Romania's Public Debt Per Capita

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Abstract: The econometric analysis presented in this study identify a model of dynamics of total public debt of Romania between 2001-2015 in the mathematic expression of an autoregressive equation which is statistically confirmed as a viable model because the requirements imposed for the formulation of this assessment are met. The econometric model highlights the fact that Romania's public debt per capita will be foreseeably higher during the following years (2019 and 2020). This study has the value and utility of a preventive character information for the correction and substantiation of government decisions, in order to enclose the budget deficit in non inflationist limits, for a financial and budgetary policy which allows maintaining macroeconomic balances and economic stability of the country.

Keywords: *Romania's public debt per capita; autoregressive econometric model; (regression) trend equation.*

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1. The content of the public debt concept and support for the option of analyzing the dynamics of public debt per capita through econometric modeling

Public debt is the direct result of budget deficits that have accumulated during previous budget years and have been financed through loans. Also, public debt, through its balance, is a factor that explains, to a certain extent, the existence of subsequent budget deficits and even their growth.

Public debt is the monetary expression of existing liabilities at a given moment as a result of loans contracted by the State in its own name or guaranteed by it. It is made up of both debt to individuals and debt to legal entities in the country or abroad.

Public debt has two ways to emerge and exist:

- *domestic* public debt that refers to state-owned loans from the domestic financial market, from individuals and legal entities, which are not redeemed at any given time. It may be contracted by the state or the local public administration authorities, as well as in the form of state-guaranteed loans.

- *external* public debt comprises short, medium or long-term external loans contracted directly by the state or by local government authorities, as well as state-guaranteed external loans.

Depending on the length of time for which state loans are contracted, two forms are distinguished: a) *floating* public debt (short term - up to one year); and b) *consolidated* public debt (longer than one year - average and long-term).

The public debt of a country can be expressed in absolute value, which helps to know the value of the existing burden a country's economy is facing at a time in relation to its the creditors, in relative value as a proportion in the gross domestic product and respectively as an average per capita to allow comparisons to be made both in a dynamic and in a territorial profile.

The Ministry of Public Finance annually prepares the "General Debt Account" as annex to the Annual General Account of the State Budget, which is submitted for approval to the Parliament of Romania. The General Government Debt Account Includes the "General Government Debt Account" and the "General Domestic Government Debt Account". At the same time, the Ministry of Public Finance prepares an annual report to the Government for approval, and to the Parliament for informing purpose, the "Government Debt Report", by 30 July of the year following the reporting year [1].

The sustainability of Romania's economic growth and macroeconomic balance are strategic objectives of governance programs that require a well-argued substantiation of legislative decisions. The achievement of this goal is possible by carrying out analyzes and studies on the impact on the budget balance, on limiting its programmed deficit as a share of the gross domestic product, i.e. positioning below the 3% threshold.

The analysis carried out in the context of this study is able to provide statistical information regarding the dynamics of the total Romania's public debt per capita, and based on the elaborated econometric model, it is estimated that possible levels will be reached in the next time intervals of the researched period, 2003-2017.

2. The mathematical definition of the econometric model

The statistical data that will be used to elaborate the econometric model of Romania's total public debt dynamics per inhabitant for the period 2003 - 2017 are presented in Table 1.

Romania's total public debt per capita between 2003 and 2017 shows steady increases from one year to another, as can be seen in Table 1 and the graphical presentation in Fig. 1 and highlights, in general, a linear growth trend that is assumed to continue in future time segments.

The choice of the mathematical form of the model that analytically defines the dynamics of the total public debt of Romania, which averages per inhabitant, is based on both the graphical form of the dynamics of the studied indicator and the calculations of the econometric representation related to several consultative variants.

After analyzing the elaborated work variants, it was concluded that the solution of the autoregressive model with two lags and with variable time presents the most convincing statistical support and consequently we proceed to a detailed description of the methodology used for this model [2] [3].

Table 1. The statistical data system required to develop the self-regressive model with two lags and variable time

	Romania's public debt per capita x_t (Lei)	x_{t-1}	x_{t-2}	t
2003	1486.382			
2004	2067.081	1486.382		
2005	2425.951	2067.081	1486.382	1

2006	2636.264	2425.951	2067.081	2
2007	2795.135	2636.264	2425.951	3
2008	2960.494	2795.135	2636.264	4
2009	3938.854	2960.494	2795.135	5
2010	5320.267	3938.854	2960.494	6
2011	7219.058	5320.267	3938.854	7
2012	9665.700	7219.058	5320.267	8
2013	11054.04	9665.700	7219.058	9
2014	12086.20	11054.04	9665.700	10
2015	13334.07	12086.20	11054.04	11
2016	14760.13	13334.07	12086.20	12
2017	15953.88	14760.13	13334.07	13

Data source: National Institute of Statistics

Figure 1 The graphical representation of Romania's total public debt dynamics per capita between 2003 and 2017

3. Calculation of the econometric representation indicators, graphical representation of the real and estimated levels of Romania's total public debt per capita between 2003 and 2017, of the residues and comments

Examining the econometric analysis methodology provides the indicators of systematized representation in Tables 2. a, 2. b and 3, as well as the representation in Fig. 2 that convey a convincing message about the viability of the model.

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Table 2. a. The system of econometric representation indicators for the autoregressive model with two lags and variable time on Romania's total public debt per capita

The dependent variable: x = Romania's total public debt per capita (Lei)				
The least squares method				
Period: 2005 - 2017; Number of observations included in the model : 13				
$\hat{x}_t = -106.095745775 + 1.37742040981 \cdot x_{t-1} - 0.638426819223 \cdot x_{t-2} + 333.527606582 \cdot t$				
$\hat{x}_t = a + b \cdot x_{t-1} + c \cdot x_{t-2} + d \cdot t$				
$\hat{x}_t = -106.0957 + 1.377420 \cdot x_{t-1} - 0.638427 \cdot x_{t-2} + 333.5276 \cdot t$				
Variable	Coefficient	Estimated standard error of the coefficient	t-statistic	Prob. (significance threshold)
(x_{t-1}) "b"	1.377420	0.205752	6.694556	0.0001
(x_{t-2}) "c"	-0.638427	0.189716	-3.365178	0.0083
(timevariable = t) "d"	333.5276	100.8256	3.307966	0.0091
C "a"	-106.0957	228.4957	-0.464323	0.6534
Coefficient of determination : R^2	0.996367	Average value of the dependent variable		8011.542
Adjusted R^2	0.995156	Standard deviation estimate of the dependent variable		5023.475
Average error estimate of the trend (regression) equation: $\hat{\sigma}_{x, \hat{x}}$	349.6104	Akaike statistical information criterion		14.79918
Sum of the square of residues	1100047	Schwarz criterion		14.97301
Log likelihood	-92.19464	Hannan-Quinn criterion		14.76345
F-statistic	822.8470	Durbin-Watson Coefficient		2.081985
Prob. (significance threshold) (F-statistic)	0.000000	Theil inequality Coefficient		1.5555%
Skewness	-0.124762	Jarque-Bera		0.151071
Kurtosis	2.534556	Probability (Jarque-Bera)		0.927247

Heteroskedasticity Test: Breusch-Pagan-Godfrey	F -statistic	Probability	(significance	0.1018
	= 2.788328	threshold)		
	χ^2 -	$F(3,9)$		0.0995
	statistic =	Probability	(significance	
	6.262302	threshold)		
		$\chi^2(3)$		

The trend (regression) equation expressed as a form of the self-regressive model with two lags and variable time on Romania's total public debt per capita, determined by the least squares method, has the following expression:

$$\hat{x}_t = -106.0957 + 1.377420 \cdot x_{t-1} - 0.638427 \cdot x_{t-2} + 333.5276 \cdot t$$

The magnitude of the parameter (coefficient) associated with the time variable ($d = 333.5276$) allows us to observe that Romania's total public debt per capita recorded, during the analyzed period, an average annual increase of 333.5276 lei ranging from 105.4443 to 561.6109 for a probability factor (critical value) following the Student Distribution Law by taking into account a 5% significance threshold.

The systematized results in Table 2.b refer to a methodological detail for defining the model for the calculation of the value ranges between which the equation of regression can be positioned according to three variants of significance threshold q (10%, 5% and 1%) under the Student Distribution Law. Usually, the option that is favored in practice takes into account the 5% significance threshold which is safe enough [4].

Table 2. b. Situation of Confidence Intervals for Model Parameters (Coefficients) for three significance thresholds (q) arranged bilaterally, based on Student distribution law

Confidence intervals for model parameters (coefficients)							
Period: 2005 – 2017; Number of observations: 13							
Variable	Coefficient	$P = 90\%, (q = 10\%)$		$P = 95\%, (q = 5\%)$		$P = 99\%, (q = 1\%)$	
		Low limit	Upper limit	Low limit	Upper limit	Low limit	Upper limit
(x_{t-1})	1.3774	1.000	1.75458	0.911	1.8428	0.708	2.0460
	20	253	8	976	65	759	82
(x_{t-2})	-	-	-	-	-	-	-
	0.6384	0.9861	0.290657	1.0675	0.20926	1.2549	0.02188
	27	97		93	0	71	2
(time variable)	333.52	148.7	518.352	105.4	561.61	5.861	661.19
	76	029	3	443	09	084	41

$= \eta$							
C	-	-	312.762	-	410.79	-	636.47
	106.09	524.95	7	622.98	75	848.66	78
	57	42		90		93	

Note: The confidence intervals estimated for the model's parameters (coefficients) under a certain significance threshold provide the support to conclude on the range in which the endogenous variable can be changed under the conditions of the change of the exogenous variable by one unit.

Actual levels, estimated levels, residues and residue margins for the autoregressive model of the total Romania's public debt per capita dynamics in the years 2005-2017, are shown in Table 3 and support the viability of the econometric construction. Residues do not exceed the maximum permissible dimension as result of multiplying the average error estimation of the trend

(regression) equation $\hat{\sigma}_{x,\hat{x}}$ with the critical value, following the Student assignment law, related to a probability of 95% and 9 degrees of freedom ($t = + 2.262$). The viability of the model is also confirmed in the graphic form of Fig. 2 by virtually overlapping the series of real values with the set of estimated values.

Table 3. The series of real levels, of the estimated levels of Romania's total public debt per capita dynamics, based on the autoregressive model with two lags and variable time and respectively the residual term interval

Year	Romania's total public debt per capita-real levels (Lei) x	Romania's total public debt per capita-estimated levels (Lei) $\hat{x}$	Residue (Lei) $u = x - \hat{x}$	Residue interval $\hat{\sigma}_{x,\hat{x}} = \pm 349.6104$ $-\hat{\sigma}_{x,\hat{x}} \ 0 + \hat{\sigma}_{x,\hat{x}}$
2005	2425.95	2125.73	300.226	. * .
2006	2636.26	2582.83	53.4301	. * .
2007	2795.14	2976.94	-181.804	. * .
2008	2960.49	3395.03	-434.535	*. .
2009	3938.85	3854.90	83.9560	. * .
2010	5320.27	5430.47	-110.202	. * .
2011	7219.06	7042.17	176.886	. * .
2012	9665.70	9109.20	556.498	. .

				*		
2013	11054.0	11600.5	-546.505	*	.	.
2014	12086.2	12284.4	-198.199	.	*	.
2015	13334.1	13153.3	180.779	.		*
2016	14760.1	14546.7	213.429	.		*
2017	15953.9	16047.8	-93.9596	.	*	.
Total	104150.0	104150.0	0.0000

Figure 2 The graphical representation of the residuals, real and estimated levels of Romania's total public debt per capita, based on the autoregressive model with two lags and variable time

Note: The legend of the graph is explained as follows:

Residual = series of residual variable values

Actual = the series of real values of Romania's total public debt per capita in the period 2005-2017

Fitted = the estimated values of Romania's total public debt per capita between 2005 and 2017 based on the autoregressive model with two lags and variable time.

Note: The presented results refer to the autoregressive model with two lags and variable time as an expression of Romania's total public debt per capita. The option for this model is considered to be the best solution in five computational variants, since both the "Schwarz Criterion" and the

"Hannan-Quinn Criterion" offer the lowest values and support the variant that has been chosen:

- Variant 1: Single-factorial linear variable-time model
- Variant 2: Autoregressive model with two lags and variable time
- Variant 3: Autoregressive model with one lag and variable time
- Variant 4: Autoregressive model with two lags and no variable time
- Variant 5: Autoregressive model with one lag and no variable time

[4]

Based on statistical tests, the viability of the autoregressive model with two lags and variable time receives the statistical confirmation of the decision adopted because the "Durbin-Watson Statistical Coefficient", "Jarque-Bera Criterion", "Theil's Coefficient of Inequality" and the "Breusch-Pagan-Godfrey Test" have statistical significance sizes that are associated with probabilities (or thresholds of significance) that support the formulated conclusion. Also, the estimate of the mean error of the trend equation (regression) 349.6104 has the lowest amplitude and the estimators of the "b", "c" and "d" model coefficients are significantly different from zero according to "Criterion t", in this case exogenous variables being correctly specified. At the same time it is mentioned that the parameter estimator "a" is affected by a pronounced average error and is not significantly different from zero, t-statistic is inferior to the value of the t-table value, and may point out that the number of observations is not large enough [2] [3] [5].

4. Calculation of estimated total public debt of Romania per capita for the years 2017-2019

Under the conditions of the two-lag and variable time autoregressive model, the levels of Romania's total public debt forecast for 2018, 2019 and 2020 are:

$$\hat{x}_{2017} = -106.0957 + 1.377420 \cdot 15.953.88 - 0.638427 \cdot 14.760.13 + 333.5276 \cdot 14 = 17.115.22 \text{ lei}$$

$$\hat{x}_{2018} = -106.0957 + 1.377420 \cdot 17.115.22 - 0.638427 \cdot 15.953.88 + 333.5276 \cdot 15 = 18.286.28 \text{ lei}$$

$$\hat{x}_{2019} = -106.0957 + 1.377420 \cdot 18.286.28 - 0.638427 \cdot 17.115.22 + 333.5276 \cdot 16 = 19.491.42 \text{ lei}$$

Note: Because the model is autoregressive, it is necessary to calculate successive estimated values of the indicator analyzed for each year following the period 2003-2017.

The model we refer to estimates for the immediate time segments the following absolute incremental increases in Romania's public debt per capita, and for an understanding of this dimension in a broader view, it is also advisable to estimate relative confidence intervals.

The estimation of confidence intervals for the absolute levels of Romania's public debt per capita is guaranteed in a usual form with a probability of 95% and is obtained by subtracting or adding the limit error size to the forecast level. It is mentioned that the model is homoscedastic and it is not necessary to use a predicted limit error.

The limit or maximum permissible error calculated for a probability factor (critical value) of ± 2.262 following a Student distribution law is determined as follows:

$$\hat{\Delta} = \pm t_{\alpha=0.05, f=n-k=19-4=9} \cdot \hat{\sigma}_{\hat{x}_t} = \pm 2.262 \cdot 349.6104 = \pm 790.819 \text{ lei}$$

For year 2018:

- lower limit: $li = 18.286.28 - 790.819 = 17.495.461 \text{ lei}$

- upper limit: $ls = 18.286.28 + 790.819 = 19.077.099 \text{ lei}$

For year 2019:

- lower limit: $li = 19.491.42 - 790.819 = 18.700.601 \text{ lei}$

- upper limit: $ls = 19.491.42 + 790.819 = 20.282.239 \text{ lei}$

At the end of the case study presented there is an accepted principle that must be observed with full rigor, according to which the forecasts prepared for the next time segments, at a closer or distant horizon, are all the more certain since the information support for describing of the past is actually quantified, it is not marked by observation errors and there is a comparable view of calculation of individual levels in terms of applied methodology.

5. Conclusions

On the basis of the obtained results, it is recommended to adopt a solution for estimating the forecast of the total public debt of Romania per capita for short periods of time (1-3 years) and respectively a successive calculation of the forecast according to the conjuncture changes which sometimes occur in very short periods of time, both in the economic and the political environment, both in the internal and the external ones.

If we conform to a general economic logic of macroeconomic vision, it is foreseeable that Romania's total public debt will follow in the future, for a medium or long time, a hyperbolic or logistic tendency of gradually slowing down and then stabilizing near a maximum ceiling, or even a parabolic mathematical form, respectively, after reaching a maximum

growth point, decrease. However, the operative identification of these realities requires constant supervision of the absolute and relative level of total public debt, but also of structural components.

This case study has the value and usefulness of preventive information for correcting and substantiating governmental decisions in order to accommodate the budget deficit within non-inflationary limits for a financial and budgetary policy that maintains macroeconomic balances and economic stability of the country.

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