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## Fiscal reaction function and fiscal fatigue: evidence for the euro area

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**Abstract:** This paper estimates a fiscal reaction function (FRF) framework for euro area countries and derives a novel approach to measure fiscal fatigue. As in previous studies, we find evidence that euro area sovereigns abide, on average, by (weak) sustainability constraints. The primary balance improves by about 0.03–0.05 for every 1 percentage point increase in the debt-to-GDP ratio after controlling for other relevant factors. The positive reaction of primary surpluses to higher debt strengthened over the crisis. Based on this framework, we propose a simple, practical measure of fiscal fatigue that can be used to assess the capacity of sovereigns to maintain primary surpluses over extended periods of time. This measure can be derived by comparing simulated primary balance paths in the context of debt sustainability analyses with countries' track-record, adjusted for the change in debt with the estimated fiscal reaction coefficient. The evidence of fiscal fatigue in non-linear FRF specifications is weaker for our euro area sample.

**JEL:** H60, E62, F41, C33

**Keywords:** fiscal fatigue, fiscal reaction function, financial crisis, debt sustainability, euro area

## Non-technical summary

After the global economic and financial crisis, as well as the euro area sovereign debt crisis, questions about fiscal sustainability in advanced economies have featured prominently in the academic and policy debates. The large debt burden of most sovereigns has weighed on the economic outlook, further complicating the sustainability of public finances in the face of rising age-related payments and the expected trend decline in potential growth.

This paper deals with the topic of fiscal sustainability by employing a so-called "fiscal reaction function" (FRF) to euro area economies (EA-18) for the period 1970–2013. First, we test empirically whether euro area governments abide, on average, by (weak) sustainability constraints, that is, whether they tend to ensure higher budget surpluses when their debt ratio increases. In this part, our focus is to tackle estimation issues such as endogeneity and cross-sectional correlation. Moreover, our dataset is adjusted for government support to the financial sector, which has been sizeable in some cases at the height of the euro area sovereign crisis. This allows us to avoid peaks in primary deficits that would otherwise unduly reflect fiscal loosening and induce high data volatility. Second, we propose a novel concept to investigate fiscal fatigue for euro area sovereigns. This is based on the estimated coefficient of the fiscal reaction function, which can be used to benchmark the realism of primary balance projections in the context of debt sustainability simulations.

As regards the first part of the paper, using various dynamic panel techniques, we find evidence that euro area sovereigns abide, on average, by (weak) sustainability constraints. The primary balance improves by about 0.03–0.05 for every 1 percentage point increase in the debt-to-GDP ratio after controlling for other relevant factors. We show that the FRF estimates are rather robust across various specifications, time periods and exclusion of individual countries. We also conduct a series of country-specific robustness checks and find that responses do not differ to a great extent. As regards other determinants of stronger fiscal positions (higher primary surpluses), we find evidence for political factors (non-election years), improved external positions (support for the twin deficits hypothesis), and lower interest payment burden, inter alia. After controlling for the economic cycle (size of output gap), the positive reaction of primary surpluses to higher debt strengthened over the crisis, which seemed to have acted as a disciplining device compared to the preceding period. We do not find strong evidence for a stable cyclical behaviour (stabilisation) function of fiscal policy across the euro area countries.

The second contribution of the paper consists in proposing a novel approach to measure fiscal fatigue. This simple measure allows to classify countries based on their actual fiscal behaviour with few assumptions. Hence, one can measure the extent of fiscal fatigue for individual euro area countries by comparing the simulated primary balance paths in the context of debt sustainability analyses with countries' track-record, adjusted for the change in debt ratios by the estimated FRF coefficient. If the projected fiscal path, say as an average for a period of 5 or 10 years, is better than the country's performance in the past adjusted for the change in the debt level, then the sovereign may be signalled at risk of fiscal fatigue. Such risk would need to be further investigated to determine more concrete country-specific risks. Illustrative examples for the application of this approach to the euro area countries in our sample are provided in the paper. We also investigate an alternative estimation of the fiscal fatigue hypothesis, that is, a non-linear FRF as proposed in Ghosh et al. (2013), but do not find sufficiently robust support for the euro area sample.

## 1. Introduction

The global economic and financial crisis, as well as the euro area sovereign debt crisis, has brought heightened volatility and uncertainty in recent years. Questions about fiscal sustainability in advanced economies have featured prominently in the academic and policy debates. In particular, the issue of early identification of fiscal fatigue that might be associated with sizeable efforts to restore fiscal sustainability has gained prominence. The large debt burden of most sovereigns, coupled in many cases with high private indebtedness, has weighed on the economic outlook. This mix further complicates the sustainability of public finances in the face of high and rising aging costs and -related pressures on potential growth.

In the empirical literature, a concept inherently related to the operationalization of fiscal sustainability is the fiscal reaction function (FRF), coined in the seminal paper of Bohn (1998). Applied to the US economy, the paper shows that a sufficient condition for sustainability is that the government reacts systematically to increases in government debt by adjusting the primary balance (reducing the deficit or increasing the surplus net of interest payments). However, as pointed out in Ghosh et al. (2013), this condition can be thought of as a *weak sustainability criterion* that does not, for example, rule out a permanently increasing debt-to-GDP ratio. In this way, such a criterion does not take into account the initial debt level (which may be regarded by markets as dangerously high) or the likely bounds to primary surpluses that a country may sustain due to (uncontrolled) institutional or political factors. Nor does it say much on the forward-looking policy that governments may implement to address (or not) sustainability concerns.[3] However, it remains informative on the type of fiscal policy reaction governments did have in the past and helpful in providing signals for potential problems linked to future policies[4]. Generally, studies employing large panels of advanced economies find evidence that governments tend, on average, to meet (such weak) fiscal sustainability constraints.

This paper seeks to estimate a fiscal reaction function for the euro area countries and to derive a simple measure of fiscal fatigue. Our dataset is an (unbalanced) panel of 18 euro area countries over the period 1970–2013, but we also conduct various robustness checks for country and time period sub-samples. Fiscal balance data is adjusted for government support to the financial sector (a specific type of 'one-off items'), which allows us to avoid peaks in primary deficits that would unduly reflect fiscal loosening and induce high data volatility. In this way, we also address the issue of extreme outliers that emerged over the recent years and add to the robustness of our results. In a first step, a simple FRF is estimated to assess whether fiscal policy in the euro area behaved overall in a (weakly) sustainable way. In this part, our focus is to tackle estimation issues such as endogeneity and cross-sectional correlation. Using various dynamic panel techniques, we find evidence that euro area sovereigns abide, on average, by such sustainability constraints. We show that the FRF estimates are rather robust across various specifications, time periods and exclusion of individual countries.

Most importantly, in a second stage, we propose a novel approach to investigate fiscal fatigue for the euro area sovereigns, which gauges a country's capacity to maintain primary surpluses based on its past efforts and the estimated fiscal reaction function. The FRF empirical framework allows quantifying the strength of the feedback from debt to primary balance. The resulting coefficient can in turn be used to benchmark the realism of primary balance projections, which represent key inputs to debt sustainability analysis (DSA). The paper also investigates the risk of fiscal fatigue in the euro area resulting from *non-linear* FRF estimation in the spirit proposed by Ghosh *et al.* (2013).

[3] For a comprehensive debt sustainability analysis framework for the euro area sovereigns, see Bouabdallah et al. (2017).

[4] This reaction can be tested not only with respect to the sustainability objective (the relation between primary balance and debt), but also to the stabilisation function of fiscal policies (e.g., the relation between primary balance and output gap).

The paper is structured as follows. Section 2 reviews the literature and the methodology. Section 3 presents the data and our model. Section 4 discusses the results for the fiscal reaction function, including extensive robustness checks. Section 5 outlines our novel measure to investigate the fiscal fatigue hypothesis, while section 6 concludes. The Appendix includes a comparative summary of literature, a description of data sources and further robustness checks.

## 2. Review of literature and methodology

Complementing the theoretical approach of Blanchard *et al.* (1990) and other more complex sustainability frameworks, Bohn (1998) proposes a simple empirical test of sustainable fiscal policy. This relates the primary balance to the level of debt, with or without conditioning on further controls. It can be written as follows:

$$pb_t = \kappa \cdot d_t + \xi_t, \qquad \text{(eq. 1)}$$

where $pb_t$ is the primary balance in terms of GDP, $d_t$ is the government debt-to-GDP ratio, $\kappa$ is the responsiveness of the primary balance to the debt ratio and $\xi_t$ contains effects of various other determinants of primary balance (such as economic, institutional, etc.) and the error term.

Bohn (2008) shows formally that for an economy to satisfy its intertemporal budget constraint and the so-called no-Ponzi condition, the coefficient $\kappa > 0$ is sufficient provided the present value of GDP is finite and $\xi_t < \infty$ as a fraction of GDP as well. However, as shown in some studies (see, inter alia, Ghosh *et al.* (2013) or Daniel and Shiamptanis (2012)), a positive coefficient $\kappa$ cannot be viewed as sufficient to achieve fiscal sustainability, if there is a limit for positive values of primary balances, for instance, at very high debt levels[5] or if the reaction of financial markets is accounted for (e.g., the increase in the primary balance is not large enough to account for the exploding interest rate-growth differential). In this respect, Ghosh et al. (2013) call Bohn's condition a "weak sustainability condition".

Further issues have been raised in the literature regarding country-specific and cross-country estimation, that is, time and country invariability. Some more recent empirical studies have employed both approaches subject to data availability (see EC, 2016). In general, most *panel* FRF studies tend to find evidence of fiscal sustainability for advanced economies ($\kappa > 0$). The intensity of the reaction (i.e. the size of $\kappa$) varies between 0.01 and 0.10 (country, time, method and estimator-dependent). See table A.1 in the Appendix for a literature review summary.

Analyses of *individual countries* find more mixed results though evidence of "weak" sustainability condition tends to be more prevalent. See, for instance, results for the US in Bohn's studies, for four euro area countries in Legrenzi and Milas (2013), for the majority (9 out of 17) OECD countries in Wyplosz (2005). For Spain, Cuerpo *et al.* (2014) find evidence of sustainability, though with regime variation during the period of investigation (1986–2012). Lukkezen and Rojas-Romagosa (2012) find sustainability concerns for three out of a sample of seven OECD countries using a combination of FRF estimation on very long time series and stochastic debt simulations. On the other hand, Galí and Perotti (2003) find in only five out of eleven euro area countries a positive and statistically significant

[5] An upper limit on the amount of debt that can be repaid creates additional restriction for government policy. An extension of Bohn's approach for a country restricted by fiscal limits using a non-linear fiscal rule is in Shiamptanis (2015). Ghosh *et al.* (2013) and Fournier and Fall (2015) considers the reaction of financial markets in conjunction with fiscal limits.

coefficient on lagged debt in a model using cyclically adjusted primary balance (CAPB) as a way to model the discretionary reaction of fiscal policy.[6]

The FRF literature has more recently focused on the investigation of *non-linear fiscal behaviour* conditional on the level of debt. Specifically, the hypothesis of fiscal fatigue has been tested[7] by means of polynomial (quadratic or cubic) functional forms for the reaction of the primary balance to the debt ratio. In this respect, some studies point to the possibility of fiscal fatigue, meaning that, at very high debt ratios, the fiscal effort must be so large that it becomes untenable. For instance, Ghosh *et al.* (2013) report evidence of fiscal fatigue starting at 90–100% of GDP for a group of 23 advanced (but rather heterogeneous) economies over the period 1970–2007 as a whole. That is, although the primary balance response to debt levels remains positive, it starts declining when the debt ratio reaches around 90–100% of GDP. At even higher debt levels (around 150% of GDP); the reaction of primary balance (the coefficient of the cubic debt term) turns negative. Yet, a shorter time period (1985–2007) leads to a significant loss of significance for the coefficient on lagged debt. Similar results are reported by Medeiros (2012) for a panel of EU countries, with debt thresholds in the range of 80–90% of GDP. However, these results seem to depend on the sample composition (inclusion of one or few high-debt countries) and estimation approach (Fournier and Fall, 2015). This latter study also finds evidence of fiscal fatigue on a sample of OECD (1985–2013) countries using a threshold model, starting around a debt ratio of 120% of GDP with a twist around 170% of GDP (without Japan there is no evidence), while for the Euro area group (15 countries) two thresholds (at 152% and 167% of GDP) are identified. These results seem to be driven by the inclusion of Greece. When Greece is dropped, fiscal fatigue appears at a debt ratio around 120% of GDP.

On the other hand, Legrenzi and Milas (2013) estimate individual non-linear FRFs over the period 1960/70–2012 for four euro area countries most affected by the sovereign debt crisis (Greece, Ireland, Portugal and Spain) and do not find evidence of fiscal fatigue. The reaction of primary balance is made conditional on the size of debt, state of the economy and a measure of financial pressure. The paper concludes that all countries adjust fiscal imbalances only in the higher debt regime (estimated to start at thresholds of 69% of GDP for Greece, 49% for Ireland, 47% for Portugal and 43% for Spain) and that financial market pressure leads all countries to lower the thresholds. Similarly, EC (2011) tests in a panel of EU countries the presence of non-linear debt effects (level above 60% of GDP, quadratic and cubic terms) for the behaviour of CAPB and does not find significant supporting evidence. The paper also verifies fiscal solvency for the panel of EU countries over the period 1975/1980–2010 and confirms a positive relationship between debt and primary balance.

[6] FRF models using CAPB instead of the primary balance generally find similar evidence of sustainability. For instance, Golinelli and Momigliano (2006) estimate FRF in a panel of 19 OECD countries based on ex-post and real-time data on CAPB for 1988–2005(2006). Their results confirm sustainability (in addition to stabilization behaviour) of fiscal policy and a positive effect of fiscal rules. Similarly, Ayuso-i-Casals *et al.* (2007) use CAPB (and primary expenditures) in a panel of 25 EU countries over the period 1990–2005. They find evidence for fiscal sustainability and stabilisation function (in addition to the main finding that the design and coverage of fiscal rules matters).

[7] The notion of fiscal fatigue can be stated as the existence of mean reversion properties in the primary balance, especially for high levels of public debt; see Ghosh *et al.* (2013).

## 3. Model and data

### 3.1. Panel model specification

Our empirical model is an extension of the relationship given by equation 1:

$$pb_{i,t} = \alpha + \varphi pb_{i,t-1} + \kappa \cdot d_{i,t-1} + \sum_{j=1}^{k} \beta_j X_{j,i,t} + \delta_i \,[+\gamma_t] + \epsilon_{i,t}, \qquad \text{(eq. 2)}$$

where $pb_{i,t}$ is the primary balance as a share to GDP and $pb_{i,t-1}$ is its one year-lagged value, $d_{i,t-1}$ is the one year-lagged debt-to-GDP ratio, $X_{j,i,t}$ is a set of various (macro)economic, institutional and political determinants of the primary balance, $\delta_i$ are country fixed effects (complemented in some specifications by time fixed effects, $\gamma_t$); measurement errors and random shocks are captured by the error term $\epsilon_{i,t}$. The coefficient $\kappa$ of interest measures the response of the primary balance to changes in the debt ratio.

The basic model is estimated for a panel of 18 euro area countries[8] over the period 1970–2013 (with various robustness checks for country and time period sub-samples). Naturally, a FRF estimated for one country for a relatively recent period of time would provide an ideal tool for assessing country-specific responses of fiscal policy to changing debt levels and economic environment. However, the number of meaningful observations for only one country (especially for the new member states) is relatively limited. Second, for the purpose of investigating fiscal policy responses, annual data capturing budgetary years are more appropriate than higher frequency data. Third, in our view, it is more meaningful for the purpose of this research to capture common policy responses for the relatively recent past than country-specific ones for very long dated periods, characterised by very different historical conditions. In this view, and given data availability constraints for most euro area countries, we prefer using a panel approach.

### 3.2. Choice of variables

Two main policy variables – the primary balance (PB) or the cyclically-adjusted primary balance (CAPB) – have been employed in the FRF literature as the *dependent variable*. Such a choice obviously highlights the primary focus of a study: models with CAPB estimate the "fiscal effort" directly, while models with PB are connected with the output gap and show the total "fiscal impulse".[9] Given that the primary balance is the "observable" fiscal policy variable, less prone to ex-post revisions (due to output gap and elasticities' uncertainty), and following most studies, we prefer using it as our dependent variable and leave the CAPB for robustness checks.

Regarding the choice for the *determinants of the fiscal position*, our approach is to follow Abiad and Baig (2005), who divide them into three groups: (1) optimizing agent (à la Barro, 1979) that has been subject to scrutiny since Bohn (1998)'s findings of a link between debt and deficits; (2) political economy considerations and (3) broadly defined institutional factors that shape the policy environment and the use of fiscal measures.

[8] All members of the Euro Area as of 2013, i.e. Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Luxembourg, Malta, the Netherlands, Portugal, Spain, Slovakia, and Slovenia. The current 19th member, Lithuania, is not included because of its later entry (in 2015).

[9] See van Riet, ed. (2010) for an exposition of the various concepts related to fiscal balance decomposition. As pointed out in Golinelli and Momigliano (2008), there is basically no difference whether one chooses the dependent variable (CAPB/PB) in first differences or in levels, only the coefficient on the lagged term is different.

Our analysis encompasses variables covering all three groups since each of them determines the willingness and ability of a government to meet sustainability constraints. The core ("Base") FRF model includes the lagged public debt-to-GDP ratio, the lagged primary balance (to account for persistency in fiscal policy), output gap (a proxy for cyclical conditions), current account balance (to control for cross-country spillovers and the hypothesis of twin deficits) and a political risk variable (dummy for election year).[10] Country fixed effects are included to capture all remaining time-invariant country-specific factors that are not explicitly controlled for. Finally, a dummy variable for the effects of the Great Recession (from 2008 onwards) and a time trend to capture common cross-country factors varying over time are also added to the basic model. For a description of the variables used in the extended specifications, see the appendix.

The main *data source* for our analysis is the AMECO database. Our panel is unbalanced because of missing observations at the beginning of our sample and the inclusion of new EU member states, whose time series are generally shorter (usually starting in the early 1990s). As a robustness check, the AMECO primary balance and debt series are extended for the old EU member states back to the 1970s with help of the historical database prepared by Mauro *et al.* (2013) complemented with the other data sources (for details see the Appendix).

### *3.3. Estimation techniques*

Several estimators have been employed in the FRF literature. A particular choice reflects key problems one has to deal with in dynamic panel data setting, especially when a set of potentially endogenous variables has to be treated appropriately. In this paper, our focus is to tackle estimation issues such as endogeneity and cross-sectional correlation.[11]

Even though our panel is dynamic and includes country fixed effects ($\gamma_i$), we start with the fixed effect estimator allowing for the presence of potentially endogenous variables (IV estimation). Being aware of criticisms of its use (the Nickell's bias), we argue that our panel is medium to large in the time dimension compared to the cross-section dimension and the potential bias should be limited ('rule of thumb' based on Bond (2002) states that for cases when $T$ is larger than 20, the potential bias of the FE estimator should be negligible[12]). It has been shown that GMM estimators would not alleviate the problem (see Judson and Owen, 1999).[13] Their asymptotic properties are negatively affected by the dimensions of our panel and they are left for robustness checks. The bias corrected least-square dummy variable (LSDVC) estimator (Bruno, 2005) offers some efficiency for large (time series) panels spanning over 30 years of data and, therefore, it is also used in the robustness section. Haque *et al.* (1999) do not recommend first-differencing in IV cases with time dimension above 20 since it may even result in less efficient estimates.

[10] Evidence of political cycles in a panel of EU countries is also shown in Golinelli and Momigliano (2006).

[11] There is also a potential problem of non-stationarity of some series (primary balance and debt, both in levels and as GDP ratios). This is, however, less acute in a panel setting and can be dealt with based on theoretical grounds (see Bohn, 1998, 2007; Favero and Marcellino, 2005 who state that the intertemporal budget constraint is not violated provided the *x*-th differencing renders the series stationary). In addition, as Betty and Shiamptanis (2013) point out, a scaling of both series by GDP also mitigates (or even eliminates) problems with non-stationarity. Alternatively, one may use panel unit root tests allowing for endogenously generated structural breaks such as Im *et al*. (2005) or Carrion-i-Silvestre *et al*. (2005). Yet, one problem is the relatively high persistence of fiscal series (as pointed out in Bohn, 1998), which makes it rather difficult to arrive at an unambiguous conclusion.

[12] This condition is met both for our large sample (1970–2013) and even for the shortened sample (1991–2013). Nevertheless, it is conditional on the actual panel setting and therefore various estimators are used in the robustness section to show stability and (unbiasedness) of our results.

[13] Celasun and Kang (2006) propose in this context a simple rule based on the main interest of the study. GMM estimators are recommended for testing cyclical sensitivity of fiscal policy variables, FE estimators (LSDV) when tests of intertemporal solvency are performed.

Another problem is the presence of cross-sectional or 'spatial' dependence that may severally affect estimation efficiency and even render some estimators inconsistent (standard difference and system GMM estimators for dynamic panels) unless the unobserved factors are not correlated with the explanatory variables (see Phillips and Sul, 2003). Similarly, standard errors should be treated accordingly to adjust for overoptimistic *t*-statistics and confidence intervals (see Petersen, 2008).[14]

Overall, in the main regressions, we prefer using an IV, FE estimator to avoid endogeneity problems and robust standard errors to deal with heteroscedasticity, serial correlation and cross-sectional dependence. In the robustness section, further estimators are included (*inter alia*, to provide results comparable with the literature). Since in case of weak instruments, the LIML (limited information maximum likelihood) estimator shows better properties in comparison with GMM estimators, it is also used alongside the differenced GMM (Arellano-Bond) estimator (with forward orthogonal deviations that are more suitable for unbalanced panels). In addition, for the sake of comparison with other studies (e.g., Ghosh et al., 2013; Plödt and Richter, 2016), a FE estimator allowing for the error term to follow an AR(1) process and cross-sectional dependence (TPCSE) is employed. As an alternative to mitigate cross-sectional correlation problems,[15] the Driscoll-Kraay estimator is also used. Since our results do not differ substantially, we consider them to have passed the robustness tests (see section 4.3.4).

# 4. Empirical results

## *4.1. Baseline specification and extended models*

In the first step we apply the *Base* specification to the whole EA-18 group and the entire time span (1970–2013) employing our original (non-extrapolated) dataset. As several variables can be affected by endogeneity (and reverse causation), primarily the output gap (both determined and affected by fiscal policy), various suggestions have been used in the literature as to what instruments ought to be employed. Some studies simply work with lagged values; others rely on additional variables or even the GMM approach.[16] Our study uses IV (and as a robustness check GMM estimators) for the output gap, lagged dependent variable (primary balance) and current account (or its alternative). Our instrument set[17] includes second and third lag of the dependent variable; lagged output gap and second

[14] One further possibility would be an estimator with AR(1) correction for serial correlation (applied for example by Ghosh *et al.*, 2013) such as FGLS, which also allows for spatial dependence. Such an estimator works fine for small (balanced) panels. However, Beck and Katz (1995) show that standard errors computed by this method are rather small (overoptimistic estimates). Another possibility is an OLS/Prais-Winstein estimator with the panel-corrected standard errors (PCSEs); however, it assumes strictly exogenous independent variables and for small ratios of $T/N$ produces rather imprecise estimates. In the best scenario of our panel this ratio is around 2.4, which is not far on the way to a large-T panel to guarantee its consistency. In addition, its superiority with respect to the FGLS estimator on the basis of efficiency has been questioned mainly for the $T > N$ case; see Reed and Webb (2010). Therefore, we prefer using an IV, FE estimator and robust standard errors.

[15] A test for the presence of cross-sectional dependence (see Pesaran, 2004) confirms it for all our specifications (longer/shorter time periods).

[16] Some country studies do not report the use of any adjustment, which may cast doubts on their results such as Weichenrieder and Zimmer (2014) or D'Erasmo *et al.* (2015).

[17] Ayuso *et al.* (2008) use a proxy for international influences (export-weighted output gap of three major export markets of each country). EC (2011) works with trend output gap and adds the contemporaneous US output lag, while Plödt and Richter (2014) use output gap instrumented with lagged output gap and potential GDP growth corrected for real GDP growth as instruments (trend GDP as robustness) and lagged debt. Neither combination was possible in our case since Hansen/Sargan test and also first stage results showed violation of assumptions for these combinations of instruments. Because of problems with output gap calculations, Berti *et al.* (2016) use the second and third lag of primary balance and debt. Baldi and Staehr (2016) work with GDP growth rates only.

and third lag of a proxy for output gap ($\frac{Y_{t-1}^{P}}{Y_{t}^{P}} - \frac{Y_{t-1}}{Y_{t}}$, following Plödt and Richter, 2016), as well as the first and second lag of the current account, unless specified differently. This *Base* model performs well in various robustness tests such as the Kleibergen-Paap test (a test for weak instruments[18]) or Sargan/Hansen test (overidentifying restrictions). Moreover, the explanatory power of the *Base* model (and of its derivations) is very good (above 0.70 as measured by the goodness of fit statistics). In this model (see Table 1, first result column), the estimated FRF coefficient of interest (the response to the debt ratio) amounts to 0.034. The model *Base A* shows results for the basic specification with time fixed effects, while in the model *Base B* the output gap was replaced with the real GDP growth rate (instrumented with its second and third lag following Baldi and Staehr, 2016). The FRF coefficient is slightly lower in these two specifications and remains highly statistically significant.

Turning to the other variables included in our basic specification, the responses of the primary balance are, overall, highly statistically significant and have the expected sign. Somewhat surprising, while the output gap coefficient is generally positive, it is not found statistically significant (only in robustness checks for shorter time periods). This result is similar to other recent studies, such as Berti et al. (2016). On the other hand, the real GDP growth is positive and highly statistically significant. Election years have, on average, a negative effect on fiscal positions. The positive coefficient of the current account balance underpins the twin-deficit hypothesis. Rather high and positive values of the lagged dependent variables indicate persistence in fiscal policy. The dummy for the effects of the crisis is negative and highly statistically significant, pointing to deteriorating fiscal positions compared to earlier periods. Finally, since the estimated value of the constant term is negative and significant, the implication from these models is that the euro area debt-to-GDP ratio is to stabilise at a positive value in the long run.[19]

The remaining columns of Table 1 present a first set of robustness checks of our basic specification by adding one variable at a time, as often used in the literature. Such a variable set includes: a proxy for openness (sum of exports and imports), inflation, consumption smoothing (in the spirit of Barro, 1979), political stability and fiscal rules (additional institutional factors), and financial markets (represented by various specifications of interest payments). Columns *mf* and *mf1* show results for models with all these variables, with and without time fixed effects. Finally, we also investigate the effects on the debt response of the financial crisis (model m7) and of other important events over the period of monetary integration (model m8 includes a Euro dummy, being one for all years after euro introduction in individual countries, and its interaction with debt; in a similar model, not shown in Table 1, the euro dummy is replaced with a dummy equalling one for the EMU period, i.e. as of 1999 onwards for all countries).

In all specifications, including the full models, the lagged debt ratio remains statistically significant, with a coefficient ranging between 0.031 and 0.041 when interest payments are included. There are no substantial changes in sign or significance level for the estimated effects of the other baseline determinants either. As regards the added explanatory variables, higher interest payments - as a ratio of lagged debt, current GDP or total revenues (the first one only shown in model m6 of Table 1) - seem to have a (residual) negative impact on the capacity of governments to maintain higher primary surpluses (after controlling for the debt level). This is in line with findings in Debrun and Kinda (2013) on the "squeezing feeling" of the interest burden. Similarly, the cyclical component of

[18] Our models are also tested using Anderson-Rubin Wald test and Stock-Wright LM S statistics for weak-instrument-robust inference (not reported due to space considerations).

[19] An estimated value can be calculated based on an estimate of the real interest rate and real economic growth. In addition, since our estimate of the government response in table 1a is the short-run response ($\hat{\kappa}$), the long-run value ($\hat{\kappa}_{LR}$) can be calculated as shown in Chudik *et al.* (2015): $\hat{\kappa}_{LR} = \frac{\hat{\kappa}}{1-\hat{\varphi}}$, where $\hat{\varphi}$ is the estimate of the lagged dependent variable for the model Base A; the long-run response is equal to 0.0783.

government consumption, used in several FRF studies to capture stabilising effects of fiscal policy, is found to limit primary surpluses.[20] At the same time, stronger government stability[21] or the existence of a fiscal rule,[22] though leading to better fiscal positions, are not found to be significant at standard levels. In the combined models (*mf–mf1*), the debt response remains broadly unchanged (somewhat lower in the model without time fixed effects).

**Table 1: Basic model and extended specifications, EA-18, 1970–2013**

| | **Base** | Base A | Base B | m1 | m2 | m3 | m4 | m5 | m6 | mf | mf1 | m7 | m8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Lagged primary balance* | 0.566*** | 0.716*** | 0.608*** | 0.626*** | 0.566*** | 0.504*** | 0.567*** | 0.510*** | 0.589*** | 0.517*** | 0.635*** | 0.581*** | 0.558*** |
| | [0.059] | [0.046] | [0.042] | [0.057] | [0.059] | [0.066] | [0.059] | [0.064] | [0.056] | [0.072] | [0.064] | [0.056] | [0.058] |
| ***Lagged debt*** | **0.034*** ** | **0.029*** ** | **0.030*** ** | **0.038*** ** | **0.037*** ** | **0.038*** ** | **0.031*** ** | **0.037*** ** | **0.041*** ** | **0.035*** ** | **0.028*** ** | **0.029*** ** | **0.030*** ** |
| | **[0.006]** | **[0.006]** | **[0.006]** | **[0.007]** | **[0.007]** | **[0.008]** | **[0.006]** | **[0.007]** | **[0.006]** | **[0.007]** | **[0.006]** | **[0.006]** | **[0.006]** |
| *Output gap* | 0.072 | 0.076 | | -0.072 | 0.072 | 0.13 | 0.061 | 0.107 | 0.058 | 0.08 | 0.03 | 0.095 | 0.100 |
| | [0.071] | [0.070] | | [0.058] | [0.073] | [0.083] | [0.069] | [0.080] | [0.064] | [0.075] | [0.076] | [0.069] | [0.074] |
| *Current account* | 0.157*** | 0.156*** | 0.101*** | | 0.152*** | 0.178*** | 0.128** | 0.166*** | 0.150*** | 0.138*** | 0.143*** | 0.173*** | 0.175*** |
| | [0.054] | [0.042] | [0.036] | | [0.055] | [0.057] | [0.055] | [0.058] | [0.047] | [0.052] | [0.044] | [0.056] | [0.058] |
| *Election dummy* | -0.448*** | -0.546*** | -0.489*** | -0.447*** | -0.451*** | -0.399** | -0.404*** | -0.437*** | -0.511*** | -0.402*** | -0.468*** | -0.445*** | -0.435*** |
| | [0.155] | [0.142] | [0.134] | [0.157] | [0.156] | [0.160] | [0.155] | [0.160] | [0.142] | [0.151] | [0.147] | [0.154] | [0.154] |
| *Crisis dummy (2008+)* | -1.884*** | -1.951*** | -0.368 | -2.250*** | -1.942*** | -1.998*** | -1.710*** | -1.912*** | -1.199*** | -0.944*** | | -3.064*** | -1.867*** |
| | [0.364] | [0.582] | [0.420] | [0.379] | [0.364] | [0.433] | [0.349] | [0.406] | [0.286] | [0.346] | | [0.570] | [0.365] |
| *GDP growth* | | | 0.350*** | | | | | | | | | | |
| | | | [0.087] | | | | | | | | | | |
| *Openness* | | | | 0.013** | | | | | | | | | |
| | | | | [0.006] | | | | | | | | | |
| *Lagged GDP deflator growth* | | | | | 0.035 | | | | | 0.021 | 0.02 | | |
| | | | | | [0.040] | | | | | [0.036] | [0.038] | | |
| *Lagged IMF fiscal rule* | | | | | | 0.342 | | | | 0.476 | 0.474 | | |
| | | | | | | [0.402] | | | | [0.344] | [0.534] | | |
| *Gov't. consumption exp.* | | | | | | | -0.078*** | | | -0.067** | -0.037 | | |
| | | | | | | | [0.027] | | | [0.029] | [0.026] | | |
| *Government stability* | | | | | | | | 0.078 | | 0.01 | 0.023 | | |
| | | | | | | | | [0.051] | | [0.051] | [0.064] | | |
| *Interest payments* | | | | | | | | | -0.156*** | -0.153*** | -0.089*** | | |
| | | | | | | | | | [0.021] | [0.027] | [0.027] | | |
| *Crisis*debt* | | | | | | | | | | | | *0.022**** | |
| | | | | | | | | | | | | *[0.007]* | |
| *Euro dummy* | | | | | | | | | | | | | -0.672 |
| | | | | | | | | | | | | | [0.449] |
| *Euro*debt* | | | | | | | | | | | | | 0.014** |
| | | | | | | | | | | | | | [0.006] |
| *Year* | -0.005 | | -0.005 | -0.005 | 0.004 | -0.002 | -0.004 | 0.002 | -0.02 | -0.042* | | -0.012 | -0.017 |
| | [0.015] | | [0.012] | [0.016] | [0.018] | [0.029] | [0.015] | [0.019] | [0.013] | [0.025] | | [0.014] | [0.020] |
| *Constant* | -1.125** | -0.307 | -1.939*** | -2.440*** | -1.605** | -1.782** | -1.027** | -2.225*** | -1.042** | -0.623 | -2.754*** | -0.705 | -0.700 |
| | [0.490] | [0.559] | [0.470] | [0.549] | [0.786] | [0.873] | [0.478] | [0.771] | [0.453] | [1.020] | [1.014] | [0.484] | [0.548] |
| Observations | 431 | 431 | 455 | 431 | 431 | 378 | 431 | 392 | 429 | 378 | 378 | 431 | 431 |
| R-squared | 0.72 | 0.807 | 0.758 | 0.711 | 0.722 | 0.726 | 0.731 | 0.722 | 0.766 | 0.774 | 0.82 | 0.731 | 0.726 |
| Country FE | yes | yes | yes | yes | yes | yes | Yes | yes | yes | yes | yes | yes | yes |
| Time FE | no | yes | no | no | no | no | No | no | no | no | yes | no | no |
| Kleibergen-Paap LM st | 35.110 | 36.260 | 24.540 | 30.030 | 33.970 | 29.000 | 34.720 | 31.550 | 38.610 | 33.130 | 28.300 | 36.260 | 36.150 |
| Kleibergen-Paap p-val | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen test | 7.264 | 4.353 | 3.184 | 6.430 | 7.437 | 7.683 | 6.621 | 6.484 | 6.565 | 6.789 | 3.694 | 7.841 | 7.881 |
| Hansen p-val | 0.123 | 0.360 | 0.364 | 0.169 | 0.115 | 0.104 | 0.157 | 0.166 | 0.161 | 0.147 | 0.449 | 0.098 | 0.096 |

*Source: own calculations. Notes: P-value: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Country fixed effects and time fixed effects are not reported, robust standard errors. The null of Kleinbergen-Paap LM test is that instruments are weak.*

As regards the events over the monetary union period, we find evidence for a significant, positive effect of the crisis on the response of fiscal policy to debt. The FRF coefficient almost doubles over the crisis (the estimated coefficient of the interaction term between the crisis dummy and the debt ratio is 0.022, while the coefficient of the debt variable, denoting now the response before the crisis, declines to 0.029).

[20] See Bohn (1998) or Mendoza and Ostry (2008) for further details.

[21] We also use other variables for political factors such as total risk rating or political risk rating (from the PRSG database) and find similar conclusions.

[22] As measured by a dummy based on the IMF fiscal rule database. Results for an alternative index (FRI) from the European Commission are less robust (FRI is statistically significant only in certain models, result that can be due to the relatively short time span of the index). In general, effects of variables capturing fiscal rules are rather mixed in the literature (subject to period and country composition, see for example Debrun *et al.*, 2008; Escolano *et al.*, 2012; EC, 2011).

The evidence with respect to the effect of the EMU creation or the euro introduction is more mixed. While the interaction terms between the respective dummies and the debt ratio are also found to be statistically significant and have a positive sign for the whole sample, these results may mask the crisis effects. When the sample is restrained to the period before the crisis (1970-2007), the interaction terms generally lose significance.

The appendix includes a robustness check (Table A.2) with respect to the choice of the dependent variable (CAPB instead of PB) and the length of fiscal series (based on the use of extrapolated series, especially for the "old" member states, as opposed to original, shorter series). The response coefficient of the lagged debt is similar with that using extrapolated series (0.027 for the *Base* model, *am0*), while when CAPB is employed the coefficient is lower in the *Base* model (0.006), but increases in other models (e.g., to 0.027 when real growth instead of output gap is used).

### *4.3. Further robustness tests*

#### *4.3.1. Period effects*

In the robustness checks, we first focus on a *period effect* since studies in the literature have shown a varying impact of some variables over time. Further to the interaction models discussed in the previous section, to test for a change in fiscal policy responses we break the sample into several sub-periods, with and without the years of financial crisis (from 1970, 1985 or from 1991, just before the signature of the Maastricht treaty).[23] In general, the primary balance response to debt for the periods that include the crisis years is larger than for periods excluding the crisis. See Table A.3 in the Appendix. The reaction coefficient of the*Base* model remains broadly unchanged, with an increase for the period after the Maastricht treaty (from 0.034 to 0.046). Yet, this increase seems to be mainly determined by the crisis period since the change in the FRF coefficient is much lower when the crisis is excluded (from 0.025 to 0.027). These results should be interpreted with some caution because of shorter data timespans (also indicated by the IV tests, especially in models *m22* and *m33*). The output gap becomes (marginally) significant (and remains positive) for models without the crisis. In addition, it turns significant for the entire period in model *m2* (1985-2013).

#### *4.3.2. Country effects*

Next, we analyse *the country dimension* of fiscal responses for subgroups of EA18 members. In case of the first subgroup, consisting of the 12 "old" EA members (EA12) or when Greece (the country with the highest average debt ratio) or/and Luxembourg (lowest debt ratio) are excluded, FRF responses are only marginally smaller, for both the entire period (1970–2013) and for the periods without the financial crisis years. Similar results are found when the Maastricht period (1991–2013) is considered. See Table A.4 in the Appendix. Regarding other variables, the output gap turns again significant in the smaller samples. Otherwise, there are no major changes in the significance or signs of individual variables.

Subsequently, we examine the issue of panel heterogeneity and control more extensively for potential outliers by running the basic specification while omitting one country at a time. Albeit there is some variability in the FRF coefficient, the differences are rather small. The statistical significance of the

[23] Because of the relatively short period since the launch of the Euro, we do not show estimates for a model covering only the post-EMU period (1999 onwards, that is, only 15 years) since results may be subject to severe bias.

debt coefficients remains unaffected by country exclusions and the size hovers around 0.03-0.04.[24] See Figure A.1 in the Appendix.

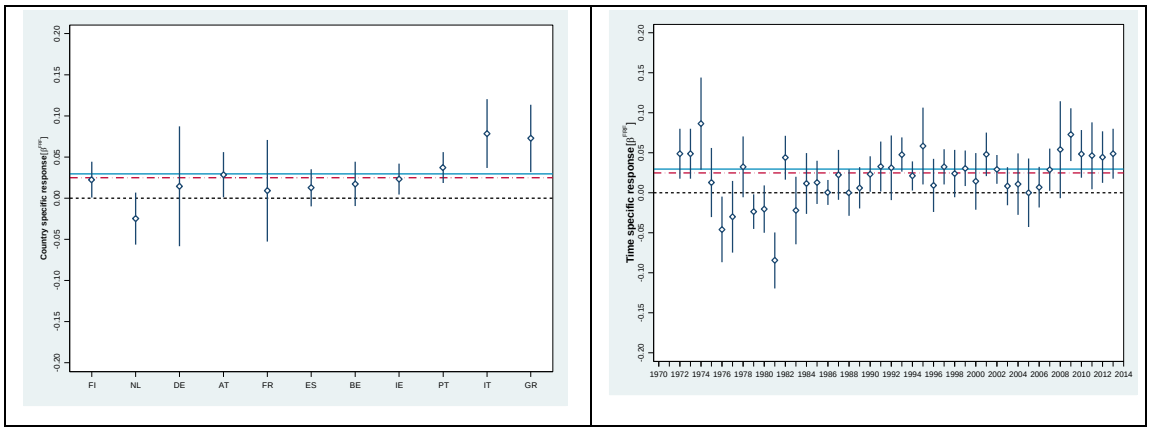
### *4.3.3. Further tests for country and period effects*

To see how robust our average estimates of FRF are two further checks are carried out. They take the form of a simple decomposition based on the "random coefficients model" over both panel dimensions (cross-section and time). For that purpose a country or a time dummy is interacted with the debt variable and our model in equation (2) is estimated with each of these additional terms.[25] In order to gain robustness, the whole exercise is carried out employing our extended data set.

We focus on the narrow group of "old" euro area members, with comparable series (same length for all countries, i.e., the EA-12 group without Luxembourg). Based on this exercise, there seems to be some evidence for a link between average response and debt ratios (low indebted countries with low responses vs. highly indebted ones with larger responses despite not being significant for some members). With the exception of the Netherlands, the other countries show positive FRF responses. Finland, Austria, Ireland have estimated responses below or close to the EA-11 average (the FRF coefficient is not significant for Germany, France, Spain, and Belgium), while Portugal and especially Greece and Italy show larger response coefficients compared to the EA average.

***Figure 1: Fiscal responses by country and by year, EA-11 countries, 1970–2013***

a) Country variation, EA-11 b) Time variation, EA-11




*Note: country ordering based on the 2013 debt level values. Blue line stands for EA-11 average response with a linear time trend, red dashed line for average response with time fixed effects (all EA11 countries and for all years). The black dotted line indicates the null response. Whiskers around point estimates (diamonds) represent the 95% confidence intervals. Source: own calculation.*

When considering the other dimension (time), there seems to be a great deal of variation in the 1970's and early 1980's, and then during the crisis. A closer inspection of the figure (and estimates) reveals

[24] We also carried out a test of homogeneity of the FRF coefficients based on a modification of the equation (2):

$$pb_{i,t} = \alpha + \varphi pb_{i,t-1} + \kappa \cdot d_{i,t-1} + \kappa_i \cdot d_{i,t-1} + controlvar_{i,t} + \delta_i + \vartheta_{i,t},$$

where $\kappa_i$ is the dummy for a country $i$, $\kappa$ and $\kappa_i$ are to-be-estimated panel (euro area average) and country-specific slope coefficients, the remaining variables have the same interpretation as those in the equation (2). After having estimated this equation by country, a test of similarity of both coefficients was carried out (the null: $(\hat{\kappa} - \hat{\kappa}_i) = 0$). Since there are no observations for all countries and all debt-to-GDP ratios, following Ghosh *et al.* (2013), we estimate this equation for the debt ratios between 30–100% of GDP (without Estonia, Latvia, Luxembourg, and Slovenia). The null was rejected at 5% level for three countries: France, Ireland and the Netherlands, but for none belonging to the narrower group of "programme countries". Detailed results are available upon request.

[25] The model specified in equation (3) includes a set of additional terms ("interactions") with the debt variable for all EA countries [panel a)] and/or years [panel b)] and one country/one period is selected as the reference country/year [$r$]: $\delta_i \cdot d_{i,t-1}\ \forall_{i,i\neq r}$ or $\gamma_t \cdot d_{i,t-1} \forall_{t,t\neq r}$. This model is similar to the random coefficient model in case of the IV FE estimator.

some ‘turning points’ that indicate changes in government responses over our sample period. However, they are not significant at standard levels (some of these turning points are, however, found significant in the non-parametric time-varying estimation).

Overall, these country-specific results should be taken with caution, because of the medium time dimension of our panel and the caveats of the method (simple linear interactions with respect to a base country/year in case of country- and time-specific responses. Mainly for the latter, this method lacks the flexibility that is associated with a Bayesian style time-varying parameter estimations (full model specification, such as in Cuerpo (2014) for the Spanish public finances).

#### *4.3.4. Choice of estimators*

As already introduced in section 3.3., we also test the robustness of our results by employing a battery of estimators to gauge any potential biases in our estimates compared to the base estimator (FE IV). See Table A.5 in the Appendix. Regarding our variable of interest, the debt ratio remains highly statistically significant across estimators (except for the simple Arellano-Bond GMM estimator). In terms of economic significance, the FRF coefficient estimated with pooled OLS is viewed as a (quasi)-lower bound (0.010 in our case). Leaving aside the pooled OLS results, relatively low FRF coefficients are found with the corrected least-squares dummy variable estimator (LSDVC) and LIML and two-step GMM estimator with time effects (0.031 and 0.033 respectively). On the other hand, an upper bound (0.064) is given by the Arellano-Bond (difference) GMM estimator, when orthogonal deviations are used. Such an estimate seems to lie near the upper interval for EU/EA countries (see the literature survey in the Appendix or a short summary in Berti et al., 2016). Regarding the other explanatory variables, they largely keep their levels of significance and signs.

#### *4.3.5. Other robustness checks*

Two further robustness checks are carried out and shown in appendix. First, we investigate the effects of fiscal rules (table A.6 in appendix). The inclusion of a proxy for fiscal institutions in a broad sense is associated with a reduced sample size since most of them are not available before 1990 (or 1985). While the impact on the FRF coefficient is rather small, the effects of the fiscal rules themselves are not found statistically significant. For example, the EU FRI index (perhaps owning to its limited availability before 1990 or its specific construction) leads only to a significant response of the output gap, while the variable itself remains insignificant. Similarly, the overall IMF fiscal rule dummy and its four subcomponents are not found to have a statistically significant effect on the primary balance. These results seem to confirm previous findings in the more recent literature (see Ayuso-i-Casals *et al.*, 2007; Cordes et al., 2015).

Second, we investigate the effects of broadly defined political institutions (such as from the *Political Risk Services Group*, PRSG, and IMF; see description in Table A.8 of the Appendix). These variables are not found statistically significant for our group of countries with the exceptions of the election dummy and total risk rating variable. One reason can be rather highly developed political systems, whose differences are hardly detectable by this type of soft-data comparable across a world sample.

## 5. Fiscal fatigue

In this section, first, we propose a novel approach to measure fiscal fatigue (FF) building on the linear FRF. In turn, we investigate the fiscal fatigue hypothesis across euro area countries using a non-linear approach. So far, the concept of fiscal fatigue based on a FRF has been investigated in the literature

mainly using a non-linear (cubic) function in line with Ghosh *et al.* (2013). In related fields, the empirical evidence on the capacity of sovereigns to maintain high primary surpluses is rich (see Eichengreen and Panizza, 2014, for a recent study).

### *5.1 Detecting fiscal fatigue – the linear case*

In the *linear FRF literature*, a sufficient condition for sustainability is that the primary balance ratio improves when the government debt ratio increases. However, large increases in primary surpluses and, especially maintenance of such surpluses over long periods of time, are constrained by a multitude of economic, institutional and political factors denoting fiscal fatigue. The linear FRF literature provides the size of the estimated coefficient for the reaction of the primary balance to debt. This can be used to calculate upper limits for the primary surpluses that a country can maintain and thus provide a useful input for debt sustainability analyses (DSA). For instance, a central question in DSA exercises is the size of the needed primary balance to stabilise the debt ratio or bring it below a certain threshold by the end of the simulation horizon. The resulting primary balance can be evaluated against the risk of fiscal fatigue by comparing it with the country's historical track-record. If the simulated primary surplus is above the average or, even worse, above some maximum primary balance maintained in the past (call it "Benchmark", B), then the government may be at risk of fiscal fatigue. However, governments may have maintained a relatively low fiscal surplus in the past given a low debt level. An increase in the debt level (due, for instance, to a crisis) would improve the fiscal effort if the respective government is to obey by sustainability constraints. To calculate such an upper limit for the fiscal fatigue, an estimated linear FRF coefficient *(k)* can be used. For instance, taking a prudent coefficient of 0.04 based on our analysis of the euro area FRF, any 10 percentage point increase in the debt ratio (ΔD) would add 0.4 percentage point to the primary balance. The "adjusted primary balance Benchmark" ($B_{adj}$) would then be derived as follows:

$$B_{adj} = B + k*(\Delta D) \qquad \text{(eq. 3)}$$

One could assign for instance a risk score (and a heat map) for fiscal fatigue as follows:

- Low risk *(L)* if the simulated primary balance (say average over 5 or 10 years during the DSA horizon) is lower than the benchmark B of the recent past;
- Medium risk *(M)* if the simulated primary balance is above the past benchmark, but below the benchmark adjusted with the FRF coefficient for the increase in the debt level ($B_{adj}$);
- High risk *(H)* if the simulated primary balance is above the debt-adjusted benchmark ($B_{adj}$).

An example for the application of the linear FRF-based fiscal fatigue criterion to the euro area countries (EA-18), based on the DSA data from IMF documents (mostly Art. IV reports), is shown in Table 2. The risk of fiscal fatigue taking as a benchmark the average fiscal performance over the monetary union period (the average primary balance net of support to the financial sector for the period 1999-2013) and an adjustment FRF coefficient of 0.04 is shown in column 8. According to this measure, from the perspective of their past track-record and an average fiscal reaction function, more than half of our EA-18 sample (10 countries) would be signalled in DSA simulations at high risk of fiscal fatigue. Results would remain unchanged if the FRF coefficient of our *Base* model (0.034) or the lower and upper bounds of its 95% confidence interval (0.022 and, respectively, 0.046) would be used instead. See columns 8.1-8.3. Results would change (to lower risks) for three countries (highlighted in column 8.4) if the upper bound estimator (0.064, difference AB) were used.

## Table 2: An application of the linear FRF-based fiscal fatigue criterion: 1999-2013 benchmark

| Country | Average 1999–2013 | | Average 5 year DSA simulations (latest IMF DSA) | | Risk of fiscal fatigue: Adjustments with FRF coefficient of 0.04 | | | | Risk of fiscal fatigue - alternative FRF coefficients: | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PB *(B)* | Debt | PB | Debt | Change in debt | Adj. in PB | Max PB ($B_{adj}$) | **Risks: Comparison with DSA sim** | 0.034 | 0.022 | 0.046 | 0.064 |
| | 1 | 2 | 3 | 4 | (5 = 4 – 2) | (6 = 5*0.04) | (7 = 1 + 6) | **8 (3 vs. 1 & 7)** | 8.1. | 8.2. | 8.3. | 8.4. |
| AT | 0.82 | 71.4 | 1.40 | 74.5 | 3.1 | 0.12 | 0.94 | **H** | H | H | H | H |
| BE | 2.96 | 100.6 | 0.74 | 104.1 | 3.5 | 0.14 | 3.10 | **L** | L | L | L | L |
| CY | -0.35 | 62.3 | 2.24 | 116.5 | 54.2 | 2.17 | 1.82 | **H** | H | H | H | M |
| DE | 0.83 | 67.6 | 1.92 | 66.0 | -1.6 | -0.06 | 0.77 | **H** | H | H | H | H |
| EE | 0.48 | 5.9 | 0.50 | 6.9 | 1.0 | 0.04 | 0.52 | **M** | M | M | M | M |
| ES | -0.70 | 55.6 | -0.32 | 97.5 | 41.9 | 1.68 | 0.98 | **M** | M | M | M | M |
| FI | 3.57 | 42.9 | -0.90 | 60.9 | 18.0 | 0.72 | 4.29 | **L** | L | L | L | L |
| FR | -0.95 | 70.6 | 0.16 | 93.0 | 22.4 | 0.90 | -0.05 | **H** | H | H | H | M |
| GR | -2.08 | 121.9 | 2.60 | 168.1 | 46.2 | 1.85 | -0.24 | **H** | H | H | H | H |
| IE | -0.51 | 54.8 | 2.08 | 103.2 | 48.5 | 1.94 | 1.43 | **H** | H | H | H | M |
| IT | 1.88 | 108.4 | 2.30 | 130.0 | 21.7 | 0.87 | 2.74 | **M** | M | M | M | M |
| LU | 2.12 | 12.0 | 0.00 | 38.5 | 26.5 | 1.06 | 3.18 | **L** | L | L | L | L |
| LV | -1.54 | 22.4 | 0.10 | 36.4 | 14.0 | 0.56 | -0.98 | **H** | H | H | H | H |
| MT | -0.78 | 66.3 | 1.40 | 67.2 | 0.9 | 0.04 | -0.74 | **H** | H | H | H | H |
| NL | 0.63 | 53.8 | -0.68 | 68.4 | 14.6 | 0.58 | 1.21 | **L** | L | L | L | L |
| PT | -2.01 | 77.0 | 1.70 | 123.4 | 46.5 | 1.86 | -0.15 | **H** | H | H | H | H |
| SI | -1.36 | 33.2 | -0.34 | 84.3 | 51.1 | 2.04 | 0.68 | **M** | M | M | M | M |
| SK | -2.86 | 41.5 | 0.64 | 51.8 | 10.3 | 0.41 | -2.45 | **H** | H | H | H | H |

*Notes: PB denotes primary balance (adjusted for the government support to the financial sector, GAFS); both PB and debt as % of GDP. Max PB ($B_{adj}$) denotes the debt-adjusted primary balance benchmark (see eq. 3). DSA simulated PB and debt are taken from IMF Article IV reports and similar materials, as available online, up to August 2015. In column 8, the FF risk categories (L, M, H – low, medium, high risks) are described in the text (see eq. 3). Source: own calculations*

## Table 3: Alternative applications of the linear FRF-based fiscal fatigue criterion

| Country | 10-year average 1999-2008 | | Risk of fiscal fatigue: Adjustments with FRF coefficient for period before crisis (0.029) | | | | Risk of fiscal fatigue: Adj. with signif. country-specific FRF coefficients (avg. 0.03 for the rest) | | |
|---|---|---|---|---|---|---|---|---|---|
| | PB *(B)* | Debt | Change in debt | Adj. in PB | Max PB for DSA sim. | **Risks: Comparison with DSA sim** | Adj. in PB | Max PB for DSA sim. | **Risks: Comparison with DSA sim** |
| | 1' | 2' | (5' = 4 - 2') | (6' = 5'*0.029) | (7' = 1' + 6') | 8' (3 vs. 1' & 7') | (6'' = 5'*k) | (7'' = 1' + 6'') | 8'' (3 vs. 1' & 7'') |
| AT | 1.19 | 66.4 | 8.1 | 0.23 | 1.42 | **M** | 0.22 | 1.40 | **M** |
| BE | 4.68 | 99.8 | 4.2 | 0.12 | 4.80 | **L** | 0.13 | 4.80 | **L** |
| CY | 0.88 | 57.7 | 58.8 | 1.71 | 2.59 | **M** | 1.77 | 2.65 | **M** |
| DE | 0.78 | 62.5 | 3.5 | 0.10 | 0.88 | **H** | 0.11 | 0.88 | **H** |
| EE | 0.78 | 5.0 | 1.9 | 0.06 | 0.84 | **L** | 0.06 | 0.84 | **L** |
| ES | 2.02 | 47.3 | 50.2 | 1.46 | 3.47 | **L** | 1.51 | 3.52 | **L** |
| FI | 5.77 | 39.8 | 21.1 | 0.61 | 6.39 | **L** | 0.49 | 6.26 | **L** |
| FR | 0.15 | 63.1 | 29.9 | 0.87 | 1.01 | **M** | 0.90 | 1.04 | **M** |
| GR | -1.26 | 104.6 | 63.5 | 1.84 | 0.58 | **H** | 4.76 | 3.50 | **M** |
| IE | 2.12 | 32.4 | 70.9 | 2.05 | 4.18 | **L** | 1.63 | 3.75 | **L** |
| IT | 2.37 | 102.9 | 27.2 | 0.79 | 3.16 | **L** | 2.17 | 4.55 | **L** |
| LU | 2.95 | 8.0 | 30.5 | 0.89 | 3.83 | **L** | 0.92 | 3.86 | **L** |
| LV | -1.26 | 12.8 | 23.5 | 0.68 | -0.58 | **H** | 0.71 | -0.55 | **H** |
| MT | -1.19 | 65.3 | 1.9 | 0.06 | -1.13 | **H** | 0.06 | -1.13 | **H** |
| NL | 2.09 | 49.6 | 18.8 | 0.55 | 2.64 | **L** | -0.47 | 1.62 | **L** |
| PT | -1.39 | 60.8 | 62.6 | 1.82 | 0.42 | **H** | 1.57 | 0.17 | **H** |
| SI | -0.36 | 25.3 | 59.0 | 1.71 | 1.35 | **M** | 1.77 | 1.41 | **M** |
| SK | -2.44 | 39.4 | 12.4 | 0.36 | -2.08 | **H** | 0.37 | -2.07 | **H** |

*Notes: Columns 3 and 4 as in Table 2. Highlighted cells show differences in risk assessment compared to column 8 Table 2.*

Alternative (less stringent) applications of the fiscal fatigue criterion refer to the chosen benchmark for the primary balance track-record (see Table 3). If the crisis years are broadly excluded from the benchmark (i.e., only the average primary balance over a 10 year-period, 1999-2008, is considered) and the FRF coefficient from model m7, table 1 (0.029) is used for the adjustment, then the upper adjusted PB benchmark increases and the risk assessment improves in several countries (7 countries, highlighted in column 8, Table 3). Such less stringent assessment would be justified by the normalisation of the economic conditions and a low probability of a crisis revival. This setup is likely more suitable for a DSA baseline, while the one in Table 2 may be considered for DSA risk scenarios.

Though less accurate estimates, the use of the statistically significant country-specific FRF coefficients (as per Figure 1.a and related text[26]) instead of the common panel coefficient would not change significantly the risk assessment. See second panel of Table 3. Only for Greece, the risk of fiscal fatigue would change (would be lower to medium risk). For countries with large increases in the debt ratio, such as Greece, the size of the FRF coefficient plays a more sizeable role. According to this model, the upper limit of the primary balance benchmark for DSA simulations ($B_{adj}$) would be around 0.6% of GDP at an average (common) FRF of 0.04, but it would increase to 3.5% of GDP if a country-specific FRF coefficient of about 0.075 were to be used.

The debt-adjusted benchmark based on the linear FRF can be complemented with upper sustainable limits suggested in other empirical literature strands, for instance, the primary surplus threshold of 4% of GDP in Eichengreen and Panizza (2014). Overall, the results of such analysis (here for illustrative purposes), can serve as a basis for further investigation of the fiscal fatigue hypothesis in the context of debt sustainability analyses.

### *5.1 Non-linear estimation of FRF*

Turning to the *non-linear FRF*, this section aims to investigate the existence of a non-linear link between primary balance and debt ratios. First, our focus is to test the fiscal fatigue hypothesis in line with Ghosh *et al.* (2013) using our euro area dataset. In this case, the model to estimate extends the specification in eq. (2) simply by adding lagged polynomial terms of public debt. The cubic specification below is only one particular form to capture a non-linear behaviour and we also explore a modification that includes only squared lagged debt term:

$$pb_{i,t} = \varphi pb_{i,t-1} + \beta_0 d_{i,t-1} + \beta_0' d_{i,t-1}^2 + \beta_0'' d_{i,t-1}^3 + \sum_{j=1}^{k} \beta_j X_{i,j,t} + \delta_i [+\gamma_t] + \omega_{i,t}, \quad \text{(eq.4)}$$

where the variable definitions are as per equation 3 (measurement errors and random shocks are captured by the error term $\omega_{i,t}$).

The results for the entire period 1970–2013 (using the original, not-extended dataset) are presented in Table A7 of the appendix. These models are divided into two groups. The first, labelled *Base,* presents results for our specification and the Ghosh et al. (2013)'s base specifications estimated with our data. The second, labelled *Extended*, presents ours and Ghosh at al.'s extended specification. Both groups include non-linear (quadratic and cubic) debt terms, as follows: *IV FE ff0a* includes not only nonlinear terms but also the lagged dependent variable (DV), while IV FE ff1 excludes the lagged DV, as in the Ghosh's models. All models are estimated with IV estimators: FE IV as in our basic models and two-stage PCSE estimator correcting for serial correlation and cross-sectional

[26] For the EA-11 countries whose coefficient was found statistically significant; for the remaining EA-18 countries, the average FRF coefficient (0.03) is used instead.

dependence with panel specific AR(1) type error term. Our *Base* results do not indicate fiscal fatigue (significance and/or signs), either for our Base specification or for the Ghosh's models. The signs and levels of significance for other variables are very similar to our previous results (and for Ghosh et al.'s model, to their results). The only exception is the output gap, which turns significant in models without the lagged dependent variable. The last two columns of the table present results of the Ghosh et al.'s extended model for our data. However, the non-linear debt specification remains insignificant.

To check the robustness of our findings, our 'fiscal fatigue' models (*IV FE ff0a and IV FE ff1*) are also estimated on samples with one country dropped at a time, but no significant differences across estimated models are found. In addition, we also explore the effect of excluding the crisis years (after 2007). While in the Ghosh et al. regressions, the results remained mostly insignificant, in our specifications, mainly FE ff3a, we find statistically significant estimates with correct signs for the nonlinear fiscal fatigue pattern. Possible debt turning points were found to be relatively unstable and very high (approaching 200% of GDP).

Overall, in this type of fiscal fatigue specification, it appears that the significance of findings is lost when instrumental variables are employed or/and when the years after 2007 are included in the sample. Apart from the sample composition, another explanation for the difference in results compared to Gosh at al. (2013) can be associated with the underlying debt series: for instance, Fournier and Fall (2015) find evidence of fiscal fatigue for OECD public debt series but not for debt series calculated according to the EDP rules. In addition, some studies have shown sensitivity of fiscal fatigue estimates to some variables, mainly interest rates (see Daniel and Shiamptanis, 2015).

To summarize our findings, we do not find clear evidence for non-linear fiscal fatigue in line with Ghosh *et al.* (2013), even though some (high debt) countries may have been exposed to such problems in the more recent past. This conclusion is not surprising given the relatively low number of observations with very high debt ratios in our sample.

## Conclusions

This paper addressed two main research questions that result in two contributions of this text. First, we estimated a 'stylised' fiscal reaction function for 18 euro area countries employing longer and more recent time series. Second, we explored the issue of fiscal fatigue in greater depth.

Having used various dynamic panel techniques and a battery of robustness checks, we found evidence that euro area sovereigns abide, on average, by weak sustainability constraints. The primary balance improves by about 0.03–0.05 for every 1 percentage point increase in the debt-to-GDP ratio after controlling for other relevant factors. The positive reaction of primary surpluses to higher debt strengthened over the crisis (2008 onwards), which seemed to have acted as a disciplining device compared to the preceding period. A similar evidence with respect to the behaviour over the monetary union period (after 1999 and in individual country after the euro adoption) is less strong (the higher FRF coefficient seemingly determined by the crisis period). Overall, we find that the FRF estimates are rather robust across various specifications, time periods and exclusion of individual countries. Moreover, the fiscal reaction is not substantially different for our base model specification across EA countries. Though country-specific results should be regarded with caution, we find that in only in a few countries, especially as a reaction to the crisis, the FRF coefficient has deviated somewhat more substantially from the average one.

As regards other determinants of fiscal positions (higher primary surpluses), we find evidence for persistence in fiscal policy; political factors (election years only, with a negative impact), for the twin

deficit hypothesis (improved external positions and more openness) and the squeezing effect of interest payments. We do not find strong evidence for a stable cyclical behaviour (stabilisation) function of fiscal policy across the euro area countries. When the whole period (crisis years included) is considered, the output gap does not seem to have a statistically significant impact in the setting of the cyclically-adjusted primary balance (a proxy for the discretionary fiscal policy) and, more surprisingly, of the primary balance. A statistical significant and positive impact, which may be taken as a weak evidence of counter-cyclical effects of fiscal policy, is found only when the GDP growth rate is used, or, in case of the output gap, only for the periods excluding the crisis years. However, neither the output gap nor the real growth rate is found to have a statistically significant impact on driving the CAPB (discretionary fiscal policy). In this sense, we do not find strong evidence for either a continuously pro- or counter-cyclical fiscal policy for the euro area countries, on average.

The second contribution of the paper consists in proposing a novel measure of fiscal fatigue that allows to classify countries based on their actual fiscal behaviour with few assumptions. Considering a prudent coefficient for the fiscal policy reaction function, we can measure the extent of fiscal fatigue by comparing simulated primary balance paths in the context of debt sustainability analyses with countries' track-record, adjusted for the estimated fiscal reaction coefficient. Support for the fiscal fatigue hypothesis using a non-linear FRF as proposed in Ghosh *et al.* (2013) is weak and not sufficiently robust in the euro area sample.

Our study is subject to some caveats associated with a panel approach when investigating the fiscal fatigue hypothesis. A natural response seems to be more data-demanding country-specific models that can be estimated with a battery of econometric techniques allowing for various types of non-linearities. This would come, though, at the cost of reduced comparability and applicability to more recent economic, institutional and political conditions. Because of limited availability or comparability of time series for our set of countries, we leave this extension for further research. As such, further investigations could focus on the use of Bayesian techniques or attempt to endogenise the fiscal fatigue hypothesis.

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# Appendix

## Table A.1: Summary of FRF literature review

| Study | Model specification | Coefficient on lagged debt | Further notes |
|---|---|---|---|
| **Country specific estimations** | | | |
| Bohn (1998) | Primary balance<br>Period 1916–1995, US | 0.054 | OLS with Newey-West S.E., GVAR and YVAR fiscal variables, extensions: fiscal fatigue (second and third polynomial terms, break at 34%); subsamples, |
| Bohn (2008) | Primary balance<br>Period 1792–2003, US | 0.094 – 0.121 | OLS with robust standard errors, with time trend; extensions: debt squared, AR(1) process for outlays, public debt is not lagged. |
| Legrenzi and Milas (2013) | Primary surplus<br>Period 1960(1970)–2012, models for Greece, Ireland, Portugal and Spain | 0.087–0.177 | OLS and 2STLS (IV) estimation, extensions: non-linear (logistic) model with state-varying thresholds, a measure of financial pressures. |
| Cuerpo (2014) | Primary balance<br>Period 1986q1–2012q4 (quarterly data), Spain | -0.032 – 0.018 | Bayesian time-varying coefficients technique (TVC) |
| D'Erasmo, Mendoza, Zhang (2015) | Primary balance,<br>1972–2014, US | 0.0767 – 0.105 | OLS with HAC standard errors and military expenditures; extensions: time trend, squared debt, asymmetrical response, with AR(1) term, with/without recession; |
| **Eurozone, EU, OECD** | | | |
| Debrun and Wyplosz (1999) | primary balance (with one lag)<br>Panel: 11 European countries, some specifications with country-specific effects, 1982–1997 | 0.01–0.03 | FE OLS, GLS and 3SLS estimators, no institutional or political variables included |
| Galí and Perotti (2003) | Cyclically adjusted primary deficit and general government primary deficit divided by potential output,<br>EU-11+OECD-5 (individual, pooled estimation), period: 1980–2002 | -0.06<br>-0.07 (only EU-11)<br>-0.02 (only OECD5) | FE and IV FE estimator with country fixed effects, extensions: debt as a fraction of potential GDP, expected output gap, pre- vs. post-Maastricht period; monetary policy rule; government investment, spending, and revenues to potential output; |
| IMF (2004) | General government cyclically adjusted primary balance (with one lag)<br>Panel (unbalanced): EA-12 (without Luxembourg), period 1971–2003 | 0.00–0.08 | 2SlS IV estimator, model with monetary gaps; country specific FRF; |
| Annett (2006) | Cyclically adjusted primary balance (with one lag)<br>Panel: EU-14 (without Luxembourg) , period 1980–2004 | 0.01–0.03 (EU-14)<br>0.01–0.02 (EU-11) | Pooled and 2SLS estimator with and without country fixed effect, extensions: dummy for election year, commitment/mixed forms of fiscal governance, and delegation, relative economic size in EU-15/EA-12, a 10-year real growth volatility; pre- and post-Maastricht period and pre- and post-SGP period estimation; |
| Golinelli and Momigliano (2006) | Change of cyclically adjusted primary balance, lagged primary balance included<br>Panel: 19 OECD, 11 Euro area, three periods covering 1988–2006 | 0.008–0.024 (only EA countries) | Real-time data, various estimators (OLS, FE, GMM), country and fixed effects; extensions: dummy variables for stages of European monetary integration, phases of business cycle and election cycle, a Maastricht variable (number of years for elimination of the excessive deficit and expected interest payments); testing symmetry of fiscal responses; |
| Ayuso-i-Casals *et al.* (2007) | Cyclically-adjusted primary balance (with one lag) and primary expenditures (with one lag)<br>Panel: 22 EU, period 1990–2005 | 0.00–0.03<br>-0.18– -0.02 (for primary expenditures) | FE estimator and TSLS (IV) estimator with country-specific fixed effects, extensions: analysis for various types of fiscal rules and fiscal institutions, cyclical stance. |
| Debrun *et al.* (2008) | General government and cyclically adjusted balance (with one lag),<br>Panel: EU-25, period 1990–2005 | 0.02-0.04<br>0.02 (only EU-15) | OLS, LSDVC, FE and FE IV estimator with country fixed effects; extensions: subgroups estimations, focus on fiscal rules; |
| Golinelli and Momigliano (2008) | Change in cyclically adjusted primary balance (one lag added)<br>Change in cyclically adjusted primary balance (lagged primary balance)<br>Change in primary balance (one lag added)<br>Panel: 11 EA, period 1978–2006 | 0.008–0.080<br>0.009–0.011<br>0.009–0.014 | Pooled OLS, Within group, difference and system (one-step) GMM estimators, extensions: real-time and ex post data, symmetry of responses, political and institutional variables, the Maastricht variable, real ex ante interest rate; rolling regression (15-year-long windows); |
| Afonso and Jalles (2011) | Primary balance (with one lag)<br>Panel: 18 OECD countries over the period 1970–2010 | 0.01–0.15<br>-0.05–0.17 (time series estimators) | Pooled OLS and FE IV estimators, system GMM estimator, narrow specification (debt and/or output gap only) extensions: panel time series estimation (MG, AMG, CCEMG) and Driscoll-Kraay estimator. |
| EC (2011) | Primary balance | 0.027 – 0.031 | FE IV estimator with country fixed effects; |

| | | | |
|---|---|---|---|
| | Panel: EU-27, period 1975/1980–2010 | 0.033 – 0.038 (extensions) | extensions: with the FRI variable for the period 1990–2008; |
| Eller and Urvová (2012) | General government primary balance (with one or two lags)<br>Panel: eight new EU member states, period 1995–2011 | 0.026–0.060 | Pooled OLS, FE, system GMM estimators with fixed and time effects; extensions: debt spline (at 40%), output gap analysis, various election variables and price indices, fiscal institutions (FRI, WB governance). |
| Escolano *et al.* (2012) | General government and cyclically adjusted balance (with one lag)<br>Panel: EU-27, period 1990–2008 | 0.0367<br>0.0455–0.0563 (for CAPB)<br>0.0415 (only EU-15) | LSDVC and FE estimator with country fixed effects; extensions: focus on fiscal rules; subgroups; |
| Medeiros (2012) | General government primary balance<br>Panel: EU-27/-21, period 1976–2011 | 0.054–0.078 | FD and FE IV estimator with country fixed effects allowing for AR(1) errors; extensions: estimation of fiscal fatigue via FD IV estimation (with output gap only) |
| Theofilakou, Stournaras (2012) | Cyclically adjusted primary balance (with lag)<br>Panel: 10 EA (unbalanced), time dummies for selected years, 1988–2009 | 0.0240–0.0426;<br>0.064 (non-linear model with a squared term)<br>0.022 (two subgroups based on a 60% threshold) | One-step BB estimator with forward orthogonal deviations; specification similar to Bohn (1998) with bond yields included; non-linear specification with quadratic term (not significant); |
| Betty and Shiamptanis (2013) | Primary balance<br>Panel: 11 EA, 1970–2011, pre-EMU (1970–1998) and post-EMU (1999–2011) | 0.0727 | Panel cointegration estimators (DOLS) allowing for heterogeneity, |
| Schoder (2014) | Primary balance<br>OECD 15, period 1981–2010 (quarterly observations) | 0.041 (1980–1996)<br>0.011 (1997–2010) | MG and PMG estimators, extensions: various sub-periods and subgroups, |
| Weichenrieder and Zimmer (2014) | general government primary balance<br>Panel: EA, 1970–2011 | 0.043-0.059 | FE estimator with time and country fixed effects; extensions: focus on changes over time – three periods (dummy shifter) and no crisis period. |
| Baldi and Staehr (2016) | Quarterly primary balance (with t-4 lag)<br>Quarterly panel, EU-27, period 2001Q1–2008Q2 (before the crisis) and 2009Q1–2014Q1 (during the crisis) | 0.026 (before, EA-12)<br>0.087 (during, EA-12) | 2SLS estimation with robust S.E., country fixed effects and quarterly dummies with GDP growth only; variables are not seasonally adjusted. Extensions: various subgroups of countries (EA12, CEE10, old and new EU countries grouped by "seriousness" of their fiscal problems); |
| **Developing and developed countries** | | | |
| IMF (2003) | General government primary balance (with one lag)<br>Panel: 54 emerging and industrial countries, period 1990–2002; | 0.039–0.047<br>0.057–0.060 (only for industrial economies) | GLS estimator, country specific fixed effects; extensions: spline regression (threshold at 50%); subsample of 20 industrial economies and spline regression (threshold at 80%); |
| Abiad and Baig (2005) | Primary balance<br>Panel: 34 emerging market countries, country-specific effects, period 1990–2002 | 0.034<br>0.055–0.086 (with debt spline)<br>0.063–0.089 (extended model with debt spline)<br>0.048–0.072 (model with all variables and debt spline) | FE OLS estimator core model (macroeconomic variables only); debt spline at 50%; extensions: model with political or institutional variables; model with both variables; |
| Abiad and Ostry (2005) | Primary balance<br>Panel: 31 emerging market countries, country-specific effects, period 1990–2002 | 0.05–0.10<br><br>0.04–0.06 (extended model) | FGLS estimator, debt spline at 50%; extensions: alternative fiscal institution measures; |
| Celasun *et al.* (2006) | General government primary balance<br>Panel: 34 emerging economies, period 1990–2004 | 0.030–0.046 | Difference LIML, GMM estimators with country fixed effects, extensions: spline regression (threshold at 50%) and positive and negative output gap; |
| Ghosh *et al.* (2011) | General government primary balance<br>Panel: 23 developed countries, period 1970/1985–2007 | -0.2080 (long)<br>-0.0805 (short) | FE estimator with robust S.E. and with AR(1) error term process; extensions: fiscal fatigue explored (coefficients of the second and third polynomial), government expenditure gap; |
| Debrun and Kinda (2013) | Primary balance<br>Panel: advanced (28) and emerging (26) countries, period 1980–2010 | 0.035–0.040 (FE)<br>0.032–0.037 (LSDVC) | FE and LSDVC estimator; extensions: interest payments, and interest payments thresholds (linear); |
| Mendoza and Ostry (2008) | Primary balance<br>Panel: 22 industrial and 34 emerging countries, period 1980/1990–2005 | 0.033–0.072<br>0.020-0.038 (only industrial countries) | FE estimator with country-fixed effects, robust S.E. with country AR(1) coefficients; extensions: subsamples (high/low debt countries); spline regression (threshold at 48%); shorter periods for most emerging countries; YVAR and GVAR government expenditure variables; |
| Ghosh *et al.* (2013) | General government primary balance<br>panel: 23 developed countries (EU-14), period 1970/1985–2007 | -0.208– -0.225 (long)<br>-0.081– -0.086 (short) | FE country-fixed effect estimator with robust S.E. and with AR(1) error term process; extensions: OLS, PCSE estimators, fiscal fatigue explored (second and third polynomial terms |

| | | | |
|---|---|---|---|
| | | | included in both specifications); government expenditure gap; age dependency, IMF arrangement, fiscal rules, oil price, non-fuel commodity price, trade openness; |
| Debrun and Kinda (2014) | Primary balance<br>Panel: advanced (28) and emerging (26) countries, period 1990–2011 | 0.015–0.023 | LSDVC estimator; extensions: exploring fiscal rules and fiscal councils; |
| Cevik and Teksos (2014) | Cyclically adjusted primary balance<br>Panel: 49 developed and developing countries, period 1990–2012 | -0.01–0.01 (reduced form)<br>0.003–0.025 | GLS (reduced form only), one and two-step system GMM estimator (with/without collapse option), output gap and country fixed effects (reduced form); extensions: macro-finance variables (real exchange rate, domestic credit, market capitalization, residential property prices, and natural resource rents), institutional and demographic variables; estimation also for standard deviation of CAPB; |
| Cordes *et al.* (2015) | Primary balance (with one lag)<br>Panel: 57 advanced and developing economies, period 1985–2012 | 0.013 | LSDVC estimator, expenditure rule index/dummy, extensions: model specified for primary expenditures; |
| D'Erasmo, Mendoza, Zhang (2015) | Primary balance<br>Panel: 25 advanced and 33 emerging economies, period 1951–2013 | -0.001 – 0.692 | FE with White cross-section corrected S.E. with output gap and government expenditures; extensions: government expenditure or consumption gap (HP filter), country AR(1) error. |

*Source: studies listed above, own adaptation.*

## Table A.2: Robustness checks – main specification EA-18, 1970–2013 with Extrapolated series CAPB (not extrapolated sample)

| | am0 | am1 | am2 | am3 | | am0' | am1' | am2' | am3' |
|---|---|---|---|---|---|---|---|---|---|
| Lagged PB | 0.645*** | 0.754*** | 0.642*** | 0.653*** | Lagged CAPB | 0.653*** | 0.690*** | 0.619*** | 0.644*** |
| | [0.049] | [0.039] | [0.038] | [0.046] | | [0.059] | [0.056] | [0.065] | [0.065] |
| ***Lagged debt*** | **0.027*** ** | **0.024*** ** | **0.027*** ** | **0.029*** ** | ***Lagged debt*** | **0.006*** ** | **0.015*** ** | **0.029*** ** | **0.027*** ** |
| | **[0.005]** | **[0.006]** | **[0.005]** | **[0.006]** | | **[0.002]** | **[0.004]** | **[0.006]** | **[0.006]** |
| Output gap | -0.034 | 0.049 | | -0.096* | Output gap | 0.001 | 0.08 | | -0.057 |
| | [0.065] | [0.063] | | [0.052] | | [0.057] | [0.068] | | [0.054] |
| GDP growth | | | 0.325*** | | GDP growth | | | 0.153 | |
| | | | [0.081] | | | | | [0.100] | |
| Current account | 0.097** | 0.105*** | 0.079** | | Current account | 0.101*** | 0.103*** | 0.099*** | |
| | [0.045] | [0.035] | [0.033] | | | [0.037] | [0.035] | [0.032] | |
| Openness | | | | 0.016** | Openness | | | | 0.008 |
| | | | | [0.006] | | | | | [0.006] |
| Election dummy | -0.516*** | -0.576*** | -0.499*** | -0.509*** | Election dummy | -0.602*** | -0.569*** | -0.556*** | -0.539*** |
| | [0.154] | [0.151] | [0.130] | [0.154] | | [0.143] | [0.143] | [0.142] | [0.148] |
| Crisis dummy | -1.973*** | -1.630*** | -0.327 | -2.245*** | Crisis dummy | -0.515*** | -0.536*** | -0.534*** | -0.501*** |
| | [0.360] | [0.552] | [0.370] | [0.373] | | [0.145] | [0.154] | [0.143] | [0.143] |
| Year | 0.006 | | -0.007 | -0.004 | Year | -0.971*** | 0.188 | -0.342 | -1.188*** |
| | [0.015] | | [0.011] | [0.016] | | [0.319] | [0.588] | [0.425] | [0.340] |
| Constant | -1.005*** | -0.102 | -1.679*** | -2.146*** | Constant | -0.020* | | -0.020* | -0.02 |
| | [0.313] | [0.552] | [0.366] | [0.500] | | [0.012] | | [0.011] | [0.014] |
| Observations | 533 | 533 | 566 | 533 | Observations | 442 | 442 | 450 | 442 |
| R-squared | 0.69 | 0.785 | 0.731 | 0.696 | R-squared | 0.708 | 0.744 | 0.7 | 0.71 |
| Country FE | yes | yes | yes | yes | Country FE | yes | yes | yes | yes |
| Time FE | no | yes | no | no | Time FE | no | yes | no | no |
| Kleibergen-Paap LM statistic | 38.220 | 41.820 | 27.490 | 40.020 | Kleibergen-Paap LM statistic | 36.370 | 46.030 | 22.480 | 34.470 |
| Kleibergen-Paap p-val | 0.000 | 0.000 | 0.000 | 0.000 | Kleibergen-Paap p-val | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen test | 5.883 | 2.793 | 2.295 | 3.913 | Hansen test | 4.908 | 2.721 | 2.907 | 2.039 |
| Hansen p-val | 0.208 | 0.593 | 0.514 | 0.418 | Hansen p-val | 0.297 | 0.606 | 0.406 | 0.729 |

*Note: Model am0 is the base model. Model am1 includes country and time fixed effects (IV). Model am2 is the base model, which uses GDP growth rates instead of output gap. Model am3 is the base model that includes export and import instead of current account. CAPB specifications are the same as PBAL models. CAPB denotes the cyclically adjusted primary balance. Robust standard errors used in all specifications. The null of Kleinbergen-Paap LM test is that instruments are weak. x – exactly identified model. P-value: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Source: own calculation.*

## Table A.3: Main specification for various periods, EA-18

| | m1 1970–2013 | m11 1970–2007 | m1a 1970–2013 | m11a 1970–2007 | m2 1985–2013 | m22 1985–2007 | m3 1991–2013 | m33 1991–2007 |
|---|---|---|---|---|---|---|---|---|
| Lagged primary balance | 0.566*** | 0.627*** | 0.645*** | 0.721*** | 0.492*** | 0.497*** | 0.493*** | 0.469*** |
| | [0.059] | [0.064] | [0.049] | [0.046] | [0.064] | [0.086] | [0.081] | [0.137] |
| ***Lagged debt*** | **0.034*** ** | **0.025*** ** | **0.027*** ** | **0.019*** ** | **0.040*** ** | **0.026*** ** | **0.046*** ** | **0.027** ** |
| | **[0.006]** | **[0.005]** | **[0.005]** | **[0.005]** | **[0.008]** | **[0.007]** | **[0.010]** | **[0.011]** |
| Output gap | 0.072 | 0.138** | -0.034 | 0.025 | 0.159* | 0.260*** | 0.14 | 0.260* |
| | [0.071] | [0.069] | [0.065] | [0.059] | [0.084] | [0.093] | [0.096] | [0.135] |
| Current account | 0.157*** | 0.102 | 0.097** | 0.052 | 0.188*** | 0.145* | 0.182** | 0.12 |
| | [0.054] | [0.070] | [0.045] | [0.046] | [0.060] | [0.080] | [0.075] | [0.126] |
| Election dummy | -0.448*** | -0.659*** | -0.516*** | -0.693*** | -0.401** | -0.624*** | -0.371** | -0.665*** |
| | [0.155] | [0.171] | [0.154] | [0.172] | [0.166] | [0.196] | [0.180] | [0.234] |
| Crisis dummy | -1.884*** | | -1.973*** | | -2.093*** | | -2.523*** | |
| | [0.364] | | [0.360] | | [0.409] | | [0.481] | |
| Year | -0.005 | -0.012 | 0.006 | 0.006 | 0.018 | -0.007 | 0.060* | -0.023 |
| | [0.015] | [0.013] | [0.015] | [0.014] | [0.023] | [0.018] | [0.033] | [0.034] |
| Constant | -1.125** | -0.591 | -1.005*** | -0.738** | -2.324** | -0.815 | -4.128*** | -0.394 |
| | [0.490] | [0.521] | [0.313] | [0.298] | [0.911] | [0.861] | [1.194] | [1.568] |
| Observations | 431 | 327 | 533 | 429 | 364 | 260 | 312 | 208 |
| R-squared | 0.720 | 0.733 | 0.690 | 0.712 | 0.729 | 0.721 | 0.731 | 0.720 |
| Country FE | Yes | yes | yes | yes | yes | yes | yes | yes |
| Time FE | No | no | no | no | no | no | no | No |
| Kleibergen-Paap LM st. | 35.110 | 25.860 | 38.220 | 32.480 | 28.210 | 19.610 | 25.070 | 15.610 |
| Kleibergen-Paap p-val | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 | 0.008 |
| Hansen test | 7.264 | 5.679 | 5.883 | 1.125 | 7.812 | 8.677 | 7.936 | 10.170 |
| Hansen p-val | 0.123 | 0.224 | 0.208 | 0.890 | 0.099 | 0.070 | 0.094 | 0.038 |

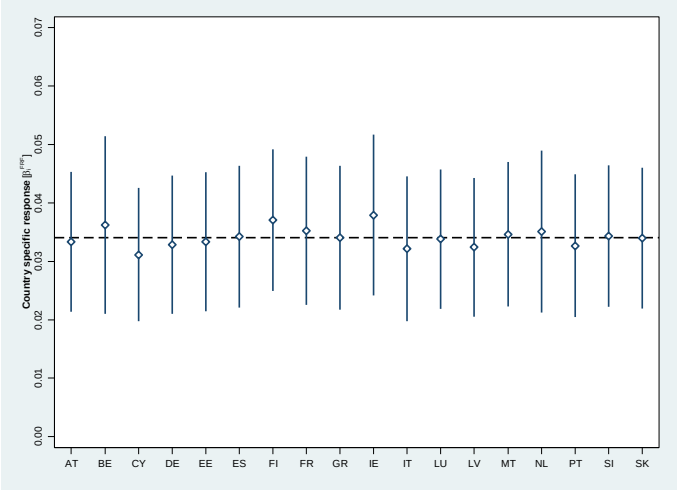
*Note: models m1a and m11a are estimated on linked series for most of the euro area countries. Robust standard errors, country FE used in all specifications. The null of Kleinbergen-Paap LM test is that instruments are weak.. P-value: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Source: own calculation.*

## *Table A.4: Main specification by groups of countries, various periods*

| | 1970–2013 | | | | | 1991–2013 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **m1 EA18** | **m2 EA12** | **m3 EA11a** | **m4 EA11b** | **m5 EA10** | **m1a EA18** | **m2a EA12** | **m3a EA11a** | **m4a EA11b** | **m5a EA10** |
| Lagged primary balance | 0.566*** | 0.581*** | 0.569*** | 0.587*** | 0.571*** | 0.493*** | 0.456*** | 0.407*** | 0.443*** | 0.358*** |
| | [0.059] | [0.061] | [0.068] | [0.065] | [0.074] | [0.081] | [0.079] | [0.093] | [0.092] | [0.109] |
| ***Lagged debt*** | **0.034*** ** | **0.029*** ** | **0.029*** ** | **0.030*** ** | **0.030*** ** | **0.046*** ** | **0.033*** ** | **0.037*** ** | **0.035*** ** | **0.040*** ** |
| | **[0.006]** | **[0.006]** | **[0.006]** | **[0.006]** | **[0.006]** | **[0.010]** | **[0.010]** | **[0.011]** | **[0.010]** | **[0.011]** |
| Output gap | 0.072 | 0.095 | 0.14 | 0.107 | 0.163 | 0.14 | 0.218* | 0.352** | 0.265* | 0.485*** |
| | [0.071] | [0.079] | [0.092] | [0.086] | [0.101] | [0.096] | [0.124] | [0.157] | [0.153] | [0.185] |
| Current account | 0.157*** | 0.218*** | 0.214*** | 0.216*** | 0.213*** | 0.182** | 0.316*** | 0.300*** | 0.325*** | 0.316*** |
| | [0.054] | [0.046] | [0.055] | [0.047] | [0.058] | [0.075] | [0.060] | [0.069] | [0.063] | [0.070] |
| Election dummy | -0.448*** | -0.424*** | -0.452*** | -0.411** | -0.440*** | -0.371** | -0.279 | -0.316* | -0.27 | -0.322* |
| | [0.155] | [0.158] | [0.158] | [0.161] | [0.160] | [0.180] | [0.187] | [0.175] | [0.190] | [0.175] |
| Crisis dummy | -1.884*** | -1.515*** | -1.437*** | -1.609*** | -1.535*** | -2.523*** | -1.948*** | -1.676*** | -2.130*** | -1.760*** |
| | [0.364] | [0.439] | [0.443] | [0.452] | [0.450] | [0.481] | [0.605] | [0.635] | [0.612] | [0.601] |
| Year | -0.005 | -0.018 | -0.019 | -0.017 | -0.019 | 0.060* | 0.029 | 0.013 | 0.034 | 0.011 |
| | [0.015] | [0.015] | [0.015] | [0.014] | [0.015] | [0.033] | [0.038] | [0.040] | [0.040] | [0.040] |
| Constant | -1.125** | -0.559 | -0.493 | -0.588 | -0.52 | -4.128*** | -2.449* | -2.15 | -2.696** | -2.301 |
| | [0.490] | [0.455] | [0.505] | [0.452] | [0.501] | [1.194] | [1.337] | [1.443] | [1.357] | [1.400] |
| Observations | 431 | 351 | 332 | 330 | 311 | 312 | 232 | 216 | 212 | 196 |
| R-squared | 0.72 | 0.756 | 0.764 | 0.761 | 0.771 | 0.731 | 0.771 | 0.792 | 0.784 | 0.812 |
| Country FE | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| Time FE | no | no | no | no | no | no | no | no | no | no |
| Kleibergen-Paap LM statistic | 35.11 | 29.28 | 28.37 | 24.97 | 23.98 | 25.07 | 16.95 | 21.6 | 14.17 | 19 |
| Kleibergen-Paap p-val | 1.43E-06 | 2.04E-05 | 3.08E-05 | 0.000141 | 0.000219 | 0.000135 | 0.0046 | 0.000625 | 0.0145 | 0.00192 |
| Hansen test | 7.264 | 9.079 | 8.895 | 9.514 | 9.285 | 7.936 | 5.604 | 5.346 | 5.093 | 4.64 |
| Hansen p-val | 0.123 | 0.0592 | 0.0638 | 0.0495 | 0.0544 | 0.094 | 0.231 | 0.254 | 0.278 | 0.326 |

*Note: robust standard errors, country FE used in all specifications. The labels: EA12 represents a group of countries without new EU member states (i.e., AT, BE, DE, ES, FI, FR, GR, IE, IT, LU, NL, PT). EA11a and EA11b represent the EA-12 group without GR, and respectively, LU; EA-10 is EA12 without both countries GR and LU. The null of Kleinbergen-Paap LM test is that instruments are weak. P-value: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Source: own calculation.*

## *Figure A.1. FRF coefficients: EA-18 panel excluding one country at a time, 1970–2013*




*Note: Country excluded shown on the OX-axis. Horizontal line shows the FRF coefficient for the whole panel (EA-18), Base model. Source: own calculation.*

## *Table A.5: Main specification: robustness check with various estimators, EA-18, 1970–2013*

| | Pooled OLS | IV FE (Base) | IV FE+TE | LIML | LSDVC | IV GMM 2s | DK | PCSE | AB GMM | ABo GMM |
|---|---|---|---|---|---|---|---|---|---|---|
| Lagged PB | 0.607*** | 0.566*** | 0.716*** | 0.570*** | 0.706*** | 0.576*** | 0.498*** | 0.204*** | 0.635*** | 0.655*** |
| | [0.047] | [0.059] | [0.046] | [0.064] | [0.034] | [0.059] | [0.079] | [0.077] | [0.099] | [0.067] |
| ***Lagged debt*** | **0.010*** ** | **0.034*** ** | **0.029*** ** | **0.033*** ** | **0.031*** ** | **0.031*** ** | **0.051*** ** | **0.056*** ** | **0.049** | **0.064** ** |
| | **[0.003]** | **[0.006]** | **[0.006]** | **[0.006]** | **[0.006]** | **[0.006]** | **[0.008]** | **[0.008]** | **[0.030]** | **[0.029]** |
| Output gap | -0.101 | 0.072 | 0.076 | 0.056 | -0.025 | 0.076 | 0.096 | 0.216*** | 0.062 | 0.113 |
| | [0.067] | [0.071] | [0.070] | [0.071] | [0.047] | [0.069] | [0.095] | [0.074] | [0.104] | [0.088] |
| Current account | 0.086*** | 0.157*** | 0.156*** | 0.159** | 0.148*** | 0.158*** | 0.167*** | 0.171*** | -0.091 | -0.023 |
| | [0.023] | [0.054] | [0.042] | [0.063] | [0.032] | [0.052] | [0.061] | [0.040] | [0.054] | [0.064] |
| Election dummy | -0.415** | -0.448*** | -0.546*** | -0.450*** | -0.484*** | -0.468*** | -0.361* | -0.414*** | -0.514*** | -0.444*** |
| | [0.195] | [0.155] | [0.142] | [0.116] | [0.168] | [0.154] | [0.210] | [0.153] | [0.166] | [0.131] |
| Crisis dummy | -1.987*** | -1.884*** | | -1.935*** | -1.591*** | -1.637*** | -1.506* | -1.669*** | | |
| | [0.372] | [0.364] | | [0.439] | [0.297] | [0.345] | [0.756] | [0.574] | | |
| Year | 0.042*** | -0.005 | | -0.003 | -0.009 | -0.009 | -0.024 | -0.018 | | |
| | [0.012] | [0.015] | | [0.021] | [0.014] | [0.014] | [0.022] | [0.024] | | |
| Constant | -0.909** | -1.125** | -2.257*** | -1.113 | | -0.901* | -1.341*** | -1.917** | | |
| | [0.379] | [0.490] | [0.558] | [0.684] | | [0.480] | [0.490] | [0.814] | | |
| Observations | 431 | 431 | 431 | 431 | 431 | 431 | 431 | 431 | 462 | 463 |
| R-squared | 0.521 | 0.72 | 0.807 | 0.716 | | 0.72 | 0.479 | 0.412 | | |
| Country FE | No | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| Time FE | No | no | yes | no | no | no | no | no | yes | yes |
| Kleibergen-Paap LM Statistics | | 35.11 | 36.26 | 12.53 | | 35.11 | | | | |
| Kleibergen-Paap LM p-val | | 0.000 | 0.000 | 0.028 | | 0.000 | | | | |
| Hansen test | | 7.264 | 4.353 | | | 7.264 | | | 19.77 | 20.24 |
| Hansen p-val | | 0.123 | 0.36 | | | | | | 0.072 | 0.063 |
| AR(1) p-val | | | | | 0.000 | | | | 0.001 | 0.003 |
| AR(2) p-val | | | | | 0.188 | | | | 0.502 | 0.484 |

*Note: All results for the original (not-extended) sample. Robust standard errors or clustered standard errors for DK; bootstrapped S.E. for pooled OLS and LSDVC estimators (500). AB GMM (xtabond2, collapsed), ABo GMM (xtabond2, orthogonal, collapsed); DK – Driscoll-Kraay estimator assuming heteroscedasticity, cross-sectional and temporal dependence with country FE; PCSE model: with a common AR(1) error term (= 0.401). Hansen test's null hypothesis is that instruments (orthogonality conditions) are valid. The null of Kleinbergen-Paap LM test is that instruments are weak. x – exactly identified model. Specification of instruments between estimators may change. For estimators without explicit IV option, we estimated the first stage for both endogenous variables on the same set of instrument as for models with IV option, including lagged dependent variable. Fitted values for these variables were then utilized for estimation of our base model. .. – not available/not calculable. P-value: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Source: own calculation.*

## *Table A.6: Robustness checks – effects of fiscal rules in detail, EA-18*

| | **afr1** | **afr2** | **afr3** | **afr4** | **afr5** | **afr6** | **afr7** | **afr8** |
|---|---|---|---|---|---|---|---|---|
| Lagged PB | 0.473*** | 0.459*** | 0.511*** | 0.504*** | 0.516*** | 0.518*** | 0.510*** | 0.510*** |
| | [0.065] | [0.066] | [0.063] | [0.066] | [0.063] | [0.062] | [0.063] | [0.063] |
| ***Lagged debt*** | **0.045*** ** | **0.045*** ** | **0.037*** ** | **0.038*** ** | **0.038*** ** | **0.038*** ** | **0.037*** ** | **0.037*** ** |
| | **[0.008]** | **[0.008]** | **[0.007]** | **[0.008]** | **[0.007]** | **[0.007]** | **[0.007]** | **[0.007]** |
| Output gap | 0.193** | 0.196** | 0.117 | 0.13 | 0.122 | 0.119 | 0.118 | 0.116 |
| | [0.081] | [0.080] | [0.080] | [0.083] | [0.080] | [0.079] | [0.080] | [0.081] |
| Current account | 0.205*** | 0.207*** | 0.174*** | 0.178*** | 0.181*** | 0.177*** | 0.174*** | 0.174*** |
| | [0.060] | [0.061] | [0.060] | [0.057] | [0.059] | [0.059] | [0.059] | [0.060] |
| Election dummy | -0.367** | -0.353** | -0.420*** | -0.399** | -0.421*** | -0.417*** | -0.422*** | -0.418*** |
| | [0.165] | [0.165] | [0.159] | [0.160] | [0.159] | [0.159] | [0.159] | [0.158] |
| Crisis dummy | -2.275*** | -2.289*** | -1.996*** | -1.998*** | -2.091*** | -2.064*** | -1.998*** | -2.007*** |
| | [0.410] | [0.429] | [0.432] | [0.433] | [0.403] | [0.400] | [0.424] | [0.418] |
| FRI fiscal rule | -0.093 | | | | | | | |
| | [0.132] | | | | | | | |
| Lagged FRI fiscal rule | | 0.149 | | | | | | |
| | | [0.167] | | | | | | |
| IMF fiscal rule | | | 0.244 | | | | | |
| | | | [0.466] | | | | | |
| Lagged IMF fiscal rule | | | | 0.342 | | | | |
| | | | | [0.402] | | | | |
| *Expenditure rule* | | | | | -0.393 | | | |
| | | | | | [0.296] | | | |
| *Revenue rule* | | | | | | -0.25 | | |
| | | | | | | [0.291] | | |
| *Balanced budget rule* | | | | | | | 0.257 | |
| | | | | | | | [0.440] | |
| *Debt rule* | | | | | | | | 0.255 |
| | | | | | | | | [0.447] |
| Year | 0.045* | 0.033 | -0.001 | -0.002 | 0.018 | 0.013 | -0.001 | -0.001 |
| | [0.025] | [0.027] | [0.029] | [0.029] | [0.021] | [0.021] | [0.028] | [0.028] |
| Constant | -3.510*** | -3.085*** | -1.700** | -1.782** | -2.166*** | -1.986** | -1.688** | -1.692** |
| | [0.932] | [0.963] | [0.819] | [0.873] | [0.784] | [0.817] | [0.815] | [0.811] |
| Observations | 348 | 340 | 385 | 378 | 385 | 385 | 385 | 385 |
| R-squared | 0.737 | 0.735 | 0.724 | 0.726 | 0.724 | 0.724 | 0.724 | 0.723 |
| Country FE | yes | yes | yes | yes | yes | yes | yes | yes |
| Time FE | no | no | no | no | no | no | no | no |
| Kleibergen-Paap LM statistic | 27.800 | 28.100 | 30.840 | 29.000 | 31.440 | 31.170 | 30.870 | 31.330 |
| Kleibergen-Paap p-val | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen test | 8.717 | 8.490 | 6.959 | 7.683 | 6.897 | 6.803 | 6.947 | 6.878 |
| Hansen p-val | 0.069 | 0.075 | 0.138 | 0.104 | 0.141 | 0.147 | 0.139 | 0.142 |

*Note: EC FRI – period: 1990–2013, IMF fiscal rule and sub rules – period: 1985–2013. Robust standard errors, country FE used in all specifications. Hansen test's null hypothesis is that instruments (orthogonality conditions) are valid. The null of Kleinbergen-Paap LM test is that instruments are weak. P-value: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Source: own calculation.*

## *Table A7: Non-linear fiscal fatigue model, EA-18, 1970–2013*

| | Base | | | | | Extended | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **IV FE ff0** | **IV FE ff0a** | **IV FE ff1** | **Ghosh – IV FE** | **Ghosh – IV PCSE** | **FE ff2** | **FE ff2a** | **FE ff3** | **FE ff3a** | **FE ff4a** | **Ghosh – ext. FE** | **Ghosh – ext. PCSE** |
| Lagged primary balance | 0.566*** | **0.516*** ** | | | | 0.564*** | 0.651*** | | | | | |
| | [0.059] | **[0.064]** | | | | [0.036] | [0.040] | | | | | |
| ***Lagged debt*** | ***0.034**** | **-0.030** | **-0.134*** | **-0.016** | **0.031** | ***0.01*** | ***-0.029*** | ***-0.115**** | ***-0.148**** | ***-0.107**** | ***-0.014*** | ***0.021*** |
| | ***[0.006]*** | **[0.043]** | **[0.078]** | **[0.088]** | **[0.090]** | ***[0.041]*** | ***[0.030]*** | ***[0.066]*** | ***[0.061]*** | ***[0.059]*** | ***[0.077]*** | ***[0.053]*** |
| ***Lagged debt2*** | | **0.001** | **0.002** | **0.000** | **0.000** | ***0.000*** | ***0.001**** | ***0.002**** | ***0.002**** | ***0.001*** | ***0.000*** | ***0.000*** |
| | | **[0.001]** | **[0.001]** | **[0.001]** | **[0.001]** | ***[0.000]*** | ***[0.000]*** | ***[0.001]*** | ***[0.001]*** | ***[0.001]*** | ***[0.001]*** | ***[0.001]*** |
| ***Lagged debt3*** | | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | ***-0.000**** | ***0.000*** | ***0.000*** | ***0.000*** |
| | | **[0.000]** | **[0.000]** | **[0.000]** | **[0.000]** | ***[0.000]*** | ***[0.000]*** | ***[0.000]*** | ***[0.000]*** | ***[0.000]*** | ***[0.000]*** | ***[0.000]*** |
| Output gap (y/n IV) | 0.072 | 0.109 | 0.484*** | 0.315*** | 0.344*** | 0.211*** | | 0.427*** | | 0.457*** | 0.398*** | 0.375*** |
| | [0.071] | [0.076] | [0.087] | [0.096] | [0.080] | [0.043] | | [0.059] | | [0.081] | [0.069] | [0.035] |
| Lagged output gap | | | | | | | -0.034 | | 0.259*** | | | |
| | | | | | | | [0.034] | | [0.053] | | | |
| Current account (y/n IV) | 0.157*** | 0.187*** | 0.323*** | | | 0.099** | | 0.197*** | | 0.352*** | | |
| | [0.054] | [0.063] | [0.084] | | | [0.039] | | [0.056] | | [0.078] | | |
| Current account | | | | | | | 0.104*** | | 0.232*** | | | |
| | | | | | | | [0.039] | | [0.069] | | | |
| Election dummy | -0.448*** | -0.424*** | -0.286* | -0.162 | -0.252 | -0.427*** | -0.454*** | -0.292* | -0.273 | -0.392** | | |
| | [0.155] | [0.155] | [0.168] | [0.173] | [0.197] | [0.139] | [0.147] | [0.158] | [0.169] | [0.181] | | |
| Dummy crisis (2008+) | | -1.930*** | -2.089*** | | | | | | | | | |
| | | [0.363] | [0.501] | | | | | | | | | |
| Lagged growth of GDP deflator | | | | 0.121* | 0.108 | | | | | | 0.158*** | 0.127*** |
| | | | | [0.064] | [0.069] | | | | | | [0.056] | [0.041] |
| IMF fiscal rule | | | | 1.582*** | 0.137 | | | | | | 1.630*** | 1.005*** |
| | | | | [0.425] | [0.470] | | | | | | [0.409] | [0.312] |
| Cyclical component of gov.'t consumption | | | | -0.157*** | -0.187*** | | | | | | -0.157*** | -0.183*** |
| | | | | [0.033] | [0.039] | | | | | | [0.031] | [0.023] |
| Government stability | | | | 0.147* | 0.152** | | | | | | 0.1 | 0.07 |
| | | | | [0.076] | [0.077] | | | | | | [0.071] | [0.046] |
| Oil prices / non-oil commodity price index | | | | -0.031*** | -0.012 | | | | | | -0.025*** | -0.007 |
| | | | | [0.007] | [0.009] | | | | | | [0.009] | [0.006] |
| Dependency ratio | | | | 0.141* | -0.099 | | | | | | | |
| | | | | [0.085] | [0.124] | | | | | | | |
| Openness | | | | 0.015* | 0.041*** | | | | | | 0.018** | 0.023*** |
| | | | | [0.008] | [0.015] | | | | | | [0.009] | [0.008] |
| Age dependency | | | | | | | | | | | 0.064 | -0.033 |
| | | | | | | | | | | | [0.069] | [0.073] |
| Future age dependency | | | | | | | | | | | -0.025 | -0.094** |
| | | | | | | | | | | | [0.058] | [0.043] |
| IMF arrangement | | | | | | | | | | | -1.326 | -0.079 |
| | | | | | | | | | | | [0.877] | [0.502] |
| Year | -0.005 | 0.001 | 0.007 | | | -0.017 | 0.003 | 0.012 | 0.029 | -0.012 | | |
| | [0.015] | [0.014] | [0.021] | | | [0.013] | [0.011] | [0.019] | [0.020] | [0.020] | | |
| Constant | -1.125** | 0.65 | 3.491* | -7.255* | -0.200 | -0.235 | 0.401 | 2.453 | 2.893* | 3.448** | -3.763 | 2.448 |
| | [0.490] | [1.180] | [1.824] | [4.258] | [5.443] | [1.060] | [0.818] | [1.589] | [1.500] | [1.430] | [3.905] | [3.471] |
| Observations | 431 | 431 | 461 | 400 | 385 | 481 | 477 | 493 | 487 | 431 | 422 | 422 |
| R-squared | 0.72 | 0.724 | 0.578 | 0.624 | 0.427 | 0.741 | 0.729 | 0.583 | 0.538 | 0.563 | 0.632 | 0.486 |
| Country FE | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| Time FE | no | no | no | no | no | no | no | no | no | no | no | no |
| ILS (+ corrected S.E.) | no | no | no | no | yes | no | no | no | no | yes | no | no |
| Kleibergen-Paap LM statistic | 35.11 | 39.21 | 37.76 | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Kleibergen-Paap LM p-val | 0.000 | 0.000 | 0.000 | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Hansen test | 7.264 | 7.812 | 6.957 | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Hansen p-val | 0.123 | 0.0987 | 0.0733 | .. | .. | .. | .. | .. | .. | .. | .. | .. |

*Note: robust standard errors. Output_gap and current account are instrumented if "IV" shown. Oil prices / non-oil commodity price index – average oil price for oil exporters, non-oil commodity price index for all other countries (in our case); for definition see appendix. Dependency ratio is defined as non-active population over active population (15–64 years old). Lagged debt2 (lagged debt3) represent the quadratic and cubic term of public debt variable. ILS – indirect (two stage) IV estimation. PCSE model (col. 6 and 13) assumes panel-specific disturbances to be heteroskedastic and contemporaneously correlated (an AR(1) error structure; estimated average value: 0.446 for IV PCSE model; 0.485 for extended PCSE model). Hansen test's null hypothesis is that instruments (orthogonality conditions) are valid. The null of Kleinbergen-Paap LM test is that instruments are weak – only for IV FE ff0 model: 24.51 and p-val =0.000. x – exactly identified model. P-value: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Source: own calculation.*

## *Table A8. Description of main variables and their sources*

| Variable | Definition | Transformation(s) | Main source |
|---|---|---|---|
| Primary balance | General government primary balance (ESA 2010, EDP); | Series extended using series of previous methodological concepts – growth rates from OECD database, complemented with EC Statistical Annexes [FR, GR, IE, LU, and PT]. Values after 2007 adjusted for government support to the financial sector (GAFS). In percent of nominal GDP. | AMECO, ECB, OECD |
| Debt ratio | General government debt (EDP, ESA 2010); | Missing AMECO series extended using growth rates of non-EDP series ESA1995 based on Mauro *et al.* (2013); in percent of nominal GDP. | AMECO |
| Price index | GDP deflator (ESA 2010) | - | AMECO |
| Output gap | GDP minus potential GDP over potential GDP | - | AMECO |
| Current account | Current account balance in percent of GDP | - | AMECO |
| Election dummy | Binary variable (1 = election); | Own corrections for errors in data for new euro area member states | Electionresources.org |
| FRI | Fiscal rules index (de jure definition, five sub-indices, random weights) | - | EC (FRI database) |
| IMF fiscal rules index | Binary variable (1 = any fiscal rule is applicable); | Own calculation from IMF database – if any fiscal rule is applied then dummy variable is equal to 1 | IMF's Fiscal Rules database |
| Government stability | A measure of both of the government's ability to carry out its declared program(s), and its ability to stay in office. | - | PRSG |
| Total risk rating score | Composite Political, Financial, Economic Risk Rating for a country | - | PRSG |
| Political risk rating score | A means of assessing the political stability of a country on a comparable basis with other countries. | - | PRSG |
| Bureaucratic quality | Institutional strength and quality of a bureaucracy | - | PRSG |
| System of checks | Checks – countries where legislatures are not competitively elected are considered countries where only the executive wields a check. | - | PRSG |
| Government system | Parliamentary (2), Assembly-elected President (1), Presidential (0). | Only non-missing observations used. | WB DPI |
| Rule of majority | Fraction of seats held by the government. | Only non-missing observations used. | WB DPI |
| Index of fractionalization | The probability that two deputies picked at random from among the government parties will be of different parties. | Only non-missing observations used. | WB DPI |
| Index of polarization | Maximum polarization between the executive party and the four principle parties of the legislature | Only non-missing observations used. | WB DPI |
| Economic policy | Party orientation with respect to economic policy, coded based on the description of the party in the sources. | Only non-missing observations used. | WB DPI |
| Interest payments | Interest payments (ESA 2010). | Relative (as % of GDP, lagged debt or total revenues). | AMECO |
| Cyclical component of government final consumption expenditures | Final government consumption expenditures, ESA 2010; | HP filtered cyclical component (lambda = 100) | AMECO |
| Trade openness | Ratio of exports and imports to nominal GDP | Own calculation | AMECO |
| Dependency ratio | Ratio of population below 15 and above 64 to population between 15 and 64 | Own calculation | AMECO |
| Age dependency | Ratio of population below 15 and above 64 to population between 15 and 64 | - | PF WG EC |
| Future age dependency | Same as age dependency, but projections for 20 years ahead (medium variant) | - | PF WG EC |
| Oil-price | Simple average of three spot prices (Dated Brent, Texas Intermediate and the Dubai Fateh) | Own calculation | IMF commodity price database<br>WB commodities database |
| Non-oil price | Non-fuel price index (Food and Beverages and Industrial Inputs Price Indices)<br>Non-energy Commodities, (including Food and Beverages, Agricultural and Other Raw materials, Metals and Minerals and Fertilizers), annual prices, nominal USD | -<br>- | IMF commodity price database<br>WB commodities database |

*Note: EC – European Commission, WD DPI (Keefer, 2013) – World Bank Database of Political Institutions, AMECO – Macroeconomic Database of the EC (EC, 2016b), PRSG (PRSG, 2015) – Political Risk Services Group, IMF WEO – IMF World Economic Outlook*

*database (IMF, 2014). GAFS – Government Assistance to Financial Institutions (see ECB, 2015). World Bank Commodities Price Data (The Pink Sheet) – WB (2015), IMF Primary Commodity Prices – IMF (2015a). Period indicate the earliest year of data available in our sample. Source: own adaptation.*

### *Table A.9. Summary statistics*

| | Debt (% of GDP) | | | | Primary balance (% of GDP) | | | |
|---|---|---|---|---|---|---|---|---|
| | min | mean | max | st.dev. | min | mean | max | st.dev. |
| AT | 16.7 | 52.9 | 82.4 | 20.0 | -2.4 | 0.5 | 3.2 | 1.4 |
| BE | 54.4 | 98.5 | 134.4 | 25.4 | -7.7 | 1.3 | 6.7 | 3.5 |
| CY | 45.1 | 60.0 | 102.5 | 12.8 | -3.7 | -0.4 | 6.0 | 2.5 |
| DE | 16.2 | 46.1 | 81.0 | 19.6 | -6.0 | 0.7 | 9.0 | 3.2 |
| EE | 3.7 | 6.2 | 9.9 | 1.7 | -2.9 | 1.2 | 9.5 | 2.6 |
| ES | 11.5 | 40.6 | 93.7 | 21.1 | -9.3 | -0.8 | 3.8 | 2.9 |
| FI | 6.3 | 29.0 | 56.2 | 17.8 | -3.8 | 3.3 | 9.6 | 3.4 |
| FR | 20.1 | 45.9 | 92.3 | 21.9 | -4.8 | -0.2 | 4.2 | 1.8 |
| GR | 15.4 | 73.4 | 177.7 | 45.5 | -5.8 | -1.1 | 2.8 | 1.9 |
| IE | 23.6 | 67.7 | 120.1 | 28.3 | -9.6 | -0.1 | 6.8 | 4.1 |
| IT | 35.8 | 87.0 | 129.0 | 26.8 | -7.0 | -0.4 | 6.2 | 3.3 |
| LU | 4.2 | 10.9 | 23.3 | 5.2 | -1.1 | 2.4 | 6.3 | 2.1 |
| LV | 8.4 | 19.7 | 47.5 | 13.2 | -6.6 | -0.2 | 6.9 | 2.8 |
| MT | 22.4 | 54.4 | 72.0 | 16.9 | -6.4 | -1.6 | 1.2 | 2.4 |
| NL | 38.0 | 56.4 | 75.5 | 12.6 | -3.4 | 1.1 | 5.2 | 2.0 |
| PT | 13.2 | 53.0 | 129.0 | 26.4 | -7.0 | -1.4 | 2.2 | 2.2 |
| SI | 18.3 | 29.7 | 71.0 | 12.9 | -6.1 | -1.4 | 1.2 | 2.0 |
| SK | 21.7 | 37.5 | 55.0 | 9.7 | -8.0 | -3.0 | -0.2 | 2.4 |

*Note: extended series (according to the ESA2010 methodology extended using Mauro et al, 2013 dataset). Source: own calculations.*

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