Testing the macroeconomic impact of the budget deficit in EU Member States using linear regression with fixed effects

Dalian Marius DORAN[1], Nicoleta Mihaela FLOREA[2]
[1,2]University of Craiova
doran.dalian@yahoo.com, nmflorea@yahoo.com

Abstract. *The article aims to research impact of budget balance, whether surplus or deficit, on the main indicator characterizing the economic growth of a country, namely GDP and the inflation rate in the 27 European Union Member States and the United Kingdom. For this analysis was used panel data, taking into account the period from 2001 to 2015. The method used for the analysis is the linear regression with fixed effects and with Driscoll-Kraay standard errors. The dependent variables are the growth rate of real GDP and the inflation rate, and the independent variable is the budget balance (surplus or deficit). The results obtained after using econometric software Stata shows a positive impact of budget balance on growth in the European Union for the analyzed period.*

Keywords: budget balance, GDP, the inflation rate, linear regression.

JEL Classification: H62, H68.

1. Introduction

The influence of the budget balance on economic growth is a widely debated issue in economic policies. Over time, it noticed that significant increases of the level of the budget deficit also with the inflation rate were recorded in times characterized by economic crisis. This is why, during the periods of economic recession, on the relationship between the budget balance and the two dependent variables taken into account, numerous analyses were made to identify their possible negative effects.

Approaches about the size of the budget deficits, about funding, and in particular about debt sizing, have a lot of specific nuances for different tips of economies. The concrete social, economic, financial and administrative conditions raises a series of issues that require a very serious approach to the potentially unfavorable impact of a budget deficit and public debt dimensioning on real non-inflationary financing opportunities (Molanescu and Aceleanu, 2011).

The appearance of budget deficit is caused by several factors, such as: increase of activity of the invisible sectors of the economy; decrease of the production of goods and services in the economy corroborated with the increased spending to achieve certain social programs; raising marginal expenses for social production; issuance in excess that is not accompanied by economic growth. In other ways, the levels revenues and expenditures of the budget are also affected by the stage of the business cycle. In times of economic recession, the budget is deficient as a result of the reduction in collected revenues.

About the fact that the budget deficit is "detrimental" to social and economic life, there are different controversies, accepted or not, that have varied over time.

The economists' views about the effects of the budget deficits on the economic performance of a country have been structured into two main fields. On the one hand, it is considered that if the deficit is a result of the reduction of marginal tax rates, is has a stimulating effect on the labor productivity. On the other hand, the existence of

budget deficits is also considered a cause of instability and economic stagnation (Romer, 1988, p. 63).

In 1979, Barro identified a positive relationship between the budget deficit and inflation, and Sill (2005) analyzing a sample of 94 countries also concluded that there was a positive relationship between the two variables.

Also related to the impact of the budget deficit on inflation, Vit (2004), analyzing the evolution of certain indicators from 1995-2002 for the Czech Republic, highlighted that the budget deficit generates some barriers to inflation.

Fisher (1993) analyses the regression of the relationship between budget deficit and economic growth and identifies an inverse causality between the two variables, in the sense that the budget deficit generates a reduction in capital accumulation and productivity growth, leading to a reduction in the rate of growth of gross domestic product.

Al-Khedair (1996), however, concluded that the budget deficit generates a positive and significant impact on economic growth.

In 2005, Adama and Bevan analyzing the relationship between the two variables on a group of 45 countries identified the existence of a reverse causal relationship between the budget deficit and economic growth and the existence of a budget deficit of 1.5% of GDP Under which the causal relationship fades.

2. The evolution of the budget balance in the EU Member States during 2001-2015

In this section, we will analyze the evolution of the budget balance as a percentage of GDP for all EU Member States from 2001 to 2015, taking into account especially the recession period that characterized the world economies in this time interval.
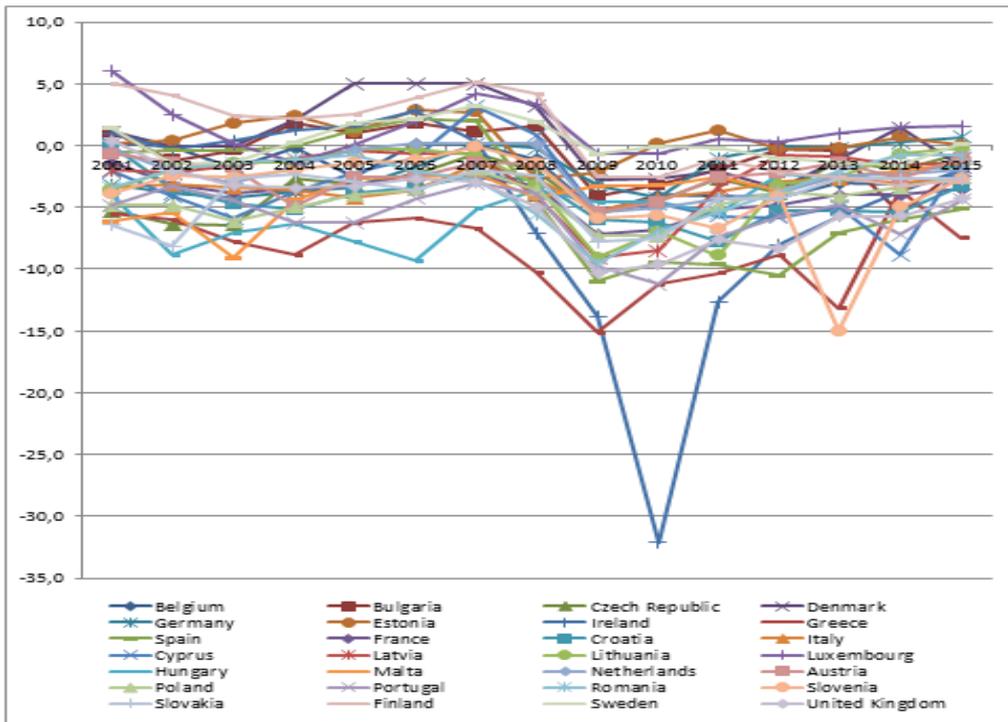
Chart 1. Evolution of budget balance (% of GDP)
Source: Own processing using data from the Eurostat website

Analyzing chart no. 1, it can be noticed that at the level of the European Union the fluctuations of the budget balance are between -10 and 5% of GDP. We see an increasing trend of the budget surplus in the period 2005-2008, and as of 2009 we notice that no EU member state has registered the positive budget balance. This is explained by the deployment of the global economic crisis at the end of 2008.

This negative trend continues in the following period, with some exceptional cases where excessive budget deficits have been recorded. Here we are referring to Ireland, which in 2010 recorded the highest budget deficit in the European Union for the analyzed period   (-31.1% of GDP), followed by Greece, which in 2009 had a budget deficit of -15.1 % of GDP and Slovenia, which reached a budget deficit of -15% of GDP.

At the opposite end is Luxembourg, which in 2001 recorded a budget surplus of 6% of GDP, followed by Finland with a budget surplus of 5.1% of GDP in 2007 and Denmark, which managed to maintain a budget surplus of 5% in GDP for three consecutive years, 2005, 2006 and 2007, respectively.

3. Methodology and data analysis

The economic and financial implications of the budget balance (surplus or deficit) on economic growth and the rate of inflation will be highlighted by simple linear regression.

The mathematical relationship of linear regression for panel data is of the form:

$$Y_t = \alpha + \beta X_t + \varepsilon_t$$

where:
Y – the dependent variable;
X – the independent variable;
ε – the stochastic variable;
α,β – scalar coefficients;
t – the period of time.

The dependent variables in this research are the real GDP growth rate and the inflation rate, and the independent variable is the budget balance. For the 15-year period (2001-2015), panel data were collected for the identified variables from the 27 EU Member States and the United Kingdom. The data were collected from the official website of the European Union (Eurostat) and AMECO.

We will first analyze the impact of the budget balance on the real GDP growth rate. The regression equation becomes the following:

$$GDP_t = \alpha + \beta DEF_t + \varepsilon_t$$

where:
GDP = the real GDP growth rate;
DEF = budget balance.

Similarly, the regression equation for estimating the impact of the budgetary balance on the inflation rate will be:

$$INF_t = \alpha + \beta DEF_t + \varepsilon_t$$

where:
INF = the inflation rate;
DEF = budget balance.

There are several types of data panel models. The main distinction is between fixed and random effects. In order to decide whether it is more appropriate to use a linear regression model with fixed effects or random effects we can perform a

Hausman test. The most widely used estimator for fixed effects models is the within estimator. It eliminates fixed effects by mean differences.

In Stata, the within estimator is calculated using the *xtreg* command along with the *fe* option. Following the order in the Stata, the Hausman test result indicates that an estimated fixed model is required. The Pesaran test indicates cross-sectional dependence.

At the same time, the xtreg command estimates the model assuming homoscedasticity. The xttest3 command in Stata calculates a modified Wald test to determine the residual heteroscedasticity of a fixed-effect regression model (Baum, 2001). The Wald test indicates acceptance of the heteroscedasticity hypothesis. The Lagram-Multiplier test indicates the acceptance of the serial correlation hypothesis.

The results obtained for the budget balance as the independent variable and the real GDP growth rate as a dependent variable are presented in Table 1.

The next step is to check the non-autocorrelation hypothesis of residues. Several autocorrelation tests have been proposed in data panel models, but the one discussed by Wooldridge (2002) is particularly attractive because it is based on relatively few hypotheses and is easy to implement (Drukker, 2003).

Table 1. Estimation of the linear regression equation with fixed effects and random effects

VARIABLES	(1) Fixed Effects	(1) Random Effects
Def	0.00712***	0.00579***
	(0.000654)	(0.000581)
Constant	0.0414***	0.0377***
	(0.00239)	(0.00302)
Observations	420	420
R-squared	0.233	0.233
Number of countries	28	28
Country FE	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Hausman Test: p < 0.01
Pesaran test: p < 0.01
Modified Wald test for groupwise heteroskedasticity in fixed effect regression model: p < 0.01
Lagram-Multiplier test for serial correlation: p < 0.01
Source: own processing using Stata econometric software

This test is implemented in the State by David Drukker under the name xtserial. The xtserial command performs a Wald test in which the null hypothesis asserts that there is no first-order autocorrelation. State has a long tradition in estimating standard errors that are robust against certain violations of the econometric model hypothesis. The xtscc program, implemented by Daniel Hoechle (2007), estimates the fixed-effect regression model with Driscoll and Kraay errors.

Consequently, we will use the regression model with Driscoll-Kraay standard errors, built for data that accept the hypotheses of heteroscedascity, cross-sectional dependence and serial correlation.

4. Results

From the results it can be noticed that the budget deficit positively influences the GDP: in the situation where the deficit increases, the GDP is also increasing. The situation is counterintuitive, but this can be explained by the European model, where GDP growth was achieved in most situations under conditions of increasing the budget deficit. Thus, the existence of budget deficit has become nowadays a common phenomenon for many states, amid increasing public spending.

Against the backdrop of worsening economic imbalances, respondents to state intervention in regulating economic mechanisms, especially through the use of the increase in public spending, have proposed some approaches aimed first of all to redefine the concept of budgetary balance and to propose several issues on the role of budget deficits in the stimulation of economic growth process.

Thus, even in practice but more in doctrine, it was proposed to subordinate the financial balance to the general economic equilibrium, considering that the financial equilibrium is only a component of the latter. Starting from this general idea emerged the theory, formulated for the first time by William Beveridge, called the "systematic deficit theory", according to which the general economic balance can be reached on the path of the budget deficit.

Table 2. Model estimation using Driscoll-Kraay standard error regression

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Regression with Driscoll-Kraay standard errors    Number of obs    =      420
Method: Fixed-effects regression                   Number of groups =       28
Group variable (i): cluster                        F(  1,    27)    =    16.80
maximum lag: 2                                      Prob > F         =   0.0003
                                                   within R-squared =   0.2331


                              Drisc/Kraay
        gdp     Coef.     Std. Err.      t     P>|t|      [95% Conf. Interval]

        def   .0071243    .001738     4.10    0.000      .0035582     .0106903
      _cons   .0414277    .0042709    9.70    0.000      .0326646     .0501909
```

Source: own processing using Stata econometric software

The systematic deficit theory is likely to lead to balanced economic growth, but in practice it is limited, on the one hand, to the state's lending capacity and, on the other hand, to the efficiency of state use, by economic principles, of the resources thus attracted from the market. The more and more frequent use of budget levers as a means of intervening in the economy, as well as the difficulties encountered in balancing the state budget on an annual basis, have led to the idea that the budget should not be balanced each year, but only one cycle economic.

As surpluses during favorable periods are to cover deficits in bad times, the followers of these approaches consider budget deficits as a means of achieving economic balance and re-launching development processes.

For the second equation where the dependent variable is the inflation rate, the result of the heteroscedasticity and autocorrelation tests is the same as in the previous

model for both fixed-regression and regression with random effects. The Hausman test indicates that it is necessary to estimate a fixed-effect model. The Pesaran test indicates cross-sectional dependence. The Wald test indicates acceptance of the heteroscedasticity hypothesis. The Lagram-Multiplier test indicates the acceptance of the serial correlation hypothesis.

Therefore, in the case of the second equation, we will use the Driscoll-Kraay regression model standard errors built for data in which the hypotheses of heteroscedasticity, cross-sectional dependence and serial correlation are assumed (table no.3).

From the resulting table it is found that the deficit has a negative influence on the inflation rate: if the deficit rises, the inflation rate will decrease. The situation is totally counterintuitive because a large budget deficit generates inflationary tensions.

Table 3. Model estimation using Driscoll-Kraay standard error regression

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Regression with Driscoll-Kraay standard errors   Number of obs    =       420
Method: Fixed-effects regression                  Number of groups =        28
Group variable (i): cluster                       F( 1,    27)     =     10.26
maximum lag: 2                                     Prob > F         =    0.0035
                                                  within R-squared  =    0.0464


                        Drisc/Kraay
      inf     Coef.    Std. Err.      t     P>|t|     [95% Conf. Interval]

      def   -.9436166   .2946447   -3.20    0.003    -1.548178   -.3390556
     _cons  85.06466    4.24328    20.05    0.000     76.35817    93.77115
```

Source: own processing using Stata econometric software

As is well known, the budget deficit occurs when government spending exceeds the revenue it receives. Among the ways to cover this deficit were monetary issues and government loans, and exceptionally the sale of state assets.

Against the background of structural crisis phenomena, the increase of budget deficits beyond the non-inflationary financing limits comes as an additional factor that contributes to the exacerbation of the imbalances in the economy. In addition, where budget expenditures are directed primarily to the satisfaction of the state redistribution function and to subsidies, in the absence of a real multiplier, the state of budget deficits worsens. One way used to cover budget deficits, which can have a strong negative impact on correlations in the real and financial economy, is the extra, uncovered, issue of national currency. This only leads to an uncontrolled and unjustified increase in the money supply, which immediately aggravates the inflationary phenomena in the economy. On the other hand, some specialists believed that if the budget deficit was covered by loans, inflation would not show yet, but Sargent and Wallace (1981) showed that actually covering the budget deficit through loans just postponed inflation.

5. Conclusions

Nowadays, the knowledge of the budget deficit and the concern for its continuous diminution are of great significance for all EU Member States, especially as the majority face major difficulties in the evolution of the economy as a result of the deployment of the global economic crisis since the beginning of the year 2008. On the

other hand, these states, as Member States of the European Union, have to respect the condition imposed by the EC Treaty on limiting the budget deficit to 3% of gross domestic product and debt to 60% of GDP by 2012.

As a result of the analysis, we found a positive impact of the budget balance on economic growth, explained by the fact that in the last years the GDP growth was achieved under conditions of increase of the budget deficit in most EU Member States.

In the case of the impact of the budget deficit on the inflation rate, the results are not robust and contradict the hypothesis formulated, and this will be subjected to a more detailed analysis in which we will use further tests: estimating regressions by group of countries (the old EU Member States And the new EU Member States) and by time (2001-2007, 2008-2012, 2012-2015). In this way, more robust results could be obtained.

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