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Fiscal policy adjustments in the euro area stressed countries: new evidence from non-linear models with state-varying thresholds

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Abstract

We introduce a non-linear model to study the adjustment of fiscal policy variables in Greece, Ireland, Portugal and Spain over the last 50 years, based on endogenously estimated budget deficit-to-GDP thresholds, which vary with fiscal disequilibria, the economic cycle and financial market conditions. We find that the budget deficit-to-GDP thresholds were rather high for Greece and Portugal particularly after 1999 and that the fiscal adjustments in "good" times were very different from the adjustments that took place in "bad" times. We also found that only in Spain fiscal deficits were reduced in expansionary times. Finally, we provide evidence that, under financial market pressure, fiscal authorities relaxed the fiscal deficit-to-GDP threshold for the adjustment in Ireland and Spain and reduced such threshold for the adjustment in Portugal.

JEL Classification: H63, H20, H60, C22.

Keywords: fiscal adjustments, budgetary disequilibria, European debt crisis, non-linear models, euro periphery.

Non-Technical Summary

The recent financial crisis has exposed fundamental weaknesses in the European Economic and Monetary Union (EMU), commanding extraordinary measures to provide financial support to four euro area countries, namely Greece, Ireland, Portugal and Spain. As these economies, taken together, account for around 17% of euro area GDP, concerns over the sustainability of their fiscal policy have the potential of destabilizing the whole euro area and endangering the credibility of the common monetary policy. With this in mind, a comprehensive analysis of fiscal policy adjustments to budgetary disequilibria in the euro periphery has become a pressing policy issue in an attempt to monitor the fiscal health of the euro area.

Fiscal policy authorities of Greece, Ireland, Portugal and Spain are shown to have, on average, historically followed a "spend-and-tax" model of fiscal adjustment, where government spending is decided by the political process, and the burden of correcting fiscal disequilibria is entirely left to the tax instrument.

The aim of this paper is to investigate if the adjustment of fiscal variables in presence of budgetary disequilibria varies with respect to the sign and the magnitude of fiscal disequilibria, but also with the economic cycle and the financial markets' conditions. Our modelling approach attempts to capture the behavior of fiscal policy authorities that might opt for re-adjusting their target, given the changing state of the economy and financial market conditions.

We find that the budget deficit-to-GDP thresholds were rather high for Greece and Portugal particularly after 1999 and that the fiscal adjustments, which took place in "good" times, were very different from the adjustments that took place in "bad" times. It is useful to point out that the fiscal adjustments were carried out also when the budget deficit-to-GDP ratio was below the identified budget deficit-to-GDP threshold, but in Greece the corrective action is estimated to be twice as slow.

During the 1960-2013 period for Greece, Ireland and Portugal and during the 1970-2013 period for Spain, we find that the threshold estimate for the budget deficit-to-GDP ratio, which led to different fiscal correction regimes, was on average 4.90% for Greece, 5.10% for Ireland, 3.22% for Portugal and 3.12% for Spain.

When considering the period after 1999, this overall picture worsens for Greece and Portugal and improves for Ireland. Moreover, the results for Ireland and Spain are driven by the financial

crisis period. In particular for Ireland, the decoupling dynamics of the government spending reflects the support to the financial sector. In fact, when considering the pre-crisis EMU period between 1999 and 2007, the threshold for fiscal adjustment in Ireland and Spain are estimated to be positive; namely, the regime change took place when the budget balance was in surplus. Conversely, the fiscal deficit-to-GDP thresholds estimated at 5.32% for Greece and 4.08% for Portugal remained rather high.

Looking at the effects of the economic cycle, we find that fiscal deficit-to-GDP ratio was not reduced in Greece, Ireland and Portugal with the improvement in economic activity. Consequently, during the contractionary times, fiscal corrections became more costly, as tax adjustments became a priority in an attempt to restore fiscal discipline. We also document an historically procyclical government spending for all four countries.

The results also suggest that during a financial crisis the fiscal deficit-to-GDP threshold was relaxed in Ireland and Spain, while it was reduced in Portugal. By relaxing the fiscal deficit-to-GDP threshold (in an attempt to stave off deep recessionary pressures) Ireland and Spain relied on business cycle improvements to raise tax revenues. Given the tendency by Portuguese authorities to improve the fiscal imbalances during a financial crisis, these figures make sustainability concerns for Ireland, Portugal and Spain less of an issue compared to Greece, in an historical perspective.

In any case, financial markets may require high interest premia on government bonds, rendering more problematic the funding of new debt; indeed, over the past few years, the countries in our sample have faced high interest rate premia and have suffered successive downgrades on their sovereign debt.

1 Introduction

The recent financial crisis has exposed fundamental weaknesses in the European Economic and Monetary Union(EMU), commanding extraordinary measures to provide financial support to four euro area countries: Greece, Ireland, Portugal and Spain.[1] Such countries (as most EU countries) have undergone an excessive deficit procedure, following the 2009 Council Decision on the existence of an excessive deficit, with a deadline for corrective action in 2014 (2015 for Ireland).[2] As these economies, taken together, account for around 17% of euro area GDP, concerns over the sustainability of their fiscal policy have the potential of destabilizing the whole euro area and endangering the credibility of the common monetary policy. With this in mind, a comprehensive analysis of fiscal adjustments to budgetary disequilibria in the euro periphery has become a pressing policy issue in an attempt to monitor the fiscal health of the euro area.

Whilst the current literature is focussed on linear models of fiscal adjustment (see, e.g. Afonso 2005, Afonso and Raut, 2010) or non-linear models with fixed, ad-hoc thresholds for fiscal adjustments (see, e.g. Mendoza and Ostry, 2008, Theofilakou and Stournaras, 2012), we introduce endogenously estimated fiscal deficit-to-GDP thresholds for the adjustment of fiscal variables in presence of budgetary disequilibria. These thresholds vary not only with respect to the sign and magnitude of fiscal disequilibria, but also consider the effect of the economic cycle. Moreover and most importantly, we introduce endogenously estimated state-varying fiscal deficit-to-GDP thresholds for the adjustment of fiscal variables which depend upon the conditions of financial markets. Such modelling strategy provides a relevant contribution to the analysis of fiscal adjustments to budgetary disequilibria, allowing to model the behaviour of fiscal policy authorities in different phases of the economic cycle as well as in presence of different financial markets conditions.

Some of the key results are summarised in Table 1, where the budget deficit-to-GDP thresholds are computed using the estimated thresholds and the mean of the sample period under considera-

[1] Greece, which was bailed-out twice (for €110bn in 2010 and then again for €109bn in 2011) negotiated, in February 2012, a new €130bn rescue package involving a voluntary haircut of some 53.5% on the face value of its bonds held by the private sector. Euro area ministers agreed in November 2012 to cut Greece's debt by a further €40bn. Ireland was bailed-out for €85bn in November 2010. Portugal was bailed-out for €78bn in May 2011. Spain was granted, in July 2012, financial assistance from the European Financial Stability Facility (EFSF) for €100bn. In September 2012, EFSF was replaced by the European Stability Mechanism (ESM).

[2] Greece had already been subject to the same procedure in 2004, concluded in 2007 with a Council Decision abrogating the existence of an excessive deficit. Similar conclusions were held for the previous two Portugal's procedures (2002-2004 and 2005-2008), whilst Spain and Ireland do not have a previous record of excessive deficit procedures.

tion. We find that the budget deficit-to-GDP thresholds were rather high for Greece and Portugal particularly after 1999 and that the fiscal adjustments, which took place in "good" times, were very different from the adjustment that took place in "bad" times. It is useful to point out that the fiscal adjustments were carried out also when the budget deficit-to-GDP ratio was below the identified budget deficit-to-GDP threshold, but in Greece the corrective action is estimated to be twice as slow.

During the 1960-2013 period for Greece, Ireland and Portugal and during the 1970-2013 period for Spain, we find that the threshold estimate for the budget deficit-to-GDP ratio, which led to different fiscal correction regimes, was on average 4.90% for Greece, 5.10% for Ireland, 3.22% for Portugal and 3.12% for Spain. The results also suggest that during a financial crisis the fiscal deficit-to-GDP threshold was relaxed from 5.10% to 6.99% in Ireland and from 3.12% to 4.00% in Spain, while it was reduced from 3.22% to 1.92% in Portugal.

[Insert Table 1, here]

When considering the period after 1999, this overall picture worsens for Greece and Portugal and improves for Ireland. Moreover, the results for Ireland and Spain are driven by the financial crisis period. In particular for Ireland, the decoupling dynamics of the government spending reflects the support to the financial sector. In fact, when considering the pre-crisis EMU period between 1999 and 2007, the threshold for fiscal adjustment in Ireland and Spain are estimated to be positive; namely, the adjustment took place when the budget balance was in surplus. Conversely, the fiscal deficit-to-GDP thresholds estimated at 5.32% for Greece and 4.08% for Portugal remained rather high.

Looking at the effects of the economic cycle, we find that fiscal deficit-to-GDP ratio was not reduced in Greece, Ireland and Portugal with the improvement in economic activity. Consequently, during the contractionary times, fiscal corrections became more costly, as tax adjustments became a priority in an attempt to restore fiscal discipline. We also document an historically procyclical government spending for all four countries.

The results also suggest that during a financial crisis the fiscal deficit-to-GDP threshold was relaxed in Ireland and Spain, while it was reduced in Portugal. By relaxing the fiscal deficit-to-GDP threshold (in an attempt to stave off deep recessionary pressures) Ireland and Spain relied on business cycle improvements to raise tax revenues. Given the tendency by Portuguese authorities to improve the fiscal imbalances during a financial crisis, these figures make sustainability concerns for Ireland, Portugal and Spain less of an issue compared to Greece, in an historical perspective.

This paper is organized as follows. Section 2 introduces the long-run relationship between fiscal revenues and expenditures. Section 3 reports the non-linear analysis of the fiscal variables' adjustments with emphasis on the size of the fiscal disequilibrium, the different phases of the economic cycle and during the financial crises. Section 4 concludes and provides some directions for further research.

2 Fiscal Adjustments in the Euro Periphery

2.1 The Long-Run Model

We initially address the issue of the existence of a long-run relationship between the budgetary variables within a long-run model based on Quintos (1995) and Afonso (2005). To allow for potential endogeneity of fiscal variables, cointegration tests are performed by estimating a Vector Error Correction Model (VECM; see Johansen, 1988, 1995) of the form:

$$\Delta y_t = \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \Pi y_{t-1} + \mu + \varepsilon_t, \tag{1}$$

where $y_t = [TAX/GDP, G/GDP]'$. TAX is the general government total revenues, G is the general government total outlays and GDP is the Gross Domestic Product; $\varepsilon_t \sim niid(0, \Sigma)$, μ is a vector of drift parameters, and Π is a $(p*p)$ matrix of the form $\Pi = \alpha\beta'$, where α and β are $(p*r)$ matrices of full column rank, with β containing the r cointegrating vectors and α carrying the corresponding loadings in each of the r vectors. For each country, the lag length k is set as to minimize the Akaike Information Criterion; the latter selects a lag length of $k = 2$ for all countries. The test for cointegration is conducted in each case using Johansen's (1988, 1995) maximal eigenvalue (λ-max) and trace (λ-trace) statistics (with critical values based on MacKinnon *et al.*, 1999).

We use annual time series data over the 1960-2013 period for Greece, Ireland and Portugal. The dataset for Spain is available over the 1970-2013 period. The source of our dataset is the Annual Macroeconomic Database of the European Commission (AMECO; for 2013, we use official estimates provided by the European Commission).[3] Figure 1 provides a plot of the data.

[Insert Figure 1, here]

Using a battery of unit root tests, preliminary analysis of TAX/GDP and G/GDP suggests that all series are non-stationary in levels.[4] We now turn our attention to the empirical results of the cointegration tests, which are reported in Table 2A. At the 5% level of statistical significance, we fail to identify the existence of a long-run relationship between fiscal revenues and outlays for Greece and Ireland and, marginally, for Portugal. For Spain, there is evidence of cointegration using the λ-trace statistic. At the 10% level of statistical significance, however, there is evidence of cointegration for Greece and Portugal (using both the λ-max and λ-trace statistics) and evidence of cointegration for Ireland and Spain (using the λ-trace statistic).

As an alternative to Johansen's cointegrating approach, we report, in Table 2B, the Phillips and Ouliaris (1990) residual-based cointegration test.[5] From Table 2B, the $Z(t)$ statistic (calculated at -8.40 for Greece, -8.39 for Ireland, -16.50 for Portugal and -10.50 for Spain) rejects the null hypothesis of no cointegration.

Under the assumption that cointegration exists, we can assess for each country the robustness of the estimated marginal response of taxes, using the dynamic OLS (DOLS) regression of Stock and Watson (1993). In particular, we regress TAX/GDP on a constant, G/GDP and $\Delta(G/GDP)$; we use a fixed lead and lag specification equal to two for the $\Delta(G/GDP)$ regressor (results are robust to alternative lead/lag specifications). The estimates are corrected for heteroskedasticity and autocorrelation in the residuals using the Newey-West (1987) covariance matrix estimator (and assuming a lag truncation parameter of one; results are robust to alternative lag truncation

[3] We use the following AMECO data series codes: URTG (tax revenues), UUTG (general government outlays) and UVGD (nominal gross domestic product). These series follow the ESA95 definition from 1980, whilst the observations pre-1980 are based on the ESA79.

[4] To save space, these results are not reported but are available on request.

[5] First we regress TAX/GDP on a constant and G/GDP and then run a regression of the estimated residuals on their own lag. We then calculate the $Z(t)$ statistic which tests the null hypothesis that the coefficient on the lagged residuals is equal to one (this test is equivalent to testing the null hypothesis of no cointegration). Our estimate is corrected for heteroskedasticity and autocorrelation in the residuals using the Newey-West (1987) covariance matrix estimator based on a lag truncation parameter of one (results are robust to alternative lag truncation parameter choices).

choices).[6]

[Insert Table 2A and 2B, here]

All in all, cointegration tests reported above indicate some evidence of cointegration using Johansen's tests and much stronger evidence of cointegration using the Phillips and Ouliaris (1990) test. Notice, however, that whatever the test, the marginal response of taxes to government spending is estimated to be less than unity for all countries.

In summary, our results would suggest some form of weak sustainability (see, e.g., Afonso 2005) of the public finances of Greece, Ireland, Portugal and Spain. This means that these governments satisfied their intertemporal budget constraint, but the fact that government spending has historically grown at a faster pace compared to fiscal revenues (as shown by the estimated marginal response of taxes), they might have compromised the marketability of their sovereign bonds, with investors requiring higher risk premia (see, e.g., Quintos (1995)).

Some caveats are nevertheless required when interpreting such long-run relationship in terms of sustainability of the government's intertemporal budget constraint (see, e.g., Bohn (1998, 2007)), and, at the same time, existing sustainability tests fail to provide unambiguous results (see, e.g. the discussion in Lame' et al. (2014)). Applied to the countries in our sample, this result becomes apparent when considering the conflicting empirical results of different studies (see, e.g. Ballabriga et al. (2005), Arghyrou and Luintel (2007), Greiner et al. (2007), Bajo-Rubio et al. (2006), Afonso and Rault, 2010; Afonso and Jalles (2012), Legrenzi and Milas (2013)). Further, alternative forward looking approaches to fiscal sustainability are adopted by the IMF (see, e.g. IMF 2013), and the European Commission (see, e.g. EC 2013).

Turning our attention to the adjustment coefficients (α) of the fiscal variables (see Table 2A), we perform a weak exogeneity test for government's outlays, via a Likelihood Ratio (LR) test which is distributed as a $\chi^2(1)$ under the null hypothesis of a statistically insignificant adjustment coefficient on G/GDP, failing to reject the null hypothesis.[7] The implication of the test is that the fiscal policy authorities of the countries considered in our sample are shown to have historically

[6] Stock and Watson (1993) and Hamilton (1994) point out that under the assumption of cointegration, DOLS delivers asymptotically efficient and asymptotically equivalent to maximum likelihood estimates obtained, for example, via Johansen's (1988, 1995) cointegration framework. Using the DOLS regression, estimates are qualitatively similar to Johansen's estimates reported in Table 2A.

[7] The test computes $\chi^2(1)$=2.02 (p-value=0.15) for Greece, $\chi^2(1)$=1.06 (p-value=0.30) for Ireland, $\chi^2(1)$=0.31 (p-value=0.57) for Portugal and $\chi^2(1)$=1.53 (p-value=0.21) for Spain.

followed a "spend-and-tax" model of fiscal adjustment, where government spending is decided by the political process, and the burden of correcting fiscal disequilibria is entirely left to the tax instrument.[8]

To gain further insight into the evolution of the behavior of fiscal policy authorities over time, Figure 2 reports the recursively estimated λ-max and λ-trace test statistics divided by their corresponding 5% critical values (values higher than one imply cointegration between government revenues and outlays), whereas Figure 3 plots the recursively estimated cointegrating vector +/- 2*Standard Errors (S.E.).

As indicated in Figure 2, cointegration between revenues and expenditures does not seem to hold for the entire sample for all countries considered: for Greece, we notice an absence of cointegration between fiscal revenues and expenditures, arising since 2004.[9] Similar issues are recorded for Spain up to the late 1990s, and for Portugal up until 2002, whilst there is no evidence of cointegration for Ireland over the entire sample.

[Insert Figure 2, here]

As suggested by Figure 3, the estimated marginal response of taxes to spending for Greece increased in the run-up to its euro area membership, after which it dropped markedly. This latter result is in line with the findings of Bénétrix and Lane (2013), who discuss the weak incentives to pursue sustainable public finances within the euro area.

The estimated 95% confidence interval of the marginal response of taxes to spending confirms that government spending historically grew at faster pace relative to fiscal revenues in all considered countries.

[Insert Figure 3, here]

3 Non-Linear Models with State-Varying Thresholds

The recursive analysis reported in the previous section suggests that cointegration switches on and off over time, which questions the assumption that fiscal adjustment is linear. It could be argued that the fiscal adjustment which takes place in "good" times is very different from the adjustment

[8] Legrenzi and Milas (2012) report a weak exogeneity of government spending, for other EMU countries.

[9] Notice that when the λ-trace and λ-max tests diverge in inference, the λ-max test is usually preferred as it has the sharper alternative hypothesis, see e.g. Enders (2010).

that takes place in "bad" times.

Therefore, in what follows, we estimate the models by relaxing the assumption of a linear fiscal adjustment. Specifically, we assume a non-linear adjustment depending upon the size of fiscal disequilibria and the economic cycle. Moreover, we consider the case that the signal providing the non-linear fiscal adjustment is in turn endogenous and a function of financial markets pressure. Such analysis provides further insights on how "good" as opposed to "bad" times affect the adjustment of fiscal policies pursued by Greece, Ireland, Portugal and Spain.

3.1 Non-Linear Adjustments of Fiscal Policy: General Government Revenues

To examine the issue of non-linear adjustment to fiscal disequilibria in the dynamics of general government revenues, we proceed by considering a non-linear model of the following form:

$$\Delta\left(\frac{TAX}{GDP}\right)_t = \beta_0 + \left(\beta_{11}CV_{t-1} + \beta_{12}gap_{t-1}\right)\theta_{t-1} + \left(\beta_{21}CV_{t-1} + \beta_{22}gap_{t-1}\right)\left(1-\theta_{t-1}\right) + u_t, \quad (2)$$

where CV_{t-1} refers to the deviations from the long-run relationship between $\frac{TAX}{GDP}$ and $\frac{G}{GDP}$ at $t-1$ (i.e. $\frac{TAX}{GDP} - \beta\frac{G}{GDP}$), gap_{t-1} is the output gap at $t-1$ (that is, the gap between actual and potential GDP as percentage of potential GDP; see Figure 4),[10] u_t is a stochastic error term, $u_t \sim i.i.d.\left(0, \sigma_u^2\right)$ and

$$\theta_{t-1} = 1 - \left[1 + \exp(-\gamma^s(s_{t-1} - \tau^s)/\sigma_{s_{t-1}})\right]^{-1} \quad (3)$$

is the logistic transition function discussed in e.g. van Dijk *et al.* (2002).

[Insert Figure 4, here]

According to (2)-(3), tax policy exhibits regime-switching behavior which depends on whether the transition variable, s_{t-1}, is below or above an endogenously estimated threshold, τ^s, with regime weights θ_t and $(1-\theta_t)$, respectively. When $(s_{t-1} - \tau^s) \rightarrow -\infty$, then $\theta_t \rightarrow 1$. In this case, the impact of CV_{t-1} and gap_{t-1} is given by β_{11} and β_{12}, respectively. When $(s_{t-1} - \tau^s) \rightarrow \infty$, then

[10] The output gap series is available from the AMECO database (code: AVGDGP) and starts in 1965; this restricts somewhat the estimation sample for the short-run models. As an alternative measure, we used GDP detrended by a Hodrick-Prescott trend based on a smoothing parameter λ equal to 100 (suggested by Hodrik and Prescott, 1997, for annual data). For robustness, we also considered the Ravn and Uhligh (2002) suggested value of 6.25, obtained from $1600\left(\frac{1}{4}\right)^4$. As an alternative measure of the business cycle, we also used annual GDP growth. Empirical results (available on request) were robust to these alternative output definitions.

$\theta_t \to 0$. In this case, the impact of CV_{t-1} and gap_{t-1} is given by β_{21} and β_{22}, respectively. The parameter $\gamma^s > 0$ determines the smoothness of the transition regimes. We make γ^s dimension-free by dividing it by the standard deviation of s_{t-1} (Granger and Teräsvirta, 1993).

We consider two possible candidates for s_{t-1}: CV_{t-1} and gap_{t-1}. In the first case, we assess how taxes adjust to the deviations from the long-run relationship between $\frac{TAX}{GDP}$ and $\frac{G}{GDP}$. Since we estimate, for all countries, $\beta < 1$, there is no clear interpretation of the threshold τ^{CV} in terms of a deficit-to-GDP ratio. Notice, however, that $CV = \frac{TAX}{GDP} - \beta \frac{G}{GDP} = \frac{TAX-G}{GDP} + (1-\beta)\frac{G}{GDP}$. Hence, we can recover the economic interpretation of the threshold in terms of a budget balance-to-GDP ratio using the adjustment $\tau^{CV} - (1-\beta)\frac{G}{GDP}$ and employing, for example, the sample average (or median) of the G/GDP series. Under the assumption that the adjusted threshold is negative, we can assess how taxes adjust in periods of a rising deficit-to-GDP ratio as opposed to periods of a falling deficit-to-GDP ratio. On the other hand, using gap_{t-1} as the transition variable allows us to assess whether taxes adjust differently during periods of economic downturns (when $gap_{t-1} < \tau^{gap}$) and during periods of economic expansions (when $gap_{t-1} > \tau^{gap}$).

Assuming that fiscal corrective action is dependent on a fixed threshold might be too restrictive; rather, corrective action might vary with the pressure arising from financial markets conditions. For this purpose, we also consider a state-varying threshold of the form:

$$\tau_t^{CV} = \tau_0^{CV} + \tau_1^{CV} finpressure_t, \tag{4}$$

where τ_0^{CV} is a fixed threshold, τ_1^{CV} is the state-varying component of the threshold and the variable $finpressure$ is a composite measure of financial turmoil/crisis (which draws heavily on Reinhart and Rogoff, 2009), meant to capture the pressure on fiscal policy authorities arising from unfavorable market conditions. This is a world financial crisis measure which takes into account banking, currency, stock market, debt, and inflation incidences in the world. For a given country in a given year, the index is bounded between zero and five, emerging as the sum of the number of types of incidences the country experienced. Therefore, the index takes the value of 0 if the country did not experience any of the five incidences above and the value of 5 if it did experience all five incidences. The index (plotted in Figure 5) pools together world's 16 largest economies with country specific weights given by their relative GDP share of the total GDP (based on Purchasing

Power Parity).[11] [12]

A negative τ_1^{CV} in (4) suggests that policymakers, possibly driven by the fear of a deep and lasting recession in periods of financial pressure, might be more willing to relax the threshold triggering a deficit correction. On the other hand, a positive estimate of τ_1^{CV} signals that financial pressure strengthens the incentives for budgetary correction, possibly driven by the increasing difficulties in marketing debt instruments.

3.1.1 The Linear Model

We start by reporting in column (i) of Tables 3-6 linear tax revenues error correction models for the countries in our sample. We also report, at the bottom of each Table, the p-value of Hamilton's (2001) λ-test, and the bootstrapped p-value (based on 1000 resamples) of the λ_A and g-tests proposed by Dahl and González-Rivera (2003). Under the null hypothesis of linearity, these are Lagrange Multiplier test statistics following the χ^2 distribution. These tests are powerful in detecting nonlinear regime-switching behavior like the one considered in our model. For all countries, all three tests reject linearity, strengthening our argument in favour of non-linear modelling of fiscal adjustments. We also report the Quandt-Andrews breakpoint test for parameter stability (to run the test for the non-linear models, we fix the threshold and γ parameters to their estimated values); this test suggests reasonable parameter stability for all estimated models.

3.1.2 The Non-Linear Model Using CV_{t-1} as Transition Variable

We now turn our attention to the non-linear models. Column (ii) of Tables 3-6 reports the non-linear models (2)-(3) using CV_{t-1} as the transition variable.[13]

As for Greece (see Table 3 (ii)), given $\tau^{CV} = 5.093\%$, $\beta = 0.72$ and the sample average of 35.7% for the G/GDP ratio, we can compute the threshold estimate of the budget balance-to-GDP ratio as follows $\tau^{CV} - (1-\beta)\frac{G}{GDP}$, which implies a threshold estimate of -4.90% (or, in terms of a

[11] Chapter 16 of Reinhart and Rogoff (2009) describes the country specific indices in more detail; these are also available from the website of Carmen Reinhart (http://www.carmenreinhart.com/data/). Country specific weights given by their relative GDP share of the total GDP have been calculated for Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Turkey, UK and US.

[12] To proxy financial market pressure, we also used the (i) spread between the 10-year yield on each one of the countries in our sample and the 10-year yield on German bonds, and (ii) a 2 (and 3)-year moving standard deviation of the spread but failed to find any significant effect.

[13] For all countries, the unadjusted τ^{CV} thresholds reported in Tables 3-6 are reasonably close to the sample average (median) of the corresponding CV series. CV has a mean of 4.7 (median: 5.0) for Greece; a mean of 6.6 (median: 6.2) for Ireland; a mean of 2.9 (median: 3.4) for Portugal and a mean of 4.1 (median: 4.3) for Spain.

deficit, a threshold of 4.90%; we will follow the deficit terminology for the rest of the paper).[14] We report a strong fiscal adjustment when the budget deficit exceeds 4.90% of national GDP (i.e. $CV_{t-1} < \tau^{CV}$ regime), whilst the corrective action is twice as slow when the fiscal deficit drops below such threshold (i.e. $CV_{t-1} > \tau^{CV}$ regime). Notice also that only in the high fiscal deficit regime, taxes respond negatively to the output gap, so that the fiscal revenues relative to GDP decrease following above trend economic growth.

[Insert Table 3, here]

With regard to Ireland (see Table 4(ii)), given $\tau^{CV} = 6.254\%$, $\beta = 0.71$ and the sample average of 39.1% for the G/GDP ratio, we estimate a threshold for the budget deficit-to-GDP equal to 5.10%.[15] In sharp contrast to Greece, the corrective action is statistically insignificant when the deficit exceeds 5.10% of GDP (the coefficient on CV_{t-1} is -0.12 and the corresponding t-ratio is -1.20). On the other hand, the corrective action is statistically significant when the deficit drops below 5.10% of GDP (the coefficient on CV_{t-1} is -0.13 and the corresponding t-ratio is -2.67); we return to this issue in Section 3.1.4. The output gap is statistically insignificant in both regimes.

[Insert Table 4, here]

With regard to Portugal (see Table 5(ii)), given $\tau^{CV} = 3.564\%$, $\beta = 0.80$ and the sample average of 33.9% for the G/GDP ratio, we estimate a threshold for the budget deficit-to-GDP equal to 3.22%.[16] Similar to the results obtained for Ireland, the corrective action is statistically insignificant when the fiscal deficit exceeds 3.22% of GDP (the coefficient on CV_{t-1} is -0.24 and the corresponding t-ratio is -1.15). On the other hand, the corrective action is statistically significant when the fiscal deficit drops below 3.22% of GDP (the coefficient on CV_{t-1} is -0.34 and the corresponding t-ratio is -3.98). Moreover, when the deficit exceeds 3.22% of GDP, an improvement of economic conditions (as measured by an increase in the output gap) may support tax revenues, although the impact is statistically weak.

[Insert Table 5, here]

[14] The threshold estimate of the budget deficit-to-GDP ratio of Greece is 5.58% if using instead the 38.1% sample median of the G/GDP ratio.

[15] The threshold estimate of the budget deficit-to-GDP ratio for Ireland is 5.46% if using instead the 40.4% sample median of the G/GDP ratio.

[16] The threshold estimate of the budget deficit-to-GDP ratio for Portugal is 3.80% if using instead the 36.8% sample median of the G/GDP ratio.

Finally, the results for Spain (see Table 6(ii)) suggest that given $\tau^{CV} = 4.237\%$, $\beta = 0.80$ and the sample average of 36.8% for the G/GDP ratio, the threshold for the budget deficit-to-GDP is estimated to equal 3.12%.[17]. Similar to the results obtained for Greece, the corrective action is stronger when the fiscal deficit exceeds the estimated threshold; in this regime, the output gap exerts a positive (but statistically weak) effect.

[Insert Table 6, here]

Overall, a common characteristic shared by all countries in our sample - in the non-linear model that allows the deviations from fiscal equilibria to be the transition variable - is that fiscal disequilibria are corrected even when these are relatively "low" (in which case there is arguably less pressure to do so). Moreover, the results provide evidence of threshold behavior in the conduct of fiscal policy by Greece and Spain, in line with the theoretical predictions derived from political economy models (see, e.g., Bertola and Drazen, 1993, suggesting that fiscal policy authorities corrected budgetary unbalances only when they became too large). On the contrary, Ireland and Portugal do not seem to have corrected fiscal imbalances when their deficits exceeded the estimated thresholds. This finding appears counter-intuitive and calls for further investigation. A possible reason might be that the non-linear model reported in column (ii) is inadequate in capturing the fiscal implications of the impact of a time-varying component in the threshold; we return to this issue in Section 3.1.4.

3.1.3 The Non-Linear Model Using gap_{t-1} as Transition Variable

Column (iii) of Tables 3-6 reports the non-linear models (2)-(3) using the output gap as possible transition variable. The near zero estimates of the threshold parameter τ^{gap} suggest a regime-switching with respect to expansionary times (characterized by the regime where the output gap is positive) versus contractionary times (characterized by the regime where the output gap is negative).

However, taxes in Greece and Portugal do not seem to have responded to the economic cycle. Conversely, the correction in Ireland was stronger in "bad" as opposed to "good" times responding positively to the economic cycle, while the correction in Spain occurred only during "good" times

[17] The threshold estimate of the budget deficit-to-GDP ratio for Spain is 3.59% if using instead the 39.1% sample median of the G/GDP ratio.

and, in this regime, taxes responded positively to the economic cycle.

Overall the non-linear model using the output gap as transition variable uncovers further interesting features of the fiscal policies pursued by the countries in our sample. In particular, we find that fiscal deficit-to-GDP ratio was not reduced in Greece, Ireland and Portugal with the improvement in economic activity.

3.1.4 The Non-Linear Model using the State-Varying CV_{t-1} as Transition Variable

It could be argued that the response of tax revenues to fiscal disequilibria non only is non-linear but also state-varying, changing with unfavourable market conditions. Column (iv) of Tables 3-6 reports the non-linear models (2)-(3) using CV_{t-1} as the transition variable and introducing a state-varying threshold given by equation (4). Note that τ_1^{CV} is statistically insignificant for Greece (see Table 3(iv)) suggesting that this model does not add value relative to the results reported in Table 3(ii)). Conversely, τ_1^{CV} is statistically significant and negative for Ireland (see Table 4(iv)) and Spain (see Table 6(iv)) and positive for Portugal (see Table 5(iv)).

With regard to Ireland, given $\tau_0^{CV} = 6.300\%$, $\tau_1^{CV} = -2.748$, $\beta = 0.71$, the sample average of 39.1% for the G/GDP ratio and the sample average of 0.712 for $finpressure_t$, we estimate a threshold for the budget deficit-to-GDP equal to 6.99%.[18] This result suggests that during a financial crisis the Irish deficit-to-GDP threshold was relaxed from 5.10% (implied by Table 4(ii)) to 6.99%. Moreover, this model provides some evidence of stronger fiscal correction when the fiscal deficit exceeded 6.99% of GDP. Indeed, the -0.210 point estimate on CV_{t-1} when $CV_{t-1} < \tau_t^{CV}$ suggests stronger adjustment than the -0.137 estimate on CV_{t-1} when $CV_{t-1} > \tau_t^{CV}$; however, the t-ratio of -1.60 on the former provides weak statistical evidence for this finding.

In the case of Spain, given $\tau_0^{CV} = 4.511\%$, $\tau_1^{CV} = -1.616$, $\beta = 0.80$, the sample average of 36.8% for the G/GDP ratio and the sample average of 0.712 for $finpressure_t$, we estimate a threshold for the budget deficit-to-GDP equal to 4%. This implies that during a financial crisis the threshold estimate was relaxed from 3.12% (implied by Table 6(ii)) to 4%.

Finally, in the case of Portugal we find a statistically positive τ_1^{CV}. Given $\tau_0^{CV} = 3.500\%$, $\tau_1^{CV} = 1.911$, $\beta = 0.80$, the sample average of 33.9% for the G/GDP ratio and the sample average

[18] Notice that the 6.99% threshold estimate appears to be well-defined. Although it exceeds the average of 5.12% for the Irish deficit-to-GDP ratio over the sample period considered, 35% of the sample values of the deficit-to-GDP ratio exceed the 6.99% threshold.

of 0.712 for $finpressure_t$, we estimate a threshold for the budget deficit-to-GDP equal to 1.92%. This implies that during a financial crisis the Portuguese deficit threshold was reduced from 3.22% (implied by Table 5(ii)) to 1.92%. Notice also that this model, in contrast to the model in column (ii), identifies statistically significant corrective action when the deficit exceeds the 1.92% threshold.

Overall, the introduction of the state-varying threshold improves the model results for Ireland, Portugal and Spain. It is useful to notice that Ireland and Spain, by relaxing the deficit threshold (in an attempt to stave off deep recessionary pressures), historically relied on business cycle improvements to push up tax revenues, as the coefficient on the output gap in the high fiscal deficit regime is positive (this is not the case for Portugal where financial pressure has reduced the threshold).

Notice also that this model reverses to some extent the counter-intuitive results of the model in column (ii) for Portugal and Ireland as it shows a significant adjustment for Portugal (when the deficit exceeds 1.92% of GDP) and some weak correction for Ireland (when the deficit exceeds 6.99% of GDP).

Amongst all estimated models, the model in column (ii) delivers the best fit for Greece. The model with the time-varying threshold component in column (iv) delivers the best fit for Spain and Portugal, respectively. For Ireland, the model in Table 4(iii) which distinguishes between different phases of the economic cycle delivers the best fit.

In order to assess the overall sustainability concerns, it is important to estimate the thresholds using the sample period after the start of EMU in 1999. Given that we cannot re-estimate the entire model using only 15 observations, we use the estimated parameters over the entire sample period and compute the thresholds using the mean of the information set over the period 1999-2013 as well as over the pre-crisis period 1999-2007.

Compared to the results already presented, the overall picture worsens for Greece and Portugal and improves for Ireland when considering the period 1999-2013 (see Table 1). It is also important to point out that the results for Ireland and Spain are driven by the financial crisis period. In particular for Ireland, the decoupling dynamics of the government spending reflects the support to the financial sector. In fact, when considering the pre-crisis EMU period between 1999 and 2007, the threshold for fiscal adjustment in Ireland and Spain are estimated to be positive; namely, the adjustment took place when the budget balance was in surplus.

To sum up, Greece and Portugal's budget deficit-to-GDP thresholds are "large", in contrast with Ireland and Spain, both of which have fiscal deficit thresholds close to the 3% threshold. Deteriorating financial market conditions have increased (on average) the threshold for Spain and reduced the threshold for Portugal. These results make sustainability concerns for these countries less of an issue compared to Greece.

3.2 Government Outlays Models

Non-linear models were also considered for the adjustment of general government expenditure. Results, not reported for space considerations (but available on request) are summarized as follows.

For all countries in our sample, own lags have a significant and positive effect on current spending, pointing to self-perpetuating spending growth dynamics. Budgetary disequilibria, on the other hand, are insignificant in explaining government spending dynamics, as evidenced by the statistical insignificance of CV_{t-1}. Output gap has a positive effect for all countries; this points to a procyclical use of government spending. In statistical terms, the evidence is stronger for Greece (the t-ratio on output gap is equal to 2.14) and much weaker for the remaining countries (the t-ratio on output gap is equal to 1.30 for Spain, 1.20 for Portugal and 1.10 for Ireland). We fail to find evidence of non-linear effects in any of the countries in our sample. These results further corroborate our earlier finding of an historical weak exogeneity of government spending, as budgetary imbalances have been corrected via the tax instrument, with government spending mainly determined by its past history.

4 Conclusions and Directions for further Research

Fiscal policy authorities of Greece, Ireland, Portugal and Spain are shown to have on average historically followed a "spend-and-tax" model of fiscal adjustment, where government spending is decided by the political process, and the burden of correcting fiscal disequilibria is entirely left to the tax instrument. The aim of this paper is to investigate if the adjustment of fiscal variables in presence of budgetary disequilibria varies with respect to the sign and the magnitude of fiscal disequilibria, but also with the economic cycle and the financial markets' conditions. Our modelling approach attempts to capture the behavior of fiscal policy authorities that might opt for re-adjusting their target, given the changing state of the economy and financial market conditions.

We find that the fiscal deficit-to-GDP ratio thresholds were rather high for Greece and Portugal particularly after 1999 and that the adjustment which took place in "good" times were very different from the adjustment that took place in "bad" times. It is useful to point out that the fiscal adjustments were carried out also when the budget deficit-to-GDP ratio was below the identified budget deficit-to-GDP threshold, but in Greece the corrective action is estimated to be twice as slow.

It must be said that the results for Ireland and Spain are driven by the financial crisis period. In particular for Ireland, the decoupling dynamics of the government spending reflects the support to the financial sector. In fact, when considering the pre-crisis EMU period between 1999 and 2007, the fiscal deficit-to-GDP threshold for fiscal adjustment in Ireland and Spain are estimated to be positive; namely, the regime change took place when the budget balance was in surplus. Conversely, the fiscal deficit-to-GDP thresholds for Greece and Portugal in the pre-crisis EMU period remained rather high.

The results also suggest that during a financial crisis the fiscal deficit-to-GDP threshold was relaxed in Ireland and Spain, while it was reduced in Portugal. By relaxing the fiscal deficit-to-GDP threshold (in an attempt to stave off deep recessionary pressures) Ireland and Spain relied on business cycle improvements to raise tax revenues.

Looking at the effects of the economic cycle, we find that fiscal deficit-to-GDP ratio was not reduced in Greece, Ireland and Portugal with the improvement in economic activity. Consequently, during the contractionary times, fiscal corrections became more costly, as tax adjustments became a priority in an attempt to restore fiscal discipline. We also document an historically procyclical government spending for all four countries. Given the tendency by Portuguese authorities to improve the fiscal imbalances during a financial crisis, these figures make sustainability concerns for Ireland, Portugal and Spain less of an issue compared to Greece, in an historical perspective.

In any case, financial markets might not tolerate large debt/deficits and slow budgetary fiscal policy corrections. That is to say, financial markets may require high interest premia on government bonds, rendering more problematic the funding of new debt; indeed, over the past few years, the countries in our sample have faced high interest rate premia and have suffered successive downgrades on their sovereign debt.

This research can be extended to all other euro area countries, in order to ascertain whether the threshold behaviour of fiscal policy authorities can be considered as a norm, and to evaluate the role of the state-varying components. A full assessment of fiscal policies during "good" and "bad" times, in conjunction with the effects of political cycles should also provide an interesting extension of this analysis. Further, the possibility of a "twin deficit" and its consequences for the fiscal policies in the euro area can bring useful insights on the behavior of the fiscal variables.

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Table 1: Estimated budget balance-to-GDP thresholds for Greece, Ireland, Portugal and Spain

	GR	IE	PT	ES
		All sample period		
Actual budget deficit	-5.15	-5.12	-3.66	-3.11
Threshold	-4.90	-5.10	-3.22	-3.12
State-varying Threshold	-4.90	-6.99	-1.92	-4.00
		1999-2013		
Actual budget deficit	-7.18	-4.37	-5.12	-3.32
Threshold	-7.18	-4.37	-5.12	-3.32
State-varying Threshold	-7.18	-6.41	-3.71	-4.52
		1999-2007		
Actual budget deficit	-5.32	1.59	-4.08	0.23
Threshold	-5.32	1.59	-4.08	0.23
State-varying Threshold	-5.32	-0.11	-2.89	-0.39

Notes: All sample period refers to the 1960-2013 period for Greece, Ireland and Portugal and 1970-2013 period for Spain. The thresholds are estimated over the entire sample periods, while they are calibrated based on the estimated parameters after 1999.

Table 2A: Johansen's (1988, 1995) cointegration λ-trace and λ-max test statistics

	Cointegrating vector $(1,-\beta)'$	λ-trace test	λ-max test	α on TAX/GDP (S.E.)	α on G/GDP (S.E.)
Greece	(1, -0.72)′	14.29	12.87	-0.24 (0.07)	-0.19 (0.13)
Ireland	(1, -0.71)′	14.88	10.13	-0.11 (0.05)	0.19 (0.15)
Portugal	(1, -0.80)′	15.41	14.11	-0.19 (0.08)	0.06 (0.11)
Spain	(1, -0.80)′	16.65	9.71	-0.15 (0.08)	0.18 (0.10)

Notes: For each country we report the estimated cointegrating vector normalized on TAX/GDP and the estimated λ-max and λ-trace statistics for the null hypothesis of zero cointegrating vectors. For each country we also report the estimated adjustment coefficients α on TAX/GDP and G/GDP, respectively (with standard errors in brackets).
MacKinnon et al (1999) 10% critical value for the λ-trace test: 13.42. MacKinnon et al (1999) 5% critical value for the λ-trace test: 15.49.
MacKinnon et al (1999) 10% critical value for the λ-max test: 12.29. MacKinnon et al (1999) 5% critical value for the λ-max test: 14.26.
Sample: 1960-2013 for Greece, Ireland and Portugal. Sample: 1970-2013 for Spain.

Table 2B: Phillips and Ouliaris (1990) residual based cointegration test

	β	$Z(t)$ test
Greece	0.68	-8.49
Ireland	0.50	-8.39
Portugal	0.76	-16.50
Spain	0.72	-10.50

Notes: For each country, the estimated marginal response β is based on the long-run regression of TAX/GDP on a constant and G/GDP. We then regress the residuals of the long-run regression on their own lag and calculate the Z(t) statistic which tests the null hypothesis that the coefficient on the lagged residuals is equal to one. The test is equivalent to testing the null hypothesis of no cointegration. The Z(t) test statistic is corrected for heteroscedasticity and autocorrelation using the Newey-West (1987) estimator. We apply a lag truncation parameter of one (results are robust to alternative lag truncation choices). The critical values for Z(t) are reported by Hamilton (1994) in Table B.9 (page 766): 10% critical value=-3.07; 5% critical value=-3.37.
Sample: 1960-2013 for Greece, Ireland and Portugal. Sample: 1970-2013 for Spain.

Table 3: GREECE-OLS estimates of alternative error correction models for $\Delta(TAX/GDP)$

	(i)	(ii)	(iii)	(iv)
	Linear model	Logistic model $s_{t-1} = CV_{t-1}$	Logistic model $s_{t-1} = gap_{t-1}$	Logistic model $s_{t-1} = CV_{t-1}$
Constant	1.259 (4.08)	1.701 (4.80)	1.298 (3.37)	1.709 (4.46)
CV_{t-1}	-0.186 (-3.27)			
gap_{t-1}	-0.029 (-0.41)			
$\Delta(G/GDP)_{t-1}$	-0.120 (-1.10)	-0.131 (-1.13)	-0.125 (-1.11)	-0.112 (-1.13)
		$CV_{t-1} < \tau^{CV}$ Regime	**$gap_{t-1} < \tau^{gap}$ Regime**	**$CV_{t-1} < \tau_t^{CV}$ Regime**
CV_{t-1}		-0.486 (-3.18)	-0.242 (-2.63)	-0.502 (-2.44)
gap_{t-1}		-0.223 (-2.12)	-0.076 (-0.87)	-0.217 (-1.55)
		$CV_{t-1} > \tau^{CV}$ Regime	**$gap_{t-1} > \tau^{gap}$ Regime**	**$CV_{t-1} > \tau_t^{CV}$ Regime**
CV_{t-1}		-0.230 (-3.92)	-0.164 (-2.56)	-0.215 (-3.39)
gap_{t-1}		0.037 (0.54)	-0.063 (-0.41)	0.026 (0.31)
τ^{CV} (%)		5.093 (11.67)		
γ^{CV}		10.00 (-)*		4.00 (-)*
τ^{gap} (%)			-0.069 (-0.11)	
γ^{gap}			20.30 (-)*	
τ_0^{CV} (%)				5.200 (11.00)
τ_1^{CV} (%)				-0.981 (-0.86)
Diagnostics				
Regression s.e.	1.10	1.02	1.08	1.05
$\overline{R}^2$	0.16	0.21	0.13	0.17
Far (p-value)	0.87	0.88	0.83	0.87
Farch (p-value)	0.68	0.63	0.66	0.62
QA break (p-value)	0.30	0.20	0.20	0.50
$\chi^2 nd$ (p-value)	0.95	0.84	0.90	0.83
λ-test (p-value)	0.01			
λ_A-test (p-value)	0.00			
g-test (p-value)	0.01			

*Notes: t-ratios in parentheses. $\overline{R}^2$ is the adjusted coefficient of determination. *Imposed value. van Dijk et al. (2002) argue that the likelihood function is very insensitive to γ, suggesting that precise estimation of this parameter is unlikely. For this reason, we run a grid search in the range [0.1, 250] and fix the γ parameter to the one that delivers the best fit of the estimated models. Far is the Lagrange Multiplier F-test for 2nd order serial correlation. Farch is the 1st order ARCH F-test. χ^2nd is a Chi-square test for normality. QA break is the p-value of the Quandt-Andrews breakpoint test. We report the p-value of the maximum LR F-statistic using 15% observation trimming, calculated using Hansen's (1997) method. Sample: 1965-2013.*

Table 4: IRELAND-OLS estimates of alternative error correction models for $\Delta(TAX/GDP)$

	(i)	(ii)	(iii)	(iv)
	Linear model	Logistic model $s_{t-1} = CV_{t-1}$	Logistic model $s_{t-1} = gap_{t-1}$	Logistic model $s_{t-1} = CV_{t-1}$
Constant	0.893 (2.09)	1.070 (2.59)	1.547 (3.36)	1.174 (3.13)
CV_{t-1}	-0.119 (-2.23)			
gap_{t-1}	0.036 (0.34)			
$\Delta(G/GDP)_{t-1}$	-0.032 (-0.58)	-0.033 (-0.59)	-0.034 (-0.49)	-0.035 (-0.49)
		$\boldsymbol{CV_{t-1} < \tau^{CV}}$ **Regime**	$\boldsymbol{gap_{t-1} < \tau^{gap}}$ **Regime**	$\boldsymbol{CV_{t-1} < \tau_t^{CV}}$ **Regime**
CV_{t-1}		-0.120 (-1.20)	-0.149 (-2.67)	-0.210 (-1.60)
gap_{t-1}		0.113 (0.93)	0.265 (1.64)	0.310 (1.70)
		$\boldsymbol{CV_{t-1} > \tau^{CV}}$ **Regime**	$\boldsymbol{gap_{t-1} > \tau^{gap}}$ **Regime**	$\boldsymbol{CV_{t-1} > \tau_t^{CV}}$ **Regime**
CV_{t-1}		-0.132 (-2.67)	-0.119 (-1.79)	-0.137 (-2.86)
gap_{t-1}		0.010 (0.05)	-0.253 (-1.15)	-0.050 (-0.43)
τ^{CV} (%)		6.254 (3.94)		
γ^{CV}		11.10 (-)*		10.90 (-)*
τ^{gap} (%)			-0.432 (-0.64)	
γ^{gap}			25.38 (-)*	
τ_0^{CV} (%)				6.300 (4.10)
τ_1^{CV} (%)				-2.748 (-2.03)
Diagnostics				
Regression s.e.	1.45	1.41	1.35	1.38
$\overline{R}^2$	0.14	0.15	0.20	0.17
Far (p-value)	0.11	0.18	0.40	0.19
Farch (p-value)	0.68	0.28	0.77	0.30
$\chi^2 nd$ (p-value)	0.15	0.49	0.29	0.50
QA break (p-value)	0.25	0.20	0.20	0.19
λ-test (p-value)	0.01			
λ_A-test (p-value)	0.02			
g-test (p-value)	0.01			

*Notes: t-ratios in parentheses. $\overline{R}^2$ is the adjusted coefficient of determination. *Imposed value. van Dijk et al. (2002) argue that the likelihood function is very insensitive to γ, suggesting that precise estimation of this parameter is unlikely. For this reason, we run a grid search in the range [0.1, 250] and fix the γ parameter to the one that delivers the best fit of the estimated models. Far is the Lagrange Multiplier F-test for 2nd order serial correlation. Farch is the 1st order ARCH F-test. $\chi^2 nd$ is a Chi-square test for normality. QA break is the p-value of the Quandt-Andrews breakpoint test. We report the p-value of the maximum LR F-statistic using 15% observation trimming, calculated using Hansen's (1997) method. Sample: 1965-2013.*

Table 5: PORTUGAL-OLS estimates of alternative error correction models for $\Delta(TAX/GDP)$

	(i)	(ii)	(iii)	(iv)
	Linear model	Logistic model $s_{t-1} = CV_{t-1}$	Logistic model $s_{t-1} = gap_{t-1}$	Logistic model $s_{t-1} = CV_{t-1}$
Constant	1.895 (3.14)	1.626 (2.75)	1.788 (2.83)	1.484 (4.25)
CV_{t-1}	-0.249 (-3.68)			
gap_{t-1}	0.070 (1.14)			
$\Delta(G/GDP)_{t-1}$	0.215 (1.83)	0.204 (1.84)	0.209 (1.86)	0.205 (1.84)
		$CV_{t-1} < \tau^{CV}$ Regime	**$gap_{t-1} < \tau^{gap}$ Regime**	**$CV_{t-1} < \tau_t^{CV}$ Regime**
CV_{t-1}		-0.241 (-1.15)	-0.338 (-3.06)	-0.321 (-2.71)
gap_{t-1}		0.141 (1.65)	0.015 (0.17)	0.070 (1.07)
		$CV_{t-1} > \tau^{CV}$ Regime	**$gap_{t-1} > \tau^{gap}$ Regime**	**$CV_{t-1} > \tau_t^{CV}$ Regime**
CV_{t-1}		-0.341 (-3.98)	-0.305 (-2.55)	-0.411 (-3.73)
gap_{t-1}		-0.027 (-0.32)	0.111 (0.73)	-0.169 (-1.18)
τ^{CV} (%)		3.564 (15.30)		
γ^{CV}		40.00 (-)*		15.00 (-)*
τ^{gap} (%)			-0.408 (-0.77)	
γ^{gap}			35.00 (-)*	
τ_0^{CV} (%)				3.500 (12.80)
τ_1^{CV} (%)				1.911 (5.45)
Diagnostics				
Regression s.e.	1.24	1.22	1.23	1.21
$\overline{R}^2$	0.17	0.20	0.18	0.21
Far (p-value)	0.49	0.58	0.50	0.56
Farch (p-value)	0.02	0.12	0.10	0.11
$\chi^2 nd$ (p-value)	0.82	0.90	0.84	0.88
QA break (p-value)	0.10	0.10	0.12	0.11
λ-test (p-value)	0.01			
λ_A-test (p-value)	0.00			
g-test (p-value)	0.01			

*Notes: t-ratios in parentheses. $\overline{R}^2$ is the adjusted coefficient of determination. *Imposed value. van Dijk et al. (2002) argue that the likelihood function is very insensitive to γ, suggesting that precise estimation of this parameter is unlikely. For this reason, we run a grid search in the range [0.1, 250] and fix the γ parameter to the one that delivers the best fit of the estimated models. Far is the Lagrange Multiplier F-test for 2nd order serial correlation. Farch is the 1st order ARCH F-test. χ^2nd is a Chi-square test for normality. QA break is the p-value of the Quandt-Andrews breakpoint test. We report the p-value of the maximum LR F-statistic using 15% observation trimming, calculated using Hansen's (1997) method. Sample: 1965-2013.*

Table 6: SPAIN-OLS estimates of alternative error correction models for $\Delta(TAX/GDP)$

	(i)	(ii)	(iii)	(iv)
	Linear model	Logistic model $s_{t-1} = CV_{t-1}$	Logistic model $s_{t-1} = gap_{t-1}$	Logistic model $s_{t-1} = CV_{t-1}$
Constant	1.214 (2.75)	1.838 (2.40)	2.224 (4.55)	2.944 (5.01)
CV_{t-1}	-0.198 (-2.15)			
gap_{t-1}	0.134 (1.46)			
$\Delta(G/GDP)_{t-1}$	0.030 (0.23)	0.020 (0.13)	0.021 (0.23)	0.029 (0.15)
		$CV_{t-1} < \tau^{CV}$ Regime	**$gap_{t-1} < \tau^{gap}$ Regime**	**$CV_{t-1} < \tau_t^{CV}$ Regime**
CV_{t-1}		-0.358 (-2.10)	-0.074 (-0.92)	-0.311 (-2.28)
gap_{t-1}		0.312 (1.57)	0.036 (0.32)	0.315 (2.14)
		$CV_{t-1} > \tau^{CV}$ Regime	**$gap_{t-1} > \tau^{gap}$ Regime**	**$CV_{t-1} > \tau_t^{CV}$ Regime**
CV_{t-1}		-0.250 (-2.31)	-0.160 (-2.61)	-0.291 (-3.49)
gap_{t-1}		-0.016 (-0.11)	0.341 (2.10)	0.070 (0.76)
τ^{CV} (%)		4.237 (19.54)		
γ^{CV}		30.00 (-)*		54.00 (-)*
τ^{gap} (%)			-0.181 (-0.55)	
γ^{gap}			40.23 (-)*	
τ_0^{CV} (%)				4.511 (11.50)
τ_1^{CV} (%)				-1.616 (-6.35)
Diagnostics				
Regression s.e.	0.95	0.93	0.95	0.90
$\overline{R}^2$	0.27	0.31	0.27	0.35
Far (p-value)	0.07	0.86	0.86	0.87
Farch (p-value)	0.91	0.92	0.92	0.93
$\chi^2 nd$ (p-value)	0.05	0.74	0.60	0.61
QA break (p-value)	0.15	0.14	0.10	0.12
λ-test (p-value)	0.01			
λ_A-test (p-value)	0.00			
g-test (p-value)	0.00			

*Notes: t-ratios in parentheses. $\overline{R}^2$ is the adjusted coefficient of determination. *Imposed value. van Dijk et al. (2002) argue that the likelihood function is very insensitive to γ, suggesting that precise estimation of this parameter is unlikely. For this reason, we run a grid search in the range [0.1, 250] and fix the γ parameter to the one that delivers the best fit of the estimated models. Far is the Lagrange Multiplier F-test for 2nd order serial correlation. Farch is the 1st order ARCH F-test. χ^2nd is a Chi-square test for normality. QA break is the p-value of the Quandt-Andrews breakpoint test. We report the p-value of the maximum LR F-statistic using 15% observation trimming, calculated using Hansen's (1997) method. Sample: 1970-2013.*

Figure 1: TAX/GDP and G/GDP series, 1960-2013 (%)

Source: European Commission. Sample period: 1960-2013. European Commission official forecast are used for 2013.

Figure 2: Recursively estimated λ-max and λ-trace statistics divided by their 5% critical value, 1985-2013

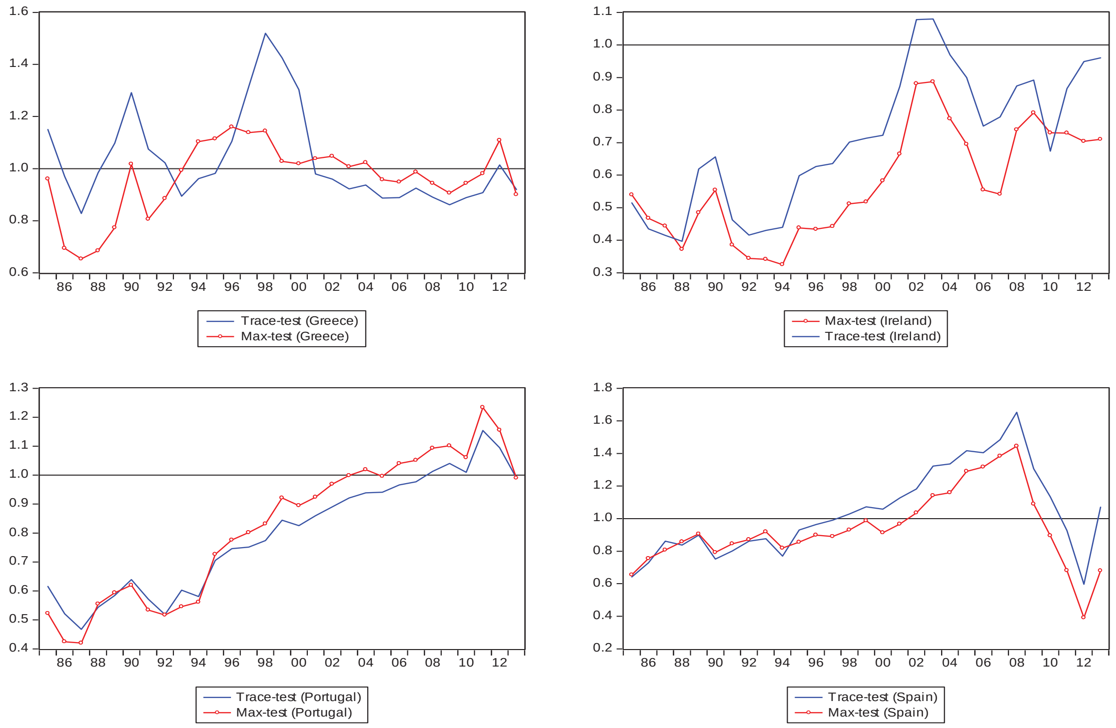


Figure 3: Recursive betas +/-2*S.E., 1985-2013

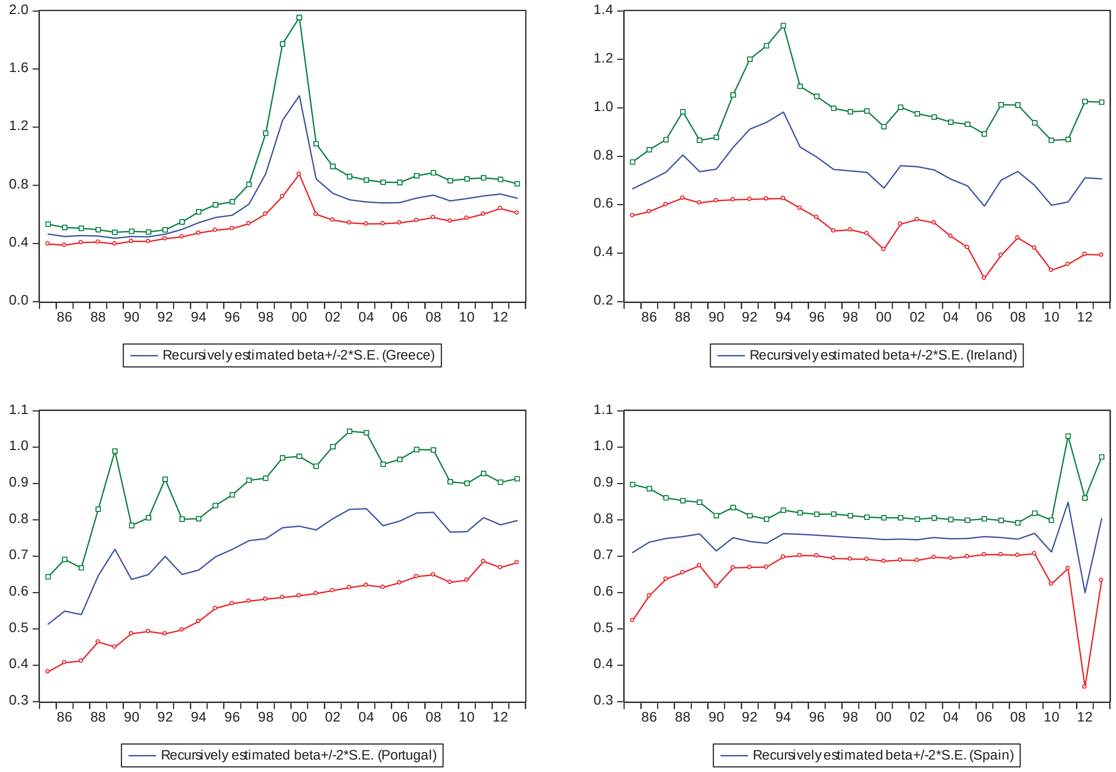
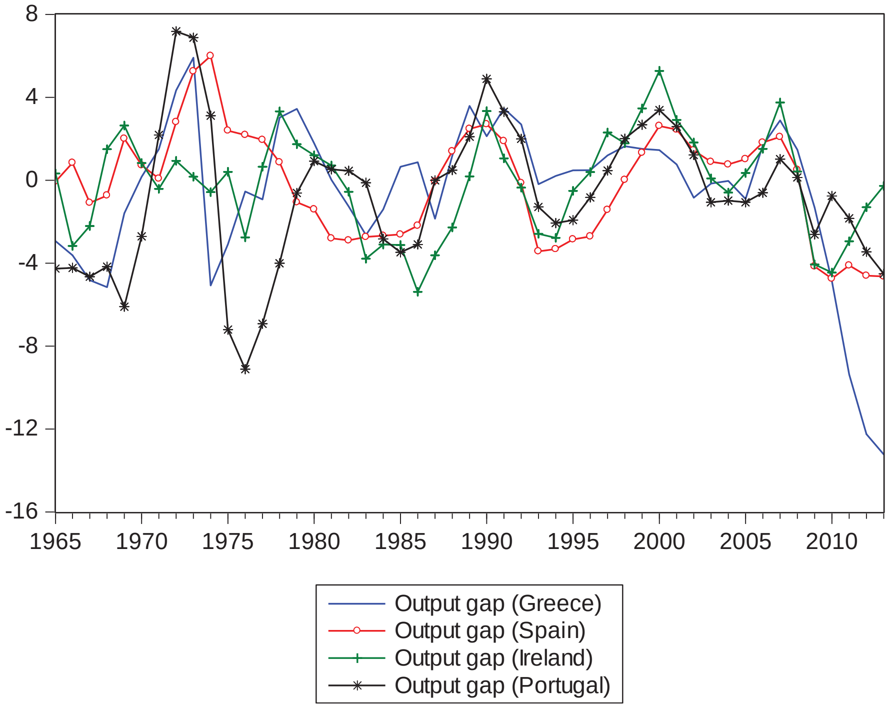
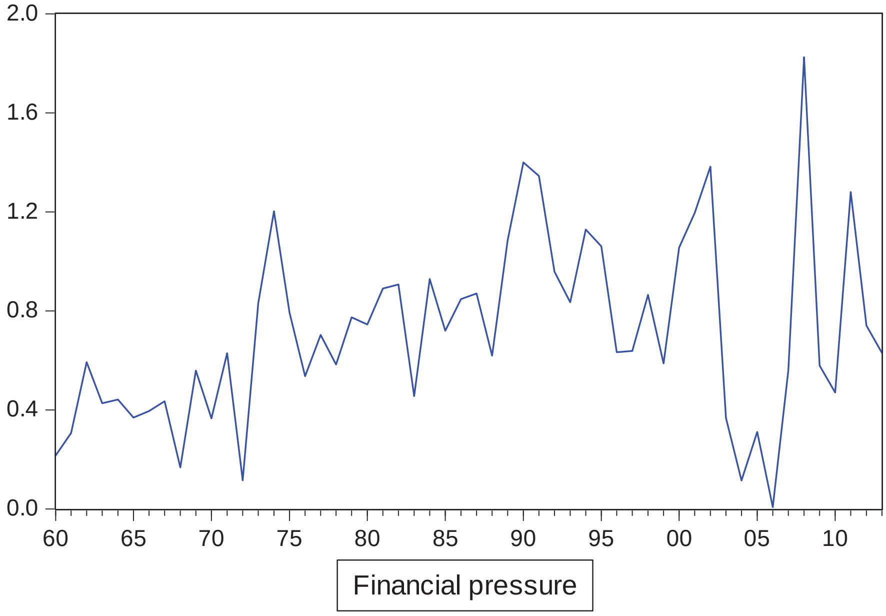


Figure 4: Output gaps (%).



Source: European Commission. Sample period: 1960-2013. European Commission official forecast are used for 2013.

Figure 5: Financial pressure



Source: Reinhart and Rogoff (2009), Legrenzi and Milas (2013).
Notes: The financial pressure index ranges between 0 (no crisis) and 5 (massive crisis).

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