EASTERN JOURNAL OF EUROPEAN STUDIES Volume 12, Issue 1, June 2021
DOI: 10.47743/ejes-2021-0109

Fiscal sustainability analysis in EU countries: a dynamic macro-panel approach

Gözde Eş POLAT[*], Onur POLAT[**]

Abstract

In this work, we analyze fiscal sustainability for 26 EU and PIIGS countries in terms of Bohn's (2008) approach. In this context, we use primary surplus-to-GDP, public debt-to-GDP, government revenues/expenditures-to-GDP, business cycle, and fluctuations in government expenditures variables in the period 1995-2018. A positive and long-run relationship between lagged public debt and primary surplus-to-GDP indicates that fiscal policy is sustainable for the EU, overall. However, the fiscal sustainability criterion is not met for the PIIGS since the transversality condition is not met. Empirical findings of the study underline an effective regulatory policy framework to monitor fiscal policy developments for both core and periphery EU states.

Keywords: Fiscal Sustainability, Intertemporal Budget Constraint, Panel Data Analysis

Introduction

Throughout the financialization and globalization era, both emerging and advanced countries have faced deep and severe financial/real crises and they have implemented different fiscal policy actions to mitigate the adverse effects of the crises, accordingly. In this context, the notion *fiscal sustainability* has been the focus of both policymakers and scholars and fiscal sustainability studies have gained momentum, particularly after the 1970s. Furthermore, emerging and advanced countries have implemented different fiscal policy actions (expansionary or contractionary) to abate the hazardous effects of the crises and to recover from them.

Despite the monetary union joined by most European Union (EU) members, overall, there is no common fiscal policy supported in the EU. This leads to different fiscal policy actions implemented by core/periphery EU states during financial crises

[*] Gözde Eş POLAT is a Research Assistant, Bilecik Seyh Edebali University, Bilecik, Turkey; e-mail: gozde.es@bilecik.edu.tr (corresponding author).
[**] Onur POLAT is an Assistant Professor, PhD, Bilecik Seyh Edebali University, Bilecik, Turkey; e-mail: onur.polat@bilecik.edu.tr.

to alleviate the crises' adverse effects. To exemplify, the core EU states performed expansionary fiscal policies during the 2007-09 global financial crisis (GFC) and the 2010-12 European Sovereign Debt Crisis (ESDC), albeit periphery EU states implemented contractionary fiscal policies (Polat and Polat, 2019). Notwithstanding a fiscal union joined by all EU members, a sustainable fiscal policy is crucial to ensure a healthy fiscal and macroeconomic system in the EU, overall. Despite the fact that EU states are subject to the same fiscal policy framework determined by the Maastricht Treaty, the Stability and Growth Pact, and the Fiscal Compact, they have performed different fiscal policy responses (Dragutinović *et al*., 2019).

In the light of heterogeneous fiscal policy actions carried out by the core/periphery EU states, this study aims to analyze fiscal sustainability for 26 EU and PIIGS countries by utilizing Bohn's (2008) model-based approach using primary-to-GDP ratios, public debt-to-GDP ratios, government revenues/expenditures (GDP%). Furthermore, we examine cyclical effects by using the business cycle (YVAR) and fluctuations in government expenditure (GVAR) variables.

Our main hypotheses for this study are as follows. First, in line with previous studies, such as Afonso and Rault (2010) and Brady and Magazzino (2018), there exists a significant long-run relationship between government expenditures and revenues and thus the fiscal sustainability is met for the panel set of EU countries. Second, since our data period covers the European Sovereign Debt Crisis (ESDC) and the crisis sorely hit the peripheral states, particularly the PIIGS countries, we expect the absence of fiscal sustainability for the PIIGS countries consistent with Brady and Magazzino (2018).

The rest of the study is organized as follows: Section 2 presents theoretical and empirical works on fiscal sustainability. Section 3 provides the theoretical framework of the work. Section 4 presents the data, the methodology and discusses the empirical findings. Finally, Section 5 summarizes the main findings of the study and concludes it.

1. Literature Review

Both emerging and advanced economies faced the 1970s financial/real crises, which conduced to payment difficulties and worsened fiscal/macroeconomic conditions. Hereby, governments have concentrated on fiscal sustainability which has become one of governments'main objectives. Following the debt crises of the 1990s, scholars and policymakers have focused on fiscal sustainability to protect economy against the crises' detrimental effects. Additionally, it is worthwhile noting that, if a country meets the fiscal sustainability criterion, the systemic risk of this country is lower, and hereby the macroeconomic conditions of this country are better. As a consequence, meeting the fiscal sustainability criterion is crucial for economies.

There is no reconciliation on the definition of fiscal sustainability and indicators to test fiscal sustainability, the common ground of the related literature is Domar's (1944) study. Domar's fiscal sustainability condition stipulates convergence of the public debt ratio to finite value to prevent continuous rising in the tax burden (Domar, 1944).

Studies have focused on fiscal sustainability both theoretically and empirically. In some theoretical studies, fiscal sustainability is examined regarding "*sustainability of the public debt*". Another strand of studies labels fiscal sustainability with the sustainability of debt deficits. Five different approaches theoretically analyze fiscal sustainability, namely, the Accounting approach, the Intertemporal Budget Deficit Constraint approach, the Present Value Constraint (PVC) approach, the Sudden Stop approach, the Probabilistic approach, and the Human Development approach.

In the Accounting approach, fiscal sustainability is analyzed based on macroeconomic indicators. The macroeconomic indicators used in this approach are the public sector net worth-to-GDP ratio (Bruiter, 1985) and the public debt-to-GDP ratio (Blanchard, 1990). This approach examines fiscal sustainability by testing whether those ratios converge back to their initial values (Blanchard *et al*., 1991).

Hamilton and Flavin developed the Intertemporal Budget Deficit Constraint approach. The authors analyzed fiscal sustainability for the US by using the post-WW2 macroeconomic data and argued that the fiscal policy is sustainable despite budget deficits (1986, p. 818). Calvo *et al*. (2003) introduced the Sudden Stop approach to determine an explanation for the fall of Argentina's Convertibility Program. The authors pointed out that Argentina's Sudden Stops were triggered by the 1998 Russian crisis owing to heavily dollarized liabilities and led to an unsustainable fiscal position.

Mendoza and Oviedo (2003) developed the Probabilistic approach, which is a dynamic stochastic general equilibrium (DSGE) model. In the model, the path of government revenues is endogenously specified by the utility-maximizing households and profit-maximizing firms, based on producing tradable and non-tradable goods. The authors argued that there is a mismatch in the government's balance sheet since the government debt mainly consists of tradable goods and tax revenues mostly include non-tradable goods.

Sachs (2002) introduced the Human Development approach. This model assumes that low-income countries are vulnerable to the poverty trap, which can be propelled by an excessive foreign debt burden. The author argued that resources should be allocated to public sector investments in basic human capital to alleviate poverty and to ensure a sustainable fiscal policy.

These aforementioned approaches can also be classified into static and dynamic. Accounting and Intertemporal Budget Constraint approaches are static ones focusing on government revenue and expenditure levels, whereas other approaches that examine the relationship between growth rate and budget indicators

by employing partial or general equilibrium models are dynamic (Slack and Bird, 2004, p. 4; Siriwardana, 1998, pp. 82-85). In this study, we implement a static fiscal sustainability model, namely, the Intertemporal Budget Constraint approach.

An extensive number of studies have empirically analyzed fiscal sustainability in terms of the Intertemporal Budget Constraint approach. These studies can be classified into two different categories. The first category consists of studies that analyze fiscal sustainability by focusing on time-series characteristics (stationarity, co-integration) of fiscal indicators (budget revenues, budget expenditures). Within this group, studies propose that if there exists a long-run relationship (co-integration) between government revenues and government expenditures, the fiscal sustainability criterion is met. The second category finds stationarity and co-integration analyses inadequate and argues that fiscal sustainability can be investigated by fiscal reaction functions (FRFs), which are the regression models of causality between fiscal policies of policymakers and public debt ratios. Both categories assume that the No-Ponzi game condition[59] is the necessary and sufficient condition for fiscal sustainability. The empirical studies on fiscal sustainability are presented in Table 1.

The 2000s studies in the first category examined fiscal sustainability for different countries. Among them, Afonso (2005) analyzed fiscal sustainability for the EU-15 by using government public debt, price deflator of final private consumption expenditure, government total revenues/expenditures, and gross domestic product data in 1970-2003. The empirical findings of the study reveal that, except for some countries (Austria, Germany, Finland, Netherlands, and Portugal), fiscal stability is met for the EU-15 (Afonso, 2005). In a similar vein, Prohl and Schineder (2006) analyzed fiscal sustainability for the EU-15 by employing panel co-integration between primary budget deficits and public debt-to-GDP ratios between 1970 and 2004. The authors argued that fiscal sustainability is accepted for the EU-15 over the analyzed period. Likewise, Claeys (2007) examined fiscal sustainability for 14 EU states (Austria, Belgium, Denmark, Germany, Spain, Finland, France, Great Britain, Greece, Ireland, Italy, the Netherlands, Portugal, and Sweden) by using real government expenditures/revenues and real net interest payments in 1970-2001. Stationarity and co-integration analyses indicate that fiscal policy is sustainable for 14 EU states overall, yet fiscal policy is not sustainable at the national level (Claeys, 2007).

[59] No-Ponzi Game condition is the necessary condition for the Intertemporal Budget Constraint approach and "is satisfied when the budget deficit is integrated of order one, therefore, distinguishes between strong (the budget deficit is stationary) and weak (the budget deficit is nonstationary) forms of solvency" (Bergman, 2001, p. 27).

Table 1. Empirical Studies on Fiscal Sustainability

Study	Frequency of Variables	Date and Country	Metodology and Data Set	Fiscally sustainable?
Hamilton and Flavin (1986)	Annual	1962-1984 (US)	Stationarity Analysis (Budged deficit and public debt)	Yes
Trehan and Walsh (1988)	Annual	1890-1983 (US)	Stationarity Analysis (Budged deficit)	Yes
Kremers (1988)	Annual	1920-1985 (US)	Stationarity Analysis (Public debt)	Before 1981 – Yes After 1981 - No
Elliot and Kearney (1988)	Annual	1953/54-1986/87 (Australia)	Co-Integration Analysis (Budget revenues/expenditures)	Yes
Wilcox (1989)	Annual	1960-1984 (US)	Stationarity Analysis (Public debt)	No
MacDonald and Speight (1990)	Annual	1961-1986 (UK)	Stationarity Analysis (Public debt), Co-Integration Analysis (Budget deficit and public debt)	Inconclusive
Hakkio and Rush (1991)	Quarterly	1959:II-1988:IV (US)	Co-Integration Analysis (Budget revenues/expenditures)	No
Smith and Zin (1990)	Monthly	1946:1-1984:12 (Canada)	Stationarity Analysis (Public debt), Co-Integration Analysis (Budget deficit and public debt)	No
Trehan and Walsh (1990)	Annual	1960-1984 (US)	Co-Integration Analysis (Budget revenues/expenditures)	Yes
Caporale (1995)	Semi-Annual and Annual	1960-1991 (EU Countries)	Stationarity Analysis (Public debt and budget deficit)	No for Italy, Greece, Denmark, and Germany
Makryradis *et al.* (1999)	Annual	1958-1995 (Greece)	Stationarity Analysis (Public debt)	No
Greiner and Semmler (1999)	Annual	1955-1994 (Germany)	Stationarity Analysis (Public debt)	No

Source: Afonso (2005, pp. 26-27).

Studies in the second category have employed the model-based sustainability (MBS) approach proposed by Bohn (1995; 1998). Bohn (1995) developed a Dynamic Stochastic General Equilibrium (DSGE) model to analyze long-term fiscal sustainability. The model employs the Intertemporal Budget Constraint approach that consists of the discounted future government spending and taxes (Bohn, 1995). Along similar lines, Bohn (1998) analyzed fiscal sustainability for the US by using primary surplus and public debt in 1916-1995 and found that fiscal policy is sustainable (Bohn, 1998).

Among studies in the second category, Ghatak and Sánchez-Fung (2007) investigated fiscal sustainability for South Africa, the Philippines, Peru, Thailand,

and Venezuela in 1970 and 2000. The findings of the study indicate that fiscal policy is sustainable for Thailand, whereas the estimations are statistically insignificant for other countries (Ghatak and Sánchez-Fung, 2007). Bohn (2008) examined fiscal sustainability for the US by utilizing the MBS approach of Bohn (1995; 1998) between 1792 and 2003. The positive long-run relationship between primary surplus and public debt reveals that fiscal policy is sustainable for the US in 1792-2003 (Bohn, 2008). Likewise, Claeys *et al*. (2008) analyzed fiscal sustainability at national and state levels for the US in 1962-2000 and Germany in 1970-2005 using fiscal variables. The authors argued that fiscal sustainability is met for the US in 1962-2000, whereas fiscal policy is not sustainable for Germany in 1970-2005 (Claeys *et al*., 2008).

Sakuragawa and Hosono (2011) analyzed fiscal sustainability for Japan by employing a DSGE model in 1982 and 2009. According to the empirical results of the study, if the government does not respond to a fiscal crisis, which leads to an increase in public debt/GDP ratio, fiscal sustainability is not met (Sakuragawa and Hosono, 2011). Mahdavi (2014) examined fiscal sustainability for 48 US states by employing Bohn's (1998) approach using primary surplus ratio, public debt ratio, state expenditures, and Federal Grant Rate in 1961-2008 and argued that fiscal policy is sustainable (Mahdavi, 2014). In a similar vein, Potrafke and Reichmann (2015) investigated fiscal sustainability for the US states in 1978-2010 and the German Federal States in 1975-2010 by applying Bohn's (1998) model. According to the findings of the study, if the transfer payments are not added to the primary surplus, fiscal policy is sustainable for both the US and the German Federal States (Potrafke and Reichmann, 2015). Cascio (2015) analyzed fiscal sustainability for the US by employing Bohn's (1998) model and the Wavelet analysis in 1792-2012. Empirical results of the study indicate that fiscal policy is sustainable until 1995 (Cascio, 2015). More recently, Feld *et al*. (2020) focused on fiscal sustainability for 16 German Federal States by implementing Bohn's (1998) approach and argued that the fiscal sustainability criterion is partially met (Feld *et al*., 2020).

2. Theoretical Framework

Feld *et al*. (2020) concentrate on the long-run fiscal sustainability by relying? on the Intertemporal Government Budget Constraint (IGBC). The IGBC imposes that "government debt equals discounted government surplus and discounted future government debt" (Feld *et al*., 2020, p. 218). The IGBC is given in Equation 1 as follows:

$$d_0 = -\sum_{t=1}^{\infty} \left(\frac{1+y}{1+r}\right)^t p_t + \lim_{T\to\infty} \left(\frac{1+y}{1+r}\right)^T d_T \qquad (1)$$

In Equation 1, d_0, d_T represent the government debt and the discounted future government debt, respectively. p_t corresponds to the government surplus at time t.

r is the interest rate and y is the growth rate. The first complementary condition is the transversality condition, which involves

> [...] whether the second term on the right-hand side (r.h.s.) is met. This condition imposes the discounted present value of public debt to converge zero an infinite timeline. The transversality condition employs unit root and stationarity tests for fiscal variables, such as public debt and budgetary and primary surpluses. The second condition is to test the first term on the r.h.s. of Equation 1. İf this condition is met, then the government has to accumulate sufficient primary surpluses to finance its debt (Feld *et al.*, 2020, p. 218).

It is worthwhile to note that the time-series analysis for testing the transversality condition is to implement unit root tests for fiscal variables. In this context, before examining the long-run FRFs, we perform unit root analysis for fiscal variables and accordingly test the transversality condition.

3. Data, methodology and empirical results

In this study, we use primary surplus-to-GDP ratios, public debt-to-GDP ratios, government revenues (GDP%), government expenditures (GDP%) for 26 EU states[60] in 1995-2018[61]. The dataset of the study is obtained from the ECB Eurosystem Statistical Data Warehouse (ECB Eurosystem Statistical Data Warehouse, 2020)[62]. Public debt/GDP ratios for 26 EU states between 1995-2018 are depicted in Figure A.1 in the Appendix.

Public debt-to-GDP ratios are below 1 for most of the EU states and mainly stable in 1995-2018 (Austria, Czech Republic, Estonia, France, Finland, Germany, the Netherlands, Spain, Sweden, Latvia, Lithuania, Luxembourg, Hungary, Malta, Poland, Romania, Slovakia, Slovenia, and the UK). On the other hand, public debt-to-GDP ratios for the PIIGS (Portugal, Ireland, Italy, Greece, and Spain) dramatically surged during the European Sovereign Debt Crisis (ESDC). The public debt-to-GDP ratio for Bulgaria exceeded 200% during the 1990s, yet it has stabilized in the recent period.

The deterioration of fiscal position and surging government debts in the EU following the 2008 global financial crisis (GFC) rendered fiscal sustainability a vital policy challenge for EU policymakers (European Commission, 2017). In view of this, scholars have extensively analyzed overall fiscal sustainability in the EU

[60] Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Estonia, France, Finland, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. Denmark and Croatia could not be included in the analysis due to the lack of data.

[61] Summary statistics for the dataset are given in Table A.1, Table A.2, Table A.3., and Table A.4 in the Appendix.

[62] Stata 14.0 is used to estimate the empirical results of the study.

(Dolenc and Stubejl, 2010; Berrittella and Zhang, 2015; Lee *et al*., 2018; Mackiewicz-Łyziak and Łyziak, 2019; Ramos-Herrera and Prats, 2020). In line with these studies, in the first stage, we examine fiscal sustainability for the panel of 26 EU states.

It should be noted that the ESDC sorely hit the PIIGS economies mostly due to fiscal deficits, public debt problems (Alexakis and Pappas, 2018). In line with this phenomenon, scholars have focused on the fiscal sustainability for the PIIGS countries by clustering the EU states (Brady and Magazzino, 2018), or employing a time-varying stock-flow system (Neto, 2020). Our main motivation for examining the fiscal sustainability for the PIIGS countries in the second stage is three-folded. First, as clearly shown in Figure A.1, the PIIGS countries confronted with considerable high public debt ratios during the GFC and could not improve their fiscal structure after the GFC despite bailouts implemented by the EU or IMF. Second, the ESDC mainly stemmed from the unfavorable fiscal/macroeconomic conditions of the periphery EU states covering the PIIGS. Third, the PIIGS' public debt ratios have remained high in the post-ESDC epoch and these countries are different from the core EU states in terms of their fiscal structure. Since the public debt-to-GDP ratio is a key indicator for fiscal sustainability, we particularly focus on the PIIGS in the second stage of the study. Our main contribution to the extant literature is to analyze fiscal sustainability for the overall EU and PIIGS levels by allowing slope heterogeneity and cross-sectional dependence in dynamic panel models. Furthermore, we estimate the long-term fiscal reaction functions (FRFs) to detect unobserved heterogeneous business and fiscal policy cyclical effects.

We follow the studies of Bohn (2008) and Feld *et al*. (2020) and analyze fiscal sustainability by employing the regression model given as follows:

$$Primary\ SurplustoGDP_{it} = \alpha Public\ DebttoGDP_{it-1} * b_i + \beta Control_{it} + v_{it} \quad (2)$$

In Equation 2, the dependent variable in the regression model is the primary surplus-to-GDP ratio, and the independent variable is the lagged public debt-to-GDP ratio for each EU state. Equation 2 involves variables to control for cyclical effects, namely temporary fluctuations of government expenditures by the GVAR, and tax smoothing by the business cycle YVAR (Barro, 1986).

Barro (1986) examined the determination of deficits for the US between 1916 and 1982 in his seminal paper. To this end, he introduced the cyclical variable YVAR based on a measure of temporary shortfall of output, $\left(1 - \frac{y_t}{y_{tT}}\right)$ and the ratio of normal real government spending to real taxable income $\frac{g_{tT}}{y_t}$. He also defined the cyclical variable GVAR by relying on the temporary real government spending $g_{t-}g_{tT}$.

YVAR and GVAR are specified as follows:

$$YVAR_{it} = \left(1 - \frac{y_t}{y_{tT}}\right) * \frac{g_{tT}}{y_t} \quad (3)$$

$$GVAR_{it} = \frac{(g_t - g_{tT})}{y_{tT}} \quad (4)$$

In Equation 3, 4; y_t, y_{tT} represent the real output and Hodrick Prescott (HP) (1997)-filtered trend of output, respectively. Likewise, g_t, g_{tT} correspond to the public debt and HP-filtered trend of the public debt, respectively. It should be noted that if the current output is larger than the HP-filtered trend of the output, the YVAR takes negative values. Similarly, if the current expenditures are larger than its trend, the GVAR takes negative values. Summary statistics of GVAR and YVAR are given in Table A.5 and Table A.6 in the Appendix.

In line with the theory, we expect a negative correlation between YVAR, GVAR, expenditure, and the primary surplus.

Firstly, we test the stationarity of primary surplus-to-GDP ratio, public debt-to-GDP ratio, government revenues, government expenditures by implementing the second generation panel unit root tests. The first generation panel data studies neglected the cross-sectional dependence of the panel variables. However, cross-sectional dependence may lead to inaccurate panel data estimations (fixed or random models, generalized method of moments) and an unexpected shock may be correlated with an independent variable in the model (Andrews, 2005; Sarafidis and Robertson, 2009). Therefore, we first analyze the cross-sectional dependence of the panel data set.

3.1. Cross-Sectional Dependence Test

The first generation panel data studies neglected cross-sectional dependence between units of the panel data sets. However, a rapid increase in global data accessibility has led the literature to evolve to panel models, which include large panel datasets that may have a cross-sectional dependence between units of micro-panel models (Chudik and Pesaran, 2013).

In this study, cross-sectional dependence between units in the panel data set is tested by employing The Pesaran (2004) CD (cross-sectional dependence) test. Pesaran (2004) introduced the CD as follows:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{I=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right) \sim N(0,1)\ i,j = 1,\ldots.,N \quad (5)$$

In Equation 5, $\hat{\rho}_{ij}$ is the estimation of pairwise correlation of the residuals. The CD test results for primary surplus-to-GDP ratios, public debt-to-GDP ratios, government revenues, government expenditures, YVAR, and GVAR are given in Table 2.

Table 2. CD Test Results

Variables	CD Test
Primary Surplus-to-GDP Ratios	27.463***
Lagged Public Debt-to-GDP Ratios	26.603***
Government Revenues (GDP %)	8.654***
Government Expenditures (GDP %)	21.629***
YVAR	31.097***
GVAR	26.721***

Note: *,** ,*** represent 10%, 5% and 1% significance levels, respectively. The null hypothesis is the cross-sectional independence.
Source: Authors' representation

According to the results in Table 2, the CD test rejects cross-sectional independence for all series at a 1% significance level. As stated by Pesaran, the CD test results are "*correctly centered for fixed N and T, and robust to single or multiple breaks in the slope coefficients and/or error variances*" (Pesaran, 2004, p.14). Thereupon, the CD test results suggest using the second generation panel unit root tests.

3.2. Panel Unit Root Test

We test the stationarity of the series by employing the Pesaran (2007) CADF (Cross-sectionally Augmented Dickey-Fuller) test due to the existence of cross-sectional dependence between panel units. Pesaran (2007) introduced a regression model that adds the levels of the cross-sections and the first differences of the series to the standard ADF regressions. According to the model, the panel unit root test CADF is defined as follows:

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + \varepsilon_{it} \quad (6)$$

Pesaran's CADF test results are presented in Table 3.

Table 3. CADF Panel Unit Root Tests

	CADF Test	
Variables	**Constant**	**Constant + Trend**
Primary Surplus-to-GDP	-1.766 (0.466)	-2.182 (0.759)

Public Debt-to-GDP	-1.943 (0.157)	-2.644 (0.034)
Government Revenues (GDP %)	-2.120 (0.027)	-2.179 (0.763)
Government Expenditures (GDP %)	-2.137 (0.022)	-2.490 (0.162)
YVAR	-2.754 (0.000)	-2.764 (0.006)
GVAR	-3.071 (0.000)	-3.334 (0.005)

Note: *,** ,*** represent 10%, 5% and 1% significance levels, respectively.
Source: Authors' representation

The CADF test results are asymptotically similar and invariant to the factor loadings (Pesaran, 2007), and thereby robust. The CADF test is estimated with optimal lag length 2 that is determined by the Hansen (1982) test statistic in the panel VAR model. The CADF test results indicate that without time trend, all series are $I(1)$. Both the control variables the YVAR and the GVAR are stationary in their level form as expected.

3.3. Westerlund Panel Co-Integration Test

Westerlund (2007) introduced the co-integration model for the panel data set as follows:

$$y_{it} = \varphi_{1i} + \varphi_{2i} t + z_{it} \tag{7}$$

$$x_{it} = x_{it-1} + v_{it} \tag{8}$$

Herein, $t = 1, \dots, T$ and $i = 1, \dots, N$ represent time and section units.

K-dimensional vector x_{it} is defined as a random walk model. y_{it} consists of deterministic $(\varphi_{1i} + \varphi_{2i} t)$ and stochastic z_{it} terms and presented as follows:

$$\alpha_i(L)\Delta y_{it} = \alpha_i(y_{it-1} - \beta_i' x_{it-1}) + \gamma_i(L)' v_{it} + e_{it} \tag{9}$$

In Equation 9, $\alpha_i(L) = 1 - \sum_{j=1}^{p_i} \alpha_{ij} L^j$ and $\gamma_i(L) = \sum_{j=0}^{p_i} \gamma_{ij} L^j$ are K-dimensional polynomial for the lag operator L. By substituting (8) in (9) we obtain the following error-correction model.

$$\alpha_i(L)\Delta y_{it} = \alpha_i(y_{it-1} - \beta_i' x_{it-1}) + \gamma_i(L)' v_{it} + e_{it} \tag{10}$$

In Equation (10), $\delta_{1i} = \alpha_1(i)\varphi_{2i} - \alpha_i\varphi_{1i} + \alpha_i\varphi_{2i}$ and $\delta_{2i} = -\alpha_i\varphi_{2i}$ represent the deterministic components.

Following Feld *et al*. (2020), we estimate the state-specific fiscal reaction functions (FRF) by analyzing co-integration between primary surplus-to-GDP ratios and public debt-to-GDP ratios, and co-integration between government revenues and

government expenditures. In this context, we apply the Westerlund Panel Co-Integration test. It should be noted that we implement the bootstrap resampling procedure at 400 re-estimations for each Westerlund panel cointegration test and hence, the test provides robust estimations. The test results are presented in Table 4.

Table 4. Westerlund Panel Co-Integration Test Results

Westerlund Panel Co-Integration Test Results			
Variables	**Test Results**		
Primary Surplus-to-GDP	$G_t: -4.003$	(0.000)	$P_t: -28.294$ (0.000)
Lagged Public Debt-to-GDP	$G_a: -23.41$	(0.000)	$P_a: -24.677$ (0.000)
Government Revenues (GDP%)	$G_t: -4.030$	(0.000)	$P_t: -22.985$ (0.000)
Government Expenditures (GDP%)	$G_a: -18.68$	(0.033)	$P_a: -17.732$ (0.000)

Source: Authors' representation

As shown in Table 4, co-integration for the FRFs and the relationship between revenues-expenditures are accepted at a 1% statistical significance level.

In the next stage, we apply the two-sided fixed effect model with Kraay-Driscoll error terms to model long-run fiscal reaction functions. Additionally, Pesaran's (2006) CCEMG (Common Correlated Effects Mean Group Estimator) are implemented to estimate heterogeneous effects between the panel data set. As stated in Chudik and Pesaran, "the CCE method is robust to different types of cross section dependence of errors, possible unit roots in factors, and slope heterogeneity" (Chudik and Pesaran, 2015, p. 393). Table 5 shows the long-run fiscal reaction functions[63].

Table 5 reveals a positive relationship between lagged public debt and the primary surplus-to-GDP ratio at a 1% statistical significance level. The explanatory power of the model is increased by adding the control variables (YVAR, GDP, and lagged primary surplus-to-GDP). The long-run positive relationship between two fiscal indicators indicates that, overall, fiscal sustainability is met in the EU. This finding is in line with the results in Afonso (2005), Prohl and Schineder (2006), and Afonso and Rault (2010).

In the next stage, we utilize the CCEMG model to estimate heterogeneous effects between cross-sections. For this purpose, we use cross-sectional averages of explanatory and independent variables in the test. Table 6 shows the CCEMG test results.

[63] Primary surplus-to-GDP ratio is the dependent variable in the model. Year is selected as the control variable. Dummy variables produced by the outputs of Table 4.

Table 5. Long-Run Fiscal Reaction Functions

Variables	**(1)**	**(2)**	**(3)**	**(4)**
Lagged Public Debt-to-GDP	0.0272	0.0272	0.00242	0.00228
	(0.006)	(0.006)	(0.005)	(0.004)
YVAR		0.0045		0.00352
		(0.01)		(0.008)
GVAR		0.12		-0.0915
		(0.01)		(0.01)
Lagged Primary Surplus-to-GDP			0.587	0.533
			(0.032)	(0.031)
R-Square (Within)	0.339	0.441	0.584	0.635

Notes**:** Primary surplus to GDP is the dependent variable in the long regression models 1-4. Column 1 is estimated with a fixed effect regression where the lagged public debt to GDP is the independent variable. Column 2 is estimated with a fixed effect regression in which the lagged public debt to GDP is the independent variable, and YVAR and GVAR are the control variables. Column 3 is estimated with a fixed effect regression where the lagged public debt to GDP and lagged primary surplus to GDP are the independent variables. Column 4 is estimated with a fixed effect regression where the lagged public debt to GDP and lagged primary surplus to GDP are the independent variables and YVAR and GVAR are the control variables.

Source: Authors' representation

Table 6. CCEMG Test Results

Variables	**(1)**	**(2)**	**(3)**	**(4)**
Cross-sectional averages of lagged public debt-to-GDP ratios	0.065	0.047	0.076	0.046
	(0.02)	(0.01)	(0.02)	(0.02)
Cross-sectional averages of YVAR		6.352		3.079
		(6.01)		(3.008)
Cross-sectional averages of GVAR		-9.596		-10.02
		(0.01)		(6.48)
Cross-sectional averages of lagged primary Surplus-to-GDP ratios			0.319	-0.017
			(0.04)	(0.04)
Constant	-0.004	-0.007	0.001	-0.008
	(0.01)	(0.01)	(0.01)	(0.01)

Source: Authors' representation

As shown in Table 6, common unobserved factors influence fiscal policy distinctively for different EU states.

In the final stage of the study, we analyze fiscal sustainability for the PIIGS. Table 7 presents Pesaran's (2004) test results for the PIIGS.

Table 7. CD Test Results for the PIIGS

Variables	***CD* Test**
Primary Surplus-to-GDP Ratios	8.862***
Public Debt-to-GDP Ratios	13.181***
Government Revenues (GDP %)	1.386
Government Expenditures (GDP %)	9.387***
YVAR	9.603***
GVAR	9.311***

Note**:** *,**,*** represent 10%, 5% and 1% significance levels, respectively.
Source: Authors' representation

As presented in Table 7, the CD test rejects cross-sectional independence for all series except government revenues[64]. In the next step, we test the stationary of the variables by employing Peseran's (2006) CADF test. Table 8 presents the CADF test results for PIIGS countries.

Table 8. CADF Test Results for the PIIGS

	CADF Test	
Variables	**Constant**	**Constant + Trend**
Primary Surplus-to-GDP Ratios	-2.012 (0.281)	-2.406 (0.409)
Public Debt-to-GDP Ratios	-1.639 (0.610)	-2.627 (0.223)
Government Revenues (GDP %)	-1.940 (0.339)	-1.761 (0.907)
Government Expenditures (GDP %)	-3.175 (0.001)	-3.035 (0.041)
YVAR	-2.488 (0.041)	-3.236 (0.013)
GVAR	-3.440 (0.000)	-3.382 (0.005)

Note**:** *,**,*** represent 10%, 5% and 1% significance levels, respectively.
Source: Authors' representation

As shown in Table 8, with and without trend, all series are non-stationary except for government expenditure. YVAR and GVAR are stationary at least at 5% significance level. Since we could not detect a long-run relationship between primary surplus-to-GDP ratio and other variables (transversality condition is not met), fiscal policy is not sustainable for the PIIGS countries in 1995-2018. This finding is in line with the results obtained in Brady and Magazzino (2018), which detected the absence of sustainability for the PIIGS in 1980-2015.

[64] The null hypothesis (cross-sectional independence) is accepted at 0.166 statistical significance level.

Conclusions

This study analyzes fiscal sustainability for 26 EU states and PIIGS by utilizing the model-based approach of Bohn (2008). Additionally, owing to the more unfavorable effects of the ESDC on the fiscal structure of the PIIGS compared to other EU states, we concentrate on fiscal sustainability for the EU overall and the PIIGS, distinctly. We utilize the Westerlund panel co-integration test to detect the long-run relationship between government revenues and government expenditure. Furthermore, we employ a two-sided fixed effect model with Kraay-Driscoll error terms to model long-run fiscal reaction functions. Estimations of this model indicate a positive relationship between primary surplus-to-GDP and lagged public debt and accordingly indicate that fiscal policy is sustainable in the EU, overall. This finding is consistent with the results in the related studies of Afonso (2005), Prohl and Schineder (2006), Afonso and Rault (2010) and verifies our research hypothesis which posits fiscal sustainability for the EU, overall.

Additionally, model estimations of the Pesaran's (2006) CCEMG model reveal that common unobserved factors influence fiscal policy distinctively for different EU states.

In the final stage of the study, we investigate fiscal sustainability for PIIGS countries. Since the transversality condition is not met for the PIIGS, it is found that the fiscal policy is not sustainable for PIIGS countries in the period 1995-2018. This finding is in line with the previous studies such as Brady and Magazzino (2018) and Neto (2020) and confirms the validity of another hypothesis of the study that assumes the absence of fiscal sustainability for PIIGS countries.

Our main contribution to the extant literature is two-folded. First, we examine a crucial policy challenge, namely fiscal sustainability, for a large panel set of EU states by allowing slope heterogeneity and cross-sectional dependence in dynamic panel models in a period that covers the GFC and the ESDC. Second, we obtain the long-term fiscal reaction functions (FRFs) to detect unobserved heterogeneous business and fiscal policy cyclical effects.

Our study proposes important policy implications. First, due to the adverse effects of financial/real crises on fiscal sustainability, the authorities should closely monitor fiscal indicators during tranquil and turmoil times. For this purpose, a robust and effective regulatory framework can be helpful. Second, performing a sustainable and autonomous fiscal policy reflecting the local conditions of the EU state is important. Third, since the fiscal sustainability criterion is not met for the PIIGS over the analyzed period, the EU authorities should enact macroprudential policies for sustaining stability in the fiscal stance of the PIIGS.

Our analysis can be extended into future research by taking into account the time-varying dynamics of fiscal sustainability. It is our belief that this type of analysis will shed light on the dynamic nature of fiscal positions of states and provide valuable insights for authorities.

References

Afonso, A. (2005), Fiscal Sustainability: The Unpleasant European Case, *Public Finance Analysis*, 61(1), pp. 19–44.

Afonso, A. and Rault, C. (2010), What Do We Really Know About Fiscal Sustainability in the EU? A Panel Data Diagnostic, *Review of World Economics*, 145(4), pp. 731-755. https://doi.org/10.1007/s10290-009-0034-1

Alexakis, C. and Pappas, V. (2018), Sectoral dynamics of financial contagion in Europe-The cases of the recent crises episodes, *Economic Modelling*, 73, pp. 222-239. https://doi.org/10.1016/j.econmod.2018.03.018

Andrews, D. (2005), Cross Section Regression with Common Shocks, *Econometrica*, 73(5), pp. 1551-1585. https://doi.org/10.1111/j.1468-0262.2005.00629.x

Barro, R.J. (1986), US deficits since World War I, *The Scandinavian Journal of Economics*, 88(1), pp. 195-222.

Bergman, M. (2001), Testing Government Solvency and The No Ponzi Game Condition, *Applied Economics Letters*, 8(1), pp. 27-29. https://doi.org/10.1080/135048501750041240

Berrittella, M. and Zhang, J. (2015), Fiscal sustainability in the EU: From the short-term risk to the long-term challenge, *Journal of policy modeling*, 37(2), pp. 261-280. https://doi.org/10.1016/j.jpolmod.2015.02.004

Blanchard, O.J. (1990), *Suggestions for A New Set of Fiscal Indicators*, No. 79, OECD Economics Department Working Papers, April. https://doi.org/10.1787/18151973

Blanchard, O.J., Chouraqui, J.C., Hagemann, R. and Sartor, N. (1991), *The Sustainability of Fiscal Policy: New Answers to An Old Question*, No: R1547, NBER Working Paper, National Bureau of Economic Research (retrieved from https://www.oecd.org/economy/outlook/34288870.pdf).

Bohn, H. (1995), The Sustainability of Budget Deficits in A Stochastic Economy, *Journal of Money, Credit and Banking*, 27(1), pp. 257–271.

Bohn, H. (1998), The Behavior of US Public Debt and Deficits, *Quarterly Journal of Economics*, 113(3), pp. 949-963.

Bohn, H. (2008), The Sustainability of Fiscal Policy in The United States, in: Neck, R. and Sturm, J.E. (eds.), *Sustainability of Public Debt*, Cambridge: MIT Press, pp. 15–49.

Brady, G.L. and Magazzino, C. (2018), Fiscal Sustainability in the EU, *Atlantic Economic Journal*, 46(3), pp. 297-311. https://doi.org/10.1007/s11293-018-9588-4

Buiter, W.H. (1985), A guide to public sector debt and deficits, *Economic policy*, 1(1), pp. 13-61.

Calvo, G.A., Izquierdo, A. and Talvi, E. (2003), *Sudden Stops, the Real Exchange Rate, and Fiscal Sustainability: Argentina's Lessons*, No: w9828, NBER Working Paper, National Bureau of Economic Research (retrieved from https://www.nber.org/papers/w9828).

Caporale, G.M. (1995), Bubble Finance and Debt Sustainability: A Test of The Government's Intertemporal Budget Constraint, *Applied Economics*, 27(12), pp. 1135-1143.

Chudik, A. and Pesaran, M.H. (2013), *Large Panel Data Models with Cross-Sectional Dependence: A Survey*, No: 13.15, CAFE Research Paper.

Chudik, A. and Pesaran, M.H. (2015). Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors, *Journal of Econometrics*, 188(2), 393-420. https://doi.org/10.1016/j.jeconom.2015.03.007

Claeys, P. (2007), Sustainability of EU Fiscal Policies: A Panel Test, *Journal of Economic Integration*, 22(1), pp. 112-127. https://doi.org/10.11130/jei.2007.22.1.112

Claeys, P., Ramos, R. and Suriñach, J. (2008), Fiscal Sustainability Across Government Tiers, *International Economics and Economic Policy*, 5(1-2), pp. 139-163. https://doi.org/10.1007/s10368-008-0112-1

Dolenc, P. and Stubelj, I. (2010). Fiscal sustainability in EU and current financial/economic crisis, *International journal of sustainable economy*, 2(1), pp. 80-91. https://doi.org/10.1504/IJSE.2010.029942

Domar, H. (1944), The Burden of Debt and National Income, *American Economic Review*, 34(4), pp. 798-827.

Dragutinović, R., Glavaški, O. and Pucar, E.B. (2019), Fiscal Sustainability in Flow Model: Panel Cointegration Approach for the EU-28, *Ovidius University Annals, Economic Sciences Series*, 19(1), pp. 15-24.

Elliot, G. and Kearney, C. (1988), *The Intertemporal Government Budget Constraint and Tests for Bubbles*, No: 8809, Research Discussion Paper, Reserand Bank of Australia.

European Commission (2017), European Semester Thematic Factsheet Sustainability of Public Finances (retrieved from https://ec.europa.eu/info/sites/info/files/european-semester_thematic-factsheet_public-finance-sustainability_en_0.pdf).

Feld, L.P., Köhler, E.A. and Wolfinger, J. (2020), Modeling Fiscal Sustainability in Dynamic Macro-Panels with Heterogeneous Effects: Evidence from German Federal States, *International Tax and Public Finance*, 27(1), pp. 215-239. https://doi.org/10.1007/s10797-019-09548-7

Ghatak, S. and Sánchez-Fung, J.R. (2007), Is Fiscal Policy Sustainable in Developing Economies?, *Review of Development Economics*, 11(3), pp. 518-530. https://doi.org/10.1111/j.1467-9361.2006.00358.x

Greiner, A. and Semmler, W. (1999), An Inquiry into the Sustainability of German Fiscal Policy: Some Time-Series Tests, *Public Finance Review*, 27(2), pp. 220-236. https://doi.org/10.1177/109114219902700205

Hakkio, C.S. and Rush, M. (1991), Is the Budget Deficit too Large?, *Economic Inquiry*, 29(3), pp. 429-445. https://doi.org/10.1111/j.1465-7295.1991.tb00837.x

Hamilton, J. and Flavin, M. (1986), On the Limitations of Government Borrowing: A Framework for Empirical Testing, *American Economic Review*, 76(4), pp. 808-819.

Hamilton, J.D. and Flavin, M. (1985), On the Limitations of Government Borrowing: A Framework for Empirical Testing, *The American Economic Review*, 76(4), pp. 808-819.

Hansen, L.P. (1982), Large Sample Properties of Generalized Method of Moments Estimators, *Econometrica: Journal of the Econometric Society*, 50(4), pp. 1029-1054.

Hodrick, R.J. and Prescott, E.C. (1997), Postwar US Business Cycles: An Empirical Investigation, *Journal of Money, Credit, and Banking*, 29(1), pp. 1-16.

Kremers, J. (1988), The Long-Run Limits of U.S. Federal Debt, *Economics Letters*, 28(3), pp. 259-262.

Lee, K.W., Kim, J.H. and Sung, T. (2018), A test of fiscal sustainability in the EU countries, *International Tax and Public Finance*, 25(5), pp. 1170-1196. https://doi.org/10.1007/s10797-018-9488-1

MacDonald, R. and Speight, A.E. (1990), The Intertemporal Government Budget Constraint in the UK, 1961-1986, *The Manchester School of Economic & Social Studies*, 58(4), pp. 329-347.

Mackiewicz-Łyziak, J. and Łyziak, T. (2019), A new test for fiscal sustainability with endogenous sovereign bond yields: Evidence for EU economies, *Economic Modelling*, 82, pp. 136-151. https://doi.org/10.1016/j.econmod.2019.01.001

Mahdavi, S. (2014), Bohn's Test of Fiscal Sustainability of The American State Governments, *Southern Economic Journal*, 80(4), pp. 1028-1054. https://doi.org/10.4284/0038-4038-2012.223

Makrydakis, S., Tzavalis, E. and Balfoussias, A. (1999), Policy Regime Changes and The Long-Run Sustainability of Fiscal Policy: An Application to Greece, *Economic Modelling*, 16(1), pp. 71-86.

Mendoza, E. and Oviedo, P.M. (2003), Public Debt Sustainability Under Uncertainty, *Mimeographed Document*, Washington, DC, United States: Inter-American Development Bank.

Neto, D. (2020), Tracking fiscal discipline. Looking for a PIIGS on the wing, *International Economics*, 163, pp. 147-154. https://doi.org/10.1016/j.inteco.2020.01.005

Pesaran, M. (2004), General Diagnostic Tests for Cross Section Dependence in Panels, *IZA Discussion Paper*, No: 1240.

Pesaran, M.H. (2007), A Simple Panel Unit Root Test in The Presence of Cross-Section Dependence, *Journal of Applied Econometrics*, 22(2), pp. 265-312. https://doi.org/10.1002/jae.951

Polat, G.E. and Polat, O. (2019), A Discussion on Fiscal Policies Implemented in EU During and After the Great Recession, in: *Global Challenges in Public Finance and International Relations*, IGI Global, pp. 143-159.

Potrafke, N. and Reischmann, M. (2015), Fiscal Transfers and Fiscal Sustainability, *Journal of Money, Credit and Banking*, 47(5), pp. 975-1005. https://doi.org/10.1111/jmcb.12231

Prohl, S. and Schneider, F.G. (2006), *Sustainability of Public Debt and Budget Deficit: Panel Cointegration Analysis for The European Union Member Countries*, No. 0610, Working Paper, Johannes Kepler University of Linz, Department of Economics.

Ramos-Herrera, M.D.C. and Prats, M.A. (2020), Fiscal Sustainability in the European Countries: A Panel ARDL Approach and a Dynamic Panel Threshold Model, *Sustainability*, 12(20), p. 8505. https://doi.org/10.3390/su12208505

Sachs, J.D. (2002), Resolving the Debt Crisis Oo Low-Income Countries, *Brookings Papers on Economic Activity*, 2002(1), pp. 257-286.

Sakuragawa, M. and Hosono, K. (2011), Fiscal Sustainability in Japan, *Journal of the Japanese and International Economies*, 25(4), pp. 434-446. https://doi.org/10.1002/app5.133

Sarafidis, V. and Robertson, D. (2009), On the Impact of Error Cross-Sectional Dependence in Short Dynamic Panel Estimation, *The Econometrics Journal*, 12(1), pp. 62-81. https://doi.org/10.1111/j.1368-423X.2008.00260.x

Siriwardana, M.K.M. (1998), An Analysis of Fiscal Sustainability in Sri Lanka, *Central Bank of Sri Lanka Staff Studies*, 27-28, pp. 80-111.

Slack, E. and Richard, M.B. (2004), *The Fiscal Sustainability of The Greater Toronto Area",* No: 0405, ITP Paper, International Tax Program, Institute for International Business, Joseph L. Rotman School of Management, University of Toronto.

Smith, G.W. and Zin, S.E. (1991), Persistent Deficits and the Market Value of Government Debt, *Journal of Applied Econometrics*, 6(1), pp. 31-44. https://doi.org/10.1002/jae.3950060104

Trehan, B. and Walsh, C. (1988), Common Trends, the Government's Budget Constraint, and Revenue Smoothing, *Journal of Economic Dynamics and Control*, 12(2-3), pp. 425-444. https://doi.org/10.1016/0165-1889(88)90048-6

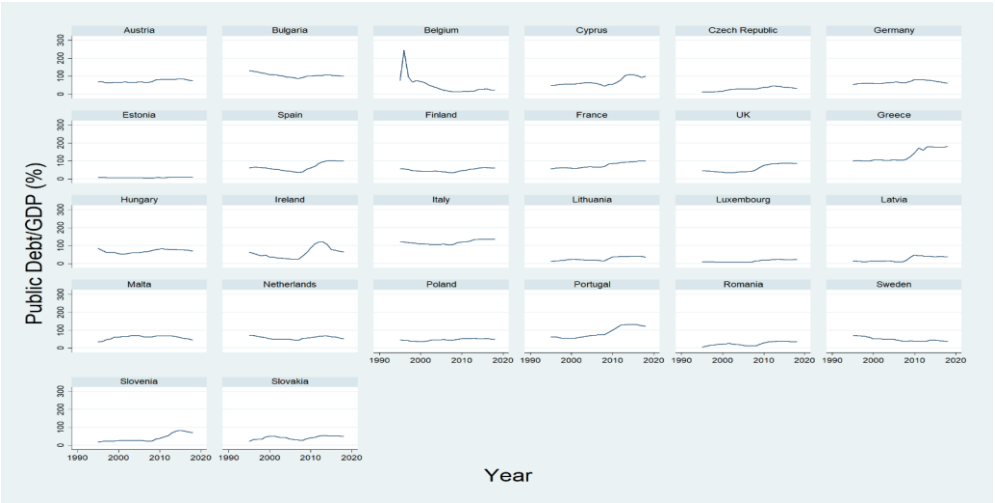
Trehan, B. and Walsh, C. E. (1991), Testing Intertemporal Budget Constraints: Theory and Applications to US Federal Budget and Current Account Deficits, *Journal of Money, Credit and Banking*, 23(2), pp. 206-223. https://doi.org/10.2307/1992777

Westerlund, J. (2007), Testing for Error Correction in Panel Data, *Oxford Bulletin of Economics and Satistics*, 69(6), pp. 709-748. https://doi.org/10.1111/j.1468-0084.2007.00477.x

Wilcox, D. (1989), The Sustainability of Government Deficits: Implications of the Present-Value Borrowing Constraint, *Journal of Money, Credit, and Banking*, 21(3), pp. 291-306. https://doi.org/10.1007/S11293-018-9588-4

Appendix

Figure A.1. Public Debt to GDP Ratios for 26 EU States in 1995-2018



Source: Authors' representation

Table A.1. Summary Statistics for Public Debt-to-GDP Ratios

Countries	Mean	Sd	Median	Min	Max	Skewness	Kurtosis
Austria	72.63275	7.78701	68.481	63.493	84.894	0.391911	-1.68714
Belgium	105.8945	11.13531	104.848	87.325	131.295	0.728142	-0.10921
Bulgaria	46.27508	48.88117	26.84	13.025	244.502	2.755371	8.390616
Cyprus	69.36971	21.13907	59.89	45.557	109.221	0.849583	-0.97934
Czech Republic	28.62542	10.4739	28.275	11.647	44.909	-0.16866	-1.22328
Germany	66.6245	8.163966	65.144	54.902	82.382	0.552849	-1.01503
Estonia	6.951708	2.125541	6.519	3.766	10.555	0.357344	-1.32387
Spain	66.18788	21.98314	61.173	35.765	100.7	0.425575	-1.3184
Finland	48.28913	9.195059	46.8665	32.561	63.015	0.102608	-1.32394
France	74.91229	15.85861	66.661	56.106	98.414	0.360255	-1.70056
United Kingdom	57.49004	21.70199	44.493	34.017	86.923	0.360863	-1.78374
Greece	129.7295	34.38865	107.238	97.425	181.21	0.514139	-1.66234
Hungary	68.70883	9.5105	70.8205	52.253	84.143	-0.10147	-1.47112
Ireland	59.04063	30.6903	52.9145	23.786	119.913	0.682899	-0.79336
Italy	117.8975	11.36798	116.6845	103.873	135.358	0.392619	-1.40799
Lithuania	26.23142	10.59469	22.795	11.526	42.712	0.260232	-1.65255
Luxembourg	13.62196	6.560614	9.581	6.942	23.686	0.318766	-1.76971
Latvia	23.88654	14.23028	13.985	8.048	47.27	0.334592	-1.80089
Malta	59.87117	10.32421	62.8875	34.365	71.918	-0.97708	-0.14642
the Netherlands	57.91171	8.44236	57.736	42.981	73.092	0.053882	-1.21356
Poland	46.76158	5.666694	46.768	36.453	55.692	-0.21827	-1.12644
Portugal	87.45267	30.75842	73.2035	54.193	132.941	0.436444	-1.63162
Romania	24.25233	10.35522	22.298	6.609	39.216	0.033716	-1.4856
Sweden	48.33283	10.68541	44.576	37.35	69.53	0.850315	-0.69178
Slovenia	40.30508	22.63417	26.838	18.237	82.586	0.815658	-1.09926

Slovakia	42.02163	9.619733	43.353	21.591	54.708	-0.36882	-1.22742

Source: Authors' representation

Table A.2. Summary Statistics for Primary Surplus-to-GDP Ratios

Countries	**Mean**	**Sd**	**Median**	**Min**	**Max**	**Skewness**	**Kurtosis**
Austria	0.520208	1.336463	0.776	-2.187	2.944	-0.64711	-0.3831
Belgium	2.845583	2.749696	3.2435	-1.543	6.804	-0.04752	-1.55665
Bulgaria	1.94125	3.003467	2.307	-4.565	7.578	-0.23933	-0.37641
Cyprus	-0.27383	2.785919	-0.8115	-5.528	6.032	0.364086	-0.6297
Czech Republic	-2.06783	2.915743	-1.897	-11.431	2.309	-1.16588	2.159072
Germany	0.724542	1.986266	1.2185	-5.926	2.938	-1.47818	2.660799
Denmark	2.916542	2.489089	2.9255	-1.681	7.011	-0.11739	-1.03921
Estonia	0.443042	1.562541	0.2665	-2.921	3.018	-0.26066	-0.46144
Spain	-0.96258	3.865836	-0.303	-9.559	3.735	-0.77016	-0.59908
Finland	2.373917	3.456064	1.8275	-2.091	9.565	0.304624	-1.3107
France	-0.91529	1.605343	-0.8165	-4.631	1.634	-0.45666	-0.0343
United Kingdom	-1.28446	2.933709	-1.0735	-8.252	3.788	-0.38414	-0.19911
Greece	-1.10121	3.846033	-0.9745	-10.108	4.277	-0.62856	-0.3624
Hungary	-0.02004	2.418205	0.2235	-5.366	4.673	-0.5144	-0.25318
Ireland	-0.46442	7.625808	1.619	-29.229	6.796	-2.3337	5.82702
Italy	2.290542	1.666017	1.8555	-0.713	6.156	0.455562	-0.52159
Lithuania	-1.64258	3.179699	-1.008	-11.02	1.569	-1.43127	1.38109
Luxembourg	2.28475	1.896514	2.1355	-1.067	6.268	0.359424	-0.46299
Latvia	-1.0055	2.387156	-0.109	-7.969	2.286	-1.52177	1.817169
Malta	-0.60342	2.916365	-0.2275	-6.371	5.232	-0.30389	-0.5038
the Netherlands	0.656792	2.431319	1.4725	-3.657	4.459	-0.35651	-1.20364
Poland	-1.15879	1.618111	-1.137	-4.907	1.438	-0.6415	0.001101
Portugal	-1.33092	2.572381	-0.5385	-8.457	2.936	-1.01507	0.957408
Romania	-1.24525	2.181725	-0.533	-7.629	1.022	-1.35436	1.13086
Sweden	2.12275	2.128946	1.7195	-1.917	6.515	0.170995	-0.87405
Slovenia	-1.336	3.169952	-0.2865	-12.034	2.765	-1.61323	2.985154
Slovakia	-2.60475	2.504716	-1.652	-8.589	0.487	-0.87865	-0.35177

Source: Authors' representation

Table A.3. Summary Statistics for Public Revenues

Countries	**Mean**	**Sd**	**Median**	**Min**	**Max**	**Skewness**	**Kurtosis**
Austria	49.1465	0.830716	48.962	47.844	51.121	0.484585	-0.42762
Belgium	50.09517	1.27658	49.7355	48.137	52.987	0.732542	-0.54219
Bulgaria	36.20542	3.854085	37.603	26.253	41.677	-0.84981	0.112066
Cyprus	35.52492	3.646771	36.5985	29.404	40.819	-0.34061	-1.29733
Czech Republic	39.64013	1.321443	39.523	37.39	42.461	0.20689	-0.87423
Germany	44.88363	0.948865	44.9555	43.457	46.493	0.019534	-1.29183
Estonia	37.96404	1.907047	38.2885	34.816	43.416	0.72558	0.714501
Spain	38.17283	1.332001	38.1555	34.955	41.141	-0.03335	0.285516
Finland	53.06879	1.378186	52.6425	51.333	56.25	0.527529	-0.90471
France	51.06	1.459652	50.489	49.255	53.609	0.625195	-1.22864
United Kingdom	36.90888	1.737837	37.48	33.16	39.183	-0.84982	-0.45074
Greece	42.09833	4.241003	40.441	36.269	49.487	0.526586	-1.30744
Hungary	44.70058	1.948324	44.4795	41.711	48.661	0.238734	-0.99269
Ireland	33.668	3.784232	34.114	25.41	38.743	-0.93438	-0.08266

Italy	45.48375	1.446122	45.442	43.159	48.097	0.26107	-1.04683
Lithuania	34.54033	1.732041	34.076	32.313	38.519	0.998495	-0.0377
Luxembourg	43.41617	0.859169	43.4055	41.597	45.056	-0.12879	-0.70975
Latvia	35.42108	1.752873	35.8155	32.089	38.096	-0.27441	-1.31203
Malta	37.37233	2.152138	38.4845	32.267	39.803	-0.70617	-0.80252
the Netherlands	43.01392	0.976667	43.0225	41.397	45.146	0.27214	-0.42267
Poland	40.24817	1.963796	40.0135	37.577	46.604	1.448487	2.337841
Portugal	40.98363	1.995729	40.5665	37.449	44.817	0.202584	-1.01755
Romania	32.79758	1.475183	32.8895	29.602	35.508	-0.38736	-0.41096
Slovakia	38.75604	3.037352	38.751	34.33	44.894	0.227988	-1.12324
Slovenia	44.41454	0.717105	44.3025	43.066	45.863	0.24236	-0.71264
Sweden	53.00829	2.904502	52.7015	49.323	58.276	0.437828	-1.25449

Source: Authors' representation

Table A.3. Summary Statistics for Public Expenditures

Countries	**Mean**	**Sd**	**Median**	**Min**	**Max**	**Skewness**	**Kurtosis**
Austria	51.63492	1.830111	51.242	48.65	55.806	0.645609	-0.07391
Belgium	52.11233	2.379941	51.886	48.563	56.478	0.268817	-1.15285
Bulgaria	37.01917	3.163807	36.931	30.361	43.323	-0.09445	-0.65506
Cyprus	38.55938	4.184284	38.475	30.933	49.353	0.383683	-0.11646
Czech Republic	42.77771	3.004084	42.1765	38.944	52.929	1.852946	3.620187
Germany	46.6805	2.570984	46.806	43.398	55.117	1.262924	2.250085
Estonia	37.73138	2.795343	38.5635	33.447	45.595	0.451929	0.474509
Spain	41.98079	3.121352	41.457	38.375	48.656	0.432663	-1.13843
Finland	52.65317	4.137582	53.3615	46.57	61.051	0.198604	-1.1744
France	54.66283	1.983615	54.67	51.652	57.228	0.01522	-1.70323
United Kingdom	40.64838	3.81258	40.9465	35.132	47.376	0.139424	-1.1749
Greece	48.88388	4.476975	47.0155	43.706	62.37	1.275942	1.07971
Hungary	49.5485	1.834857	49.389	46.654	55.23	0.828318	1.652734
Ireland	36.604	8.376235	34.2285	25.358	65.08	1.521625	3.110642
Italy	48.80163	1.698491	48.5345	46.536	51.619	0.254979	-1.48726
Lithuania	37.39321	4.310218	35.4035	33.169	50.273	1.327135	1.076919
Luxembourg	41.52467	2.041749	41.655	37.809	45.147	-0.21991	-0.89937
Latvia	37.41217	2.983817	37.47	33.546	45.311	1.106388	0.769616
Malta	40.977	2.116459	41.5495	35.863	45.188	-0.93894	0.654861
the Netherlands	44.79908	2.661613	43.9565	42.053	53.721	1.507892	2.649881
Poland	44.17113	2.330868	43.948	41.108	51.14	1.041872	1.126095
Portugal	45.91917	3.073974	45.2935	42.459	51.899	0.606921	-1.06142
Romania	36.06317	2.095446	35.4995	33.167	39.99	0.482299	-1.13359
Sweden	53.01929	3.860444	52.0995	49.272	63.487	1.270241	0.679656
Slovenia	47.83088	3.617285	47.0875	43.409	60.268	1.625187	3.333209
Slovakia	43.51146	4.481852	42.486	36.381	53.27	0.490443	-0.47772

Source: Authors' representation

Table A.5. Summary Statistics for the YVAR

Countries	**Mean**	**Sd**	**Median**	**Min**	**Max**	**Skewness**	**Kurtosis**
Austria	0.0002093	0.0043154	0.0000169	-0.0089378	0.0079596	-0.2328418	-0.3196051
Belgium	0.0001297	0.0030966	0.0003726	-0.0064537	0.0062822	-0.1199903	-0.4288173
Bulgaria	0.0028300	0.0569303	0.0043287	-0.1455904	0.1017655	-0.6367742	0.7436966
Cyprus	0.0176955	0.1713811	0.0172170	-0.2760524	0.2710244	-0.1015218	-1.3840273
Czech Republic	0.0000201	0.0005170	0.0000177	-0.0009450	0.0007352	-0.4299255	-1.0363270

Germany	0.0000027	0.0003256	-0.0000144	-0.0004879	0.0009335	0.7293199	0.6267472
Spain	0.0002223	0.0024946	0.0002377	-0.0039824	0.0046773	0.0337893	-1.0980372
Estonia	0.0398156	0.2493106	0.0827321	-0.5395405	0.4367329	-0.6063741	-0.1013679
Finland	0.0017415	0.0200665	0.0002875	-0.0324369	0.0493260	0.4866343	-0.1019690
France	0.0000312	0.0007596	0.0001311	-0.0012658	0.0015083	0.2305204	-0.8237323
United Kingdom	0.0000387	0.0008287	0.0001001	-0.0014908	0.0015177	-0.1869487	-0.9294196
Greece	0.0039126	0.0307160	0.0130400	-0.0466685	0.0496205	-0.3100291	-1.4545022
Hungary	0.0000079	0.0000990	0.0000322	-0.0001823	0.0001591	-0.4588502	-1.0407888
Ireland	0.0003790	0.0183446	-0.0087677	-0.0205802	0.0352062	0.6128342	-1.2366490
Italy	0.0000469	0.0012082	0.0001700	-0.0021220	0.0021637	-0.0976248	-1.1966810
Lithuania	0.0147243	0.0954383	0.0261921	-0.2128091	0.1656048	-0.8210789	0.1600669
Luxembourg	0.0044977	0.0481954	-0.0003413	-0.0910499	0.1168259	0.3900361	-0.2024112
Latvia	0.0408184	0.2144462	0.0828143	-0.4737276	0.3793383	-0.8934069	0.0226164
Malta	-0.0257769	0.3989028	-0.0629167	-0.6608071	0.5751547	0.0680674	-1.4714410
the Netherlands	0.0001736	0.0030079	-0.0004152	-0.0042793	0.0078619	0.7479435	0.1408927
Poland	-0.0001393	0.0013831	-0.0000280	-0.0029558	0.0021751	-0.2347834	-0.6168797
Portugal	0.0007488	0.0144183	-0.0024771	-0.0173748	0.0351135	0.6625235	-0.6343177
Romania	0.0000920	0.0062316	0.0012329	-0.0155536	0.0097956	-0.7965211	0.3076202
Slovakia	-0.0007222	0.0544189	0.0010801	-0.0926837	0.0900365	-0.0637829	-0.9480216
Slovenia	0.0084092	0.0846076	0.0105468	-0.1760483	0.1530673	-0.4409620	-0.3608880
Sweden	0.0000191	0.0003473	-0.0000007	-0.0007199	0.0005731	-0.1802881	-0.6841371

Source: Authors' representation

Table A.6: Summary Statistics for the GVAR

Countries	Mean	Sd	Median	Min	Max	Skewness	Kurtosis
Austria	0.0000161	0.0055877	-0.0026809	-0.0081751	0.0108202	0.6206481	-0.9428087
Belgium	0.0000206	0.0061038	-0.0006642	-0.0104958	0.0093036	0.0547350	-1.3226942
Bulgaria	-0.0006274	0.0539304	0.0028287	-0.1251246	0.0933897	-0.3138772	-0.3438977
Cyprus	-0.0016045	0.1479936	-0.0057775	-0.3126907	0.3850376	0.2441945	0.6024077
Czech Republic	0.0000019	0.0009387	-0.0001818	-0.0010682	0.0031952	1.7265634	3.4107197
Germany	0.0000022	0.0006913	-0.0000913	-0.0012323	0.0024200	1.6091854	4.0130326
Spain	0.0000163	0.0028521	0.0001015	-0.0043367	0.0074534	0.4399080	-0.0381529
Estonia	0.0039674	0.2136815	-0.0584588	-0.2453933	0.4866410	0.5243169	-0.9680130
Finland	0.0002275	0.0259209	0.0015600	-0.0346861	0.0652255	0.6896444	-0.1056695
France	0.0000033	0.0007960	-0.0001028	-0.0011380	0.0014746	0.2624191	-1.2422278
United Kingdom	-0.0000104	0.0016885	-0.0001242	-0.0021710	0.0034937	0.5235482	-0.8728246
Greece	-0.0000069	0.0175100	-0.0022754	-0.0295026	0.0535104	0.9754887	1.5324621
Hungary	0.0000002	0.0000710	0.0000062	-0.0001296	0.0002197	0.7825029	1.8618801
Ireland	-0.0008909	0.0452973	-0.0194554	-0.0516146	0.1498201	1.5360311	2.5421517
Italy	0.0000004	0.0010743	-0.0002815	-0.0012927	0.0022128	0.5402102	-1.0061072
Lithuania	-0.0004650	0.1970349	-0.0327335	-0.3367391	0.6514859	1.3765862	2.7280997
Luxembourg	-0.0001667	0.0551922	0.0082512	-0.1058546	0.0859188	-0.3406202	-0.9229618
Latvia	0.0001014	0.1662050	-0.0301232	-0.2214259	0.3819633	1.0717766	0.2819546
Malta	-0.0108447	0.3031139	0.0147533	-0.8390440	0.6504252	-0.5227293	0.7238775
the Netherlands	0.0000173	0.0047493	-0.0015426	-0.0058421	0.0162951	1.5975468	3.1258662
Poland	0.0000236	0.0016891	0.0000336	-0.0038292	0.0056615	0.8780091	3.7410639
Portugal	-0.0000195	0.0137795	-0.0018464	-0.0296866	0.0290178	0.1391020	-0.3461749
Romania	-0.0000850	0.0045583	-0.0011538	-0.0079299	0.0092504	0.4346394	-0.9148323
Slovakia	0.0021976	0.0472464	-0.0034019	-0.0606918	0.1527646	1.4148753	2.3869985
Slovenia	0.0000289	0.1055240	-0.0168257	-0.1337069	0.3223181	1.4375890	1.9974279
Sweden	0.0000167	0.0012255	0.0002009	-0.0020807	0.0025224	0.0351181	-0.4178263

Source: Authors' representation