	2009 – 2018, (n = 10)	2009 – 2018, (n = 10)	2009 – 2018, (n = 10)	2009 – 2018, (n = 10)
Correlation report: $R = \sqrt{R^2}$	0.99039	0.99734	0.98486	0.98133
Coefficient of determination: R^2 (%)	98.0877%	99.4694%	96.9959	0.963012
Durbin-Watson coefficient Range of acceptance of the residual non-correlation hypothesis, based on the Durbin-Watson distribution: $1001 < DW < 2999$, for $q = 1\%$; n =10; k` = 1 $1320 < DW < 2680$, for $q = 5\%$; n =10; k` = 1	1.233758	2.869586	1.340972	1.506868
Theil inequality coefficient (%)	1.3398%	0.2776%	1.3861%	1.1328%
Estimation of the average error of the regression equation - the absolute expression: (euro), $\hat{\sigma}_{y*\hat{y}}$	± 52.92293	± 44.44590	± 139.0446	± 108.1023
Estimation of the average error of the regression equation - relative expression (%): $\hat{V}_{y*\hat{y}} = \frac{\hat{\sigma}_{y*\hat{y}}}{\bar{y}} * 100$	3.0531%	0.62245%	3.1392%	2.5505%
Jarque-Bera Probability J-B (%). Based on the distribution X^2 for 2 degrees of freedom	1.677171 43.2322%	0.719216 69.7950%	0.586147 74.5967%	0.774644 67.8872%
F-statistic	410.3411	1,499.797	258.3048	208.2872
F-theoretical: $F_{p=0.95}$; $f_1 = k - 1$; $f_2 = n - k$; k = 2; n = 10	5.32	5.32	5.32	5.32
Probability (F-statistic) (%)	0.00%	0.00%	0.00%	0.00%
Heteroskedasticity Test: White	Homoskedastic model	Homoskedastic model	Homoskedastic model	Homoskedastic model
Number of observations (n)	10	10	10	10
Proportion of total receipts from taxes and social contributions in gross domestic product (%), in 2018	29.9%	37.9%	34.3%	37.6%
Gross domestic product per inhabitant (euro), in 2018	7,980	22,080	16,470	13,690

Note: p = predicted

3.2. RESULTS ABOUT THE SIGNIFICANCE OF THE REPRESENTATION INDICATORS ECONOMETRICS AND MODEL VALIDATION

The study of the interdependence of the dynamics of the total tax receipts and social contributions per inhabitant with the dynamics of the gross domestic product per inhabitant, customized in 7 states of the European Union, highlights both common aspects regarding the performance of the tax administrations and results of some realities that differentiate them.

The analysis methodology used as support for obtaining distinct econometric representations related to the seven territorial components has argumentative and safe support considering the palette of judgments on which the mathematical construction of each model is implemented, on the outline of the degree of viability of the model based on a system criteria for verifying statistical hypotheses based on probability theory and mathematical statistics respectively.

Econometric models are represented by unifactorial regression equations in which the endogenous variable considered, the total tax collections and social contributions per inhabitant, is dependent on the exogenous variable, the gross domestic product per inhabitant, which expresses the level of development of each of the 7 states of the European Union.

The results obtained and formalized in sizes of the econometric representation indicators offer the possibility to formulate argumentative and specific conclusions that can define the quality of each model.

Tables 3 and Table 4 expose for the seven states of the European Union the comparative results that define and ensure the viability of the unifactorial models of the dynamics of the total collections of taxes and social contributions per inhabitant according to the dynamics of the gross domestic product per inhabitant, elaborated based on the observations regarding the period 2009- 2018. The detailed form of the econometric representation indicators in Tables 3 and 4 offers the possibility to outline aspects of approximation or differentiation of the seven territorial components, through the following statistical specifications:

(i).The mathematical form of the econometric model is in all cases, the simple linear regression equation;

(ii). The estimator of the parameter "b" (the regression coefficient) dimension, by its size, the speed with which the total collections of taxes and social contributions per inhabitant have changed on the increase of the gross domestic product per inhabitant by 1 euro, during the period 2009-2018. The 6 states to which the analysis refers (Greece being excluded) are grouped as follows: Slovakia (0.533828 euros) and Poland (0.433807 euros); Slovenia (0.372294 euros), Bulgaria (0.363106 euros) and Hungary (0.377100 euros); Romania: 0.256694 euros. From this comparison results the statistical finding that Romania registers the lowest average increase of the total income from taxes and social contributions per inhabitant as a result of the increase of the gross domestic product per inhabitant, of the 6 countries we refer to. Slovakia and Poland have the highest level of record, 2.08 times, and 1.69 times respectively Romania's level. Slovenia, Bulgaria, and Hungary have close values at 0.363 - 0.377 euros. The information regarding the situation of the increase of the total receipts from taxes and social contributions per inhabitant by increasing the gross domestic product per inhabitant significantly differentiates the three groups of states, which will be reflected in the mass of the financial resources of the state budget and the possibilities of respectively financing of the planned objectives.

(iii). The calculations made for the attestation of the viability of the econometric models for the 6 states of Eastern Europe confirm that between the two variables that give the mathematical form of the regression equations, there is a powerful correlation in terms of correlation ratios that exceed an appreciation threshold of 0, 98, with a further statistical attestation in favor of the model representing Slovenia, (0.99734). These results induce the appreciation that the econometric models are statistically supported as viable representations of the reality of the system interdependent with the variables considered;

(iv). The characterization of the viability of each econometric model in terms of the results offered by the testing of the residual variable is distinctly supported, as follows: The "Jarque-Bera statistical coefficient" based on which the distribution of the residual variable is tested if it is asymptotic with the normal-normal theoretical distribution leads to the following findings: in the models of Romania, Poland, Slovenia, Slovakia and Hungary the residuals follow a normal distribution. Probability of over 60% while in the Bulgarian model it is not statistically confirmed that the residues follow a normal distribution, the probability associated with the "Jarque-Bera statistical coefficient" is lower than the 60% threshold (according to the law of distribution it has been squared with two degrees of freedom). Taking into account the results of these tests the linear model developed for Bulgaria is vulnerable, the quality of the estimators of the regression equation parameters to be of maximum likelihood is affected, and a calculation of forecast through confidence intervals can record a certain distortion compared to a real result; The size of the "Durbin-Watson statistical coefficient" is positioned outside the acceptance range and does not confirm that the variants of the residual variable are not autocorrelated only in the case of the Polish model. The autocorrelation state of the errors induces the appreciation that the correlation ratio and the coefficient of determination respectively, are relatively higher than in the case of this model. The models that formalize the situation of Romania, Slovakia, and Hungary are statistically confirmed as viable. From this point of view, the residual variable is not marked by a state of autocorrelation.

A particular situation is found for Bulgaria and Slovenia where testing offered the solution of indecision; The elaborated models are homoscedastic and by virtue of this statistical finding, the dispersion of errors is constant. The estimators of the parameters have accuracy and efficiency that ensures the viability necessary for an extrapolation calculation; Regarding the safety of the calculation of estimated estimates of the total tax collections and social contributions per inhabitant according to the gross domestic product per inhabitant, statistical information comparable between the analyzed territorial components is retained, thus: "Theil inequality coefficient " and "Estimation of the average error of the regression equation" in the relative expression, calculated for all six econometric models, support by their percentage size less than 5%, the certainty of a prediction calculation by extrapolating the simple linear regression equations.

(v). The proportion of the total receipts from taxes and social contributions in the gross domestic product, expressed as a percentage, in 2018, highlights the level of efficiency of the process of collecting the revenues of the national state budget in the seven states included in the research, which confirms the existence of significant discrepancies, so: Greece with 41.5% has the highest proportion in the context of the macroeconomic difficulties and imbalances they face and their efforts to mitigate them. According to the data published by EUROSTAT, at the end of 2018, the level of governmental government debt in the gross domestic product is the highest in the European Union (28 states), 181.1%; Poland, Slovenia, Slovakia, and Hungary have comparable proportions between 34.3% (Slovakia) and 37.9% (Slovenia); Romania with 27.1% and Bulgaria with 29.9% have the lowest levels, being exceeded as a low level, only by Ireland which has a proportion of 23.0%, taking into account the 28 EU states. Note that the general ratio registered for 2018 in the 28 EU states is 40.3%.

3.3. ESTIMATES REGARDING THE FORECASTS UNDER THE CONDITIONS OF POSSIBLE SCENARIOS FOR ESTIMATING THE LEVEL OF TOTAL TAX COLLECTIONS AND SOCIAL CONTRIBUTIONS PER INHABITANT IN THE FOLLOWING TIME SEGMENTS

There is sufficient statistical information to consider that the presented results and the elaborated models respectively have adequate and entirely acceptable support to be used as a basis for calculating punctual forecast levels or confidence intervals, guaranteed with a high probability, based on the Student distribution law.

It is mentioned that a fully reliable forecast must be based on a model confirmed as valid [21]in the light of all the fundamental assumptions: hypothesis of confirmation of the form of the regression equation; the hypotheses concerning the significance of the coefficients of the regression equation and the correlation ratio of the total tax collections and social contributions per inhabitant according to the gross domestic product per inhabitant; the hypotheses targeting the error term in the sense that they are independent (not autocorrelated), are normally distributed and are homoscedastic [22-24].

Under the potential increases of the gross domestic product per inhabitant (x), an estimation of the total income from taxes and social contributions per inhabitant for the years 2019 and 2020 can be estimated by extrapolating the linear unifactorial models that have been elaborated:

Romania: $\hat{y} = a + b * x \rightarrow \hat{y} = 1119.9188 + 0.256694 * x$
Poland: $\hat{y} = a + b * x \rightarrow \hat{y} = -1033.973 + 0.433807 * x$
Greece: -
Bulgaria: $\hat{y} = a + b * x \rightarrow \hat{y} = -503.3332 + 0.363106 * x$
Slovenia: $\hat{y} = a + b * x \rightarrow \hat{y} = 121.9353 + 0.372294 * x$
Slovakia: $\hat{y} = a + b * x \rightarrow \hat{y} = -3076.306 + 0.533828 * x$
Hungary: $\hat{y} = a + b * x \rightarrow \hat{y} = 80.94155 + 0.377100 * x$

Estimated values for total taxes and social contributions can be considered as rigorous information to be used in an interdependent process of works required to finalize the project of the state budget in relation to the budgetary expenses related to the objectives set by the government programs [25-27].

3.4. DEFINITION OF THE ECONOMETRIC MODEL WITH PANEL DATA

In order to extend the content of the study, it was also decided to elaborate a general model of the seven states of Eastern Europe, which is in the form of a panel data model.

Meeting the objective of analyzing the system of variables taken into account: the total tax collections and social contributions per inhabitant as an endogenous variable ("y") and the gross domestic product per inhabitant as an exogenous variable ("x"), for seven states and 10 years (2009 - 2018) is based on the data presented in Table 5 in which the dummy variables related to the components of space and time are entered.

Table 5. The panel data system on total tax and social contributions receipts per inhabitant (y) and gross domestic product per inhabitant (x) - 7 states and 10 years

		y	x	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D_{10}	D_{11}	D_{12}	D_{13}	D_{14}	D_{15}	D_{16}	D_{17}
Romania	1 - 09	1592.85	6150	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	1 - 10	1677.49	6190	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	1 - 11	1853.65	6550	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	1 - 12	1845.92	6640	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	1 - 13	1970.06	7190	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	1 - 14	2076.25	7550	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	1 - 15	2273.29	8090	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	1 - 16	2300.90	8650	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	1 - 17	2471.64	9580	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	1 - 18	2848.21	10510	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Poland	2 -09	2645.04	8240	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	2 - 10	3032.97	9390	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	2 - 11	3227.49	9870	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	2 - 12	3333.00	10100	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	2 - 13	3372.25	10250	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	2 - 14	3513.72	10680	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	2 - 15	3737.46	11190	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	2 - 16	3818.40	11100	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	2 - 17	4256.00	12160	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	2 - 18	4664.12	12920	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Greece	3 - 09	7037.31	21390	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	3 - 10	6949.44	20320	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	3 - 11	6729.04	18640	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	3 - 12	6716.28	17310	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	3 - 13	6526.08	16480	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	3 - 14	6412.40	16400	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	3 - 15	6486.48	16380	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	3 - 16	6797.70	16380	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	3 - 17	6955.40	16760	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	3 - 18	7142.15	17210	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Bulgaria	4 - 09	1336.03	4930	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
	4 - 10	1318.05	5050	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
	4 - 11	1424.94	5610	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
	4 - 12	1535.25	5750	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
	4 - 13	1638.68	5770	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
	4 - 14	1686.96	5940	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0
	4 - 15	1850.76	6360	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
	4 - 16	1984.62	6820	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
	4 - 17	2172.66	7390	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
	4 - 18	2386.02	7980	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Slovenie	5 - 09	6677.76	17760	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
	5 - 10	6798.25	17750	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
	5 - 11	6822.90	18050	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
	5 - 12	6734.66	17630	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
	5 - 13	6690.60	17700	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
	5 - 14	6880.25	18250	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
	5 - 15	7136.57	18830	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
	5 - 16	7429.00	19550	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
	5 - 17	7862.16	20910	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
	5 - 18	8368.32	22080	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Slovakia	6 - 09	3430.70	11830	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
	6 - 10	3548.82	12540	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
	6 - 11	3851.48	13190	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
	6 - 12	3913.92	13590	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
	6 - 13	4273.14	13740	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
	6 - 14	4502.40	14070	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
	6 - 15	4824.88	14710	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
	6 - 16	4968.36	14920	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
	6 - 17	5330.22	15540	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
	6 - 18	5649.21	16470	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Hungary	7 - 09	3683.22	9420	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
	7 - 10	3692.70	9900	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
	7 - 11	3736.06	10180	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
	7 - 12	3949.65	10050	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
	7 - 13	3989.97	10310	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
	7 - 14	4152.51	10730	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
	7 - 15	4457.40	11400	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
	7 - 16	4649.04	11740	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
	7 - 17	4926.72	12830	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
	7 - 18	5147.44	13690	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1

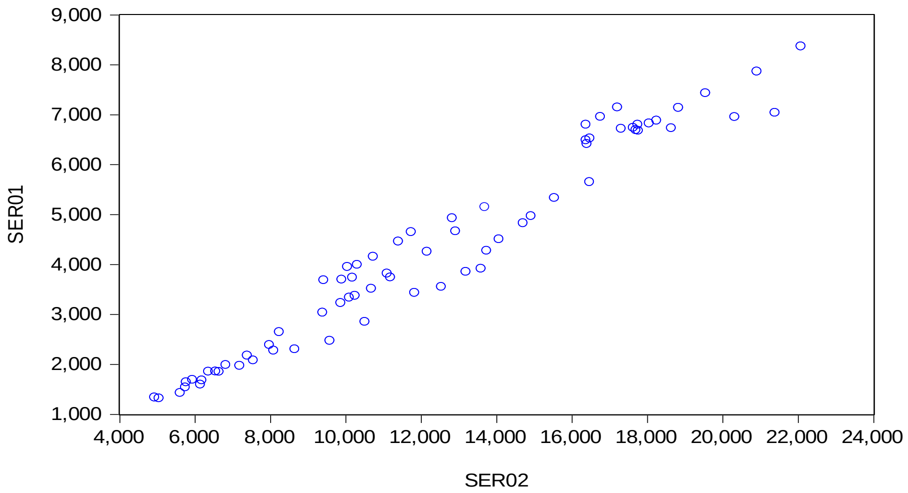


Figure 2. Graphical representation of the interdependence of the total amount of taxes and social contributions per inhabitant (SER01) with the gross domestic product per inhabitant (SER02).

In Tables 6a and 6b, the results obtained from applying the econometric modeling methodology with panel data are presented in two optional calculations.

Table 6a. Synoptic table of the econometric representation indicators (model with panel data, fixed effects specified for country and time).

Dependent Variable: $SER01 = y$Total receipts from taxes and social contributions per inhabitant (euros)

Method: Least Squares

Sample: 1 – 70; Included observations: 70

$$y = a + bx + cD_2 + dD_3 + eD_4 + fD_5 + gD_6 + hD_7 + iD_9 + jD_{10} + kD_{11} + lD_{12} + mD_{13} + nD_{14} + oD_{15} + pD_{16} + rD_{17} + ust$$

$$y = 290.9037 + 0.189969x + 921.9093D_2 + 2781.286D_3 - 63.17759D_4 + 2932.580D_5 + 1131.986D_6 + 1517.699D_7 + 49.2935D_9 + 113.2035D_{10} + 195.6160D_{11} + 247.3034D_{12} + 297.2432D_{13} + 426.9367D_{14} + 535.9723D_{15} + 662.4106D_{16} + 826.6604D_{17} + ust$$

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SER02 = x: Gross domestic product per inhabitant - market prices - (euro) „b”	0.189969	0.018077	10.50894	0.0000
SER04 = D_2 „c”	921.9093	84.09786	10.96234	0.0000
SER05 = D_3 „d”	2781.286	192.7449	14.42988	0.0000
SER06 = D_4 „e”	-63.17759	71.74353	-0.880603	0.3825
SER07 = D_5 „f”	2932.580	211.9476	13.83635	0.0000
SER08 = D_6 „g”	1131.986	132.4325	8.547644	0.0000
SER09 = D_7 „h”	1517.699	89.17985	17.01841	0.0000
SER11 = D_9 „i”	49.2935	79.02509	0.623770	0.5355
SER12 = D_{10} „j”	113.2035	79.17686	1.429754	0.1587
SER13 = D_{11} „k”	195.6160	79.01690	2.475623	0.0165
SER14 = D_{12} „l”	247.3034	79.06482	3.127856	0.0029
SER15 = D_{13} „m”	297.2432	79.57984	3.735157	0.0005
SER16 = D_{14} „n”	426.9367	81.12387	5.262776	0.0000
SER17 = D_{15} „o”	535.9723	82.61841	6.487323	0.0000
SER18 = D_{16} „p”	662.4106	88.44991	7.489105	0.0000
SER19 = D_{17} „r”	826.6604	95.97822	8.612999	0.0000
C = model constant „a”	290.9037	141.6837	2.053192	0.0450
R-squared	0.995858	Mean dependent var		4281.075
Adjusted *R*-squared	0.994608	S.D. dependent var		2011.163
S.E. of regression	147.6831	Akaike info criterion		13.03553
Sum squared resid	1155946.	Schwarz criterion		13.58159
Log likelihood	-439.2434	Hannan-Quinn criter.		13.25243
F-statistic	796.4513	Durbin-Watson stat		0.756486
Prob (*F*-statistic)	0.000000			

Note: Dummy variables D1 and D8 were excluded from the model to avoid the phenomenon of collinearity.

Table 6b. Synoptic table of the econometric representation indicators (model with panel data, fixed effects specified for country and time).

Dependent Variable: $SER01 = y$: Total receipts from taxes and social contributions per inhabitant (euros)				
Method: Least Squares				
Sample: 1- 70				
Included observations: 70				
$y = a + bx + cD_1 + dD_2 + eD_3 + fD_4 + gD_5 + hD_6 + iD_8 + jD_9 + kD_{10} + lD_{11} + mD_{12} + nD_{13} + oD_{14} + pD_{15} + rD_{16} + ust$ $y = 2635.263 + 0.189969x - 1517.699D_1 - 595.7896D_2 + 1263.587D_3 - 1580.876D_4 + 1414.881D_5 - 385.7129D_6 - 826.6604D_8 - 777.3669D_9 - 713.4569D_{10} - 631.0443D_{11} - 579.3570D_{12} - 529.4172D_{13} - 399.723D_{14} - 290.6881D_{15} - 164.2498D_{16} + ust$				
Variable	**Coefficient**	**Std. Error**	***t*-Statistic**	**Prob.**
SER02 = *x*: Gross domestic product per inhabitant - market prices - (euro) „*b*”	0.189969	0.018077	10.50894	0.0000
SER03 = D_1 „*c*”	-1517.699	89.17985	-17.01841	0.0000
SER04 = D_2 „d”	-595.7896	66.51237	-8.957576	0.0000
SER05 = D_3 „e”	1263.587	137.9843	9.157469	0.0000
SER06 = D_4 „f”	-1580.876	109.9827	-14.37386	0.0000
SER07 = D_5 „g”	1414.881	156.1272	9.062363	0.0000
SER08 = „h”	-385.7129	85.86060	-4.492315	0.0000
SER10 = D_8 „i”	-826.6604	95.97822	-8.612999	0.0000
SER11 = D_9 „*j*”	-777.3669	93.94086	-8.275067	0.0000
SER12 = D_{10} „*k*”	-713.4569	92.63388	-7.701900	0.0000
SER13 = D_{11} „*l*”	-631.0443	94.03898	-6.710455	0.0000
SER14 = D_{12} „*m*”	-579.3570	93.52315	-6.194797	0.0000
SER15 = D_{13} „*n*”	-529.4172	90.62899	-5.841588	0.0000
SER16 = D_{14} „*o*”	-399.7237	86.71796	-4.609468	0.0000
SER17 = D_{15} „*p*”	-290.6881	84.52464	-3.439093	0.0011
SER18 = D_{16} „*r*”	-164.2498	80.29588	-2.045557	0.0458
C = model constant „*a*”	2635.263	247.6335	10.64179	0.0000
R-squared	0.995858	Mean dependent var		4281.075
Adjusted *R*-squared	0.994608	S.D. dependent var		2011.163
S.E. of regression	147.6831	Akaike info criterion		13.03553
Sum squared resid	1155946.	Schwarz criterion		13.58159
Log likelihood	-439.2434	Hannan-Quinn criter.		13.25243
F-statistic	796.4513	Durbin-Watson stat		0.756486
Prob (*F*-statistic)	0.000000			

Note: Dummy variables D_7 and D_{17} were excluded from the model to avoid the phenomenon of collinearity.
Note: The estimated levels of the endogenous variable are identical to the two models from which differently positioned dummy variables were excluded. The coefficients of the two models are not similar except the coefficient "b" which has the same value, (b = 0.189969).

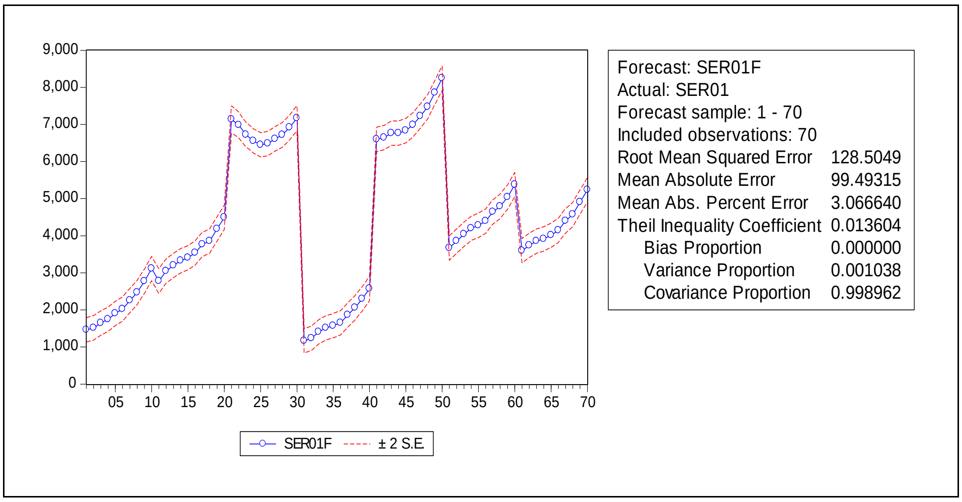


Figure 3. Graphic presentation of the estimated levels based on the econometric model with panel data.

3.5. DISCUSSION REGARDING THE PANEL DATA MODEL, FIXED EFFECTS SPECIFIED FOR COUNTRY AND TIME

a) The fixed effects model specified for the country and for the time is elaborated in two constructive variants with comparable statistical characteristics.

Model 1:

$$y = 290.9037 + 0.189969x + 921.9093D_2 + 2781.286D_3 - 63.17759D_4 + 2932.580D_5 + 1131.986D_6 + 1517.699D_7 + 49.2935D_9 + 113.2035D_{10} + 195.6160D_{11} + 247.3034D_{12} + 297.2432D_{13} + 426.9367D_{14} + 535.9723D_{15} + 662.4106D_{16} + 826.6604D_{17} + ust$$

Model 2:

$$y = 2635.263 + 0.189969x - 1517.699D_1 - 595.7896D_2 + 1263.587D_3 - 1580.876D_4 + 1414.881D_5 - 385.7129D_6 - 826.6604D_8 - 777.3669D_9 - 713.4569D_{10} - 631.0443D_{11} - 579.3570D_{12} - 529.4172D_{13} - 399.723D_{14} - 290.6881D_{15} - 164.2498D_{16} + ust$$

The econometric model with panel data highlights the dummy variables D_1 - D_7 which measure the fixed effect specified for the country and the dummy variables D_8 - D_{17} refer to the fixed effect specified for the time.

b) The model with fixed effects specified for the country and for the time gives us the information according to which it is specified that if the *gross domestic product per inhabitant* is increased by one unit (1 euro), the sum of the *total receipts from taxes and social contributions per inhabitant* increases with 0.189969 units (euros). It is also identified that between the two variables included in the model is a real direct correlation that is attested by a very strong correlation size (R = 0.997927) and significantly different from zero based on the following Criterion F a Fisher distribution law.

c) The size of parameter "*b*", (0.189969), associated with the exogenous variable (the gross domestic product per inhabitant), although it is very small, proves at the same time to be significantly different from zero based on Criterion *t*, (t-statistic>t-theoretical)).

d) The panel type model with effects specified for the country and time that has representation for 7 states in Eastern Europe (Romania, Poland, Greece, Bulgaria, Slovenia, Slovakia, and Hungary) is for the period 2009 - 2018 and has reserved statistical viability because all the conditions imposed for the residual variable are not fulfilled (Durbin-Watson criterion with an autocorrelation error conclusion, the Jarque-Bera criterion with an indecision conclusion and the Breusch-Pagan-Godfrey test with the conclusion of correlating the error with the exogenous variable).

4. CONCLUSIONS

The informational value of a model with panel data is considered very well only when the existence of an acceptable degree of homogeneity of the states that make up the panel is ascertained, considering the size of the variables included in the model. The power of the panel data model, which was developed, is deemed to be acceptable and is retained as a source of information for people who have decision-making responsibilities.

A general appreciation of the practical usefulness of this study brings into question the need for community decisions that will gradually contribute to the homogenization of the fiscal effort of the population of each state. It is obvious that this wish can only be achieved by approaching the level of development expressed by the gross domestic product per inhabitant. From this point of view, Slovenia, Greece, and Slovakia are visibly distant from the other four states of the group of seven states included in the research.

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