Sustainability, Management and Policy of Public Debt

Authors: **Mirela Anca POSTOLE**, Titu Maiorescu University from Bucharest, The Faculty of Economic Sciences, Department of Finance and Business Administration, Romania, anca.postole@yahoo.com, **Ioana DUCA**, Titu Maiorescu University from Bucharest, The Faculty of Economic Sciences, Department of Finance and Business Administration, Romania, ducaioana@yahoo.com, **Rodica GHERGHINA**, Bucharest Academy of Economic Studies, Department of Finance, Romania, rodicagherghina@yahoo.com, **Florin VADUVA**, Titu Maiorescu University from Bucharest, The Faculty of Economic Sciences, Department of Finance and Business Administration, Romania, florin_vaduva@yahoo.com

The present scientific work aims at establishing the connection between the sustainability and the management of public debt both as hot stringent issues, and as strategic components of the state public policies. The authors analyze the relationship between public debt and some macroeconomic variables, by using a model structured on two time periods. Also, the study the same relationship based on data concerning public debt as a quota of the GDP (%) and the economic growth as a quota of the GDP (%) in 2009, by applying the econometric models for several European Union members.

Therefore, the results of the present research highlight the role played by the debt management in ensuring the debt sustainability and also prove that the connection between the economic growth and the public debt is indirect and only medium strong, due to the results obtained after applying a unifactorial econometric model.

Keywords: *sustainability, public debt management, public policies, economic growth, indebtedness level*

JEL Classification: *H6, H60, H63*

Introduction

In general terms, the concept of sustainability of public finances concerns the ability of a government to service the costs of all its debt – internal and external alike, contracted by both public and private subjects – without endangering its perspectives for future economic growth and development. Still, it is not easy to answer the question „What is the sustainable or optimal indebtedness level of a country?"

In our scientific effort to define the debt sustainability, we have mentioned a series of issues concerning the debt management, which involves a careful selection of debt instruments, in order to maintain the entailing interest payments and debt accumulation under control.

In the countries with high levels of indebtedness, in which the interest payments absorb a significant percentange of the state budget, reducing the interest-related costs is crucial. Also, these countries must reduce the risk that unfavourable shocks on the real performance or production growth might lead to an unsustainable indebtedness level.

As for the public debt management, the problems often start from the decision factors' lack of attention to the benefits of a prudential strategy of debt management, to the costs of a poor macroeconomic management and to the excessive levels of public indebtedness. As a result, the public authorities shouls be more careful with the advantages deriving from a reasonable public debt management and from debt policies coordinated within a complete macroeconomic framework.

In a larger context, when dealing with public policies, the governments should make sure that both the level of indebtedness and the growing pace of the public debt are sustaineble in time and can be maintained this way during a large aray of situations in which the costs and the risk objectives are met.

The aim of the present work is to put into light the connection between the sustainability and the public debt management as „hot" issues (especially in those times of economic crises), while considering them strategic components of the public policies of a country.

The present work is structured as it follows: the first section presents the level of present knowledge in the concerned field of study. The scientific effort continues with the introduction of a simple model in which the debt management objectives ensure the stability of the public debt ratio in the GDP and contributes to the sustainability. The research goes on with the analysis of the relation between the indebtedness level and the real economic growth, by using an unifactorial econometric model. The work ends with the conclusions and the directions for further research.

Sustainability and Public Debt Management – Components of State Public Policies

The concept of sustainability of public debt or, in a larger context, sustainability of fiscal policies reveals its complexity and importance on both national and international level.

Defining the sustainability of public debt and, implicitly, the sustainability of fiscal policies has gained different connotations throughout time, along with the changes in the implications of these concepts on the macroeconomic level.

One of the first definitions of the sustainability of public debt was provided by Keynes (1923), who explained the necessity for the governments to take into account the budgetary constraints in order to apply sustainable fiscal and budgetary policies.

Other authors, such as Domar (1944), Buiter (1985), Blanchard, Chouraqui, Hagemann and Sartor (1990) have formulated different definitions for the sustainability of public debt, insisting on the indebtedness level, which, in their opinion, had to converge either towards a finite value, in order to avoid the progressive fiscal pressure, or to towards the initial level.

Also, according to Zee (1987), the sustainability aims at stability, a concept developed in its work on sustainability and the optimal level of public debt.

As a matter of fact, the importance and implications of the sustainability of both fiscal and public debt policies led to the intervention of the International Monetary Fund, which set up procedures to investigate the sustainability of public debt, as well as the external sustainability (Campeanu, Stoian, Miricescu and Gyorgy, 2009). The IMF procedures were put into practice following the programmes initiated between the Fund and different countries, and were therefore meant to reach an overall balance (IMF, 2002). Beside the various ways to define sustainability, one can also use sustainability indicators. These indicators do not take into account the previous periods of evolution of the public debt. As a result, studying the sustainability of public debt based on the sustainability indicators reflects how the risk of non-sustainability is calculated, depending on the probability of serving the planned public debt over a medium term. These studies are particularly useful in countries where the indebtedness level is growing fast.

There are several empirical studies proving that the external public debt and its structure (the component currencies) can influence the reduction of the public debt sustainability (Eichengreen, Hausmann and Panizza, 2003). Similarly, Detragiache and Spilimbergo (2001) have shown that, depending on the structure of the debt after its maturity date, a very high volume of debt on short term can generate crises in emergent countries in permanent need of liquidities.

As part of the state public policies, the public debt management (IMF, 2003) is the process pf establishing and applying strategies to manage the government debt, to collect the necessary funds, to fix the balance between costs and risk objectives, to reach any other management objectives established by the government. Every government is confronted with strategy choices as to: the objectives of the public debt management, the preferred risk tolerance threshold, the part of the government responsible with the public debt management, how to manage the conditioned liabilities (which can be turned into financial liabilities and can

materialize in case of guarantees for loans in foreign currencies) and how to ensure a stable governance for the public debt management (IMF, 2001).

Also, a proper public debt management, oriented towards ensuring the fiscal sustainability in the long run involves the existence of a stable and effective legal and institutional framework.

The Relation between Public Debt and Some Macroeconomic Variables

In order to study the role of the short-term debt, as well as the role of the long-term debt, we must consider a model structured over two periods of time (Missale and Giavazzi, 2004). Thus, the accumulation of the public debt over the time horizon on which the model is structured is the following:

$$B_{t+1} = (1+X_{t+1} + X_t)B_{t-1} - S_t \quad (1)$$

where:

B_{t+1} represents the ratio between the debt and the GDP;

S_t represents the primary surplus decided at the moment t for the moment t+1;

X_{t+1} represents the real rate of the public debt profitableness minus the rate of production increase.

As a matter of fact,

$$X_{t+1} = I_{t+1} - \pi d_{t+1} - y_{t+1} \quad (2)$$

where:

I_{t+1} represents the nominal rate of profitableness;

πd_{t+1} represents the inflation rate calculated by means of the GDP deflator;

y_{t+1} represents the growth rate of the GDP.

We consider that, in order to ensure the sustainability of the debt, the government chooses the primary surplus as an increasing function of the debt percentage:

$$SP_t = \theta B_{t-1} + (X_t - E_{t-1}X_t)B_{t-1} \quad (3)$$

As a consequence, a government reacts not only to a higher percentage of the debt (Bohn, 1998), but it also compensates for the increase

of this percentage generated by a higher real efficiency than anticipated minus the production increase. In conclusion, a government tends to correct the increase of the debt percentage resulted following unfavorable past conditions (such as a higher efficiency or the gradual decrease of production). If we replace function (3) in the equation (1), the modification of the debt percentage during the two reference periods becomes:

$$B_{t+1} - B_{t-1} = (E_{t-1}X_{t+1} + E_{t-1}X_t - \theta)B_{t-1} + (X_{t+1} - E_{t-1}X_{t+1})B_{t-1} \quad (4)$$

In fact, the equation (4) shows that, if we anticipate the stabilization of the debt percentage, so that $(E_{t-1}X_{t+1} + E_{t-1}X_t - \theta)B_{t-1} < 0$, θ could not be high enough to prevent the increase of this percentage, when the real debt efficiency is extremely high or the rate of the GDP growth drops significantly. Therefore, if these unexpected changes become permanent, the debt percentage could become instable. According to Bohn (1998), a high enough value of θ „could maintain the stability of the debt/GDP ratio in the future, if the interest rate and the rate of the increase do not follow an unfavorable course." As a consequence, the debt percentage can grow, either due to unexpected changes in the real debt rate, or because of the variations in the production increase.

Also, the role played by the debt management in ensuring the debt stability is projected on two directions, as it results from the two terms in the right side of the equation (4).

Even more, the debt instruments can be selected either to reduce the real anticipated efficiency of the public debt, or to minimize the impact of unfavorable conditions, such as a very high level of debt efficiency or a dropping percentage of the production increase.

The research goes on with the study of the connection between the public debt and the real economic growth and reveals the fact that one of the main influence factors is the level of economic development of a country or a region. Starting from these coordinates, one can aim at measuring the influence of the real economic growth on the public debt, using statistical methods and econometric models. Dealing with the interdependencies between such economic variables usually requires, among other things, having multiple year data at your disposal, expressing the empirical values

in real terms and a lot of prudence in interpreting the economic results, because of the co-linearity of the factorial variables involved in the econometric models.

The approach of the relationship between the real economic growth and the indebtedness level must take into account the fact that these indicators are expressed in percentages of the GDP, which makes their deflation unnecessary. The data related to the variables are classified according the „time" criterion, therefore they form chronological series. Analyzing the chronological series means that the terms must meet the criterion of comparability from the perspective of prices; in our case, the variables are expressed in percentages.

In this context, we have analyzed the relationship between the public debt and some macroeconomic variables, based on data concerning the public debt as percentage of the GDP (%) and the economic growth as percentage of the GDP (%) in 2009, by applying a series of econometric models to several European Union members:

Tabel 1: The Relationship between the Public Debt as Percentage of the GDP and the Economic Growth in 2009

Country	**PD/GDP**	**Economic growth**
Belgium	96,7	2,2
Bulgaria	14,8	6,2
Czech Republic	35,4	4,9
Denmark	41,6	1,4
Germany	73,2	2,2
Estonia	7,2	6,2
Ireland	64,0	3,8
Greece	115,1	3,7
Spain	53,2	2,3
France	77,6	1,8
Italy	115,8	1,6

Cyprus	56,2	3,9
Latvia	36,1	6,2
Lithuania	29,3	6,3
Luxembourg	14,5	4,5
Hungary	78,3	3,4
Malta	69,1	2,9
Holland	60,9	2,5
Austria	66,5	2,4
Poland	51,0	5,2
Portugal	76,8	2,1
Romania	23,7	5,8
Slovenia	35,9	4,0
Slovak Republic	35,7	6,2
Finland	44,0	2,8
Sweden	42,3	2,4
Great Britain	68,1	2,5
Norway	43,7	2,2

Source: Eurostat, 2010

Using the Data Analysis module from Excel, we have studied the relationship between the two variables. Based on these data, we have built a unifactorial econometric model such as:

$$y_i = f(x_i) + \varepsilon_i$$

The analysis of the data in the table, in relation with the described economic process, leads to the following specification of the variables:

y – the real values of the dependent (endogenous) variables – the public debt as percentage of the GDP;

x – the real values of the independent (exogenous) variables / the economic growth (%);

ε – the residual variable, representing the influence of other factors of the y variable, unspecified in the model and considered as arbitrary factors, having an insignificant influence over the y variable.

In case of a unifactorial model, the most used procedure to specify an econometric model is to draw a graphic representation of the two series of values by means of a **correlogram**.

One can notice that the distribution of the empirical points (x_i, y_i) can be approximated with a straight line → a unifactorial linear model: $y = a + bx + \varepsilon$, where a and b represent the parameters of the model. The incline of the line is negative, which means that the linear connection between the two variables is indirect or reversed.

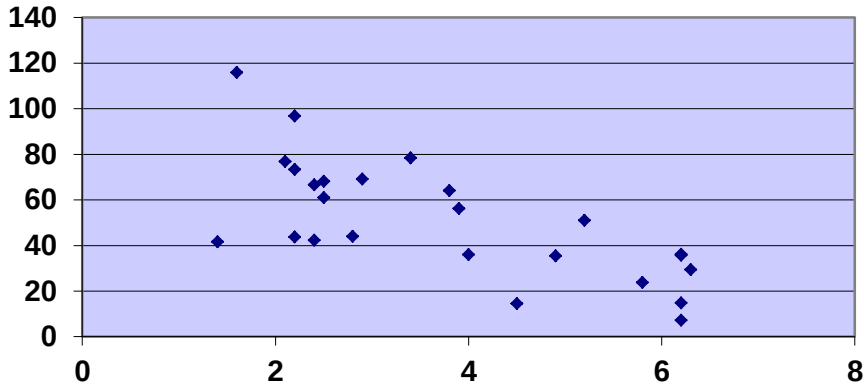

Figure 1: The Graphic Representation of the Public Debt as a Percentage of the GDP and the Economic Growth in 2009

Source: Eurostat, calculations by the authors

Tabel 2: The Results of Regression between the Indebtedness Level and the Economic Growth

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.641952331
R Square	0.412102795
Adjusted R Square	0.389491364
Standard Error	21.68161397
Observations	28

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	8567.630507	8567.631	18.22542	0.000231058
Residual	26	12222.40199	470.0924		
Total	27	20790.0325			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	93.86826263	10.085604 88	9.307152	9.25E-10	73.13700511	114.5995202
Real economic growth(%)	10.84263143	2.539779064	-4.26912	0.000231	-16.063222	-5.622040952

RESIDUAL OUTPUT

Observation	*Predicted PD/GDP(%)*	*Residuals*
1	70.01447348	26.6855652
2	26.64394744	-11.8439774
3	40.7393686	-5.339368605
4	78.68857863	-37.08857863
5	70.01447348	3.185526522
6	26.64394774	-19.44394774
7	52.66626318	11.33373682
8	53.75052633	61.34947367
9	68.93021033	-15.73021033
10	74.35152605	3.248473948
11	76.52005234	39.27994766

12	51.58200004	4.617999961
13	26.64394774	9.45605226
14	25.5596846	3.740315404
15	45.07642118	-30.57642118
16	57.00331576	21.29668424
17	62.42463147	6.675368526
18	66.76168405	-5.861684048
19	67.84594719	-1.345947191
20	37.48657917	13.51342083
21	71.09873662	5.701263379
22	30.98100031	-7.281000314
23	50.4977369	-14.5977369
24	26.64394774	9.05605226
25	63.50889462	-19.50889462
26	67.84594719	-25.54594719
27	66.76168405	1.338315952
28	70.01447348	-26.31447348

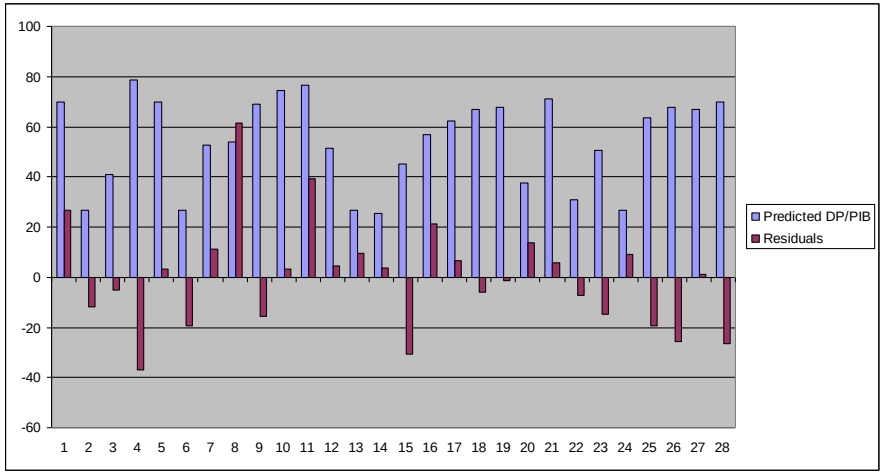

Figure 2: The Graphic Representation of the Regression
Source: calculations by the authors

In order to determine the two parameters, we use the method of the least square:

According to the table above, the value of the coefficients is:
C(1):â = 93,86, the free term is the point in which the regression axis intersects the OY axis, which means that, in case the economic growth is 0, the public debt as percentage of the GDP will be 93,86%.
C(2):b = -10,84< 0 the relationship between the two variables is indirect, which means that, when the GDP increases by 1%, the public debt calculated as percentage of the GDP will drop by 10,84%.

$\hat{y}$ = 93,86 – 10,84x

The estimators obtained using the method of the least square can be considered as verisimilar if the following hypotheses are accepted:
1) The observed values are not affected by errors of measurement

$$x_i \in \left(\bar{x} \pm 3\sigma_x\right)$$

$$\sigma_x = \sqrt{\frac{\sum\left(x_i - \bar{x}\right)^2}{n}} = 1{,}64291$$

3,628571-3* 1,64291<xi<3,628571+3*1,64291; xi ∈ (-1,300159;8,557301);

$$y_i \in \left(\bar{y} \pm 3\sigma_y\right)$$

$$\sigma_y = \sqrt{\frac{\sum\left(y_i - \bar{y}\right)^2}{n}} = 27{,}7489$$

54,525-3* 27,7489<xi<54,525+3* 27,7489; yi ∈ (-28,7217;137,7717);
As the values of these variables belong to their specific intervals, the hypothesis is accepted without reserve;

2) The random variable u is of zero average $M(\hat{u}) = 0$ and the dispersion $s_{\hat{u}}^2$ is constant and independent from X – the homoskedasticity hypothesis, which can lead to the conclusion that the relationship between Y and X is relatively stable.

Table 3: The Analysis of the Relation between the Public Debt and the Economic Growth

Dependent Variable: PD
Method: Least Squares
Included observations: 28
DP=C(1)+C(2)*ECONOMIC GROWTH

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	93.86826	10.08560	9.307152	0.0000
C(2)	-10.84263	2.539779	-4.269124	0.0002
R-squared	0.412103	Mean dependent var		54.52500
Adjusted R-squared	0.389491	S.D. dependent var		27.74890
S.E. of regression	21.68161	Akaike info criterion		9.059555
Sum squared resid	12222.40	Schwarz criterion		9.154713
Log likelihood	-124.8338	Durbin-Watson stat		2.015815

Source: calculations by the authors

The application of the White test involves passing through the following stages:

- building an auxiliary regression, based on the assumption thta there is a dependency relationship between the square of the error's values, the exogenous variable included in the initial model and the square of its values: $\hat{u}_i^2 = \alpha_0 + \alpha_1 x_i + \alpha_2 x_i^2 + \omega_i$

Table 4: The Results of the Verification of Errors in the Applied Unifactorial Linear Model

White Heteroskedasticity Test:

F-statistic	0.519905	Probability	0.600866
Obs*R-squared	1.118083	Probability	0.571757

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Included observations: 28

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	421.9760	1080.590	0.390505	0.6995
CREST.ECON.	113.4999	617.8118	0.183713	0.8557
CRESTEC^2	-25.19480	76.08926	-0.331122	0.7433

R-squared	0.039932	Mean dependent var	436.5144
Adjusted R-squared	-0.036874	S.D. dependent var	771.7950
S.E. of regression	785.8958	Akaike info criterion	16.27248
Sum squared resid	15440804	Schwarz criterion	16.41522
Log likelihood	-224.8148	F-statistic	0.519905
Durbin-Watson stat	2.418828	Prob(F-statistic)	0.600866

Source: calculation by the authors

The Fisher - Snedecor test is based on the nullity of the parameters H_o : $\alpha_0 = \alpha_1 = \alpha_2 = 0$; the null hypothesis according to which the results of the estimation are irrelevent is accepted, the homoskedasticity hypothesis is confirmed. $F_c = 0.519905 < F_{0,01;126} = 7.72$ (the calculated F is taken from the White Heteroskedasticity Test).

3) The values of the residual variables of u are independent, as there is no case of self-correlation.

While using the Durbin Watson test, we obtain d = 2,015815, and for a number of observations n=28, α=0,05 and a number of independent variables k=1, we take d1=1,33 and d2=1,48.

$$d = \frac{\sum_{i=2}^{n} (\hat{u}_i - \hat{u}_{i-1})^2}{\sum_{i=1}^{n} \hat{u}_i^2} = 2{,}015815$$

d2< d <4-d2 => the errors are independent

4) Verifying the normality hypothesis of the values of the residual variables

It is a known fact that, if the errors follow the normal rule of zero average and the root-mean square deviation $s_{\hat{u}}$ (the consequence of hypotheses c_1, c_2, c_3), then the relation becomes:

$$P\left(|\hat{u}_i| \le t_\alpha s_{\hat{u}}\right) = 1 - \alpha .$$

The verification of the normality hypothesis of the errors will be made using the Jarque-Berra test, an asymptotic test (valid only in case of a high volume sample), which follows a chi-square distribution with a number of degrees of freedom equal to 2, with the form of:

$$JB = n\left[\frac{S^2}{6} + \frac{(K-3)^2}{24}\right]$$

n = number of observations, *S* = skewness coefficient, *K* = the Pearson kurtosis coefficient;

Using the EViews programme pack to calculate the Jarque-Berra test, we notice that $JB = 3{,}722198 > \chi^2_{0,05;1} = 3{,}84$ and *p*(JB) = 0,1555502. Since the calculated value of the J-B test is lower than the tabled value of $\chi^2_{\alpha;2}$, and the probability that the J-B test surpasses the tabled value is high enough, the normality hypothesis of the errors cannot be accepted.

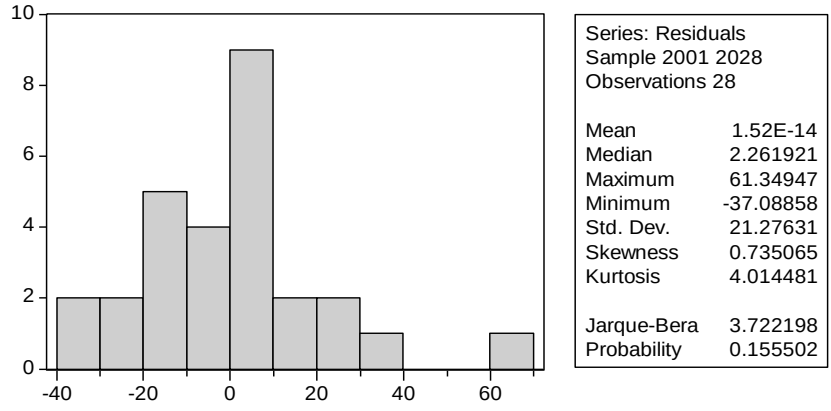

Figure 3: Verifying the Normality Hypothesis of the Errors
Source: calculations by the authors

5. Calculating the standard errors (Std. Error) of the estimated parameters s_a=10.08 and s_b= 2.53. These errors are used to calculate the statistical values *t* in order to test the significance of the parameters. The calculations appear in the column t-Statistic, t_a= 9.30, t_b= -4.26; as the associated p values are very close to zero(Prob.), we can conclude that the estimators are significant.

With a probability of 95%, the values of the variables fall into the following intervals:

73.137 < â< 114.5995
-16.06< b̂<-5.62

The intervals do not contain the value 0 => the respective parameters are significant from a statistical perspective;

6. The validity of the model for a significance threshold α=0,05, a number of observations n=28, and a number of independent variables k=1. The value of the critical Fisher test is 7,72;

According the ANOVA table, the Fisher test F=39,7411 > critical F, resulting that the regression model is correctly identified (valid);

7. The intensity of the relation between the two variables is determined by means of the correlation coefficient r= - 0.64. Aa a result, using statistical and econometric models, we have revealed the relationship between the economic growth and the public debt and we have concluded that we are dealing with an indirect relationship, because r<0 and of a medium strong intensity.

Conclusions

The scientific approach of the authors has highlighted the importance of the debt management in ensuring its stability. By using statistical methods and econometric models, they have proved the relationship between the economic growth and the public debt and they have concluded that this relationship is indirect and of a medium strong intensity, as a result of the values obtained by applying the unifactorial econometric model.

Therefore, the relation between the public debt and the real economic growth reveals that one of the main influence factors is the level of economic development of a certain country. A very high volume of debt on a short term can induce a series of crises in emergent countries, in permanent need of liquidities.

References

[1] Albu, L. L., Pelinescu, E.(2002), "Sustenabilitatea Datoriei Externe, Cerope", study 35 ro

[2] Bohn, H. (1998),"The behavior of US public debt and deficits", The Quarterly Journal of Economics, August

[3] Blanchard, O., Chouraqui, J.C., Hagemann, P.R. and Sartor, N. (1990),"The Sustainability of Fiscal Policy: New Answers to old Questions", OECD Economic Studies No. 15 Autumn 1990

[4] Buiter,W.W.(1985),"A Guide to Public Sector Debt and Deficits,Economic Policy", No.1, November, pp.13,79

[5] Campeanu, E., Soian, A., Miricescu, E. si Gyorgy, A. (2009),"Sustenabilitatea politicii de indatorare a Romaniei in contextul economic actual", Editura ASE, Bucuresti

[6] Detragiache, E., Spilimbergo, A. (2001),"Crises and Liquidity - Evidence and Interpretation", IMF Working Papers 01/2, International Monetary Fund

[7] Domar, Evsey D.(1944),"The Burrden of the Debt and the National Income", American Economic Review, Vol.34, No.4, December, pp. 798,827

[8] Eichengreen, B. Hausmann, R. Panizza, U. (2003),"Currency Mismatches, Debt Intolerance and Original Sin: Why They Are Not the Same and Why it Matters", NBER Working Paper no. 10036

[9] Fondul Monetar International si Banca Mondiala (2003),"Debt Sustainability In Low- Income Countries – Towards A Forward – Looking Strategy", Working Paper, May

[10] Fondul Monetar International (2002),"Assessing Sustainability", Working Paper, May

[11] International Monetary Fund and World Bank (2003),"Guidelines for Public Debt Management: Accompanying document and selected case studies"

[12] International Monetary Fund and World Bank (2001),"Guidelines for Public Debt Management", 21 march

[13] Gherghina, R., Postole, M. A., Duca, I., and Văduva, F. (2010),"Public Debt Management – Public Policy Component", Universitatea "TIBISCUS", Annals. Economic Science Series, Vol. XVI

[14] Keynes, J. (1923),"A Tract on Monetary Reform", in The Collected Writings of John Maynard Keynes vol. IV, Macmillan, 1971, pp.23

[15] Missale, A. and F. Giavazzi (2004),"Public Debt Management in Brazil," NBER Working Paper 10394.

[16] Zee, H. H. (1987),"On the Sustainability and Optimality of Government Debt", IMF Working Paper WP/87/83, December