



# Fiscal and External Deficits Nexus in GIIPS Countries: Evidence from Parametric and Nonparametric Causality Tests

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**Abstract** This paper investigates the relationship between fiscal and external deficits in five European Union countries (Greece, Ireland, Italy, Portugal, and Spain) using quarterly data for the period 1980:1–2020:1. Literature on the relationship between these series used linear techniques, but generally reported inconclusive results. Non-linearity has been overlooked even though fiscal policy is likely to exhibit nonlinearity due to its sensitivity to political decisions. To capture this nonlinearity behaviour, nonlinear causality techniques are applied here in addition to the usual linear techniques used in the extant literature. The results show that there is evidence of unidirectional nonlinear causality from trade balances to government deficits in Greece and Italy, and a nonlinear unidirectional causality from government deficits to trade balance in Portugal. The results also indicate evidence of a nonlinear bi-directional causality between the trade and government balances in Ireland and Spain. The policy implication of these results is that governments of these countries need to address fiscal deficits to manage their trade balances. Policies that will improve the countries' revenue base, such as tax and labour market reforms as well as capital market reforms to engender productivity and increase competitiveness, would be beneficial.

**Keywords** Twin deficits · Nonlinear causality · GIIPS

**JEL** E62 · H6 · C22

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## Introduction

Since the advent of the financial crises in 2008 and the subsequent European sovereign debt crisis, attention has been focused on sustainability of public debt in the Eurozone, particularly in what are referred to as peripheral countries. There is no consensus in the theoretical literature on what role fiscal deficits play in creating internal and external equilibrium in an economy that will eventually manifest in current account deficits. Thus, this question must be evaluated empirically. Collignon (2012), Ahmad and Fanelli (2014), Papadopoulos and Sidiropoulos (1999), De Castro and De Cos (2008), Trachanas and Katrakilidis (2013), Arghyrou and Luintel (2007), Bajo-Rubio et al. (2009), Legrenzi and Milas (2012), Afonso and Jalles (2017), Paniagua et al. (2017), Brady and Magazzino (2018), Constâncio (2020), Wysocki and Wójcik (2021), and Albu and Albu (2021) are among the empirical works that examined fiscal sustainability in the Eurozone, but reported contradictory results.

The twin-deficits hypothesis posits that a continuous budget deficit puts more strain on the current account deficit. Empirical exploration of the theoretical relationship of the twin deficits started in the 1980s when the United States (U.S.) (under the administration of President Reagan) experienced huge government deficits and external balances. Due to these simultaneous increases, many researchers attributed a large part of the deteriorating external balance of the U.S. during the period to the advent of huge government deficits, leading to a wide range of empirical investigations in many countries. However, the results remained inconclusive for many reasons. For example, the methodology used to analyse the relationship varied from well-specified theoretical models to using simple one-to-one relationships between the budget deficit and current account deficit, as well as the use of different sample periods.

Due to the inconclusive results reported by both the theoretical and empirical literatures, it is imperative to re-examine the issue using a different methodology. The literature agrees that fiscal policy can exhibit nonlinearity due to its sensitivity to political decisions. This paper undertakes this analysis using data from Greece, Ireland, Italy, Portugal, and Spain (GIIPS) using nonlinear techniques. These economies represent a litmus test to examine the dynamic causal relationship of the twin deficits, due to their huge government deficits and external deficits, as well as increases in their public debt in recent times.

The existing research on the twin-deficit hypothesis in the GIIPS countries has focused mainly on a linear causal relationship and ignored the possibility of a nonlinear causal relationship. A major gap in the literature remains regarding the twin-deficit relationship for these economies. The first main contribution of this paper is that the study conducts a battery of unit root tests, including the Ng-Perron test (NP) (Ng & Perron, 2001), which can overcome problems associated with traditional Augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979), Phillips and Perron (PP) (1988), and Kwiatkowski et al. (KPSS) (1992) unit root tests. The Ng-Perron unit root tests correct for size distortions in the presence of negative serial correlation and also have a relatively higher power to detect the level of integration compared to traditional unit root tests. Second, the study examines the causal relationship using two different types of parametric causality tests, the pairwise Granger causality test and the Toda-Yamamoto causality test. Third, the study examines not only linear, but also nonlinear, causality between government deficits and external deficits in the GIIPS countries. In

addition, the nonlinear test of Brock et al. (1996) (hereafter BDS) was conducted, but using the nonparametric methodology of Diks and Panchenko (2006), which rectifies the potential over-rejection that tainted the non-linear Granger causality test of Hiemstra and Jones (1994). The empirical findings confirm the presence of a nonlinear causal relationship for twin deficits with causality running from trade balances to government deficits in Greece and Italy, a non-linear unidirectional causality from government deficits to trade balance in Portugal, and a non-linear bidirectional causality between trade balances and government balances in Ireland and Spain.

## Stylized Facts

The five countries in this study are Greece, Ireland, Italy, Portugal, and Spain. The main variables (the fiscal, current account, and trade deficits) are all expressed as a percentage of gross domestic product (GDP). Table 1 and Figs. 1-3 provide an overview of the fiscal and external balances for the sample period (1980–2020). A comparison of the mean values of the current account deficits and trade deficits shows that the trade deficits are greater than the current account deficits in Greece, Portugal, and Spain. This implies that trade changes are crucial to their current account deficits.

The fiscal deficits in all the countries in the sample are lower than the 5% critical value, except in Greece where the fiscal deficit is greater than the 5% critical value (Fig. 1). The major reason for this was that Ireland had a surplus between 2003 and 2007 and Spain had a surplus between 2005 and 2007. Both countries later returned to deficits. In the period from 2008 to 2020, all the countries recorded higher deficits. This can be traced to the global recession, macroeconomic instability, and uncertainties due to the European sovereign debt crisis from which the GIIPS countries suffered more than the core Euro countries, such as Germany and France. The deficits imply that when spending exceeds revenue, an increase in public debts will occur.

Figure 2 shows that in Italy and Ireland, the current account deficits were greater than the trade deficits on average, implying that these two countries are net exporters of goods and services. Thus, it can be concluded that higher liabilities abroad are the main cause of the increase in the current account deficits. The highest trade deficits were recorded in Greece, representing about 64% of GDP in the second quarter of 1981 (Fig. 3). This implies that total imports were greater than total exports, and thus Greece is a net importer of goods and services.

## Methodology

### Parametric and Linear Causality

Consider two variables changing over time,  $X_t$  and  $Y_t$ . Linear Granger causality predicts whether past values of  $X_t$  have significant linear predictive power for current values of  $Y_t$  given past values of  $Y_t$ . If so,  $X_t$  is said to linearly Granger cause  $Y_t$ . Bidirectional causality exists if Granger causality runs in both directions.

The test for linear Granger causality between government balances and external balances involves the estimation of the following equations in a vector autoregressive (VAR) framework:

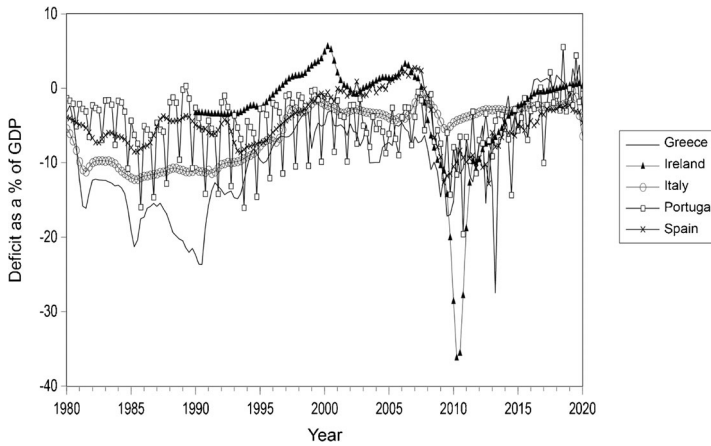
$$FD_t = \sum_{i=1}^{\rho_1} \alpha_i \Delta FD_{t-i} + \sum_{j=1}^{\rho_2} \beta_j CAB_{t-j} + \varepsilon_{1t} \text{ , and} \tag{1}$$

$$CAB_t = \sum_{i=1}^{\rho_3} \delta_i CAB_{t-i} + \sum_{j=1}^{\rho_4} \varphi_j FD_{t-j} + \varepsilon_{2t} . \tag{2}$$

**Table 1** Descriptive Statistics, GIIPS, 1990Q1-2020Q1

Statistics	Country				
<b>Panel A: Current Account</b>	<b>Greece</b>	<b>Ireland</b>	<b>Italy</b>	<b>Portugal</b>	<b>Spain</b>
Mean	-7.35	-1.41	-0.11	-4.33	-2.21
Median	-5.88	-0.54	-0.36	-4.02	-2.54
Maximum	10.51	23.81	3.79	14.13	7.05
Minimum	-36.49	-40.62	-3.73	-19.91	-11.59
Std. Dev.	8.02	6.82	1.84	5.94	3.74
Skewness	-1.25	-2.03	0.13	0.01	0.03
Kurtosis	5.06	16.67	2.07	3.05	2.70
Jarque-Bera	70.68 [0.00]	1024.88 [0.00]	6.28 [0.04]	0.02 [0.99]	0.62 [0.73]
Observations	161	121	161	161	161
<b>Panel B: Trade Balance</b>	<b>Greece</b>	<b>Ireland</b>	<b>Italy</b>	<b>Portugal</b>	<b>Spain</b>
Mean	-12.46	22.08	0.85	-10.00	-4.15
Median	-12.00	20.99	0.52	-9.75	-4.07
Maximum	-1.91	43.99	4.33	-3.91	-0.74
Minimum	-35.26	3.84	-4.03	-26.62	-9.28
Std. Dev.	4.82	8.85	1.88	3.87	2.01
Skewness	-1.68	0.54	-0.16	-1.66	-0.60
Kurtosis	7.81	3.08	2.38	7.44	2.79
Jarque-Bera	230.88 [0.00]	5.93[0.05]	3.24 [0.20]	206.09 [0.00]	10.06 [0.01]
Observations	161	121	161	161	161
<b>Panel C: Fiscal Deficits</b>	<b>Greece</b>	<b>Ireland</b>	<b>Italy</b>	<b>Portugal</b>	<b>Spain</b>
Mean	-9.51	-2.83	-0.11	-4.96	-4.59
Median	-8.11	-0.74	-0.36	-3.83	-4.76
Maximum	3.13	5.66	3.79	5.55	2.73
Minimum	-27.51	-36.18	-3.73	-19.60	-12.79
Std. Dev.	6.31	7.02	1.84	4.15	3.38
Skewness	-0.28	-2.74	0.13	-0.89	0.09
Kurtosis	2.62	11.95	2.07	3.86	2.61
Jarque-Bera	3.06 [0.22]	555.76 [0.00]	6.28 [0.04]	25.98 [0.00]	1.24 [0.54]
Observations	161	121	161	161	161

Notes: Probability values for the Jarque-Bera statistic are in brackets []. FD = government balance, CAB = current account deficits and TB = trade balance. The sample period is from 1980Q1–2020Q1 for all countries except Ireland which is from 1990Q1–2020Q. Source: Authors’ elaborations on data collected from Datastream Databank (Refinitiv, 2020)



**Fig. 1** GIIPS Fiscal Deficits, 1980:Q1–2020:Q1. Source: Datastream Databank (Refinitiv, 2020)

$FD_t$  and  $CAB_t$  are, respectively, the government fiscal balance and external balance.  $\alpha, \beta, \delta$  and  $\varphi$  are the parameters to be estimated.  $(\varepsilon_1, \varepsilon_2)$  are zero-mean error terms with a constant variance-covariance matrix. The optimal lag lengths are determined using the information criterion.

Linear causal relationships are inferred from Eqs. (1) and (2). To test for linear Granger non-causality at specific lags, the statistical significance of the individual  $\beta$  and  $\varphi$  coefficient estimates were examined. Furthermore, the study tested for cumulative linear Granger non-causality by testing the null hypothesis that  $\sum\beta_j = 0$  in Eq. (1) or  $\sum\varphi_j = 0$  in Eq. (2) using a t-statistic.

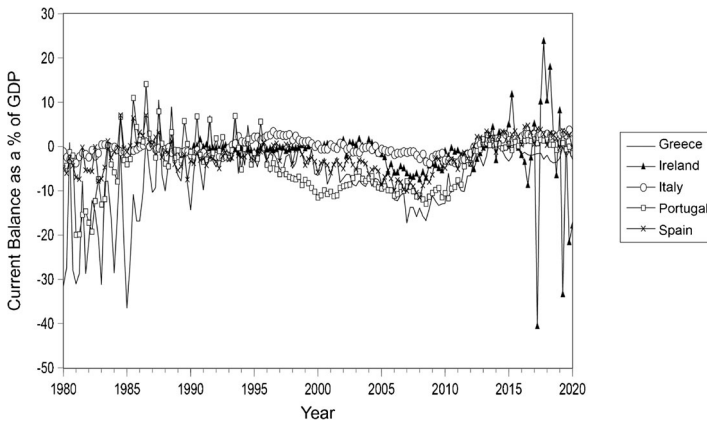
The appropriate lag selection for the Toda-Yamamoto Granger causality test follows the rule of thumb that the number of lags should be  $(k + dmax)$ , where  $K$  is the chosen lag and  $dmax$  is the maximum order of integration of the series. Thus, an extra lag is added to the Toda-Yamamoto Granger causality because the highest order of integration of the series is  $I(1)$ .

The Brock et al. (1996) (BDS) test assumes the correlation integral as well as the spatial estimator of probabilities across time (Grassberger & Procaccia, 1983). It tests the identically and independently distributed error term (i.i.d) assumption of the time series. The BDS test is based on the null of linearity with the alternative of nonlinearity. Thus, rejection of the null indicates a nonlinear relationship.

Given an  $m$ -dimensional time series  $X_t$  and its observations  $(X_t, X_{t-1}, X_{t-2}, \dots, X_{m-1})$ , the correlation integral can be represented as:

$$C_m(T, e) = \sum_{t=1}^{T_{m-1}} \sum_{s=t+1}^{T_m} I(X_t^m, X_s^m, e) \cdot \frac{2}{T_m(T_m-1)} \tag{3}$$

$$I(X_t^m, X_s^m, e) = \begin{cases} 1, & \|X_t^m, X_s^m\| < e \\ 0, & \text{otherwise} \end{cases}$$



**Fig. 2** GIIPS Current Account Balances, 1980:Q1–2020:Q1. Source: Datastream Databank (Refinitiv, 2020)

$\|X_t^m, X_s^m\|$  is the Euclidian distance between  $X_t^m$  and  $X_s^m$ .  $T_m$  is the sample size and  $T$  can be divided into  $T_m$  sub-samples of  $m$ -dimension vectors. The correlation integral measures the fraction of data  $(X_t^m, X_s^m)$  that are within a maximum norm distance of  $e$ . Thus, the BDS test statistic, which follows a standard normal distribution, is given as:

$$W_m(T, e) = \frac{\sqrt{T} [C_m(T, e) - C_1(T, e)^m]}{\sigma_m(e)}, \tag{4}$$

where  $T$  is the sample size and  $\sigma_m$  is the standard deviation.

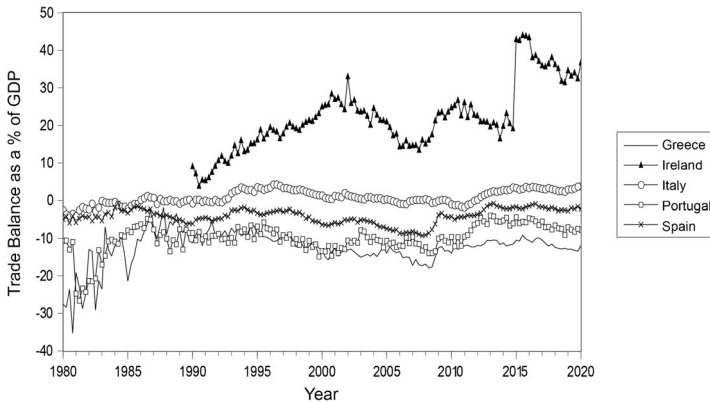
To estimate the BDS statistics, this study followed Brock et al. (1996) where the  $\varepsilon$  is set to between 0.5–1.5 times the standard deviation of the actual data, and  $m$  is set in line with the number of observations available (for example,  $m \leq 5$  for  $T \leq 200$ ).

**Nonparametric and Non-linear Causality**

The study used the nonparametric test developed by Diks and Panchenko (2006) (DP test) for testing nonlinear Granger causality. This test is better because it overcomes the over-rejection issue observed in the previously popular test advocated by Hiemstra and Jones (1994) (HJ test). The general setting for this approach is summarized as follows. The null hypothesis for the Granger test for non-causality from one series ( $X_t$ ) to another series ( $Y_t$ ) is that  $X_t^{\ell_X}$  does not contain additional information about  $Y_{t+1}$ . That is,

$$H_0 = Y_{t+1} | (X_t^{\ell_X}; Y_t^{\ell_Y}) \sim Y_{t+1} | Y_t^{\ell_Y}. \tag{5}$$

For a strictly stationary bivariate time series, such as Eq. (3), it comes down to a statement about the invariant distribution of the  $(\ell_X + \ell_Y + 1)$ -dimensional vector  $W_t$



**Fig. 3** GIIPS Trade Balances, 1980:Q1–2020:Q1. Source: Datastream Databank (Refinitiv, 2020)

=  $(X_t^{\ell_X}, Y_t^{\ell_Y}, Z_t)$  where  $Z_t = Y_{t+1}$ . To keep the notation compact, and to emphasize that the null hypothesis is a statement about the invariant distribution of  $(X_t^{\ell_X}, Y_t^{\ell_Y}, Z_t)$ , the time index is dropped and  $\ell_X = \ell_Y = 1$  is assumed. Hence, under the null, the conditional distribution of  $Z$  given  $(X, Y) = (x, y)$  is the same as that of  $Z$  given  $Y = y$ . Further, Eq. (3) can be restated in terms of ratios of joint distributions. Specifically, the joint probability density function,  $f_{X,Y,Z}(x, y, z)$ , and its marginals must satisfy the following relationship:

$$\frac{f_{X,Y,Z}(x, y, z)}{f_Y(y)} = \frac{f_{X,Y}(x, y)}{f_Y(y)} \cdot \frac{f_{Y,Z}(y, z)}{f_Y(y)} . \tag{6}$$

This explicitly states that  $X$  and  $Y$  are independent, conditional on  $Y = y$  for each fixed value of  $y$ . Diks and Panchenko (2006) showed that this reformulated  $H_0$  implies:

$$q = E[f_{X,Y,Z}(X, Y, Z)f_Y(Y) - f_{X,Y}(X, Y)f_{Y,Z}(Y, Z)] = 0 . \tag{7}$$

Let  $\hat{f}_w(W_i)$  denote a local density estimator of a  $d_w$ -variate random vector  $W$  at  $W_i$  defined by  $\hat{f}_w(W_i) = (2\mathcal{E}_n)^{-d_w}(n-1)^{-1} \sum_{j \neq i} I_{ij}^{w}$  where  $I_{ij}^{w} = I(\|W_i - W_j\| < \varepsilon_n)$  with  $I(\cdot)$  the indicator function and  $\varepsilon_n$  the bandwidth, depending on the sample size  $n$ . Given this estimator, the test statistic is a scaled sample version of  $q$  in Eq. (5):

$$T_n(\varepsilon_n) = \frac{n-1}{n(n-2)} \cdot \sum_i \left( \hat{f}_{X,Z,Y}(X_i, Z_i, Y_i) \hat{f}_Y(Y_i) - \hat{f}_{X,Y}(X_i, Y_i) \hat{f}_{Y,Z}(Y_i, Z_i) \right) . \tag{8}$$

For  $\ell_X = \ell_Y = 1$ , if  $\varepsilon_n = Cn^{-\beta}$  ( $c > 0, \frac{1}{4} < \beta < \frac{1}{3}$ ), then Diks and Panchenko (2006) proved under strong mixing that the test statistic in Eq. (6) satisfies:

$$\sqrt{n} \frac{T_n(\varepsilon_n) - q}{S_n} \xrightarrow{D} N(0, 1) , \tag{9}$$

where  $\xrightarrow{D}$  denotes convergence in distribution and  $S_n$  is an estimator of the asymptotic variance of  $T_n(\cdot)$ .

## Empirical Results

### *Data and Unit Root Test Results*

This study focuses on the GIIPS countries. Quarterly data from 1980:1 to 2020:1, consisting of government balance as a percentage of GDP, current account balance as a percentage of GDP, and the trade balance as a percentage of GDP for all countries were used. The data were sourced from the Datastream Databank (Refinitiv, 2020).

The series is subjected to several unit root tests to determine the level of integration. The ADF (1979), PP (1988), KPSS (1992), and NP (2001) tests were used. The Schwartz Information Criterion (SIC) was used to ascertain the appropriate lag lengths for the unit root tests. The results are reported in Table 2.

The ADF, PP, and NP tests have the null hypothesis of a unit root while the KPSS test has the null of stationarity. The results in Table 2 show that the null of the unit root cannot be rejected for most series in levels as the unit root test statistics are less than the critical values of  $-3.99$ ,  $-3.43$  and  $-3.13$  at the 1%, 5% and 10% levels of significance, respectively. However, all series were stationary in their first difference at the 5% level of significance as indicated by the test statistics which are greater than the critical values at all the conventional significance levels. Therefore, the series are nonstationary  $I(1)$ .

### Parametric Causality Test Results

Two parametric causality tests, the Granger causality test and Toda-Yamamoto causality test discussed previously, were used. The relationship between the trade balance and the budget balance, and the relationship between the current account deficits and the fiscal deficits were tested. For each of the relationships, four probable hypotheses were tested. First, changes in the external balance Granger cause changes in fiscal deficits. Second, changes in fiscal deficits Granger cause the external balance. Third, a feedback causality between external balance and fiscal balance exists. Fourth, there is no feedback causal relationship between the fiscal balance and the external balance. The Granger causality test shows that the movement of one variable is followed by that of another variable (Brooks, 2008).

Table 3 reports Granger causality results which indicate the absence of either a unidirectional or bidirectional relationship between trade deficits and fiscal deficits as well as between current account deficits and fiscal deficits for Ireland and Italy. However, there is evidence of unidirectional causality from fiscal deficits to current account deficits in Greece and Spain, and unidirectional causality from fiscal deficits to the trade balance in Portugal and Spain. These findings are consistent with the ones reported by Ahmad et al. (2015). In addition, there is evidence of unidirectional causality from the current account balance to fiscal deficits in Portugal, and unidirectional causality from the trade deficits to fiscal deficits in Portugal and Spain. Therefore, the results provide evidence for the twin-deficits hypothesis in Greece, Portugal, and Spain.

The Toda-Yamamoto causality test shows that there is evidence of the twin deficits in Spain, with causality running from fiscal deficits to trade deficits. However, in Italy and Portugal, the Granger tests show that trade deficits Granger cause fiscal deficits,



**Table 2** Unit roots, GIIPS, 1980Q1–2020Q1

Country	Variable	ADF	PP	NP	KPSS
<b>Panel A: Series in Levels</b>					
Greece	FD	-2.340	-1.356	-2.044	0.782***
	CAB	-2.309	-8.427***	-2.031	0.195**
	TB	-1.717	-1.940	-1.203	0.187***
Ireland	FD	-2.619	-1.375	-2.689	0.209***
	CAB	-1.995	-9.571***	-0.440	0.667***
	TB	-2.883	-2.903	-2.712	0.498***
Italy	FD	-1.469	-2.349	-1.249	0.184**
	CAB	-1.772	-2.232	-1.822	0.216***
	TB	-2.236	-2.232	-1.978	0.267***
Portugal	FD	-2.956	-2.537	-1.911	0.196**
	CAB	-2.665	-2.071	-2.339	0.272***
	TB	-1.945	-4.521***	-1.391	0.218***
Spain	FD	-1.880	-2.340	-1.813	0.226***
	CAB	-2.492	-5.381***	-0.143	0.190**
	TB	-2.028	-1.961	-2.009	0.187**
<b>Panel B: Series in first differences</b>					
Greece	$\Delta$ FD	-11.427***	-18.107***	-6.006***	0.170
	$\Delta$ CAB	-8.529***	-28.148***	-19.171***	0.146
	$\Delta$ TB	-4.079***	-22.377***	-5.582***	0.177
Ireland	$\Delta$ FD	-4.494***	-4.658***	-3.931**	0.076
	$\Delta$ CAB	-3.742**	-35.288***	-4.124***	0.113
	$\Delta$ TB	-13.152***	-13.113***	-5.392***	0.045
Italy	$\Delta$ FD	-7.339***	-3.343**	-4.040***	0.173
	$\Delta$ CAB	-11.301***	-16.309***	-3.809***	0.089
	$\Delta$ TB	-14.038***	-13.998***	-5.610***	0.068
Portugal	$\Delta$ FD	-26.083***	-41.612***	-8.631***	0.083
	$\Delta$ CAB	-6.214***	-22.379***	-7.046***	0.054
	$\Delta$ TB	-6.869***	-18.691***	-4.213***	0.035
Spain	$\Delta$ FD	-7.211***	-13.314***	-4.945***	0.053
	$\Delta$ CAB	-3.981**	-22.628***	-3.449***	0.062
	$\Delta$ TB	-14.038***	-14.024***	-4.518***	0.076

Notes: ADF, PP, NP and KPSS denote the Augmented Dickey-Fuller unit root test, the Phillips-Perron unit root test, the Ng-Perron unit root test and the Kwiatkowski-Phillips-Schmidt-Shin stationarity test, respectively. The critical values are -3.99 (1%), -3.43 (5%), and - 3.13 (10%). \*, \*\*, and \*\*\* indicate level of significance at 10, 5, and 1%, respectively. FD = government balance, CAB = current account deficits and TB = trade balance. The sample period is from 1980Q1–2020Q1 for all countries except Ireland which is from 1990Q1–2020Q1. Source: Authors' elaborations on data collected from Datastream Databank (Refinitiv, 2020)

and a reverse causality runs from the current account balance to the government balance in Portugal, suggesting evidence in favour of the current account targeting

**Table 3** Linear Causality Test for GIIPS Countries, 1980Q1–2020Q1

<b>Panel A: Pairwise Granger causality</b>				
	CAB → F D	F D → CAB	TB → F D	FD → TB
Greece	1.628 [7]	3.426** [7]	0.232 [8]	1.713 [8]
Ireland	0.837 [4]	0.055 [4]	1.615 [4]	0.286 [4]
Italy	0.131 [5]	0.570 [5]	1.742 [5]	0.948 [5]
Portugal	3.448*** [5]	1.444 [5]	2.239* [4]	4.038*** [4]
Spain	0.842 [9]	2.789** [9]	3.837* [1]	14.899*** [1]
<b>Panel B: Toda-Yamamoto causality test</b>				
	CAB → F D	F D → CAB	T B → F D	F D → T B
Greece	4.442 [8]	9.779 [8]	1.952 [9]	2.455 [9]
Ireland	11.436 [5]	4.119 [5]	7.737 [5]	1.037 [5]
Italy	0.558 [6]	2.093 [6]	9.767* [6]	5.042 [6]
Portugal	17.358** [6]	2.716 [6]	10.014* [10]	5.504 [10]
Spain	5.399 [10]	9.968 [10]	2.955 [7]	23.159*** [7]

Notes: \*, \*\*, and \*\*\* indicate level of significance at 10, 5, and 1%, respectively. The lag lengths of VAR specification are set using the Schwartz Information Criterion (SIC). The number of lags chosen are in brackets []. FD = government balance, CAB = current account deficits and TB = trade balance. The sample period is from 1980Q1–2020Q1 for all countries except Ireland which is from 1990Q1–2020Q1. Source: Authors' elaborations on data collected from Datastream Databank (Refinitiv, 2020)

hypothesis. These results agree with those of Garg and Prabheesh (2017). In Greece and Ireland, there are no unidirectional or bidirectional relationships between trade deficits and fiscal deficits, or between current account deficits and fiscal deficits.

The BDS test was performed on the residual series of VAR models to test for nonlinearity under the null of linearity (Brock et al., 1996). Rejection of the null implies that the series is characterized by nonlinearity. Table 4 reports the BDS test results. Panel A shows evidence of nonlinearity in the fiscal deficits and current account balance residuals for all the GIIPS countries considered. This is clear from the BDS calculated test statistics that exceed the critical values of  $\pm 2.33$ ,  $\pm 1.96$ , and  $\pm 1.64$  at the 1, 5, and 10% levels, respectively.

Panel B shows that there is evidence of nonlinearity in the fiscal deficits and trade balance residuals in all the GIIPS countries as their BDS calculated statistics exceed the critical values for  $\pm 2.33$ ,  $\pm 1.96$ , and  $\pm 1.64$  at the 1, 5, and 10% levels, respectively. From the above results, there is evidence of nonlinearity in both pairs of residuals for the series in all the countries. Therefore, the use of a parametric causality test would be inappropriate. Thus, it is essential to examine the possibility of nonlinearity using the DP nonparametric causality test explained next.

### Nonparametric and Non-linear Causality Results

To implement the DP nonparametric causality test, the current study followed the method of Diks and Panchenko (2006) by setting the bandwidth to 1.5. The following remarks are based on the results presented in Table 5. The nonlinear Granger tests show

**Table 4** BDS Non-Linearity Test for GIIPS Countries, 1980Q1–2020Q1

**Panel A: VAR Residuals of Current Account Balance and Government Balance**

Current Account Balance Residuals						
m	Greece	Ireland	Italy	Portugal	Spain	
2	5.758***	2.984***	-1.478	1.087	1.084	
3	7.291***	-2.285***	0.553	1.904*	0.810	
4	8.327***	-0.820	-5.986***	3.308***	1.469	
5	9.350***	-0.381	-3.834***	4.033***	2.387***	
Government Balance Residuals						
m	Greece	Ireland	Italy	Portugal	Spain	
2	4.465***	4.582***	5.386***	1.095	1.873*	
3	5.178***	5.635***	6.729***	2.636***	2.769***	
4	6.109***	5.654***	6.747***	2.654***	3.744***	
5	6.275***	5.889***	8.022***	3.347***	4.090***	

**Panel B: VAR Residuals of Trade Balance and Government Balance**

Trade Balance Residuals						
m	Greece	Ireland	Italy	Portugal	Spain	
2	4.897***	-1.538	2.638***	1.689*	1.778*	
3	6.321***	-1.897***	2.428***	1.433	2.087**	
4	7.243***	1.672*	2.318***	2.184**	2.670***	
5	7.989***	-2.403***	2.384***	2.127**	2.651***	
Government Balance Residuals						
m	Greece	Ireland	Italy	Portugal	Spain	
2	4.092***	6.794***	3.473***	0.825	2.270**	
3	4.687***	8.372***	4.982***	2.144**	3.152***	
4	5.388***	9.203***	5.148***	2.207**	4.420***	
5	5.597***	9.817***	6.213***	2.704***	5.162***	

Notes: \*, \*\*, and \*\*\* indicate level of significance at 10, 5, and 1%, respectively. m = embedding dimension; ε = distance between points, measured in terms of number of standard deviations. The critical values for the BDS statistics are ±2.33, ± 1.96 and ± 1.64 at the 1, 5 and 10% level, respectively. Source: Authors' elaborations on data collected from Datastream Databank (Refinitiv, 2020)

evidence of bidirectional causality between fiscal deficits and trade balances in Ireland and Spain using the raw data.

Thus, the null of no nonlinear Granger causality was rejected because the statistics were significant at the 5 and 10% levels. In Greece and Italy, there is evidence of unidirectional nonlinear causality from trade balances to fiscal deficits, thus providing evidence in favour of the trade balance targeting hypothesis. This is consistent with earlier studies, such as Kouassi et al. (2004) for 18 developed and developing countries, Holmes (2011) for the U.S., and Kalou and Paleologou (2012) for Greece. However, the results for Portugal indicate that no unidirectional or bidirectional nonlinear relationship between the deficits was found.

Following Bekiros and Diks (2008), the nonparametric DP test on the residuals from the VAR was reapplied, showing that the detected causality was strictly nonlinear. The

**Table 5** Diks and Panchenko (2006) Non-linear Causality Test by GIIPS Country, 1980Q1 – 2020Q1

<b>Panel A: Raw Data</b>				
Country	CAB → F D	F D → CAB	T B → F D	F D → T B
Greece	0.038 [8]	0.893 [8]	1.647** [9]	1.188 [9]
Ireland	0.304 [5]	0.541 [5]	1.630* [5]	1.715** [5]
Italy	1.274 [6]	0.260 [6]	1.865** [6]	1.005 [6]
Portugal	1.049 [6]	0.617 [6]	1.042 [5]	0.347 [5]
Spain	0.186 [10]	0.800 [10]	1.784** [7]	1.342* [7]
<b>Panel B: VAR Residuals</b>				
Country	CAB → F D	F D → CAB	T B → F D	F D → T B
Greece	0.208 [3]	1.282* [3]	0.303 [3]	0.581 [3]
Ireland	0.613 [2]	0.633 [2]	0.231 [3]	0.293 [3]
Italy	0.683 [4]	0.595 [4]	0.068 [5]	0.792 [5]
Portugal	0.513 [3]	0.039 [3]	0.132 [3]	1.690* [3]
Spain	0.179 [3]	0.843 [3]	0.641 [2]	1.202 [1]

Notes: \* and \*\* indicate level of significance at 10 and 5%, respectively. The lag lengths of VAR specification are set using the Schwartz Information Criterion (SIC). The embedding dimension is maximum lag plus 1 and the number of lags chosen are in brackets []. FD = government balance, CAB = current account deficits and TB = trade balance. The sample period is from 1980Q1–2020Q1 for all countries except Ireland which is from 1990Q1–2020Q1. Source: Authors' elaborations on data collected from Datastream Databank (Refinitiv, 2020)

causality on the filtered residuals and the lags were determined using the SIC as the VAR is sensitive to lag length.

The results show that the nonlinear causal relationship discovered for the unidirectional causality from the fiscal deficits to the external deficits only held for Greece and Portugal, while the nonlinear causality observed for Ireland and Spain diminished. This implies that the non-linear causality for Ireland and Spain might not be strictly nonlinear.

## Conclusion

This paper employed linear (Granger causality) and nonlinear (Toda-Yamamoto causality and DP) tests to investigate the existence of causality between fiscal deficits and external balances in the GIIPS countries. The empirical findings from the linear causality test show evidence of causality running from fiscal deficits to external balances in Greece, Portugal, and Spain. Evidence of unidirectional causality from the external balances to the fiscal deficits was found for Portugal and Spain, suggesting evidence in favour of the twin-deficits hypothesis. The Toda-Yamamoto causality test indicates evidence of twin deficits only for Spain. However, for Italy and Portugal, the Granger tests show evidence of reverse causality from external deficits to fiscal deficits, while there is no evidence for twin deficits in Greece and Ireland.

The study also performed a nonlinearity test on the residuals of the series using the BDS test and found evidence for a nonlinear relationship in both pairs of the VAR

residuals and, thus, the need to examine the possibility of a nonlinear relationship between the twin deficits in the countries. Results from the Diks and Panchenko (2006) nonlinear Granger tests show the existence of bidirectional causality between fiscal deficits and trade balances only in Ireland and Spain using the raw data. In Greece and Italy, there is evidence of unidirectional nonlinear causality from trade balances to fiscal deficits, providing evidence in favour of the trade balance targeting hypothesis. There is no evidence of non-linear Granger causality in Portugal. Applying the nonparametric DP test to the residuals obtained from the VAR model, results show that the nonlinear causal relationships discovered on the unidirectional causality from the fiscal deficits to the external deficits only holds for Greece and Portugal, while the nonlinear causality observed for Ireland and Spain diminished.

The policy implication of the results is that reducing fiscal deficits to achieve either current account deficits or trade deficits may not be sufficient. A mix of appropriate fiscal and monetary policy measures should be implemented. As the countries are in the Eurozone, controlling the twin-deficits issues would require a reassessment of the institutional framework of the countries to achieve financial stability and fiscal prudence. In addition, implementation of tax policy as well labour market and capital market reforms to engender productivity and increase competitiveness would be important.

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