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Drivers of Fiscal Sustainability: a Time-Varying Analysis for Portugal*

António Afonso,[$] José Carlos Coelho[#]

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Abstract

We assess the drivers of fiscal sustainability in Portugal during the period 1999Q4-2021Q4. We resort to expanding window and Schlicht (2003, 2021)'s time-varying approaches to construct the responses of government revenues to government expenditures and the responses of the primary government balance and the cyclically adjusted primary government balance (CAPB) to the debt-to-GDP ratio. Our results show the prevalence of a Ricardian fiscal regime in Portugal. If the (*i-g*) differential is positive, the positive response of the primary government balance to the debt-to-GDP ratio is amplified. An improvement in the external accounts, the increase in the European Commission's fiscal rules index and the extension of the debt maturity were beneficial for fiscal sustainability. Sovereign debt rating downgrades implied a posterior fiscal reaction that improves fiscal sustainability. Moreover, fiscal sustainability increased during the implementation of the international financial assistance program to Portugal, between 2011Q2 and 2014Q2.

Keywords: fiscal sustainability; primary government balance; government debt; expanding window; time-varying; Portugal.
***JEL* codes**: C23, H61, H63, E62

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1. Introduction

The fiscal effort that Portugal has made in recent years has been expressive, the country has benefited from an improvement in the ratings attributed by the financial rating agencies, has recovered external credibility and has signalled its commitment and capacity to embark on a sustainable path for its public accounts.

In Portugal, between the first quarter of 2000 and the first quarter of 2014, the public debt-to-GDP ratio increased from 56.4% to 135.2%, which corresponds to the maximum value of the period 2000Q1-2021Q4.[1] As of the first quarter of 2014, the series began a downward trajectory, only interrupted in some quarters due to the economic and budgetary effects of the pandemic crisis. The accumulation of the stock of public debt between 2000 and 2014 of around 80 pp was problematic for several reasons. The first reason is related to the burden that the public debt represents for future generations and the need for increased taxation that will be imposed in order to amortize part of the stock of public debt and bear the burdens associated with servicing the public debt, in order to respect the intertemporal government budget constraint. This question is particularly relevant since it refers to the notion of intergenerational justice.

The second reason refers to the risk of fiscal unsustainability for the Portuguese Republic, given that high levels of the public debt-to-GDP ratio compromise the State's ability to honour its commitments, with consequences for the economy as a whole. The third reason has to do with the fact that the high accumulation of public debt hampers the function of macroeconomic stabilization through fiscal policy (in this context, the fiscal space is smaller or, at the limit, non-existent) and requires a high level of taxation, which discourages work, savings and investment, and therefore is detrimental to economic growth. On the other hand, economic growth appears to be an essential ingredient of fiscal sustainability, and even of sovereign debt bond yields. For these reasons, the economic policy authorities in Portugal chose the reduction of the public debt-to-GDP ratio as the main objective of economic policy. However, this policy is the target of criticism and limitations are pointed out, regarding the constraints it imposes on the fiscal level, on the functioning of public services, on the deterioration of the share of public investment on GDP and on the intertemporal efficiency of public expenditure. A continued policy of reducing the fiscal deficit and public debt, both as a percentage of GDP, over time undermines other economic objectives, namely short-term

[1] Based on Eurostat data.

macroeconomic stability and long-term productivity growth, in addition to threatening dimensions of political and social sustainability.

The main purpose of this article is to investigate the explanatory factors of fiscal sustainability in Portugal during the period 1999Q4-2021Q4. To this end, in the first step, we resorted to time-varying analysis, using the expanding window approach and the methodology of Schlicht (2003, 2021), to construct the responses of government revenues to government expenditures and the responses of the primary government balance and the cyclically adjusted primary government balance (CAPB) to variations in the lagged public debt-to-GDP ratio. In the second step of this empirical assessment, we identify explanatory factors for these responses. This analysis is relevant, from the point of view of the economic policy maker, since it suggests a set of determinants that amplify or attenuate the fiscal sustainability indicators. Understanding the performance of these factors allows fiscal authorities to incorporate existing information in the design, implementation and decision-making of economic policies.

The time-varying analysis of fiscal sustainability is followed by several authors, who consider that the response of the primary government balance (% of GDP) to the public debt-to-GDP ratio varies over time, i.e., it is time-dependent, and not fixed (Fincke and Greiner, 2012; Lee *et al.*, 2018; Afonso and Jalles, 2017; Saadaoui *et al.*, 2022). In addition to the time-varying analysis, in this paper we carry out the canonical empirical assessments of fiscal sustainability, namely the unit root tests on the government revenues and expenditures series, primary government balance, CAPB, government debt and first differences of the stock of real government debt (based on Hamilton and Flavin, 1986, and Trehan and Walsh, 1991); the analysis of the cointegration relationship between government revenues and expenditures, as well as the primary government balance and CAPB with government debt (following Hakkio and Rush, 1991); and, finally, the study of fiscal reaction functions à la Bohn (1998).

Our results show the prevalence of a Ricardian fiscal regime in Portugal. Additionally, if the (*i-g*) differential is positive, the primary government balance improves, and the response of the primary government balance to changes in the public debt-to-GDP ratio is amplified. Within the scope of the time-varying analysis, we find that the improvement in the external accounts, the increase in the European Commission's fiscal rules index and the extension of the maturities of sovereign debt gave revealed beneficial from the point of view of fiscal sustainability. In addition, sovereign debt rating downgrades imply a fiscal reaction that improves fiscal sustainability. Regarding legislative elections, the results also point to a worse fiscal behaviour by the government. Moreover, fiscal sustainability improved during the implementation of the international financial assistance program to Portugal, between 2011Q2

and 2014Q2. Finally, the output gap does not seem to be particularly relevant regarding fiscal sustainability.

The remainder of the paper is structured as follows. Section 2 presents an empirical literature review. We explain the empirical strategy in Section 3. Next, Section 4 describes the data. The obtained empirical results are reported and discussed in Section 5. Finally, Section 6 concludes.

2. Related Literature

The empirical literature on fiscal sustainability initially focused on individual countries or small groups of countries and was based on unit root tests and the study of the causality and cointegration relationship between government revenues and expenditures. In this regard, Hamilton and Flavin (1986) is a pioneering study applied to the United States, between 1962 and 1984, where stationarity tests are carried out on the budget balance and public debt. Hakkio and Rush (1991), Haug (1995) and Quintos (1995) for the United States, Olekalns (2000) for Austria, and Hatemi (2002) for Sweden test the observance of cointegration relationships between the two sides of the budget, comprising time horizons between the end of the Second World War and the 2000s. Owoye (1995), Payne (1997) and Chen (2014) study G7 and some European countries individually (including Portugal) and report a diversity of results. Magazzino *et al.* (2019) perform a panel analysis for the G7 countries considering the period between 1980 and 2015 and conclude that there is a cointegration relationship between the primary budget balance and public debt and bi-directional causality between these variables as well as between public revenues and expenditures.

Getzner *et al.* (2001) conclude, for Austria, that fiscal sustainability was ensured in the period between 1960 and 1974, but not for the period 1975-1999. Bajo-Rubio *et al.* (2014) study the sustainability of the budget deficit for Spain between 1850 and 2000 and discover that fiscal sustainability was guaranteed by a regime of fiscal dominance. More recently, Brady and Magazzino (2019) find a long-term cointegration relationship between public revenues and expenditures in the period 1862-1913 for Italy. However, between 1947 and 2013, troubles with fiscal policies sustainability were detected.

Portugal is also object of analysis in several empirical studies on fiscal sustainability (Papadopoulos and Sidiropoulos, 1999; Bravo and Silvestre, 2002; Greiner *et al.*, 2007; Fincke and Greiner, 2012; Saadaoui *et al.*, 2022). While Papadopoulos and Sidiropoulos (1999), Greiner *et al.* (2007) and Fincke and Greiner (2012) point to fiscal sustainability in the Portuguese case, Bravo and Silvestre (2002) do not. Saadaoui *et al.* (2022) conclude that there

is equivocal evidence regarding fiscal sustainability in Portugal. Furthermore, Marinheiro (2006) and Correia *et al.* (2008) investigate fiscal sustainability for Portugal considering long periods of time (second half of the 19th century until the 2000s). More specifically, Marinheiro (2006) finds that, between 1903 and 2003, there was sustainability of public finances, although it was not maintained after 1975. Correia *et al.* (2008), in turn, analyses the relationship between government revenues and expenditures and highlights that fiscal sustainability has not always occurred. More recently, Neto (2020), using quarterly data between 1999 and 2017, and through a time-varying multicointegration model, finds that Portugal experienced different fiscal regimes throughout the analysed period.

Within the scope of the empirical literature on fiscal sustainability, later, studies emerged using a panel data structure from a relatively wide range of countries, employing standard panel techniques and examining panel cointegration relationships (Afonso, 2008; Afonso and Rault, 2010). The use of data with an annual frequency is a common approach (Weinchenrieder and Zimmer, 2014; Lee *et al.*, 2018), nevertheless, there are also studies that use quarterly data (Afonso and Jalles, 2017; Afonso and Coelho, 2023).

3. Empirical Strategy

The first step of the empirical analysis consists of studying the properties of the series of the government revenues and expenditures, primary government balance, CAPB and government debt, as a percentage of GDP, and of first differences of the stock of real public debt. In addition to the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests, and in order to guarantee robustness and completeness, we also performed the four tests proposed by Ng and Perron (2001) based on the modified information criteria (MIC), namely, the modified PP test MZ_a; the modified PP MZ_t; the modified Sargan-Bhargava test *MSB*; and the modified point optimal test *MPT*. Lastly, we complement with the modified ADF test proposed by Vogelsang and Perron (1998), allowing for one endogenously determined break. The null hypothesis is the existence of a unit root against the break stationary alternative hypothesis. In this context, there are two generating mechanisms of shifts, namely, additive outlier (AO) and innovational outlier (IO).

Then, we use the Johansen-Juselius test in order to verify the existence of cointegration relationships between government revenues and expenditures, primary government balance and lagged government debt and CAPB and lagged government debt. This methodology estimates the long-term attracting set in a Vector Auto-Regressive (VAR) context that incorporates the short and long-run dynamics of the several models.

If the series under study are non-stationary, the relevant question is whether a linear combination of two pairs of variables is stationary. With such a combination, government revenues and expenditures, primary government balance and lagged government debt and CAPB and lagged government debt are cointegrated. More specifically, variables are attracted to a long-term equilibrium and any deviation from this relationship reflects a temporary (short-term) imbalance.

In this context, we consider the following relationship based on Hakkio and Rush (1991):

$$R_t = \alpha + \beta G_t + \varphi_t \quad (1)$$

where R_t denotes government revenues and G_t corresponds to the government expenditures.

In addition, we can test the fiscal reaction function proposed by Bohn (1998):

$$s_t = \gamma + \theta B_{t-1} + \omega_t \quad (2)$$

where s_t is the primary government balance and B_{t-1} is the lagged government debt.

We can also test the relationship between the CAPB and the lagged government debt:

$$CAPB_t = \delta + \rho B_{t-1} + \epsilon_t \quad (3)$$

where $CAPB_t$ is the cyclically adjusted primary government balance. φ_t, ω_t and ϵ_t are iid disturbance terms satisfying standard assumptions of zero mean and constant variance.

As a third step of empirical analysis, we use the Dynamic Ordinary Least Squares (DOLS) method of Stock and Watson (1993) to estimate the parameters β, θ and ρ of equations (1), (2) and (3), respectively. This method provides a robust correction to the possible presence of endogeneity in the explanatory variable as well as of serial correlation in the error terms of the ordinary least squares estimation. We first estimate the long-run dynamic equation including leads and lags of the explanatory variable and then perform Shin's (1994) test from the calculation of C_μ, a Lagrange Multiplier (LM) statistic from the dynamic ordinary least squares residuals that tests for deterministic cointegration, that is, no trend is present in the regression.

The existence of positive and significant coefficients β and θ in equations (1) and (2), respectively, is a sufficient condition for fiscal solvency.

The next step is the estimation of fiscal reaction functions for Portugal by Ordinary Least Squares (OLS), and using quarterly time series, between 2001Q1 and 2021Q4, following the approach of Bohn (1998):

$$s_t = \beta_0 + \beta_1 s_{t-4} + \beta_2 b_{t-4} + \beta_3 Z_t + \beta_4 (i-g)_t + \beta_5 (i-g)_t * b_{t-4} + \sum_{i=6}^{n} \beta_i * D_{j,t} + \varepsilon_t \quad (4)$$

where s_t corresponds to the primary government balance as a percentage of GDP in quarter *t*; s_{t-4} is the primary government balance as a percentage of GDP in quarter *t-4*; b_{t-4} denotes the government debt as a percentage of GDP in quarter *t-4*; Z_t is the output gap in quarter *t*; $(i-g)_t$ is the differential between the implicit interest rate of the nominal stock of public debt and the nominal growth rate of GDP in quarter *t*; and $D_{j,t}$ are binary variables intended to capture structure breaks. ε_t is iid disturbance term satisfying standard assumptions of zero mean and constant variance.

The presence of lagged terms of the explained variable aims to capture persistence of the fiscal policy, and the introduction of the output gap as an explanatory variable seeks to control the cyclical fluctuations of the output.

The β_2 coefficient represents the response of the primary budget balance to the public debt-to-GDP ratio. If $\beta_2 < 0$, the primary government balance negatively reacts to the level of public debt, with a non-Ricardian fiscal regime in force. On the other hand, if $\beta_2 > 0$, the primary government balance reacts to the existing public debt stock, signalling the existence of a Ricardian fiscal regime. According to Bohn (1998), if the government systematically adjusts the primary budget balance to increases in public debt, then the fiscal sustainability condition is met. Therefore, if, in (4), $\beta_2 > 0$, this is a sufficient condition to ensure fiscal sustainability.

In the last step of the empirical assessment, we estimate the marginal responses of the government revenues to unit changes in the government expenditures and of the primary government balance and the CAPB to unit changes in the lagged government debt, using two time-varying parameter models, namely the expanding window approach and the methodology proposed by Schlicht (2003, 2021), by introducing the assumption that the regression coefficients may vary over time. The use of both time-varying methodologies is justified since, on the one hand, it allows performing a comparative analysis between the obtained results, and, on the other hand, the time-varying model based on Schlicht (2003, 2021) is restrictive due to the random walk hypothesis (Neto, 2020).

The expanding window method allows estimating models with time-varying parameters, in which the weights of historical data are treated equally. We use an expanding window that weights historical data equally until 2005Q1. More specifically, we estimate series of β, θ and ρ for the periods 1999Q4-2005Q1, 1999Q4-2005Q2, 1999Q4-2005Q3, and, finally, 1999Q4-2021Q4.

The Varying-Coefficient model assumes that β, θ and ρ (respectively, in (1), (2) and (3)) change slowly and not systematically over time:

$$\beta_t = \beta_{t-1} + \tau_t \quad (5)$$

$$\theta_t = \theta_{t-1} + \pi_t \quad (6)$$

$$\rho_t = \rho_{t-1} + \mu_t \quad (7)$$

As it is assumed that the coefficients are random walks, the expected value of the coefficient at time *t* is equal to the value of the coefficient in time *t-1*. The changes of the coefficients are denoted by τ_t, π_t and μ_t, which are assumed to be normally distributed with zero mean and variance σ_i^2. The variances σ_i^2 are computed using a method of moments estimator, which coincides with the maximum-likelihood estimator for large samples, although it is statistically more efficient and numerically more transparent and straightforward to interpret in small samples. The specifications (1), (2) and (3) are special cases when the variance of the disturbances in the coefficients approaches to zero.

The approach proposed by Schlicht (2003, 2021) has several advantages compared to other methods to compute time-varying coefficients (TVC), such as expanding window and Gaussian methods. First, it allows using all observations in the sample to estimate the magnitude of spillover in each year, which by construction is not possible in the expanding window approach. Second, changes in the size of estimated TVC in a given year come from innovations in the same year, rather than from shocks occurring in neighbouring years. Third, it reflects the fact that changes in policy are slow and depend on the immediate past. Lastly, it reduces reverse causality problems when the estimated TVC is used as explanatory variable since it depends on the past.

In the second step of the time-varying analysis, we use the computed time-varying estimates as dependent variables and identify explanatory factors for these marginal responses. The equations that identify the explanatory factors of the time-varying fiscal sustainability coefficients are estimated using Weighted Least Squares (WLS), since the dependent variables are based on estimates. In particular, the estimates of marginal responses are weighted by the respective standard deviations.

4. Data

The empirical research implemented in this paper considers the following variables: government revenues, government expenditures and government debt, as a percentage of GDP, REV, EXP and d, respectively. The stock of real public debt (PD) results from the stock of nominal public debt adjusted by the GDP deflator. The primary government balance was calculated as the difference between the overall budget balance and the interest paid to service

the public debt, and it is expressed as a percentage of GDP (PGB). The cyclically adjusted primary government balance, as a percentage of potential output (CAPB) was estimated through the Hodrick-Prescott (HP) filter, with a smoothing parameter of 1,600, using data from the primary government balance. The country output gaps (OUTGAP) were estimated through the Hodrick-Prescott (HP) filter, with a smoothing parameter of 1,600, using the real GDP data adjusted for seasonality and calendar effects. These variables were obtained or calculated based on Eurostat data.

In order to obtain a comparable annual metric of the data, we calculate moving sums of four quarters for the quarterly government revenues, government expenditures, primary government balance, and the nominal GDP series. Hence, we compute the shares of government revenues, government expenditures and primary government balance on GDP for each observation, dividing the moving sums of these variables by the moving sum of the four quarters of nominal GDP. On the other hand, government debt data are already the respective stock at the end of each quarter.

In the estimated fiscal reaction functions, we also consider as explanatory variables the differential between the implicit interest rate of the nominal stock of public debt and the nominal growth rate of GDP (i-g); and the dummies D_1 and D_2, which capture structural breaks in 2009Q3 and 2012Q4.[2] The (*i-g*) differential was calculated based on Eurostat data.

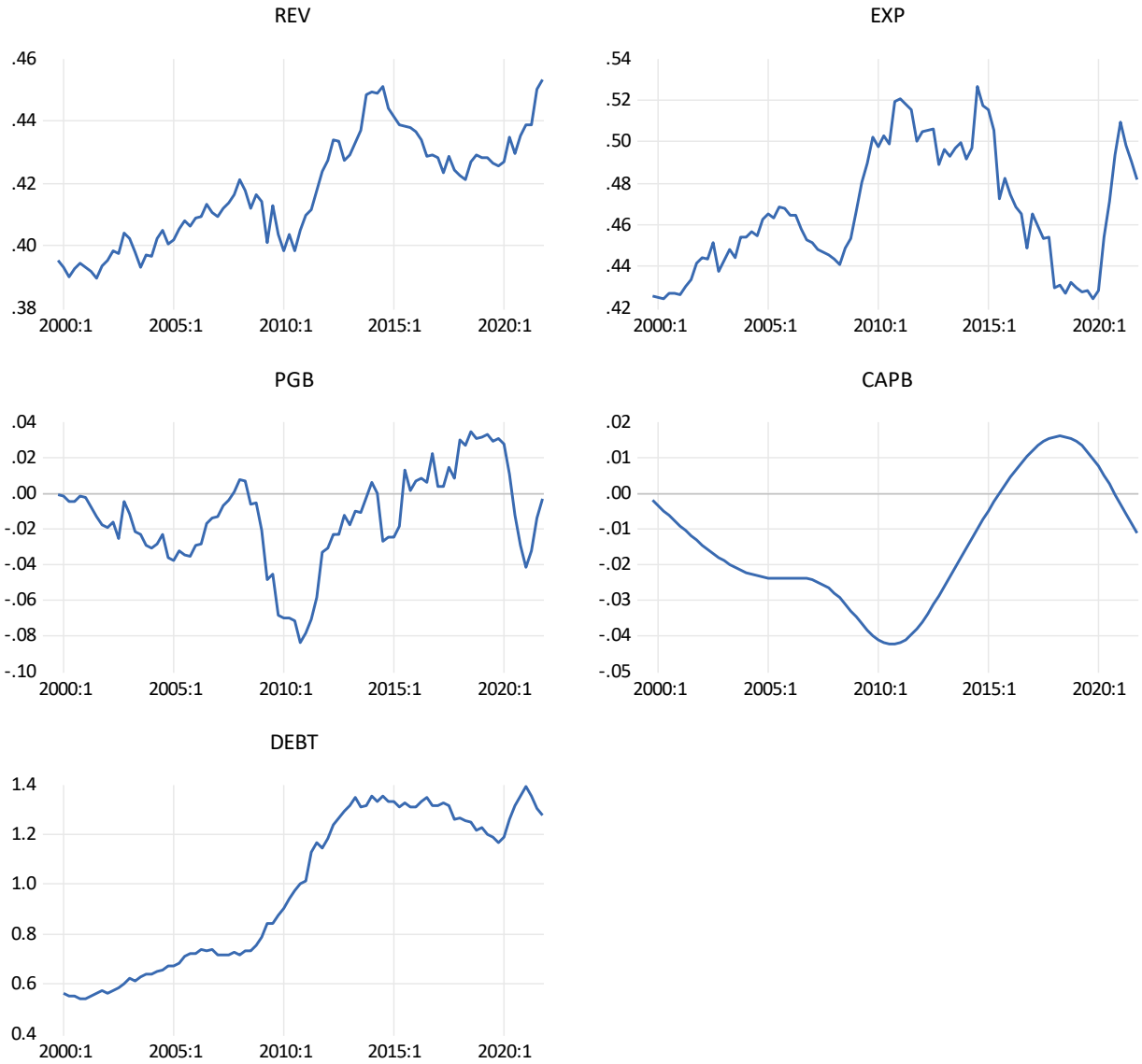
In addition, we estimate the expanding window coefficients of the response of the government revenues to a unit change in the government expenditures (REV-EW), the response of the primary government balance to a unit change in the government debt lagged by four periods (PGB-EW) and the response of the CAPB to a unit change in the government debt lagged by four periods (CAPB-EW). Moreover, we estimate the coefficients of the response of the government revenues to a unit change in the government expenditures (REV-TVC), the response of the primary government balance to a unit change in the government debt lagged by four periods (PGB-TVC) and the response of the CAPB to a unit change in the government debt lagged by four periods (CAPB-TVC), resorting to the Schlicht (2003, 2021)´s procedure. The variables are expressed as a percentage of GDP.

Beyond the output gap and the (*i-g*) differential, the other explanatory variables of these marginal responses are as follows: a dummy that assumes the value 1 if legislative elections took place in the year to which the quarter refers (DELECT); a dummy variable that investigates the effect of the international economic and financial adjustment programme, between 2011Q2

[2] Using the Bai-Perron (1998) test, we detected the presence of two structural breaks, in 2009Q3 and in 2012Q4.

and 2014Q2 (DTROIKA); the current account balance as a percentage of GDP (CA); a fiscal rules index (FR); the average value of the sovereign ratings assigned by Moody's, Standard and Poor's and Fitch on a quantitative 21 level scale (RATING), (AAA; Aaa = 21; C; SD; DDD = 1); and the average residual maturity of the Portuguese public debt stock (MAT). The political dummy variable was built based on the Database of Political Institutions 2020. The CA was adjusted based on Eurostat data. The fiscal rules index is obtained from the European Commission website. The variable associated with the ratings were calculated based on data from the rating agencies. The MAT variable was calculated based on monthly data from the IGCP, the Portuguese debt management agency.

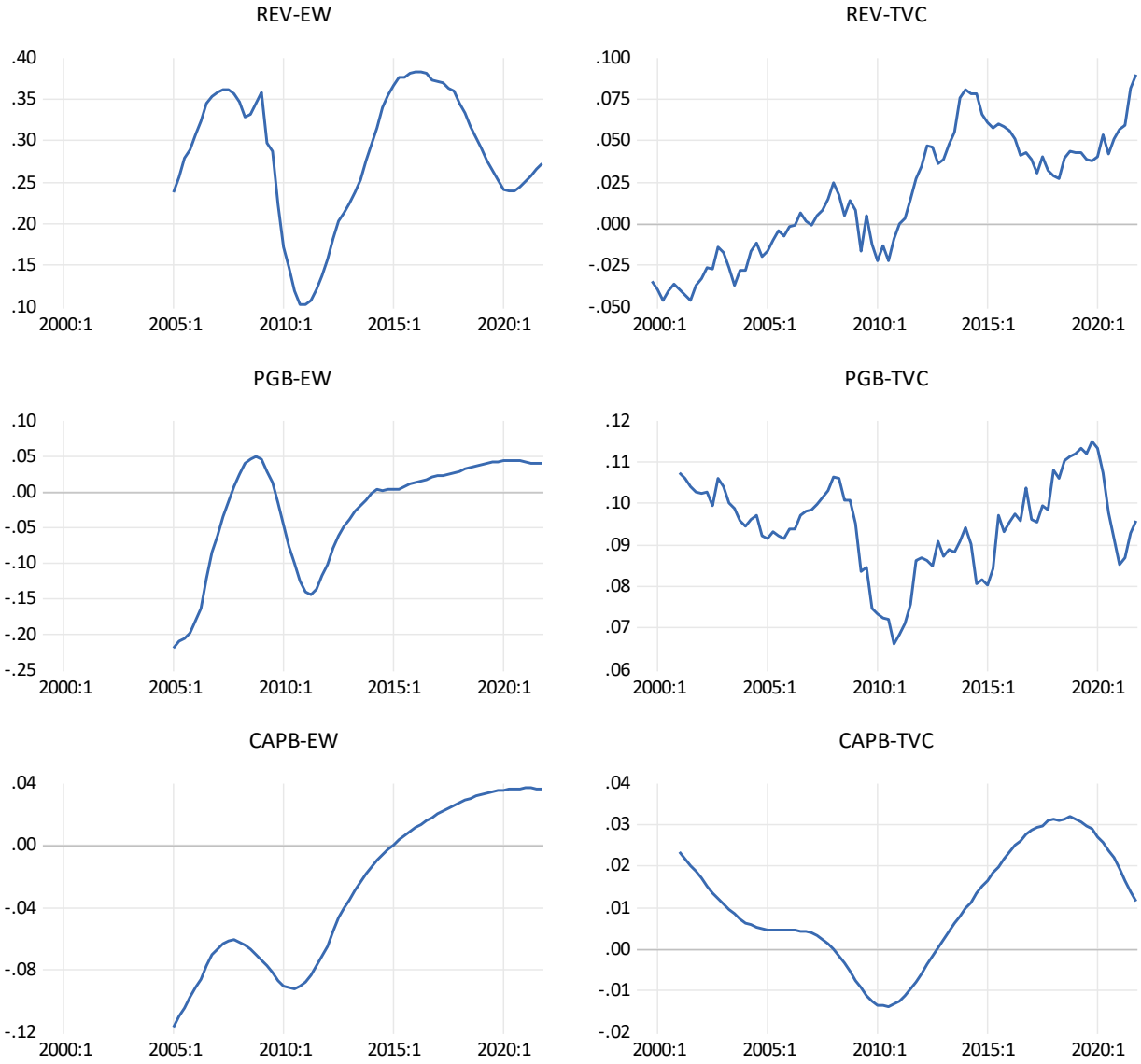
Figure 1: Fiscal variables – government revenues and expenditures, primary government balance, CAPB and government debt, as a percentage of GDP, 1999Q4-2021Q4



In the Appendix, we provide a detail description of the variables and also of the data sources in Table A1. Table A2 reports the usual descriptive statistics for the variables under study, and Table A3 is the correlation matrix between the variables considered in time-varying analysis.

Figure 1 shows the evolution of fiscal variables, namely government revenues and expenditures, primary government balance, CAPB and government debt, as a percentage of GDP, during 1999Q4 and 2021Q4. In turn, Figure 2 represents the evolution of the time-varying coefficients, estimated using the expanding window method and Schlicht's (2003, 2021) procedure.

Figure 2: Time-varying coefficients, 1999Q4-2021Q4



5. Analysis and discussion of results

Table 1 presents the results of the unit roots tests for the series of main fiscal variables, namely, government revenues and expenditures, primary government balance, CAPB, government debt, as a percentage of GDP, and first differences of the stock of real government debt. The series of government revenues, expenditures and debt are not stationary in levels, according to the various unit root tests performed. The primary government balance is stationary at levels based on Ng-Perron's MZ_a, MZ_t and MPT statistics, although not for the ADF and PP tests. The results of the additive outlier and innovational outlier tests point to the stationarity of the series with breaks in 2013Q4 and 2014Q4, respectively. In turn, the CAPB is stationary at levels according to ADF and Ng-Perron´s statistics, but not for the PP test, and has a break in 2021Q3. The series of the stock of real government debt is stationary in first differences according to the ADF and PP tests and has a break in 2011Q2. As Trehan and Walsh (1991) state that the stationary of the first differences of the stock of real public debt is a sufficient condition for fiscal sustainability, this result therefore suggests the sustainability of public finances in Portugal between 2000Q1 and 2021Q4. The 2011 break occurs typically in the aftermath of the global and financial crisis and when Portugal had to ask for financial support from the international organizations.

Table 2 shows that there are cointegration relationships between the primary government balance and lagged government debt and the CAPB and lagged government debt. Nevertheless, between government revenues and expenditures there is not a cointegration relationship. This result can perhaps be explained due to the end-of-sample bias.[3] Using the Stock and Watson (2003) method of long-run cointegration (see Table 3), we confirm that there is not a relationship between government revenues and expenditures, and the relationships between the primary government balance and lagged government debt and the CAPB and lagged government debt are positive and highly significant. These results allow us to corroborate Bohn (1988)´ backward-looking approach and to conclude that a Ricardian fiscal regime was in force in Portugal during its participation in the Economic and Monetary Union (EMU).

[3] Afonso (2005), Marinheiro (2006), Afonso and Rault (2010) and Afonso and Jalles (2016), using annual data and different time periods, report the absence of cointegration between public revenues and expenditures for Portugal. On the other hand, Correia *et al.* (2008) finds that the cointegration relationship between public revenues and expenditures changes over time. As noted by the authors, the trace test performs worse in the presence of breakpoints. Afonso and Coelho (2023), in turn, using quarterly data between 1999Q4 and 2020Q4, conclude that there is a cointegration relationship between both sides of the budget balance.

Table 1: Unit root tests

Variable	ADF	PP	Ng-Perron				VP(AO)	VP(IO)
			MZ_a	MZ_t	MSB	MPT		
Government revenues (% of GDP)	-2.180	-2.409	-9.303	-2.100	0.226	10.029	2010Q3	2013Q1
Government expenditures (% of GDP)	-1.749	-2.017	-4.789	-1.543	0.322	18.999	2013Q4	2013Q1
Primary government balance (% of GDP)	-1.859	-2.234	-5.825*	-1.706*	0.293	4.207*	2013Q4*	2014Q4*
CAPB (% of GDP)	-2.586*	-1.295	-6.830*	-1.844*	0.270*	3.601*	2021Q3***	2003Q3
Government debt (% of GDP)	-0.819	-1.032	-3.422	-1.188	0.347	24.480	2011Q2	2011Q1
First differences of the stock of real government debt	-8.669***	-8.776***	-5.422	-1.608	0.297	16.694	2011Q2***	2011Q2***

Notes: (a) ADF corresponds to the Augmented Dickey-Fuller test and PP is the Phillips-Perron test; (b) In Vogelsang–Perron (VP) test, "IO" means innovational outlier and "AO" means additive outlier; (c) The null hypothesis of ADF, PP, Ng-Perron and VP tests is the presence of unit root; (d) Tests for government revenues and expenditures and government debt are carried out with constant with linear time trend; (e) In ADF and VP tests, it is considered the lag length automatic based on Schwarz Information Criterion, with maxlag=12; (f) In PP tests, the spectral estimation method is based on Bartlett kernel and bandwitch is automatically selected following Newey-West method; (g) In Ng-Perron tests, the spectral estimation method is AR-GLS detrended and it is considered the lag length automatic based on Schwarz Information Criterion, with maxlag=12; (h) In VP tests, the break selection minimize Dickey-Fuller t-statistic; (i) Test statistics are reported; (j) * and *** denote statistical significance at the 10% and 1% level, respectively.

Table 2: Johansen–Juselius Cointegration Tests

Relationship	Trace		Maximum Eigenvalue	
	r=0	r ≤ 1	r=0	r ≤ 1
Government revenues and expenditures	10.574	2.331	8.243	2.331
Primary government balance and lagged public debt-to-GDP ratio	23.180*	1.871	21.310*	1.871
CAPB and lagged public debt-to-GDP ratio	15.495*	3.841	14.265*	3.841

Note: *This symbol denotes rejection of the null hypothesis of no cointegration at the 5% level (based on MacKinnon–Haug–Michelis *p* values).

Table 3: Stock–Watson–Shin Estimates

Relationship	β	C_μ	R-squared
Government revenues and expenditures	0.351	0.254	0.430
	(0.566)	(0.265)	
Primary government balance and lagged public debt-to-GDP ratio	0.030***	-0.032	0.729
	(0.008)	(0.009)	
CAPB and lagged public debt-to-GDP ratio	0.029***	-0.036***	0.862
	(0.009)	(0.010)	

Notes: (a) The C_μ is the Shin (1994) LM statistic that tests for deterministic cointegration; (b) Standard errors in parentheses, adjusted for long-run variance; (c) The long-run variance of the cointegrating regression residuals was estimated using the Bartlett window with $l = 6 \approx INT(T^{1/2})$ as proposed by Newey and West (1987); (d) The number of leads and lags selected is $q = 4$; (e) *** denote statistical significance at the 1% level, respectively.

Table 4: Fiscal Reaction Functions, 2001Q1-2021Q4

Regressors/Specification	(1)	(2)	(3)	(4)	(5)	(6)
PGB_{t-4}	0.510***	0.530***	0.530***	0.291**	0.253**	0.257**
	(0.100)	(0.097)	(0.096)	(0.120)	(0.121)	(0.119)
d_{t-4}	0.028***	0.029***	0.029***	0.111***	0.103***	0.104***
	(0.006)	(0.006)	(0.006)	(0.027)	(0.030)	(0.029)
$OUTGAP_t$	0.200*	0.283***	0.292***	0.219	0.349***	0.356***
	(0.101)	(0.085)	(0.085)	(0.138)	(0.110)	(0.113)
$(i\text{-}g)_t$		0.198***			0.294**	
		(0.059)			(0.146)	
$d_{t-4}*(i\text{-}g)_t$			0.181***			0.258*
			(0.051)			(0.131)
$D1_t$				0.054***	0.047**	0.047**
				(0.020)	(0.022)	(0.021)
$D2_t$				-0.004	-0.013	-0.012
				(0.015)	(0.018)	(0.017)
Observations	84	84	84	84	84	84
R-squared	0.466	0.488	0.491	0.650	0.696	0.699

Notes: (a) Ordinary Least Squares (OLS) Estimates; (b) The dependent variable is the primary government balance as a percentage of GDP; (c) Robust standard errors in brackets; (d) Constant term estimated, but omitted for reasons of parsimony; (e) *, **, *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

The results of the estimation of fiscal reaction functions, alternatives for Portugal, between 2001Q1 and 2021Q4, are reported in Table 4. The primary government balance is a highly persistent variable over time. The output gap has a positive and highly significant sign in the various estimates, except in specifications (1) and (4), which suggests the adoption of a counter-cyclical fiscal policy. The (*i-g*) differential translates into an improvement in the primary government balance, according to specifications (2) and (5). This result can be explained based on the relationship that expresses the dynamics of the public debt. Faced with a positive differential between the implicit interest rate of the nominal stock of public debt and the nominal growth rate of GDP, it is necessary for positive primary government balances to occur to guarantee the relative sustainability of the public debt. Based on specifications (3) and

(6), if (i-g) > 0, the response of the primary government balance to the public debt-to-GDP ratio is amplified. Conversely, if (i-g) < 0, the response is attenuated. It is recalled that implementing the Bai-Perron (1998) test, we detected the presence of two structural breaks, in 2009Q3 and in 2012Q4. The dummy variables D_1 and D_2 assume the value 1 until these quarters, respectively. D_1 has a positive and significant effect and D_2 is non-significant. In fact, from the third quarter of 2009 onwards, there was a strong deterioration in the primary government balance. Finally, lagged government debt has a positive and highly significant effect on the primary government balance, with coefficients ranging between 0.028 and 0.111 in specifications (1)-(6). For instance, according to specification (4), the increase of 10 pp of lagged government debt result in an increase of 1.11 pp on primary government balance.

Tables 5 and 6 show the results of the estimation of the determinants of the response of government revenues to government expenditures, using the expanding window method and the Schlicht (2003, 2021)´ procedure, respectively. The several specifications point to the strong persistence of the response of government revenues to government expenditures. The output gap has a negative significant sign in all estimations in the Table 5 and in specification (7) in Table 6. The (i-g) differential is non-significant in all estimations. Consequently, it does not appear to be a determinant of the response of government revenues to government expenditures. The holding of legislative elections and the fiscal rules index also do not influence the response. In the quarters in which the economic and financial assistance program was implemented, government revenues adjusted more to government expenditures. The current account balance improves fiscal sustainability, although the ratings worsen it. The longer the average maturity of the stock of government debt, the greater the fiscal sustainability, based on estimates à la Schlicht (2003, 2021).

The negative coefficients for the sovereign rating implies that in the face of a deterioration in the rating, and of the country's lower credibility in the capital markets, this may have led the budgetary authority to carry out fiscal consolidations, in the sense that, for example, government revenues increase more to respond to increases in government spending.

The estimates of the determinants of the response of the primary government balance to the lagged government debt appear in Tables and 7 and 8. The response of primary government balance to lagged public debt is highly persistent. The output gap and the (i-g) differential have a positive and highly significant sign, according to Schlicht (2003, 2021)´ methodology, although they are not significant using the expanding window method. The holding of legislative elections negatively influences the solvency of public accounts, and the current account balance, the fiscal rules index and the average maturity of the stock of government debt

have a positive effect. In the quarters in which the economic and financial adjustment program was in force, fiscal sustainability increased, and the lower the average rating, the higher the response of the primary government balance to lagged public debt. These results are only obtained based on estimates from the Schlicht (2003, 2021)´ procedure; by the expanding window method these effects are non-significant.

Analysing the information in Tables 9 and 10, the response of the CAPB to changes in the public debt-to-GDP ratio is highly persistent. The output gap negatively affects the expanding window response, although it has no influence on the response based on Schlicht (2003, 2021). The (*i-g*) differential and the holding of legislative elections do not affect the CAPB time-varying response. In the quarters in which the Troika's economic and financial adjustment program was in force, the response improved. Likewise, the current account balance, the index of fiscal rules and the maturity of the public debt increase the response. Conversely, the average rating assigned by the main financial rating agencies results in its decrease, and again, it flags a Ricardian behaviour by which lower ratings lead the government to adjust (improve) more the CAPB vis-à-vis rising public debt ratios.

Taking the obtained empirical evidence in the time-varying analysis, we can conclude that: (i) the current account balance, the index of fiscal rules and the average maturity of the stock of government debt increase fiscal sustainability; (ii) in opposition, the average of the ratings attributed by the financial rating agencies deteriorates the fiscal sustainability, as well as the holding of legislative elections; (iii) in the quarters in which the Troika's economic and financial adjustment program was in force, fiscal sustainability improved; (iv) the (*i-g*) differential benefits fiscal sustainability, although the evidence found is weaker; and finally (v) the output gap has a mixed influence on fiscal sustainability coefficients.

Table 5: Determinants of expanding window fiscal sustainability coefficients, 2005Q1-2021Q4, government revenues and expenditures

Regressors/Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)
REV-EW$_{t-4}$	0.745***	0.776***	0.882***	0.645***	0.673***	0.740***	0.618***
	(0.073)	(0.090)	(0.076)	(0.068)	(0.097)	(0.064)	(0.094)
OUTGAP$_t$	-18.168**	-21.165**	-16.212**	-13.937*	-18.145**	-16.044*	-14.587*
	(7.139)	(8.706)	(6.254)	(7.146)	(8.168)	(8.079)	(7.360)
(i-g)$_t$	-11.620	-12.257	-11.580	-9.360	-10.914	-10.323	-9.503
	(10.606)	(11.993)	(9.209)	(10.268)	(12.294)	(11.230)	(10.225)
DELECT$_t$		0.289					
		(0.277)					
DTROIKA$_t$			0.953***				
			(0.269)				
CA$_t$				7.234**			
				(2.759)			
FR$_t$					0.178		
					(0.138)		
RATING$_t$						-0.114***	
						(0.042)	
MAT$_t$							0.315
							(0.197)
Observations	64	60	64	64	60	59	64
R-squared	0.632	0.648	0.679	0.681	0.652	0.707	0.663

Notes: (a) Weighted Least Squares (WLS) Estimates. The weights are given by the inverse of the standard errors of the estimated expanding window coefficients; (b) The dependent variable is the response of the government revenues to a unit change in government expenditures, both variables as a percentage of GDP; (c) Robust standard errors in brackets; (d) Constant term estimated, but omitted for reasons of parsimony; (e) *, **, *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 6: Determinants of Schlicht (2003, 2021) fiscal sustainability coefficients, 1999Q4-2021Q4, government revenues and expenditures

Regressors/Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)
REV-TVC$_{t-4}$	0.875***	0.834***	0.856***	0.594***	0.721***	0.451***	0.230
	(0.050)	(0.043)	(0.044)	(0.081)	(0.099)	(0.053)	(0.182)
OUTGAP$_t$	-1.187	-1.449	0.042	-0.715	-1.891	-1.632	-3.960**
	(1.406)	(1.515)	(1.568)	(1.464)	(1.556)	(1.113)	(1.872)
(i-g)$_t$	1.363	2.089	0.398	1.703	2.076	0.809	-0.173
	(1.443)	(1.857)	(1.403)	(1.396)	(1.714)	(0.969)	(1.251)
DELECT$_t$		-0.028					
		(0.083)					
DTROIKA$_t$			0.546***				
			(0.096)				
CA				4.999***			
				(1.236)			
FR					0.081		
					(0.063)		
RATING						-0.092***	
						(0.013)	
MAT							0.320***
							(0.085)
Observations	85	81	85	85	81	80	84
R-squared	0.751	0.762	0.821	0.790	0.766	0.857	0.787

Notes: (a) WLS Estimates. The weights are given by the inverse of the standard errors of the estimated time-varying coefficients; (b) The dependent variable is the response of the government revenues to a unit change in government expenditures, both variables as a percentage of GDP; (c) Robust standard errors in brackets; (d) Constant term estimated, but omitted for reasons of parsimony; (e) * and *** denote statistical significance at the 10% and 1% level, respectively.

Table 7: Determinants of expanding window fiscal sustainability coefficients, 2005Q1-2021Q4, primary government balance and lagged government debt

Regressors/Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$PGB\text{-}EW_{t-4}$	0.834***	0.881***	0.795***	0.742***	0.603***	0.833***	0.696***
	(0.057)	(0.065)	(0.079)	(0.056)	(0.078)	(0.071)	(0.056)
$OUTGAP_t$	-7.896	-3.830	-9.407	-0.257	0.682	-6.968	0.524
	(6.837)	(7.437)	(6.975)	(5.192)	(5.612)	(7.880)	(5.817)
$(i\text{-}g)_t$	-8.856	-6.197	-8.520	-3.599	-0.748	-8.877	-1.441
	(6.139)	(5.870)	(5.767)	(4.933)	(4.850)	(6.843)	(5.510)
$DELECT_t$		-1.229**					
		(0.490)					
$DTROIKA_t$			-0.593				
			(0.678)				
CA_t				14.206***			
				(4.109)			
FR_t					0.949***		
					(0.221)		
$RATING_t$						-0.039	
						(0.068)	
MAT_t							0.855***
							(0.197)
Observations	64	60	64	64	60	59	64
R-squared	0.735	0.731	0.740	0.780	0.768	0.688	0.796

Notes: (a) WLS Estimates. The weights are given by the inverse of the standard errors of the estimated expanding window coefficients; (b) The dependent variable is the response of the primary government balance to a unit change in government debt lagged by a four periods, both variables as a percentage of GDP; (c) Robust standard errors in brackets; (d) Constant term estimated, but omitted for reasons of parsimony; (e) ** and *** denote statistical significance at the 5% and 1% level, respectively.

Table 8: Determinants of Schlicht (2003, 2021) fiscal sustainability coefficients, 2001Q1-2021Q4, primary government balance and lagged government debt

Regressors/Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$PGB\text{-}TVC_{t-4}$	0.797***	0.826***	0.858***	0.317***	0.143	0.655***	0.423***
	(0.061)	(0.062)	(0.052)	(0.079)	(0.126)	(0.061)	(0.094)
$OUTGAP_t$	2.595***	2.245***	3.320***	3.760***	2.172***	2.161***	2.326***
	(0.834)	(0.846)	(0.844)	(0.852)	(0.758)	(0.645)	(0.803)
$(i\text{-}g)_t$	2.068***	2.038***	1.762***	2.676**	2.286***	1.484***	1.913***
	(0.556)	(0.683)	(0.552)	(1.019)	(0.530)	(0.520)	(0.646)
$DELECT_t$		-0.106*					
		(0.054)					
$DTROIKA_t$			0.274***				
			(0.048)				
CA_t				4.591***			
				(0.560)			
FR_t					0.247***		
					(0.037)		
$RATING_t$						-0.036***	
						(0.006)	
MAT_t							0.118***
							(0.019)
Observations	80	76	80	80	76	75	80
R-squared	0.651	0.705	0.728	0.823	0.802	0.811	0.746

Notes: (a) WLS Estimates. The weights are given by the inverse of the standard errors of the estimated time-varying coefficients; (b) The dependent variable is the response of the primary government balance to a unit change in government debt lagged by a four periods, both variables as a percentage of GDP; (c) Robust standard errors in brackets; (d) Constant term estimated, but omitted for reasons of parsimony; (e) *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Table 9: Determinants of expanding window fiscal sustainability coefficients, 2005Q1-2021Q4, CAPB and lagged government debt

Regressors/Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$CAPB\text{-}EW_{t-4}$	1.006***	1.023***	1.134***	0.795***	0.615***	0.962***	0.815***
	(0.043)	(0.049)	(0.027)	(0.024)	(0.054)	(0.038)	(0.037)
$OUTGAP_t$	-36.138**	-38.795**	-23.900**	-15.390***	-20.239**	-24.106**	-20.838***
	(13.607)	(16.639)	(11.544)	(5.395)	(8.660)	(11.889)	(7.056)
$(i\text{-}g)_t$	-18.523	-19.684	-16.244	-10.802	-10.481	-16.088	-9.797
	(17.092)	(20.529)	(15.349)	(6.497)	(8.472)	(14.442)	(6.646)
$DELECT_t$		-0.298					
		(0.510)					
$DTROIKA_t$			3.859***				
			(0.664)				
CA_t				44.564***			
				(2.870)			
FR_t					2.703***		
					(0.248)		
$RATING_t$						-0.454***	
						(0.053)	
MAT_t							1.871***
							(0.190)
Observations	64	60	64	64	60	59	64
R-squared	0.926	0.920	0.958	0.984	0.963	0.963	0.965

Notes: (a) WLS Estimates. The weights are given by the inverse of the standard errors of the estimated expanding window coefficients; (b) The dependent variable is the response of the CAPB to a unit change in government debt lagged by a four periods, both variables as a percentage of GDP; (c) Robust standard errors in brackets; (d) Constant term estimated, but omitted for reasons of parsimony; (e) ** and *** denote statistical significance at the 5% and 1% level, respectively.

Table 10: Determinants of Schlicht (2003, 2021) fiscal sustainability coefficients, 2001Q1-2021Q4, CAPB and lagged government debt

Regressors/Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$CAPB\text{-}TVC_{t-4}$	0.940***	0.971***	1.036***	0.693***	0.624***	0.902***	0.805***
	(0.041)	(0.042)	(0.036)	(0.027)	(0.045)	(0.033)	(0.038)
$OUTGAP_t$	-4.511	-5.266	-1.883	3.615	-0.474	-3.089	-3.054
	(5.088)	(6.332)	(4.855)	(3.169)	(4.937)	(5.762)	(4.381)
$(i\text{-}g)_t$	-2.460	-4.047	-3.215	0.509	-2.029	-5.086	-2.007
	(6.647)	(8.734)	(6.819)	(3.491)	(6.939)	(8.766)	(5.861)
$DELECT_t$		-0.228					
		(0.191)					
$DTROIKA_t$			1.310***				
			(0.152)				
CA_t				17.665***			
				(1.213)			
FR_t					0.891***		
					(0.063)		
$RATING_t$						-0.171***	
						(0.011)	
MAT_t							0.409***
							(0.046)
Observations	80	76	80	80	76	75	80
R-squared	0.874	0.894	0.907	0.951	0.952	0.963	0.921

Notes: (a) WLS Estimates. The weights are given by the inverse of the standard errors of the estimated time-varying coefficients; (b) The dependent variable is the response of the CAPB to a unit change in government debt lagged by a four periods, both variables as a percentage of GDP; (c) Robust standard errors in brackets; (d) Constant term estimated, but omitted for reasons of parsimony; (e) *** denotes statistical significance at the 5% and 1% level, respectively.

6. Conclusions

The topic of fiscal sustainability applied to Portugal during its participation in the EMU is assessed in this paper, using a quarterly dataset and various empirical methodologies. Although we did not find a cointegration relationship between government revenues and expenditures, according to Trehan and Walsh's (1991) criterion, Portuguese public finances were sustainable between 2000 and 2021. Furthermore, we report the existence of cointegration relationships between the primary government balance and past government debt and between CAPB and past government debt. The estimated coefficients are positive and highly significant, which confirms the fiscal solvency of the Portuguese State.

By estimating fiscal reaction functions à la Bohn (1998), we corroborate the prevalence of a Ricardian fiscal regime in Portugal. Additionally, if the (*i-g*) differential is positive, not only does the primary government balance improve, but also the response of the primary government balance to changes in the public debt-to-GDP ratio is amplified, which contributes to the reduction of the public debt-to-GDP ratio.

From the obtained results within the scope of the time-varying analysis, we find that the improvement in the external accounts, the rise in the European Commission's fiscal rules index and the extension of the maturities of sovereign debt bonds that occurred in Portugal in recent years have revealed beneficial from the point of view of fiscal sustainability. On the other hand, sovereign debt rating downgrades implies a fiscal reaction that improves fiscal sustainability. Regarding legislative elections, the results also point to a worse fiscal behaviour by the government. Moreover, fiscal sustainability improved during the implementation during the implementation of the international financial assistance program to Portugal, between 2011Q2 and 2014Q2. Finally, the output gap and the (*i-g*) differential do not seem to be particularly relevant in fiscal sustainability, especially the output gap.

Most likely, for the Portuguese economy, the issues of fiscal sustainability and economic growth will have to be solved simultaneously. On the one hand, policies to promote economic growth are required not only to increase productivity in the long term, but also to ensure fiscal solvency. On the other hand, the implementation of policies that guarantee the sustainability of public finances proves to be beneficial for economic growth. Nevertheless, there may be a certain trade-off between the objectives, and these may conflict, at least in the short term. Increasing the efficiency of public expenditure, as part of a comprehensive reform of the public sector, could make it possible to overcome the trade-off between both economic policy objectives.

Appendix

Table A1: Variables, definitions, and data sources

Variable	Definition	Source
REV	government total revenues as a percentage of GDP	Eurostat data adjusted by the authors
EXP	government total expenditures as a percentage of GDP	Eurostat data adjusted by the authors
PGB	primary government balance as a percentage of GDP	Eurostat data adjusted by the authors
CAPB	cyclically adjusted primary government balance as a percentage of GDP	Author´s estimations based on the Hodrick-Prescott (HP) filter and using adjusted data from Eurostat
d	government debt as a percentage of GDP	Eurostat
PD	stock of real public debt, the stock of nominal public debt adjusted by the GDP deflator	Author´s calculations based on Eurostat data
OUTGAP	gap between effective and potential gross domestic product at constant market prices	Author´s estimations based on the Hodrick-Prescott (HP) filter and using data from Eurostat
i-g	differential between the implicit interest rate of the nominal stock of public debt and the nominal growth rate of GDP	Autors´ calculations based on Eurostat data
D_1	dummy variable that takes the value 1 until 2009Q3	Own definition
D_2	dummy variable that takes the value 1 between 2009Q4 and 2012Q4	Own definition
DELECT	dummy that assumes the value 1 if legislative elections took place in the year to which the quarter refers	Database of Political Institutions 2020
DTROIKA	dummy variable that takes the value 1 in the quarters in which the economic and financial adjustment programme in Portugal was implemented	Own definition
CA	current account balance as a percentage of GDP	Eurostat data adjusted by the authors
FR	fiscal rules index	European Commission (2020)
RATING	average value of the sovereign ratings assigned by Moody's, Standard and Poor's and Fitch on a quantitative 21 level scale (AAA; Aaa = 21; C; SD; DDD = 1)	Autor´s transformation based on rating agencies data
MAT	average residual maturity of the Portuguese public debt stock	Author´s calculations based on IGCP data
REV-EW	expanding window coefficient of the response of the government revenues to a unit change in the government expenditures	Authors´ estimations
REV-TVC	time-varying coefficient of the response of the government revenues to a unit change in the government expenditures	Author´s estimations based on Schlicht (2003, 2021)' procedure
PGB-EW	expanding window coefficient of the response of the primary government balance to a unit change in public debt-to-GDP ratio lagged by four periods	Authors´ estimations
PGB-TVC	time-varying coefficient of the response of the primary government balance to a unit change in public debt-to-GDP ratio lagged by four periods	Author´s estimations based on Schlicht (2003, 2021)' procedure

CAPB-EW	expanding window coefficient of the response of the CAPB to a unit change in public debt-to-GDP ratio lagged by four periods	Author´s estimations
CAPB-TVC	time-varying coefficient of the response of the CAPB to a unit change in public debt-to-GDP ratio lagged by four periods	Author´s estimations based on Schlicht (2003, 2021)' procedure

Table A2: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Maximum	Minimum
REV	89	0.418	0.017	0.453	0.389
EXP	89	0.466	0.029	0.526	0.424
PGB	89	-0.015	0.027	0.034	-0.085
CAPB	89	-0.015	0.017	0.016	-0.043
d	88	0.985	0.308	1.389	0.540
OUTGAP	92	0.000	0.024	0.053	-0.148
i-g	87	0.003	0.023	0.141	-0.123
CA	89	-0.052	0.050	0.016	-0.118
FR	88	0.362	1.165	2.059	-0.999
RATING	87	15.364	3.787	19.000	10.000
MAT	84	6.557	1.467	8.821	3.736
REV-EW	68	0.283	0.080	0.383	0.103
REV-TVC	89	0.016	0.037	0.090	-0.047
PGB-EW	68	-0.026	0.076	0.049	-0.221
PGB-TVC	84	0.095	0.011	0.115	0.066
CAPB-EW	68	-0.026	0.076	0.049	-0.221
CAPB-TVC	84	0.095	0.011	0.115	0.066

Table A3: Correlations matrix, Time-varying analysis

	OUTGAP	i-g	DELECT	DTROIKA	CA	FR	RATING	MAT	REV-EW	REV-TVC	PGB-EW	PGB-TVC	CAPB-EW	CAPB-TVC
OUTGAP	1.000													
i-g	-0.444	1.000												
DELECT	0.097	0.044	1.000											
DTROIKA	-0.204	0.177	-0.078	1.000										
CA	-0.154	-0.067	-0.109	0.245	1.000									
FR	-0.024	-0.086	-0.075	0.010	0.916	1.000								
RATING	0.119	-0.048	0.086	-0.551	-0.884	-0.787	1.000							
MAT	-0.025	-0.064	-0.062	0.124	0.822	0.879	-0.830	1.000						
REV-EW	0.022	-0.179	-0.174	-0.454	0.252	0.406	0.040	0.446	1.000					
REV-TVC	-0.162	0.005	-0.053	0.334	0.833	0.811	-0.877	0.883	0.274	1.000				
PGB-EW	0.039	-0.059	-0.234	-0.227	0.529	0.642	-0.334	0.752	0.451	0.568	1.000			
PGB-TVC	0.189	-0.012	-0.122	-0.326	0.175	0.255	0.132	0.028	0.563	-0.014	0.472	1.000		
CAPB-EW	-0.023	-0.134	-0.186	-0.150	0.888	0.961	-0.695	0.887	0.359	0.784	0.760	0.506	1.000	
CAPB-TVC	0.057	-0.164	-0.098	-0.318	0.678	0.724	-0.354	0.476	0.545	0.350	0.538	0.680	0.883	1.000

References

Afonso, A. (2005), "Fiscal Sustainability: The Unpleasant European Case", *FinanzArchiv/Public Finance Analysis*, Vol. 61, Issue 1, pp. 19-44.

Afonso, A. (2008), "Ricardian fiscal regimes in the European Union", *Empirica*, Vol. 35, pp. 313-334.

Afonso, A. and C. Rault (2010), "What do we really know about fiscal sustainability in the EU? A panel data diagnostic", *Review of World Economics*, Vol. 145, pp. 731-755.

Afonso, A. and J. C. Coelho (2023), "Public finances solvency in the Euro Area", *Economic Analysis and Policy*, Vol. 77, pp. 642-657.

Afonso, A. and J. T. Jalles (2016), "The elusive character of fiscal sustainability", *Applied Economics*, Vol. 48, pp. 144-155.

Afonso, A. and J. T. Jalles (2017), "Euro area time-varying fiscal sustainability", *International Journal of Finance and Economics*, Vol. 22, Issue 3, pp. 244-254.

Bajo-Rubio, O., C. Díaz-Roldán and V. Esteve (2014), "Deficit sustainability, and monetary versus fiscal dominance: The case of Spain, 1850–2000", *Journal of Policy Modeling*, Vol. 36, Issue 5, pp. 924-937.

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

Brady, G. L. and C. Magazzino (2019), "The sustainability of Italian fiscal policy: myth or reality?", *Economic Research-Ekonomska Istraživanja*, Vol. 32, Issue 1, pp. 772-796.

Bravo, A. B. S. and A. L. Silvestre (2002), "Intertemporal sustainability of fiscal policies: some tests for European countries", *European Journal of Political Economy*, Vol. 18, Issue 3, pp. 517-528.

Chen, S. – W. (2014), "Testing for fiscal sustainability: New evidence from the G-7 and some European countries", *Economic Modelling*, Vol. 37, pp. 1-15.

Correia, M. R., R. Neck, T. Panagiotidis and C. Richter (2008), "An empirical investigation of the sustainability of the public deficit in Portugal", *International Economics and Economic Policy*, Vol. 5, Issues 1-2, pp. 209-223.

Fincke, B. and A. Greiner (2012), "How to assess debt sustainability? Some theory and empirical evidence for selected euro area countries", *Applied Economics*, Vol. 44, Issue 28, pp. 3717-3724.

Getzner, M., E. Glatzer and R. Neck (2001), "On the sustainability of Austrian budgetary policies", *Empirica*, Vol. 28, pp. 21-40.

Greiner, A., U. Koeller and W. Semmler (2007), “Debt sustainability in the European Monetary Union: Theory and empirical evidence for selected countries”, *Oxford Economic Papers*, Vol. 59, Issue 2, pp. 194-218.

Hakkio, C. S. and M. Rush (1991), “Is the Budget Deficit “Too Large?””, *Economic Inquiry*, Vol. 29, Issue 3, pp. 429-445.

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

Hatemi-J., A. (2002), “Fiscal policy in Sweden: effects of EMU criteria convergence”, *Economic Modelling*, Vol. 19, Issue 1, pp. 121-136.

Haug, A. A. (1995), “Has federal budget deficit policy changed in recent years?”, *Economic Inquiry*, Vol. 33, Issue 1, pp. 104-118.

Lee, K., J. – H. Kim and T. Sung (2018), “A test of fiscal sustainability in the EU countries”, *International Tax and Public Finance*, Vol. 25, pp. 1170-1196.

Magazzino, C., G. L. Brady and F. Forte (2019), "A panel data analysis of the fiscal sustainability of G-7 countries", *The Journal of Economic Asymmetries*, Vol. 20, e00127.

Marinheiro, C. F. (2008), “The sustainability of Portuguese fiscal policy from a historical perspective”, *Empirica*, Vol. 33, Issue 2-3, pp. 155-179.

Neto, D. (2020), "Tracking fiscal discipline. Looking for a PIIGS on the wing", *International Economics*, Vol. 163, pp. 147-154.

Newey, W. K. and K. D. West (1987), “A Simple, Positive-Definite. Heteroskedasticity and Autocorrelation Consistent Covariance Matrix”, *Econometrica*, Vol 55, pp. 703–708.

Ng, S. and P. Perron (2001), “Lag length selection and the construction of unit root tests with good size and power”, *Econometrica*, Vol. 69, Issue 6, pp. 1519-1554.

Olekalns, O. (2000), “Sustainability and Stability? Australian Fiscal Policy in the Twentieth Century”, *Australian Economic Papers*, Vol. 39, Issue 2, pp. 138-151.

Owoye, O. (1995), "The causal relationship between taxes and expenditures in the G7 countries: cointegration and error-correction models", *Applied Economics Letters*, Vol. 2, Issue 1, pp. 19-22.

Payne, J. E. (1997), "International evidence on the sustainability of budget deficits", *Applied Economics Letters*, Vol. 4, Issue 12, pp. 775-779.

Papadopoulos, A. P. and M. G. Sidiropoulos (1999), “The sustainability of fiscal policies in the European Union”, *International Advances in Economic Research*, Vol. 5, pp. 289-307.

Quintos, C. E. (1995), “Sustainability of the Deficit Process With Structural Shifts”, *Journal of Business & Economic Statistics*, Vol. 13, Issue 4, pp. 409-417.

Saadaoui, J., C. K. M. Lau and Y. Cai (2022), "Testing fiscal sustainability in OECD countries: new evidence from the past centuries", *Applied Economics Letters*, pp. 1-7.

Shin. Y. (1994), “A residual-based test of the null of cointegration against the alternative of no cointegration”, *Econometric Theory*, Vol. 10, Issue 1, pp. 91-115.

Schlicht, E. (2003), “Estimating Time-Varying Coefficients with the VC Program”, Munich Discussion Paper No. 2003-6, June. Available at: https://epub.ub.uni-muenchen.de/34/.

Schlicht, E. (2021), “VC: a method for estimating time-varying coefficients in linear models”, *Journal of the Korean Statistical Society*, Vol. 50, pp. 1164-1196.

Stock. J. H. and M. W. Watson (1993), “A simple estimator of cointegrating vectors in higher order integrated systems”, *Econometrica*, Vol. 61, Issue 4, pp. 783-820.

Trehan, B. and C. E. Walsh (1991), “Testing Intertemporal Budget Constraints: Theory and Applications to U. S. Federal Budget and Current Account Deficits”, *Journal of Money. Credit and Banking*, Vol. 23, Issue 2, pp. 206-223.

Vogelsang, T. J. and P. Perron (1998), “Additional tests for a unit root allowing the possibility of breaks in the trend function”, *International Economic Review*, Vol. 39, Issue 4, pp. 1073-1100.

Weichenrieder, A. J. and J. Zimmer (2014), “Euro membership and fiscal reaction functions”, *International Tax Public Finance*, Vol. 21, pp. 598-613.