

## ASSESSING THE FISCAL SUSTAINABILITY OF GOVERNMENT FINANCES IN EUROPEAN COUNTRIES

Yuriy Melnykov

Scientific & Technical Complex of Statistical Research

Address: 27B/70 Svyatoshinska str., apt. 52, Vishneve, Kyivska oblast, UA-08132 Ukraine

E-mail: melnykov@yahoo.com

Received: June 2013

Revised: September 2013

Published: November 2013

**Abstract.** This paper analyses the fiscal sustainability of government finances in the 27 EU countries and Norway using an empirical, statistical approach and ADF tests for a unit root in the time series of the differences between the GDP growth rate and the long-term interest rate, and the primary balance.

**Keywords:** Fiscal sustainability, government finances, solvency, unit root.

### 1. Introduction

The fiscal sustainability of government finances has become a critical issue for many countries around the world after the financial crisis of 2008, especially in the Eurozone that has been hit hard. These countries faced downfalls in key macroeconomic indicators such as GDP growth rates and government revenue, simultaneously with increasing government expenditures and debt stock. Greece, Spain, Portugal and Ireland are the examples of countries with debt and solvency problems.

This article analyses the fiscal sustainability of government finances using an empirical approach and statistical tests.

### 2. Sustainability framework

A government finances a budget deficit through the issuance of debt when that country's expenditure exceeds revenue [4]:

$$\text{Deficit financing} = \text{Net issuance of debt} + \text{Seigniorage} \quad (1)$$

or expressed in mathematical notation as:

$$G_t - T_t = (B_t - B_{t-1}) + (M_t - M_{t-1}), \quad (2)$$

where  $t$  – time,  $G_t$  – government expenditure,  $T_t$  – government revenue,  $B_t$  – quantity of public debt at the end of period  $t$ ,  $M_t$  – monetary base at the end of period  $t$ .

If we subtract interest payments ( $I_t$ ) from both sides of equation (2) we get:

$$G_t - T_t - I_t = (B_t - B_{t-1}) + (M_t - M_{t-1}) - I_t. \quad (3)$$

Since  $[T_t - (G_t - I_t)]$  is the primary balance, we obtain:

$$(B_t - B_{t-1}) = I_t - X_t - (M_t - M_{t-1}) \quad (4)$$

where  $X_t$  is the primary balance in time  $t$ .

The identity (4) is the government budget constraint and the central concept of fiscal sustainability analysis.

Another key indicator is the inter-temporal budget constraint, which states that the government finances its initial debt by the present value of future primary surpluses:

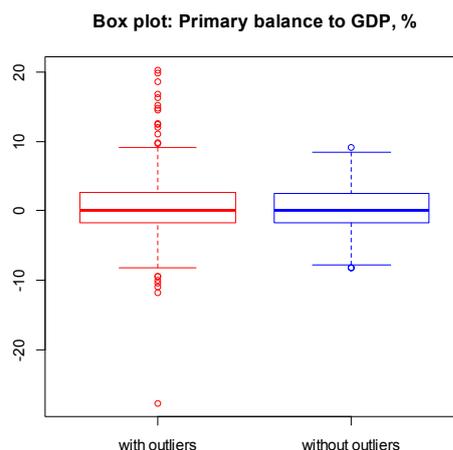
$$B_t = \sum_{i=1}^{\infty} (1+r)^{-i} X_{t+i} \quad (5)$$

### 3. Empirical and statistical analysis in assessing fiscal sustainability

There are four important variables in assessing fiscal sustainability: Primary balance to GDP, Public Debt to GDP, Long-term interest rate and GDP growth rate. We are going to investigate the effect of these variables on the fiscal sustainability of government finances.

The budget is said to be balanced if government revenue equals its expenditure. We believe that countries tend to have a balanced budget process in the long-run (eventually all revenues and expenditures must equal). We cannot say that about the short-run or medium-run and this is the task of fiscal sustainability analysis.

Let's look at the box plot for the sample of the primary balance to GDP ratio in percentages for 28 countries from 1997-2012 in figure 1, on the left (the list of the countries includes the 27 EU countries and Norway). As we can see, the shape of the data is quite symmetric (a little bit right-skewed with extreme observations) and centered approximately around zero. Although this dataset has some very extreme observations from -27.67% of primary deficit to 20.25% primary surplus, we would like to concentrate on most of the observable data and treat negative extreme observations as the ones when country definitely has fiscal problems. On the other hand, positive extreme observations may tell us that the government generates high surpluses in order to reduce its debt burden faster.



**Fig. 1.** A sample of 448 primary balances to GDP in percentages for 28 countries from 1997 to 2012  
*Source:* AMECO database – European Commission and author's calculations.

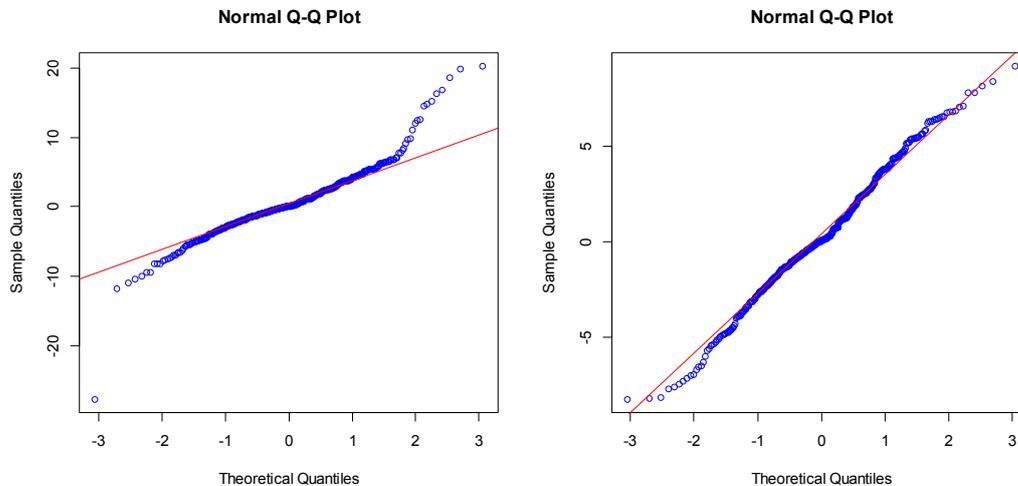
We can eliminate outliers in our sample from both ends and try to get robust estimation for the mean in order to test a country's ability to repay its debt.

Table 1 shows summary statistics for two datasets: with and without outliers respectively. We can see that the mean, median, first quartile and third quartile haven't changed much after removing outliers.

**Table 1.** Summary statistics for the samples of 448 primary balances to GDP

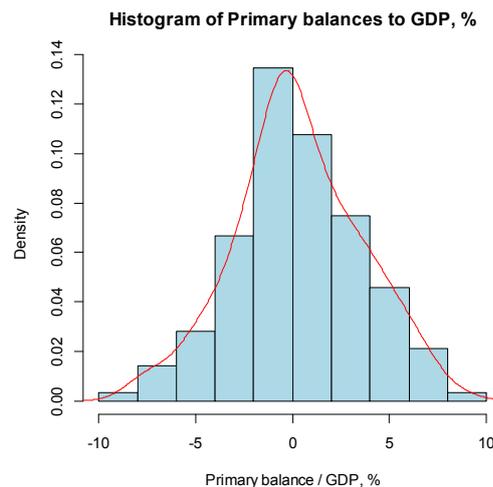
Sample	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	IQR	SD
with extreme observations	-27.67	-1.79	0.07	0.52	2.66	20.25	4.45	4.51
without extreme observations	-8.26	-1.73	0.03	0.28	2.48	9.18	4.21	3.30

Figure 2 shows Quantile-Quantile plots for the sample with (on the left) and without (on the right) outliers. As we see, the distribution of the sample without outliers approximately normal.



**Fig. 2.** Quantile-Quantile plots for the sample of primary balances with and without outliers (left and right panel respectively)

We can also observe this in figure 3, which shows the same distribution.



**Fig. 3.** A sample of 448 primary balances to GDP in percentages for 28 countries from 1997 to 2012  
*Source:* AMECO database – European Commission and author's calculations.

As we mentioned above, the budget process should be balanced in the long-run because in the end all revenues must equal expenditures. Now let's test the hypothesis that the average ratio of the primary balance to GDP equals zero using the sample of primary balance to GDP ratios without outliers.

One Sample t-test:

$H_0: \mu = 0$  (the average ratio of the primary balance to GDP equals zero).

$H_A: \mu \neq 0$  (the average ratio of the primary balance to GDP does not equal zero).

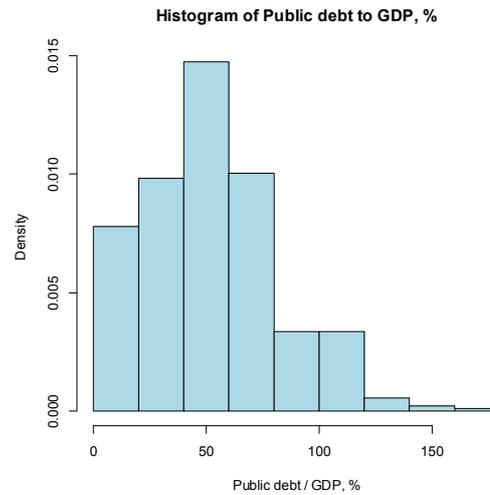
$t = 1.729$ ,  $df = 426$ ,  $p\text{-value} = 0.08454$

95% confidence interval: (-0.0377, 0.5896)

The  $p\text{-value} = 0.08454 > 0.05$ , so we fail to reject the null hypothesis that the average ratio of the primary balance to GDP is equal to zero.

Based on the results we obtained from our test, we can suggest that in the long-run countries have indeed a balanced budget process, so that revenues must equal expenditures.

The distribution of the public debt to GDP ratios for the 28 countries from 1997 to 2012, shown in figure 4, has mean 51.7% (95% confidence interval: 48.97, 54.43) and standard deviation 29.39%. This distribution is right-skewed.



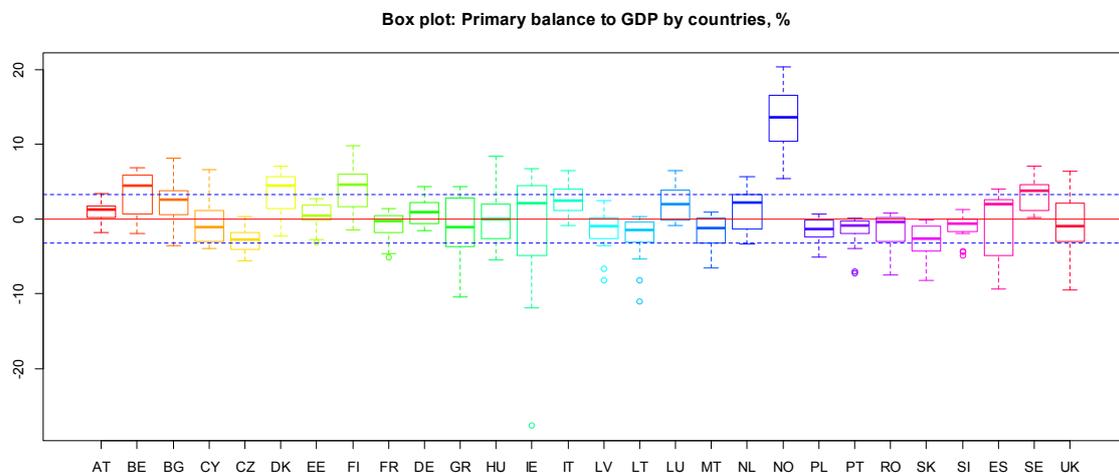
**Fig. 4.** A sample of 448 public debts to GDP in percentages for 28 countries from 1997 to 2012  
*Source:* AMECO database – European Commission and author’s calculations.

The summary statistics for the sample of public debt to GDP is shown in the table below.

**Table 2.** Summary statistics for the samples of 448 public debts to GDP

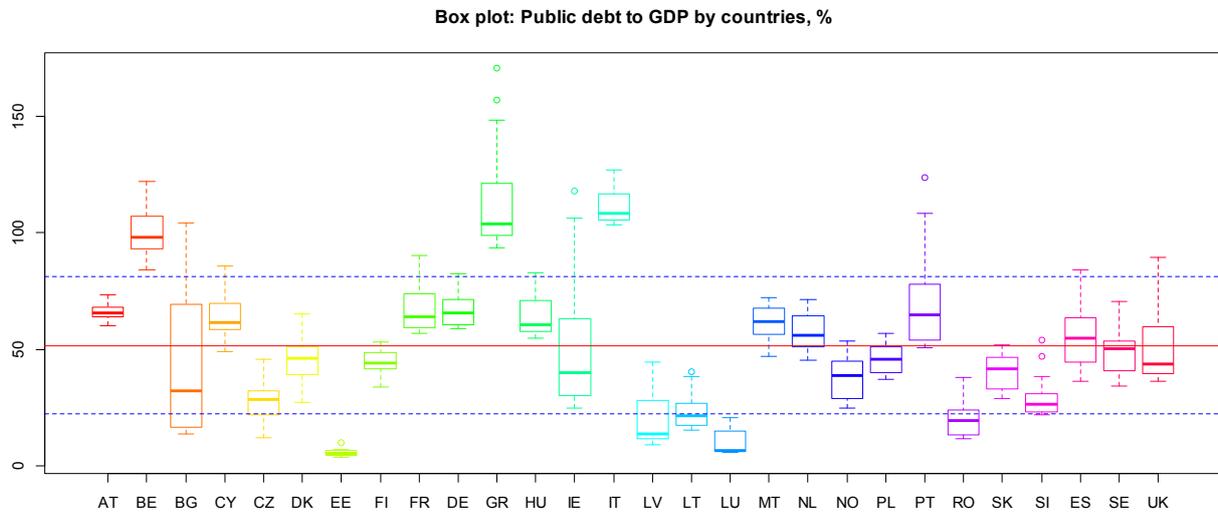
Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	IQR	SD
3.68	29.47	49.71	51.70	66.19	170.30	36.72	29.39

Now let’s look at figure 5, it shows the box plots of primary balances to GDP for all 28 countries from 1997 to 2012. The horizontal red line is the mean of the primary balance to GDP ratio which equals zero as we suggested above. The two dashed blue lines are the standard deviations for the sample without outliers (-3.30, 3.30). We can observe that 23 or 82% of the country medians are less than one standard deviation and none of them are less than one negative standard deviation. We also calculated that none of the country means is below the negative threshold of -3.3%. We would like to take that fact as an indicator for assessing fiscal sustainability, so if the country has primary balance (primary deficit) to GDP ratio less than -3.3% in a particular year then it has a risk of having unsustainable government finances.



**Fig. 5.** Box plots of primary balance to GDP by country from 1997-2012  
*Source:* AMECO database – European Commission and author’s calculations.

Figure 6 shows box plots of the public debt to GDP ratio for the 28 countries from 1997 to 2012. The horizontal red line is the mean of the public debt to GDP ratio (51.7%). The two dashed blue lines are the boundaries of one standard deviation from the mean of the public debt to GDP ratio (51.7% - 29.39%, 51.7% + 29.39%).



**Fig. 6.** Box plots of public debt to GDP by country from 1997-2012  
*Source:* AMECO database – European Commission and author's calculations.

We see that only three countries have medians which are more than the upper bound: Belgium, Greece and Italy. We would like to take that fact also as an indicator for assessing fiscal sustainability. If country has a ratio of public debt to GDP in a particular year of more than the upper bound (81.09%) than it has a risk of having unsustainable finances.

**Table 3.** Countries with a potential risk of unsustainable government finances

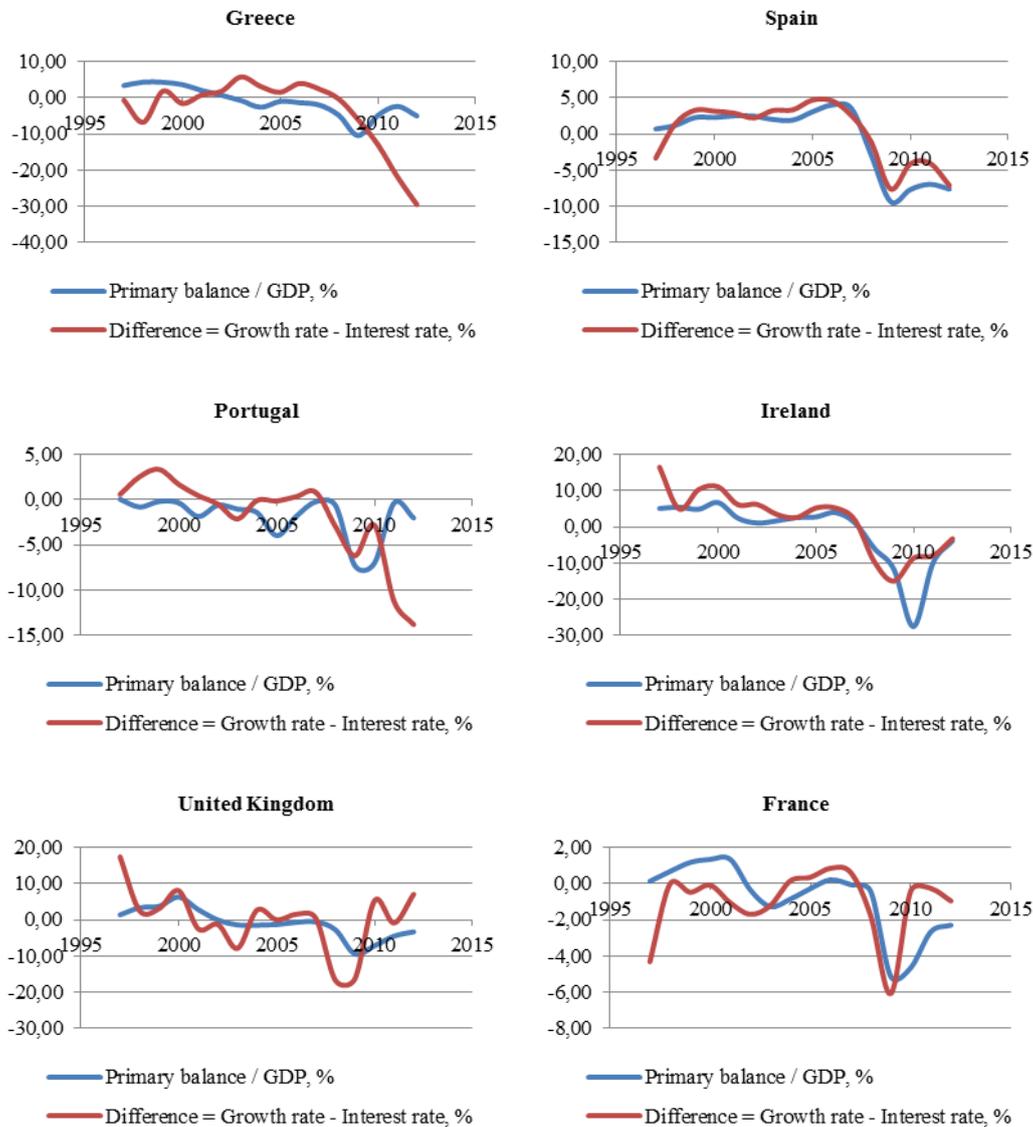
Year	Country	Primary balance to GDP, %	Public Debt to GDP, %	Long-term Interest rate, %	GDP growth rate, %
2012	Greece	-5.01	156.85	22.56	-7.09
2012	Spain	-7.65	84.22	5.85	-1.30
2011	Ireland	-10.03	106.42	9.60	1.60
2011	United Kingdom	-4.54	88.79	3.05	2.16
2010	Ireland	-27.67	92.15	5.74	-2.97
2010	Greece	-4.89	148.32	9.09	-3.86
2010	France	-4.66	82.33	3.12	2.73
2010	Portugal	-7.02	94.01	5.40	2.57
2009	Greece	-10.45	129.69	5.17	-0.91
2009	Portugal	-7.32	83.72	4.21	-2.01
2008	Greece	-4.81	112.91	4.80	4.50

*Source:* AMECO database – European Commission and author's calculations.

Taking into account our indicators, we split the countries first by the critical value of the primary balance to GDP ratio of -3.3%, because having sufficient primary surpluses is crucial for sustainable government finances. The obtained sample we split again by the critical value of the public debt to GDP ratio of 81.09%. The result is presented in table 3. This table tells us that countries started to have risks of having unsustainable government finances after financial crisis in 2008. Greece is observed almost in every year, except 2011. For this country, the stock of debt is rising each year coupled with primary deficits, high interest rates and negative GDP growth rates.

In the literature of assessing fiscal sustainability, there are many papers that use an analysis of time series of fiscal data, the most important are Hamilton and Flavin [5], Trehan and Walsh [6].

We also propose another procedure for assessing the fiscal sustainability of government finances by testing for a unit root in the following time series: [GDP growth rate] – [long-term interest rate] – [Primary balance to GDP]. Figure 7 shows times series of Primary balance to GDP and the difference between GDP growth rate and long-term interest rate for the countries listed in table 3.



**Fig. 7.** Time series of primary balances to GDP and differences between GDP growth rates and long-term interest rates  
*Source:* AMECO database – European Commission and author's calculations.

Table 4 contains the results of an ADF test for the difference between GDP growth rate and long-term interest rate and Primary balance to GDP. As we can see, Greece and Portugal are at the risk of having unsustainable government finances.

**Table 4.** Augmented Dickey-Fuller Test

Country	Lag order	ADF test statistic	P-value	Risk of having unsustainable government finances
Greece	0	0.217	0.6768	Yes
Portugal	0	-1.2551	0.2095	Yes
Spain	0	-2.9036	0.01	No
Ireland	0	-3.8726	0.01	No
United Kingdom	0	-3.8845	0.01	No
France	0	-3.0429	0.01	No

#### 4. Conclusions

In this paper we analyzed the fiscal sustainability of government finances in the 27 EU countries and Norway. We found that the distribution of primary balances to GDP is approximately normal with mean zero and standard deviation 3.3%. This gave us the intuitive conclusion that the budget process of a country should be balanced or at least the ratio of primary deficit to GDP should not be below -3.3% in a particular year. Otherwise, it might have a risk of being unsustainable. We also found that the ratio of public debt to GDP should not be more than 81%.

We came to the conclusion that Greece and Portugal are still at the high risk of having unsustainable government finances at the end of 2012.

#### References

1. Afonso, A. 2005: Fiscal Sustainability: The Unpleasant European Case, *FinanzArchiv*, 61 (1), p. 19-44.
2. Van Aarle B., and Kappler M., 2011: Fiscal Adjustment in Greece: In Search for Sustainable Public Finances, *ZEW Discussion Papers*, Mannheim, paper No. 11-080.
3. Bohn, H. 1995: The Sustainability of Budget Deficits in a Stochastic Economy, *Journal of Money, Credit and Banking*, 27, p. 257-271.
4. Burnside C. 2005: *Fiscal Sustainability in Theory and Practice: a Handbook*, Washington, D.C, The World Bank.
5. Hamilton H. D., and Flavin M. A. 1986: On the Limitations of Government Borrowing: A Framework for Empirical Testing, *The American Economic Review*, 76(4), p. 808-819.
6. Trehan, B., and Walsh C., 1991: Testing Intertemporal Budget Constraints: Theory and Applications to U.S. Federal Budget and Current Account Deficits, *Journal of Money, Credit and Banking*, 23, p. 206-223.

### EUROPOS ŠALIŲ VALDŽIOS SEKTORIAUS FINANSŲ FISKALINIO STABILUMO VERTINIMAS

Yuriy Melnykov

**Santrauka.** Straipsnyje empiriniu, statistiniu požiūriu analizuojamas 27 Europos Sąjungos šalių ir Norvegijos valdžios sektoriaus finansų fiskalinis stabilumas, taikant bendrojo vidaus produkto augimo tempų, ilgalaikių interesų lygio ir pirminio balanso skirtumų laiko sekų Dikio ir Fulerio praplėstąjį vienetinės šaknies kriterijų.

**Reikšminiai žodžiai:** fiskalinis stabilumas, valdžios finansai, mokumas, vienetinė šaknis.