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Which country after Greece? Sustainability of budget deficits in selected EU countries: A panel cointegration analysis with multiple structural breaks under cross-section dependence

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Abstract. *The sustainability of budget deficits is one of the most important macroeconomic problems in countries. High public spending and insufficiency of public revenue are the main reasons for the collapsing of Greek, Italy, Spain, Portugal and Ireland economies. In this study, the sustainability of budget deficit has been examined for 17 EU countries by means of panel cointegration with multiple structural breaks under cross-section dependence, for the period of 1996-2012. At the end of the analysis; cross-section dependence was determined in these countries. Therefore, an economic shock that comes to one of these countries also affects the others. According to the long-run analysis, budget deficits of these countries are sustainable in weak form.*

Keywords: sustainability of budget deficits, cross-sectional dependence.

JEL Classification: C23, H61, H62.

1. Introduction

A system that is economically sustainable keeps internal and external debt at manageable levels and ensures continuous production of goods and services (Haris, 2000). Fiscal balance is essential for increasing investments and sustainable economic growth (Blanchard, 2010). There are many undesirable effects of public debt such as disruption of social security programs, crowding out of capital and the generational imbalance of tax burden (Aso, 2013). The fiscal crises observed in countries such as Greece, Italy, Ireland, Portugal, and Spain, turned on the red light for emerging economies (Mendonça and Machado, 2013). With the concept of sustainability in terms of budget, governments should be able to fulfil their obligations to current and future generations by managing financial resources. For that reason, the sustainable budget system ensures allocation of public resources fairly between generations, keeps the interest rates at a level to encourage investments, eliminates uncertainty and makes the economy more durable against unexpected shocks (Intergenerational Report, 2002). That's why governments are required to balance their budgets inter-temporally by setting the current value of debt equal to the discounted sum of expected future surpluses (Chen, 2014).

The idea that governments should intervene in the economy at the expense of the state budget deficit began with Keynes. Budget deficits have become a growing and permanent problem for countries. Many countries are attempting to pay the debts of the day, by means of the new debts (Huidumac-Petrescu and Popa, 2016) . This situation is making financing and sustaining the budget deficit much more difficult and it causes a vicious cycle of debt and can cause economic crises (Collignon, 2012).

In order to decrease the level of indebtedness of countries, some arrangements have been accepted with Maastricht Criteria in 1993. According to these arrangements, so as to participate The European Monetary Union (EMU) for European Union (EU) member states, the ratio of the annual government deficit to Gross Domestic Product (GDP) shouldn't exceed 3% at the end of the preceding fiscal year and the ratio of gross government debt to GDP shouldn't exceed 60% at the end of the preceding fiscal year. Nowadays many European Union member states do not meet these criteria. For example in Europe, indebtedness reached a very high state; it passed over acceptable limits and became serious problem and threat to global economy (Staněk, 2004). If budget deficit reaches to an unmanageable level by growing continuously over time, it affects whole economy so much that the government needs to take steps to reduce it (Yoon, 2012).

There are various indicators to determine a sustainable level of budget deficit such as debt to GDP ratio, foreign debt to exports ratio, government debt to current fiscal revenue ratio, share of foreign debt to total debt and short-term debt to total debt. For example, the threshold for debt sustainability can be accepted for debt to export ratio of 150%, debt to Gross National Income (GNI) ratio of 250% (IMF, 2000). According to Manasse and Roubini (2009), a relatively debt safe country type is described by a handful of debt management prerequisites: low total external debt below 49.7% of GDP, low short-term debt below130% of reserves, low public external debt below 214% of fiscal revenue and an exchange rate that is not excessively appreciated overvaluation below 48%.

Main aim of this study is to examine the sustainability of budget deficit for 17 EU countries whose budget deficit exceeded 3% of the GDP in 2012 by means of panel unit root and cointegration test with multiple structural breaks under cross-section dependence, for 1996Q1-2012Q4 period. The following parts of this paper are organised as follows: in the second section, theoretical background of the sustainability of budget deficit will be investigated, third section includes information about the budget deficit of countries, fourth section contains the literature summary and the fifth section involves the empirical analysis. The study will be completed with the conclusion and policy implications.

2. Theoretical background

Sustainability of budget deficit is discussed with the accounting approach and intertemporal budget constraint approach (Sriwardana, 1998). In the first approach, sustainability of budget deficit takes place if present discounted value of future primary surplus is greater or equal to the current public debt stock (Trehan and Walsh, 1988; Hakkio and Rush, 1991; Haug, 1991). However, governments encounter limits to how much they can borrow. They face a present-value borrowing constraint; in other words, governments must balance their budgets intertemporal by setting the current market value of debt equal to the discounted sum of expected future surpluses (Quintos, 1995). If governments continually increase their debt at a rate that exceeds the growth rate of the economy, it causes debt service to absorb more and more of national income (Labonte, 2012). This is the common idea behind all modern models of debt sustainability (Collignon, 2012).

In the second approach the sustainability of budget deficits depends on the equality of total values of assets and liabilities of state to each other or more assets than liabilities in the present and future (Buiter, 1985; Anand and Wijnbergen, 1989; Blejer and Cheasty, 1991). In this respect, Hakkio and Rush (1991) analysed US economy. Relationship between government expenditures and government revenues examined via intertemporal budget constraint approach by using 1950:Q2-1988:Q4 period data. Budget revenue and expenditure to GDP ratio are used. Provided that the cointegration relationship exists between the series, whether the coefficient is equal to one was tested. If the parameter is equal to one, the budget deficits are sustainable, while smaller than one is considered to be unsustainable budget deficits in the long run. Later, Quintos (1995) expanded these conditions. If the coefficient of the budget expenses is equal to one, the budget deficits sustainability is considered strong. If it is between zero and one, sustainability is in a weak form. According to Hakkio and Rush (1991) the government's one period budget constraint is written as follows:

$$EXP_t + (1+i)_t B_{t-1} = REV_t + B_t \qquad (1)$$

where EXP_t is government expenditure, B_t is government debt at time t, i is interest rate and REV_t is government revenue. Forward substitution yields:

$$B_0 = \sum_{t=1}^{\infty} r_t(REV_t - EXP_t) + \lim_{n\to\infty} r_n B_n \quad (2)$$

where $r_t = \prod_{s=1}^{t} \sigma_s$ and $\sigma_s = \frac{1}{1+i_s}$. For the intertemporal budget deficit sustainability to hold, the limit term in equation (2) must be zero. This restriction is to provide the condition of no-Ponzi Game where government issues new debt to finance its deficits. The restriction also means that the stock of government debt B_0 must be equal to the present value of primary budget surpluses $\sum_{t=1}^{\infty} r_t(REV_t - EXP_t)$. Assuming that the interest rate is stationary, Hakio and Rush (1991) transform equation (1) into the following equation that has the testable implications:

$$REV_t = \beta_0 + \beta_1 EXP_t + u_t \quad (3)$$

where REV_t is government revenue, EXP_t is government expenditure inclusive of interest payments on the debt and u_t is stochastic error term.

3. Budget deficits in EU countries

In recent years, it can be said that uncontrolled budget deficits have a significant share for the economic crises that are experienced in different countries. Budget deficits lies on the basis of the economic problems in Ireland, Greece and Spain. The risk of a default on Greek has thrown the Euro into its first serious crisis and raised the issue of the sustainability of public debt in Europe (Collignon, 2012). The budget deficits to GDP ratio of the selected countries were presented in Table 1.

Table 1. *General government net lending (Percent of GDP)*

	2000	2006	2007	2008	2009	2010	2011	2012
Ireland	4.6	2.8	0.1	-7.3	-13.9	-30.9	-12.7	-8.3
U. Kingdom	3.5	-2.7	-2.8	-5.0	-10.3	-9.9	-8.5	-8.2
Greece	-3.7	-6.0	-6.8	-9.9	-15.5	-10.4	-9.1	-7.5
Spain	-0.9	2.0	1.9	-4.1	-11.1	-9.3	-8.9	-6.9
Portugal	-3.3	-3.7	-3.2	-3.6	-10.1	-9.8	-4.2	-4.9
France	-1.5	-2.3	-2.7	-3.3	-7.5	-7.1	-5.1	-4.7
Netherlands	1.9	0.5	0.1	0.5	-5.3	-5.1	-4.6	-3.6
Belgium	-0.1	0.3	-0.1	-1.1	-5.6	-3.8	-3.8	-3.2
Italy	-0.9	-3.4	-1.5	-2.6	-5.3	-4.4	-3.8	-3.0

Source: IMF-International Financial Statistics (2014).

According to Table 1, the ratio of the budget deficit to GDP in 2012 was very high in Ireland, United Kingdom, Greece, and Spain. Especially the United States and other major economies, appear to be higher than the 3% level of the Maastricht criteria. The sustainability of budget deficits in these countries is at risk. Countries and international organizations must take action against that situation. The ratios of the general government gross debt to GDP in selected countries were presented in Table 2.

Table 2. *General government gross debt (Percent of GDP)*

	2000	2006	2007	2008	2009	2010	2011	2012
Greece	103.4	107.3	107.4	112.6	129.0	144.6	165.4	170.7
Italy	108.5	106.1	103.1	105.7	116.0	118.6	120.1	126.3
Portugal	48.4	63.7	68.3	71.6	83.1	93.3	107.8	119.1
Ireland	37.5	24.8	25.0	44.5	64.9	92.2	106.5	117.7
Belgium	107.8	88.0	84.0	89.3	95.7	95.6	97.8	99.0
Spain	59.4	39.7	36.3	40.2	53.9	61.3	69.1	90.7
France	57.4	64.1	64.2	68.2	79.2	82.3	86.0	90.0
U. Kingdom	40.9	43.0	43.7	52.2	68.0	75.0	81.8	88.7
Germany	60.2	67.9	65.4	66.9	74.7	82.4	80.6	83.0
Austria	66.2	62.3	60.2	63.8	69.2	71.8	72.3	74.3

Source: IMF-International Financial Statistics (2014).

According to Table 2, the country which has the highest total public debt stock to GDP ratio is Greece. It is followed by Italy, Portugal and Ireland. In the Maastricht criteria, when the ratio of total public debt to GDP passed the critical value 60%, it was considered to be risky in terms of countries. In this case, the debt stocks of major countries reached the values at risk.

4. Literature

Fiscal deficits have gathered substantial attention in the literature due to their effects on the macroeconomic performance. A lot of empirical studies on this subject exist in the literature. In particular, the enormous budget deficits of the United States attracted the attention of many researchers. For the USA economy, Kremers (1989), Wilcox (1989), Roberds (1991) and Hakkio and Rush (1991), Mankiw (2010) have found that the budget deficits were unsustainable. But Hamilton and Flavin (1986), Trehan and Walsh (1988), Trehan and Walsh (1991), Quintos (1995), Arestis et al. (2004) found that the budget deficits were sustainable. Takeuchi (2010) examined US external debt sustainability by using Markov Chain Monte Carlo method for 1961Q1-2008Q4 period and found that the probability of sustainability is unexpectedly high. Yoon (2012) analysed US federal budget deficit for 1947:Q2–2007:Q3 period by recursive unit root test and reached that there is a difficulty for budget deficit sustainability.

Fountas and Wu (1996) and Makrydakis et al. (1999) tested budget deficit sustainability for Greece economy and found that it was unsustainable. But Arghyrou and Luintel (2003) determined budget deficits were sustainable in this country. Panagiotis et al. (2009) tested the theory of the twin deficits for Greece's economy and found that both deficits are sustainable in a weak form.

Rubio et al. (2006) investigated this subject on Spain and found that the budget deficit is unsustainable in the long run. Escario et al. (2012) analysed Spain fiscal policy for 1857-2000 period and found budget deficit is in a weak sustainability due to loss of monetary independence when participating the EMU in 1998.

Payne (1996) has found that budget deficits are unsustainable in France and Italy; meanwhile there is low level sustainability in Canada and United Kingdom. Arghyrou

and Luintel (2003) analysed the sustainability of budget deficits for Ireland, Italy and Netherlands and found that it was sustainable.

Aristovnik and Berčič (2007) found that budget deficits are unsustainable in Albania and Croatia. Collignon (2012) tested budget deficit sustainability of European countries via intertemporal budget constraint approach and found that public debt of these countries is unsustainable. Cuestas and Staehr (2013) analysed fiscal balance in the 10 EU countries and found that budget balance in these countries exhibit substantial instability. Paleologou (2013) analysed asymmetries in the revenue-expenditure nexus in Sweden, Greece and Germany for 1965-2009 period via MTAR method and reached there are fiscal synchronization between revenues and expenditures in Sweden and Germany but an asymmetries in Greece. Chen (2014) examined whether government deficit is sustainable in the G-7 and some European countries with non-linear unit root tests and concluded that government deficits are stationary and sustainable in Canada, Germany, the US and Italy in the long-run. Dybczak and Melecky (2014) investigated the effect of aggregate shocks on the fiscal stance of the EU countries and emphasized that EU countries should support application of fiscal rules focused on government expenditure rather than other fiscal variables.

Ozmen and Kogar (1998) and Payne et al. (2008) reached the conclusion that the budget deficit is sustainable in Turkey. Akcay et al. (2001), Ozdemir (2004) and Sen et al. (2010) obtained the result that the budget deficit is unsustainable. Onel and Utkulu (2006) analysed Turkish budget deficit sustainability with Hakkio and Rush (1991) procedure for 1970 to 2002 period by unit root and cointegration tests with structural breaks. They found that β_1=0.64 and explained that Turkey satisfies weakly the solvency condition in the long-run. Smilarly Peker and Gocer, (2012) determined that the budget deficit is sustainable in a weak form.

Baharumshah and Lau (2007) searched sustainability of fiscal imbalance in Korea, Malaysia, Philippines, Singapore and Thailand by using Ng and Perron univariate unit root test, Gregory-Hansen cointegration test, Toda and Yamamoto causality test and DOLS for 1975Q1-2003Q2 period. They concluded that the fiscal stance in Thailand and South Korea are sustainable while in Philippines and Malaysia are weakly sustainable. Moreover, it was found a one-way causality from expenditure to revenue for Korea, Singapore and Thailand. This finding indicates that reducing the size of government spending may improve fiscal budget deficits sustainability. Liu et al. (2014) searched fiscal policy stationary in China for 1978-2011 period by means of flexible Fourier function and reached that fiscal policies are sustainable in the Eastern and Central regions while unsustainable in the Western and Northeastern regions.

5. Analysis

5.1. Data

In this study, 17 European Union member countries'[(1)], whose ratio of budget deficit to GDP has been greater than 3% in 2012 year, quarterly data of *REV* (General government revenue percent of GDP) and *EXP* (General government total expenditure percent of

GDP) for 1996Q1-2012Q4 period data have been used. Data was taken from the IFS (International Financial Statistics) database. The program Gauss 9.0 and the codes were generated for this program has been used for the analysis.

5.2. Testing the cross-section dependency

Before proceeding with further steps, cross-section dependence must be tested. Otherwise, results may be biased and inconsistent (Breusch and Pagan, 1980; Pesaran, 2004). Therefore, prior to further analyses, the existence of cross-section dependency in the series and the cointegration equation should be tested.

The existence of a cross-section dependency among countries is tested via Breusch-Pagan (1980) LM test. This test is biased when the average of the group is zero, but the average of the individuals is different from zero. Pesaran et al. (2008) adjusted this deviation by adding the variance and the average to the test statistics. Therefore, it is called the bias-adjusted *LM* test (LM_{adj}). The first form of *LM* test statistics is as the following:

$$LM = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\left(\hat{\rho}_{ij}^{2}\right) \sim \chi^{2}_{\frac{N(N-1)}{2}} \qquad (4)$$

Equation (4) can be rewritten with the following with the adjustment:

$$LM_{adj} = \left(\frac{2}{N(N-1)}\right)^{1/2}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\left(\hat{\rho}_{ij}^{2}\frac{(T-K-1)\hat{\rho}_{ij}-\hat{\mu}_{Tij}}{\upsilon_{Tij}}\right) \sim N(0,1) \qquad (5)$$

Where $\hat{\mu}_{Tij}$ represents the avarage, υ_{Tij} represents the variance. The test statistics to be obtained here show a standard normal distribution as asymptotic (Pesaran et al. 2008). The null hypothesis of the LM_{adj} test is no cross-section dependency. The LM_{adj} test was used and obtained results are presented in Table 3.

Table 3. *Crosssectional dependency (LM_{adj}) test results*

	Test Statistics	Prob. Value
REV	13.134	0.000
EXP	13.985	0.000
Cointegration Equation	149.501	0.000

Note: *p*-values were computed 1000 bootstrap replications.

As can be seen from Table 3, since the probability values of series and cointegration equation are smaller than 0.05, H_0 hypotheses are strongly rejected and it has been decided that there is cross-sectional dependency among these countries. This reveals that a significant change in the series in one of the countries also affects the others. Therefore, while the decision makers in these countries set their policies, they should take into consideration the policies of the other countries and the other external factors. Furthermore, since cross-section dependency determined, this situation should be taken into account while choosing the unit root and cointegration tests method. Therefore, panel unit root tests and cointegration analysis considering the cross-section dependency have been also used in the study.

5.3. Panel unit root test with multiple structural breaks

The first problem in the panel unit root test is whether the cross-section dependency among the countries forming the panel is independent to each other. Panel unit root tests here are divided into two as first and second generation tests. First generation tests are Levin, Lin and Chu (2002), Breitung (2005), Hadri (2000), Im, Pesaran and Shin (2003), Maddala and Wu (1999) and Choi (2001). First generation unit root tests are based on the hypothesis that the cross-section units forming the panel are independent and all the cross-section units are equally affected by the impact which comes to one of the units in the panel. However, it is a more realistic approach that units are differently affected from the impact if it is thought that national economies are related to each other today. In order to overcome this deficiency, second generation unit root tests carrying out the unit root analysis considering the cross-section dependence between the cross-section units have been developed. Main second generation unit root tests are MADF (Taylor and Sarno, 1998), SUDARF (Breuer et al., 2002) and CADF (Pesaran, 2006).

However, these methods were insufficient with the presence of structural breaks in series since the tests not featuring the structural breaks give biased results in the direction that there is a unit root in the wrong form (Charemza and Deadman, 1997). Panel unit root tests have been employed in the study using PANKPSS (Panel Kwiatkowski-Phillips-Schmidt-Shin), which is one of the second-generation unit root tests and developed by Carrion-i-Silvestre et al. (2005). PANKPSS takes the cross-section dependency and the structural breaks in series into consideration while testing for unit roots. Through PANKPSS, in the case of structural breaks in the average and trends of the series, the stationarity of the series can be tested. It also allows the occurrence of structural breaks in different numbers and dates in each cross-section unit in the panel. Therefore, the stationary of the series can also be estimated one by one for the panel overall and each cross-section. The model of the test is as follows:

$$Y_{i,t} = \alpha_{i,t} + \beta_{i,t}t + \varepsilon_{i,t} \qquad i = 1, 2, \ldots\ldots, N \;\; and \; t = 1, 2, \ldots\ldots, T \tag{6}$$

$$\alpha_{i,t} = \sum_{k=1}^{m} \theta_{i,k} D_{1i,t} + \sum_{k=1}^{m} \gamma_{i,k} D_{2i,t} + \alpha_{i,t-1} + u_{i,t} \tag{7}$$

$$\beta_{i,t} = \sum_{k=1}^{n} \varphi_{i,k} D_{1i,t} + \sum_{k=1}^{n} \aleph_{i,k} D_{2i,t} + \beta_{i,t-1} + v_{i,t} \tag{8}$$

D_1 and D_2 are dummy variables and can be defined as follows.

$$D_1 = \begin{cases} 1, & t = T_B + 1 \\ 0, & in\ other\ cases \end{cases} \qquad D_2 = \begin{cases} 1, & t > T_B + 1 \\ 0, & in\ other\ cases \end{cases} \tag{9}$$

Where T_B expresses the breakpoint and allows m structural break in constant term and n structural break in trend, α is expected value of Y. Carrion-i-Silvestre et al. (2005) arranged so as to allow a maximum of five structural breaks. This test, following Bai-Perron (1998), determines structural break points where residual sum of squares are at minimum. Bai-Perron (1998) has offered two different processes: The first one is based

on changed Schwarz information criterion (LWZ) developed by Liu et al. (1997) and the second one is based on the calculation of the *F* statistics consecutively in order to determine the number of structural breaks. While determining the number of structural breaks, Carrion-i-Silvestre et al. (2005) use the first process for the model with trend and the second process for the model without trend. The null hypothesis denotes that series are stationary. Test statistics and critical values have been computed for each country and panel. Results are presented in Table 4.

Table 4. *PANKPSS panel unit root test results*

	REV		***ΔREV***	***EXP***		***ΔEXP***
	Test Stat.	Break Dates	Test Stat.	Test Stat.	Break Dates	Test Stat.
Austria	0.025(0.010)	1996Q4;2000Q4;2007Q2	0.025*(0.064)	0.025(0.010)	1997Q4; 2004Q4; 2008Q4	0.019*(0.106)
Belgium	0.016(0.015)	1999Q4; 2006Q4; 2008Q4	0.082*(0.103)	0.046 (0.018)	2000Q4; 2004Q4; 2008Q4	0.045*(0.106)
Cyprus	0.101(0.018)	1999Q4; 2006Q4; 2008Q4	0.134*(0.084)	0.029(0.018)	2001Q3; 2004Q4; 2009Q2	0.035*(0.099)
Czech R.	0.091(0.018)	2002Q1; 2005Q3; 2007Q4	0.014*(0.061)	0.024(0.018)	1999Q4; 2003Q4; 2008Q4	0.037*(0.094)
Denmark	0.083(0.019)	1998Q4; 2008Q4; 2010Q4	0.026*(0.072)	0.081(0.017)	1999Q4; 2008Q4; 2009Q4	0.098*(0.179)
France	0.073(0.017)	1998Q4; 2003Q3; 2009Q4	0.069*(0.076)	0.081(0.018)	2000Q4; 2008Q2; 2009Q2	0.078*(0.087)
Hungary	0.085(0.017)	2000Q2; 2008Q2; 2009Q2	0.027*(0.102)	0.081(0.017)	1997Q4; 2006Q4; 2009Q3	0.095*(0.102)
Greece	0.065(0.019)	2001Q4; 2009Q4; 2010Q4;	0.019*(0.078)	0.018(0.017)	2001Q4; 2005Q3	0.052*(0.111)
Ireland	0.075(0.018)	2000Q4; 2007Q1; 2009Q4	0.058*(0.067)	0.075(0.017)	2000Q4; 2009Q4; 2010Q4	0.043*(0.080)
Italy	0.095(0.016)	2002Q4; 2007Q1; 2011Q4	0.111*(0.132)	0.020(0.018)	2000Q4; 2008Q4; 2011Q2	0.081*(0.095)
Netherland	0.018(0.017)	1998Q4; 2006Q4; 2010Q2	0.069*(0.108)	0.098(0.017)	1999Q4; 2008Q2; 2009Q2	0.017*(0.101)
Poland	0.060(0.017)	1997Q4;; 2003Q4; 2008Q4	0.127*(0.134)	0.020(0.018)	2000Q4; 2006Q4; 2010Q4	0.055*(0.107)
Portugal	0.060(0.017)	2001Q4; 2008Q4; 2010Q4;	0.025*(0.096)	0.059(0.020)	1999Q3; 2008Q2; 2010Q1	0.021*(0.072)
Slovakia	0.017(0.016)	1998Q4; 2004Q4; 2009Q4	0.014*(0.102)	0.028(0.017)	1998Q2; 2002Q4; 2008Q4	0.021*(0.072)
Slovenia	0.088(0.018)	1997Q4; 2006Q4	0.063*(0.098)	0.075(0.018)	2001Q4; 2007Q2; 2008Q4;	0.084*(0.100)
Spain	0.101(0.018)	2004Q1; 2007Q4; 2008Q4;	0.094*(0.074)	0.060(0.019)	2000Q2; 2008Q4; 2009Q4	0.039*(0.076)
U. Kingdom	0.107(0.017)	2000Q4; 2006Q4; 2008Q4;	0.029*(0.083)	0.138(0.018)	1999Q4; 2004Q3; 2007Q3;	0.142*(0.102)
Panel	36.369(31.42)	-	20.84*(25.04)	25.415(13.693)	-	26.30*(32.01)

Note: Critical values were computed 1000 bootstrap replications; * Indicates the series are stationary in the 5% significance level. The model allowing the structural break in constant and trend has been chosen as a test model; Δ Shows the first difference. Three structural breaks were allowed because the data set was covering a short period.

Results in Table 4 show that series are non-stationary at level values. This situation shows that government debt shocks don't lose their effects on the countries. Series become stationary at first differences. They are integrated in first order, *I(1)*. In this case, it has been decided that the existence of cointegration relationship between these series can be tested since series under consideration are integrated of the same order.

5.4. Panel cointegration test with multiple structural breaks

The existence of cointegration relationship between the series has been investigated through the multiple structural break cointegration test of Basher and Westerlund (2009), which considers the cross-section dependency and multiple structural breaks in the cointegration equation. This test allows breaks in the constant term and trend. The test statistic is computed as:

$$Z(M) = \frac{1}{N}\sum_{i=1}^{N}\sum_{J=1}^{M_i+1}\sum_{t=T_{ij-1}+1}^{T_{ij}}\frac{S_{it}^2}{(T_{ij}-T_{ij-1})^2\hat{\sigma}_i^2} \quad (10)$$

Where $S_{it} = \sum_{s=T_{ij-1}+1}^{t} \widehat{W}_{st}$. However, $\widehat{W}_{st}$ are the residuals obtained by using any efficient estimator of the cointegration vector such as the fully modified least squares estimator. $\hat{\sigma}_i^2$ is the usual Newey and West (1994) long-term variance estimator based on $\widehat{W}_{st}$. *Z(M)* becomes the following when it is abbreviated by taking their cross-sectional averages.

$$Z(M) = \sum_{t=T_{ij-1}+1}^{T_{ij}} \frac{S_{it}^2}{(T_{ij}-T_{ij-1})^2 \hat{\sigma}_i^2} \sim N(0,1) \quad (11)$$

Null hypothesis is existence of cointegration relationship. The Basher and Westerlund (2009) cointegration test was run and the results are presented in Table 5.

Table 5. *Panel cointegration test results*

	Test Statistics	***p-Value***	***Decision***
Break in Constant	1.845	0.123	Cointegration
Break in Constant and trend	4.636	0.081	Cointegration

Note: *p*-values were computed 1000 bootstrap replications.

Results presented in Table 5 indicate that there is a cointegration relationship -because of lower *p*-value than 0.05- between the series in the panel when the structural breaks and cross-section dependency are taken into consideration in the cointegration equations. Obtained structural break dates from cointegration test presented in Table 6.

Table 6. *Break dates in the cointegration equation*

Country	1th Break	2nd Break	3rd Break
Austria	2000Q4	2005Q4	2009Q1
Belgium	1999Q4	2003Q4	2008Q4
Cyprus	1999Q3	2002Q4	2007Q4
Czech R.	2002Q4	2006Q2	2009Q3
Denmark	2002Q3	2005Q4	2009Q3
France	-	2004Q4	2009Q3
Hungary	2000Q1	2004Q4	2008Q4
Greece	-	-	2006Q3
Ireland	2002Q4	2006Q2	2009Q3
Italy	1999Q1	2005Q4	2009Q1
Netherland	1999Q1	2003Q1	2008Q4
Poland	-	2004Q4	2008Q4
Portugal	-	-	2008Q4
Slovakia	1999Q1	2002Q4	2007Q3
Slovenia	-	-	2008Q4
Spain	-	2003Q3	2007Q4
U. Kingdom	2000Q3	2003Q4	2008Q4

Note: These results obtained from the structural breaks in level and trend model. In this study, maximum break point is taken three because the data set was covering a short period.

Results presented in Table 6 indicate that the test method has successfully determine the structural break dates in countries. 1999 and 2008 indicate the Russia and the global economic crisis, 2003 indicates monetary expansion globally.

5.5. Estimation of cointegration coefficients

In this part of the study, the long-run individual cointegration coefficients were estimated with the Common Correlated Effects (CCE) method which is developed by Pesaran (2006). CCE is an estimator that can generate results providing consistent and asymptotic

normal distribution and can calculate the long term cointegration coefficients for each cross-section units (Pesaran, 2006). Long term cointegration coefficients of panel were calculated with the Common Correlated Effects Mean Group (CCEMG) method. In this analysis, these structural break points were added to the analysis with dummy variables as;

$$D = \begin{cases} 1, & t = T_B + 1 \\ 0, & in\ other\ cases \end{cases} \quad (12)$$

CCE and CCEMG estimations that have been carried out using equation (9) and results are presented in Table 7.

$$REV_{it} = \beta_{0i} + \beta_{1i} EXP_{it} + \beta_{2i} D_{1_{it}} + \beta_{3i} D_{2_{it}} + \beta_{4i} D_{3_{it}} + u_{it} \quad (13)$$

According to Table 7, the long-run cointegration coefficients are smaller than one. According to Hakkio and Rush (1991) and Quintos (1995), the budget deficits in these countries are sustainable in a weak form. The coefficients are high in Belgium, Cyprus, Netherland, Poland and Portugal because of less budget deficit relative to others.

Table 7. *The long-run cointegration coefficients*

Country	***EXP***	***D₁***	***D₂***	***D₃***
Austria	0.59 [7.04]***	0.55[1.46]*	-0.56[-1.03]	0.56[1.99]**
Belgium	0.94[1.30]*	-0.93[-2.43]***	0.37[0.98]	1.27[1.99]**
Cyprus	0.95[10.33]***	-0.09[-0.12]	-2.38[-3.36]***	5.72[4.88]***
Czech R.	0.45[7.47]***	-1.09[-4.08]***	-1.09[-1.75]**	-0.06[-0.12]
Denmark	0.34[5.67]***	0.04[0.20]	1.64[4.00]***	0.34[0.86]
France	0.58[3.50]***	-1.69[-1.58]*	0.12[1.24]	0.18[0.51]
Hungary	0.78[7.94]***	-1.20[-6.70]***	-1.15[-2.23]***	-0.40[-0.25]
Greece	0.48[2.36]***	1.15[1.90]**	0.25[2.01]***	0.25[0.17]
Ireland	0.27[7.71]***	0.15[0.38]	0.56[1.61]*	1.99[2.21]**
Italy	0.50[1.69]**	0.19[0.68]	-0.85[-2.56]***	0.70[1.43]*
Netherland	0.83[1.25]	0.25[0.36]	-0.88[-2.16]***	0.58[0.44]
Poland	0.83[19.88]***	2.97[3.38]***	0.01[0.27]	-0.44[-0.88]
Portugal	0.86[5.62]***	1.02[0.35]	0.15[0.89]	2.66[2.62]***
Slovakia	0.68[11.74]***	-0.83[-2.34]***	0.94[0.84]	-0.59[-1.05]
Slovenia	0.37[6.52]***	1.02[4.42]***	0.04[2.10]***	-0.45[-0.59]
Spain	0.42[1.73]**	0.19[0.68]	0.78[0.53]	2.00[2.74]***
U. Kingdom	0.27[6.44]***	0.14[0.41]	-0.79[-3.89]***	0.08[0.16]
Panel	0.48[6.39]***	-0.03[-0.12]	-0.24[-1.10]	0.83[2.17]***

Note: Autocorrelation and heteroscedasticity problems were adjusted with the Newey-West process.
t statistics in parenthesis. *, **, *** Indicate significance level in 10%, 5% and 1% respectively.

5.6. Estimation of the error correction model

At this stage of the analysis, individual coefficients have been estimated with the CCE method and the panel's coefficient has been estimated with the CCEMG method using following error correction model:

$$\Delta REV_{it} = \beta_{0i} + \beta_{1i} ECT_{i,t-1} + \beta_{2i} \Delta EXP_{it} + \varepsilon_{it} \quad (14)$$

ECT_{t-1} is error correction term and means one period lagged error terms of the long-run analysis. Equation (10) was estimated and results were presented in Table 8.

Table 8. *The short-run coefficients*

Country	ECT_{t-1}	ΔEXP
Austria	-0.32[-3.01]***	0.26[5.78]***
Belgium	-0.13[-0.65]	0.14[2.32]***
Cyprus	-0.13[-2.84]***	0.02[0.08]
Czech R.	-0.42[-0.56]	0.44[7.48]***
Denmark	-0.15[-2.88]***	0.46[5.08]***
France	-0.64[-1.28]*	0.49[3.04]***
Hungary	0.16[0.39]	0.019[0.07]
Greece	-0.75[-4.96]***	0.45[1.96]**
Ireland	0.37[0.68]	0.41[3.72]***
Italy	-0.14[-4.51]***	0.17[0.07]
Netherland	-0.74[-0.94]	0.67[5.47]***
Poland	-0.51[-0.80]	0.08[0.24]
Portugal	-0.11[-0.16]	0.11[4.23]***
Slovakia	0.18[0.07]	0.24[1.01]
Slovenia	-0.12[-2.06]***	0.07[0.25]
Spain	-0.11[-3.7]***	0.54[2.38]***
U. Kingdom	0.47[0.17]	0.06[0.70]
Panel	-0.55[-3.68]***	0.18[2.69]***

Note: Autocorrelation and heteroscedasticity were adjusted with the Newey-West process. *t* statistics in parenthesis. *, **, *** Indicate significance level in 10%, 5% and 1% respectively.

When the results in Table 8 are examined, it can be seen that error correction term is negative and statistically significant in Austria, Cyprus, Denmark, Greece, Italy, Slovenia, Spain and for overall panel. In the other words, the short run deviations converge to the long-run balance level in these counties. Error correction mechanism is working in this model.

6. Conclusion and policy implications

In this study, the sustainability of budget deficit has been examined for 17 EU countries whose budget deficit exceed 3% of the GDP in 2012 by means of panel unit root and cointegration method with multiple structural breaks under cross-section dependence for 1996Q1-2012Q4 period.

The cross-section dependence for variables and cointegration equation were tested via LM_{adj} method. At the end of this analysis, cross-section dependence was determined, that is, a shock that comes to one of these countries affects the others. Therefore, countries' policy makers should consider the developments in the related countries. Since cross-section dependence is determined on the panel, this must be taken into account while selecting the panel unit root and cointegration tests. The panel unit root and cointegration tests which take the cross-sectional dependence into account were chosen.

Panel unit root was tested by means of PANKPSS and series were found non-stationary in level values and become stationary when their first difference is taken. This situation shows that shocks don't lose their effects on the countries and budget policies should be revised.

The presence of panel cointegration relationship is tested by the Basher and Westerlund (2009) method. It has been observed that there exists a cointegration relationship between series which move together in the long term.

The long-run and the short-run individual cointegration coefficients have been estimated via the Pesaran (2006) CCE method, while panel cointegration coefficient is estimated by CCEMG method. It is found that budget deficits are weakly sustainable in these countries according to Hakio and Rush (1991) and Quintos (1995) because the cointegration coefficients is smaller than one (0.48). According to the long-run analysis, budget deficits of these countries are sustainable in weak form. Results of the short-run error correction model tell that the short run deviations converge to the long-run balance level in these counties, that is, error correction mechanism is working in this model. These results are in accordance with Panagiotis et al. (2009); Escario et al. (2012) and Paleologou (2013). Therefore, EU countries should take measures to avoid potential problems of unsustainability of budget deficit.

As macroeconomic theory stated; high budget deficits may cause scarcity of investment, lack of consumption, high foreign borrowing and low private savings. Some economic precautions should be implemented even they are not welcomed in some parts of the society as in happened in Greece. Since it is found that the sustainability of budget deficits is low, EU economy management should take the necessary precautions, alert the related countries and implement the necessary sanctions. In this context, it will be helpful to implement the fiscal rule in countries and to establish the independent supervisory and regulatory institutions. The effects of the global crisis in 2008 on economy and banking sector were limited thanks to some institutions such as Banking Regulation and Supervision Agency (BRSA) established after the banking and financial crisis in 1999 and 2001 in Turkey.

In this respect, establishing independent national/international regulatory and supervisory institutions and further economic integration between EU countries such as expanding the number of countries using common currency, implicating common budget, common fiscal policy and common monetary policies can help to manage their budget deficit.

Note

(1) Austria, Belgium, Cyprus, Czech Republic, Denmark, France, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Slovak Republic, Slovenia, Spain and United Kingdom.

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