# THE RELATION BETWEEN PUBLIC DEBT AND GDP – EMPIRICAL ANALYSIS FOR MACEDONIA AND ROMANIA

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**Abstract.** The financial crises in 2008 initiated a broad debate on the challenges posed to the economic growth and development by crossing a specific threshold in the ratio between the public debt and the GDP, so that it can be sustainable and without harmful consequences on the future development perspectives. In this paper analysis of comparative data for Macedonia and Romania is performed, having in mind the following facts: both countries belonged to the former socialist block of countries; both countries went through very painful process of socio-economic transition; and Romania is an EU member-country since 2007 and is a good example for Macedonia for its future macroeconomic policies, once it becomes the EU member country in near future. The initial assumption in the research is that there is long run causality between public debt and GDP, as well as short run inverse relationship between the growth rates of these variables. Therefore, cointegration test for the data for Romania is conducted and then vector error correction model (VECM) is applied.

**Key words:** public debt, GDP, analysis, co-integration, vector error correction model, Granger causality

## INTRODUCTION

The financial crises in 2008 initiated broad academic and policymaking debate on the challenges posed to the economic growth and development by crossing a specific threshold in the ratio between the public debt and the GDP, so that it can be sustainable and without harmful consequences on the future development perspectives. For developed countries, studies show and refer to the prudential limit (upper red line) of 60% of GDP (this coincides with the Maastricht treaty criteria). In less developed countries and developing countries, prudent limit is calculated at 40% of GDP [Reinhart and Rogoff 2010].

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On one hand, it goes without saying that public debt creation and management can be a very useful tool for the Government, if it is used properly and if it serves to encourage short-term or long-term economic growth, or for sound macroeconomic policy management (anti-cyclical policy). However, on the other hand, excessive reliance on public debt and inappropriate public debt management and strategies can increase macroeconomic risks and obstruct economic growth. Here, one should take into consideration the fact that public debt must be managed very carefully, because its excessive use can lead to liquidity problems of public finances (on central, regional and local level).

## PUBLIC DEBT DEVELOPMENT AND CURRENT SITUATION IN MACEDONIA AND ROMANIA

In this paper, analysis of the comparative data for Macedonia and Romania is performed, having in mind the following facts:
• both countries belonged to the former socialist block of countries;
• both countries went through very painful process of socio-economic transition;
• Romania is an EU member-country since 2007 and is a good example for Macedonia for its future macroeconomic policies, once it becomes the EU member country in near future.

### Macedonia

Republic of Macedonia is an upper middle-income country that implemented numerous reforms over the last decade. However, even though the country achieved important progress in terms of its economic development, there is still work to be done related to generating economic growth, job creation and improvement of the living standard for all its citizens [IMF 2015]. Figure 1 presents data on the public-debt-to-GDP ratio and Figure 2 presents data on GDP and public debt for the Republic of Macedonia.
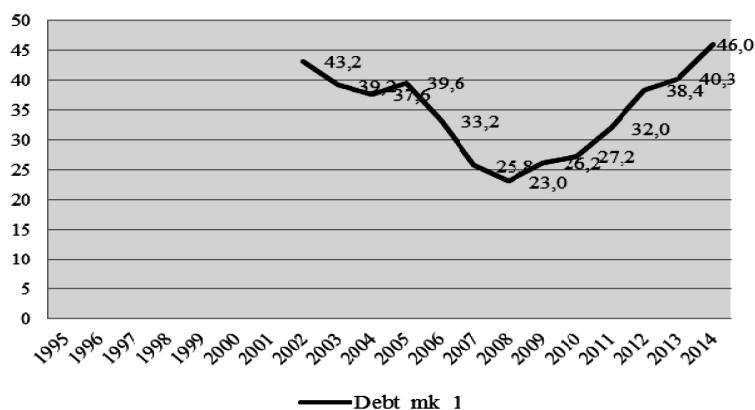


Fig. 1.    Republic of Macedonia – public debt as procentage of GDP
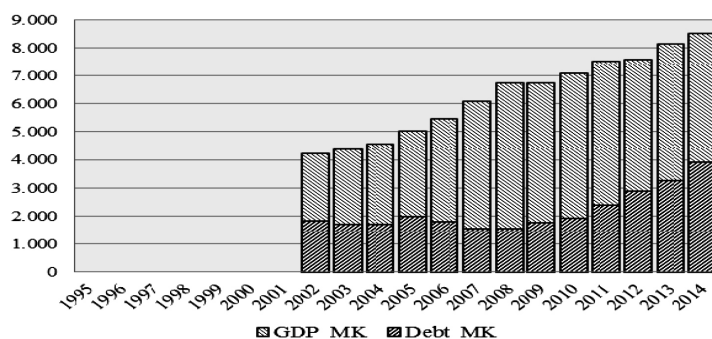Source:    Ministry of Finance (www.finance.gov.mk).

Fig. 2.  Republic of Macedonia – GDP and public debt (million EUR)

Table 1 presents basic data for the Republic of Macedonia, for the period 2002–2014. The essence of the public debt problem is not its level per se, but the dynamics of its increase since 2008/2009. The public debt in Macedonia is constantly rising and the main dilemma here is the purpose of these newly acquired borrowings, which can be justified if the money is used for capital projects, and not for funding public employees' salaries, pensions, social transfers, etc. [IMF 2015]. Hence, it is well accepted scientific and policy fact that a developing country, like Macedonia, should only borrow to finance its future socio-economic development priorities (investments in infrastructure, education, health, information, research and development), that will in turn increase the competitiveness

Table 1.  Basic data – Republic of Macedonia

| Year | GDP (million EUR) | Public debt (million EUR) | Public debt as % of GDP |
|------|-------------------|---------------------------|-------------------------|
| 2002 | 4 240,5 | 1 829,9 | 43.2 |
| 2003 | 4 385,9 | 1 717,8 | 39.2 |
| 2004 | 4 577,7 | 1 722,4 | 37.6 |
| 2005 | 5 032,0 | 1 992,2 | 39.6 |
| 2006 | 5 472,2 | 1 818,3 | 33.2 |
| 2007 | 6 094,5 | 1 569,8 | 25.8 |
| 2008 | 6 772,1 | 1 558,3 | 23.0 |
| 2009 | 6 766,5 | 1 772,2 | 26.2 |
| 2010 | 7 108,3 | 1 936,3 | 27.2 |
| 2011 | 7 544,2 | 2 414,9 | 32.0 |
| 2012 | 7 584,8 | 2 908,8 | 38.4 |
| 2013 | 8 149,6 | 3 281,4 | 40.3 |
| 2014 | 8 529,4 | 3 921,3 | 46.0 |

of the economy. The increased competitiveness will contribute to higher growth rates in the economy, thus allowing the future generations to easily repay the loans taken by the present generations in the country.

**Romania**

The analysis of public debt dynamics has the purpose to offer answers and solutions concerning the government's capacity to maintain the same direction of expenditures an-drevenues, to keep the public debt at sustainable level (as percentage of the GDP). Table 2 presents basic data on the GDP, public debt and public-debt-to-GDP ratio for Romania, for the period 1995–2014.

Romania went through three periods of time differing in economic background and applicable legal regulations [Oprea et al. 2012]:

1. Period of 1990–2000 was extremely difficult and tumultuous socio-economically for Romania. Data from Table 2 shows that the public-debt-to-GDP ratio has generally recorded, with some exceptions, an upward trend, increasing from 8.0% in 1996 to a maximum of 19.2% in 1999 and slight decline to 18.5 in 2000.

2. Period of 2001–2007 – marked by high GDP growth rates (exceeding even, in real -figures, 8% of GDP in 2004) and a constant decline in the public-debt-to-GDP ratio,

Table 2.　Basic data – Romania

| Year | GDP (million EUR) | Public debt (million EUR) | Public debt as % of GDP |
|------|-------------------|---------------------------|-------------------------|
| 1995 | 28 763,0 | – | – |
| 1996 | 29 228,7 | 2 333,9 | 8.0 |
| 1997 | 31 683,6 | 4 334,5 | 13.7 |
| 1998 | 37 313,9 | 4 852,1 | 13.0 |
| 1999 | 33 942,7 | 6 527,4 | 19.2 |
| 2000 | 40 796,8 | 7 532,8 | 18.5 |
| 2001 | 45 503,5 | 10 917,2 | 24.0 |
| 2002 | 48 810,4 | 10 757,1 | 22.0 |
| 2003 | 52 931,0 | 10 309,5 | 19.5 |
| 2004 | 61 404,0 | 11 768,7 | 19.2 |
| 2005 | 80 225,6 | 12 397,6 | 15.5 |
| 2006 | 98 418,6 | 12 585,6 | 12.8 |
| 2007 | 125 403,4 | 14 763,0 | 11.8 |
| 2008 | 142 396,3 | 17 158,6 | 12.0 |
| 2009 | 120 409,2 | 27 970,5 | 23.2 |
| 2010 | 126 746,4 | 37 451,2 | 29.5 |
| 2011 | 133 305,9 | 44 688,3 | 33.5 |
| 2012 | 133 511,4 | 50 128,6 | 37.5 |
| 2013 | 144 253,5 | 54 170,0 | 37.6 |
| 2014 | 150 230,1 | 59 273,0 | 39.5 |

Source: Eurostat database (http://ec.europa.eu/eurostat/data/database).

from 24.0% in 2001 to 11.8% in 2007 (Table 2), avalue that has not been recorded since 1996. The progress in reducing public debt ratio registered over this period can be considered especially important.

3. After 2008 – when Romania joined the EU, it had among the lowest public debt levels in Europe (11.8% of the GDP in 2007 and 12.0% in 2008). However, the years following the financial and economic crisis, witnessed constant increase of the public-debt--to-GDP ratio, from 23.2% in 2009 to 39.5 in 2014 (Table 2).

From the above data analyses, one can notice the fact that although the indebtedness rate of Romania continues to be lower than other EU member states, the worrying factor is its accelerating trend, fact that imposes the analyses of the public debt sustainability and of public deficit [Căruntu 2013].

Figure 3 presents data on GDP and public debt and Figure 4 presents data on the public-debt-to-GDP ratio for Romania.
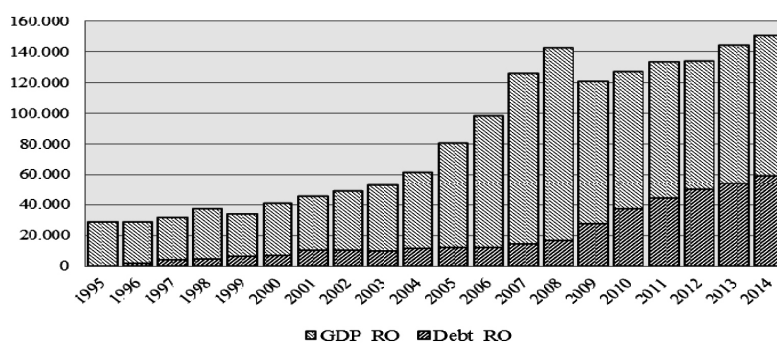


Fig. 3.     Romania – GDP and public debt (million EUR)
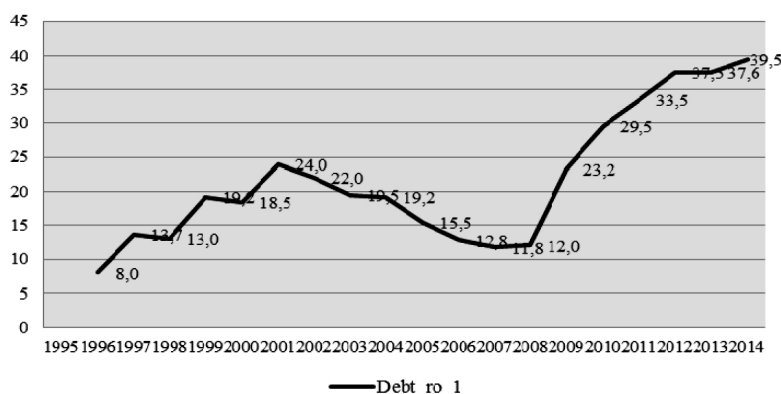Source:     Eurostat database (http://ec.europa.eu/eurostat/data/database).



Fig.4.     Romania – public debt as % of GDP
Source:     Eurostat database (http://ec.europa.eu/eurostat/data/database)**.**

## ECONOMETRIC ANALYSIS FOR ROMANIA

Unfortunately, the data for the Republic of Macedonia are available only for the sample period 2002–2014, or totally 11 observations, which is insufficient number to conduct Johansen cointegration test and to build vector error correction model. Moreover, both variables are I(2), which means two additional observations are lost and if one adds here the number of lags that needs to be included, there are practically 4–5 degrees of freedom left.

Therefore, the comparison between Romania and Macedonia would be the public--debt-to-GDP ratio through the years and the figureical presentation of the growth rates of GDP and public debt in these countries, as well as their correlation coefficients (already presented in the above section of this paper).

### Data

For the purpose of this research, annual data on general government gross consolidated debt and gross domestic product (1995 to 2014) from the Eurostat database have been used. Variables are in current prices, in million EUR. Due to a missing data and higher level of integration of the variables for Republic of Macedonia, as it was mentioned before, modeling will proceed only using the data for Romania.

In order to reduce the variance and avoid heteroskedasticity problems, both variables have been transformed using natural logarithms. Additionally, to reflect reality and take into account global financial crisis, dummy variable with value 1 for the year 2009 is imposed. This dummy variable is used as an exogenous variable in the model so that the structural breaks in the data in this period can be isolated.

Taking into consideration the fact that most economic variables that exhibit strong trendsare non-stationary (have unit roots), augmented Dickey–Fuller (ADF) unit root test is conducted to determine level of integration of the data [Cavaliere and Taylor 2007].

Table 3. ADF unit root test

| Country | Variable | Level | p-Values | | | Level of integration |
|---|---|---|---|---|---|---|
| | | | Intercept | Trend and intercept | None | |
| Romania | ldebt | level | 0.4797 | 0.7035 | 0.9998 | I(1) |
| | | 1st diff. | 0.0027 | 0.0183 | 0.0034 | |
| | lgdp | level | 0.8062 | 0.8863 | 0.9994 | I(1) |
| | | 1st diff. | 0.0222 | 0.0746 | 0.0221 | |
| Macedonia | ldebt | level | 0.9967 | 0.9668 | 0.9439 | I(2) |
| | | 1st diff. | 0.3748 | 0.2821 | 0.1738 | |
| | | 2nd diff. | 0.0343 | 0.1022 | 0.0034 | |
| | lgdp | level | 0.7436 | 0.8827 | 1.0000 | I(2) |
| | | 1st diff. | 0.0864 | 0.1672 | 0.2220 | |
| | | 2nd diff. | 0.0375 | 0.0368 | 0.0003 | |

Source: Author's calculations.

From the p-values presented in the Table 3 one can notice that variables for Romania are integrated of first order I(1), at 0.05 significance level, unlike Macedonia, where variables are I(2).

## Empirical model

When dealing with non-stationary time series data, probably the initial response is to take first differences of each of the I(1) variables and then use these first differences in the subsequent modeling process. But, when the relationship between variables is important this approach is not preferable, since it does have the problem that pure first difference models have no long-run solution. Based on the theoretical background, as well as the figureical presentation of the time series in this case, the assumption is that there is a long run relationship (cointegration) between the public debt and GDP. A cointegrating relationship between the variables may be seen as a long-term or equilibrium phenomenon, since it is possible that cointegrating variables may deviate from their relationship in the short run, but their association would return in the long run [Brooks 2008]. To statistically test for long run relationship between variables, one can conduct Johansen test for cointegration. Important issue in this regards is the number of lags to be taken into account. Although it is a matter of personal judgement, information criteria are usually used to determine the optimal lag length.

Starting with estimation of simple vector autoregression (VAR) model (in levels), test for determining number of lags is applied. Akaike information criterion (AIC), as one of the most often used criteria in the analysis, indicates 3 lags as optimal for the model. However, one should notice that the Johansen cointegration test take the variables in their first differences and therefore one lag is lost. Consequently, the number of lags for the model will be 2. Another fact to emphasize is that dummy variable for the financial crisis is considered as exogenous during the whole modeling process (lag selection criteria, cointegration test, model estimation).

Table 4 presents the results from Johansen cointegration test. Namely it provides two tests, Trace test and maximum Eigen value test, both suggesting that there is one cointegrating equation at 0.05 level.

In the Engle and Granger framework, at a second step after the cointegration test, one can use the residuals from the static regression as an error correction term in a dynamic, first-difference regression [Green 2012]. In other words, when cointegration between variables exists, vector error correction model (VECM) should be implemented, and in this case using the following equation:

$$
\begin{cases}
\Delta ldebt = a_{1,1}(ldebt_{t-1} - b_{1,1}lgdp_{t-1} - b_{1,2}) + c_{1,1}\Delta ldebt_{t-1} + \\
+ c_{1,2}\Delta ldebt_{t-2} + c_{1,3}\Delta lgdp_{t-1} + c_{1,4}\Delta ldebt_{t-2} + c_{1,5} + c_{1,6}dum + u_1 \\
\Delta ldebt = a_{2,1}(ldebt_{t-1} - b_{1,1}lgdp_{t-1} - b_{1,2}) + c_{2,1}\Delta ldebt_{t-1} + \\
+ c_{2,2}\Delta ldebt_{t-2} + c_{2,3}\Delta lgdp_{t-1} + c_{2,4}\Delta lgdp_{t-2} + c_{2,5} + c_{2,6}dum + u_2
\end{cases}
\tag{1}
$$

where: *ldebt* – natural logarithm of general government gross consolidated public debt;
        *lgdp* – natural logarithm of GDP;
        $a_i, b_i, c_i$ – estimated coefficients;
        *dum* – dummy variable for the financial crisis;
        $u_i$ – obtained residuals.

Table 4.   Cointegration tests

| Johansen cointegration test | | | | |
|---|---|---|---|---|
| Sample (adjusted): 1999, 2014 | | | | |
| Included observations: 16 after adjustments | | | | |
| Trend assumption: Linear deterministic trend | | | | |
| Series: LDEBT LGDP | | | | |
| Exogenous series: DUM | | | | |
| Warning: critical values assume no exogenous series | | | | |
| Lags interval (in first differences): 1 to 2 | | | | |
| Unrestricted cointegration rank test (Trace test) | | | | |
| Hypothesized No. of CE(s) | Eigen value | Trace statistic | 0.05 critical value | prob. |
| None* | 0.678248 | 19.19197 | 15.49471 | 0.0132 |
| At most 1 | 0.063424 | 1.048400 | 3.841466 | 0.3059 |
| Trace test indicates 1 cointegrating eqn(s) at the 0.05 level. | | | | |
| * Denotes rejection of the hypothesis at the 0.05 level. | | | | |
| Unrestricted cointegration rank test (Maximum Eigen value test) | | | | |
| Hypothesized No. of CE(s) | Eigen value | Max-Eigen statistic | 0.05 critical Value | prob. |
| None* | 0.678248 | 18.14357 | 14.26460 | 0.0116 |
| At most 1 | 0.063424 | 1.048400 | 3.841466 | 0.3059 |
| Max-Eigen value test indicates 1 cointegrating eqn(s) at the 0.05 level. | | | | |
| *Denotes rejection of the hypothesis at the 0.05 level. | | | | |

Source: Author's calculations.

The error correction term or the co-integrating equation is presented in the first part of the equations. Estimated coefficients that refer to this co-integrating equation ($a_i$) show the speed of adjustment towards equilibrium in the model and they should be negative and statistically significant.

Having in mind that VECM uses first differences of the variables, they could be interpreted as an increase in the level of public debt and increase in GDP. Thus, if one recalls of the assumption that there is an inverse relationship between the growth rates of public debt and GDP, it is logically to obtain negative estimated coefficients for $c_{1,3}$, $c_{1,4}$, $c_{2,1}$ and $c_{2,2}$. Moreover, if these coefficients are simultaneously statistically significant, than the model indicates bi-directional relationship between the variables. Simpler way to test this hypothesis is to use Granger causality (block exogeneity) test. It is important to point

out that estimated model follows the assumptions of the ordinary least squares (OLS) method: normally distributed residuals, no serial correlation in the model and no hetero-skedasticity [Gujarati 2004, Stock and Watson 2006, Green 2012].

**Results' analysis**

Empirical analysis of the data has largely confirmed the initial assumptions about the connection between public debt and GDP. Above all, the research showed negative correlation coefficients between the growth rates of these two variables, which is mostly a result of the use of public debt as a counter-cyclical measure. It is interesting, though, that almost the same correlation coefficients between the growth rates of public debt and GDP are found in both countries, Macedonia and Romania (–0.46), which could be easily noticed from Figures 5 and 6.

Important message from these figures is the dynamics of the post crisis gap between the growth rates of the variables. Namely, both countries experienced economic stabiliza-
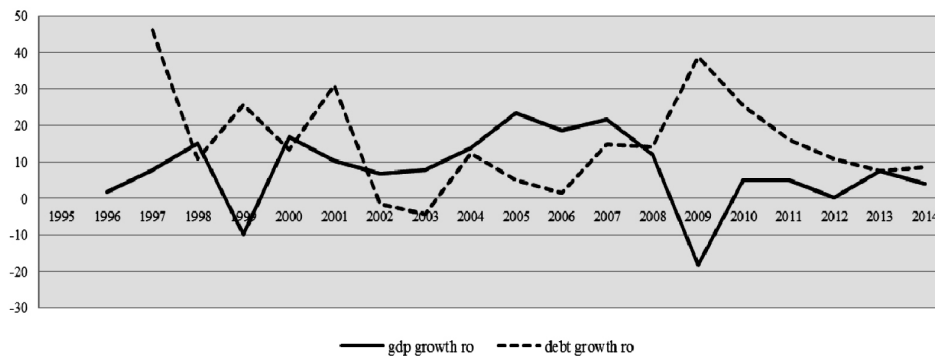
Fig. 5.  Growth rates of public debt and GDP in Romania
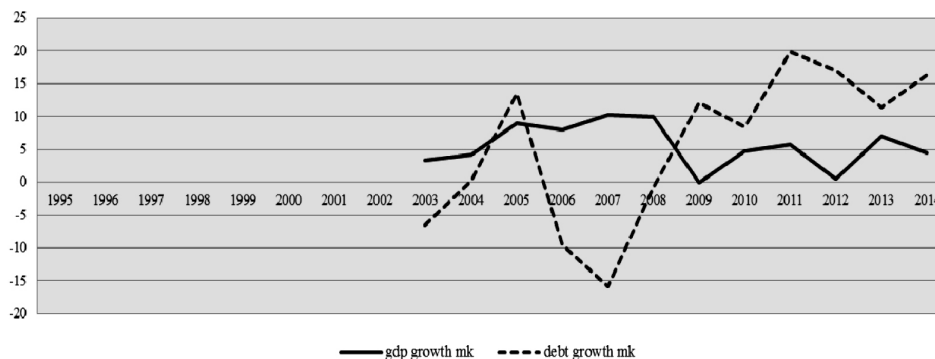Source:  Author's calculations.

Fig. 6.  Growth rates of public debt and GDP in Macedonia
Source:  Author's calculations.

tion after the economic and financial crisis. Romania and Macedonia faced the beginning of the financial and economic crisis with favorable trends (lowest level of public debt in Romania when it joined EU in 2007 and the low debt level in 2008 in Macedonia as a result of the early debt repayment). However, Romania and Macedonia witnessed a sharp decline in the GDP growth and increase in the public debt growth in 2009, whereas, both countries, after the initial impact of the crisis, went through a process of economic and financial stabilization, expressed in fairly favorable public debt and GDP growth rates. The main challenge in Macedonia was to maintain economic recovery without jeopardizing sustainability. Macedonia government's growth strategy focusing on attracting foreign investment and enhancing public infrastructure has produced robust growth and a well--diversified export portfolio [IMF 2015]. In the case of Romania, it reduced internal and external imbalances through sound macroeconomic policies [Dumitrescu 2014]. However, the main concern for Romania and Macedonia is both countries to implement sound macroeconomic policies, based on rationalized and redesigned public expenditures in order to adjust them to socio-economic needs of the current level of development in both economies.

Another confirmation of the theoretical assumptions is the econometric analysis of data in the case of Romania. Estimated equations for both variables in the VECM high level of the R-squared coefficients and both are statistically significant at 0.05 significance level. This means that data well fits the statistical model.

Regarding the long run relationship, obtained results of the model show significant negative co-integrating coefficient for the debt equation. This means that the model tends to equilibrium with speed of adjustment of 32.16%. Although also negative, co-integrating coefficient in the GDP equation is not statistically significant, therefore one cannot accept the hypothesis of long run causality of GDP from public debt.

On the other hand, short run relationship in the model could be explained by the estimated coefficients. Although some of them are not statistically significant at 0.05 significance level, they should be interpreted as a block of coefficients, not individually. For such interpretation Granger causality test is used. This test shows that there exists short run mutual relationship between variables. In other words, public debt Granger causes GDP and GDP Granger causes public debt, at 0.05 level of significance in the short run. Null hypotheses in the Granger causality test are as follows:

- $H_0$: $c_{1,3} = c_{1,4} = 0$ $\hspace{4cm}$ (2)

- $H_0$: $c_{2,1} = c_{2,2} = 0$ $\hspace{4cm}$ (3)

where: $c_i$ – short run coefficients from equation (1).

Finally, the influence of the financial crisis on GDP and public debt of Romania is notably expressed in the model. It shows highly significant coefficients of the intercept and the exogenous variable in both equations. The most interesting finding is that the increase of public debt in the crisis period is almost the same as the decrease of GDP in the same period (around 30%).

**CONCLUSION**

1. Non-stationary variables. For the case of Romania, both variables are integrated of first order I(1), whereas for Macedonia they are I(2). Higher level of integration of the variables, on one hand, and smaller sample of observations, on the other, makes modelling the data for Macedonia irrelevant.
2. Inverse relationship between growth rates of public debt and GDP. This conclusion is confirmed by obtained negative correlation coefficients of around –0.46 for both countries, as well as the figureical presentation of these data. It favours the use of public debt management as a means of counter-cyclical economic policy.
3. Estimated model for Romania is statistically significant and it fulfils the assumptions of the OLS method. Both equations of the model have high values of the F-statistics and high R-squared coefficients. Further, residuals in the model are normally distributed, homoskedastic and no serially correlated. Overall, the model is relevant to derive conclusions.
4. Mutual short run causality of the variables. Although not all of the estimated coefficients in the model for Romania are statistically significant, block exogeneity test (Granger causality test) indicates bi-directional causal relationship between variables. If one adds up here the negative sign of these estimated coefficients, it is another confirmation of the power of the public debt management as a means of counter-cyclical economic policy of the Romanian government.
5. Long run relationship from GDP to public debt. Statistically significant and negative error correction coefficient (–0.3216) in the estimated equation for public debt shows the speed of adjustment to equilibrium of 32.16% per period. This coefficient is also negative, but not significant in the equation for GDP (–0.09241), which means that there is only one-way long run relationship in the model for Romania.
6. High impact of the financial crisis. Economic reality in the model is shown by introducing dummy variable reflecting the financial crisis as exogenous variable. Estimated coefficients of this variable show 30% increase in the public debt and almost the same decrease in GDP in the first post-crisis year (2009). This is the ex-post reaction of the Romanian government to the financial crisis.

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## RELACJA MIĘDZY DŁUGIEM PUBLICZNYM A PKB – ANALIZA EMPIRYCZNA DLA MACEDONII I RUMUNII

**Streszczenie.** Kryzys finansowy z 2008 roku stał się przyczynkiem do szerokiej debaty dotyczącej wyzwań dla wzrostu i rozwoju ekonomicznego, które pojawiają się przy przekroczeniu pewnego progu relacji długu publicznego do PKB, mając równocześnie na uwadze, aby rozwój ten był zrównoważony, bez negatywnych konsekwencji dla przyszłego wzrostu. W niniejszym artykule analizie poddane są dane porównawcze dla Macedonii i Rumunii, mając jednocześnie na uwadze następujące fakty: obydwa kraje są byłymi członkami bloku socjalistycznego; obydwa kraje przeszły przez bolesny okres transformacji socjo-ekonomicznej; Rumunia jest krajem członkowskim Unii Europejskiej od 2007 roku i z tego powodu może stanowić dobry punkt odniesienia dla przyszłej polityki makroekonomicznej Macedonii, która w najbliższej przyszłości również stanie się członkiem UE. Wstępnym założeniem dla naszego badania jest istnienie związku przyczynowego w długim okresie między długiem publicznym a PKB, jak również istnienie odwrotnej relacji między tempem wzrostu tych dwóch zmiennych. Z tego względu przeprowadzono test kointegracji dla Rumunii, a następnie zastosowano model wektorowej korekty błędem (VECM).

**Słowa kluczowe:** dług publiczny, PKB, analiza, kointegracja, model wektorowej korekty błędem, test przyczynowości Grangera