Fiscal Reaction Function and Fiscal Fatigue in the Euro Area

Cristina Checherita-Westphal[1] and Vaclav Ždarek[2]

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Abstract: This paper applies a fiscal reaction function (FRF) framework to euro area countries and derives a novel approach to measure fiscal fatigue. We use various dynamic panel techniques and find evidence that euro area sovereigns abide, on average, by sustainability constraints. The positive reaction of primary surpluses to higher debt strengthened over the crisis. The primary balance improves by about 0.03–0.06 for every 1 percentage point increase in the debt-to-GDP ratio after controlling for other relevant factors. Considering a prudent coefficient for the fiscal policy reaction function (of around 0.04), one 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. The evidence of fiscal fatigue in non-linear FRF specifications is weaker.

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[1] European Central Bank, DG Economics, Fiscal Policies Division, E-mail: Cristina.Checherita-Westphal@ecb.europa.eu .
[2] University of Warwick, Department of Economics, PhD candidate. E-mail: v.zdarek@warwick.ac.uk.

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. The large debt burden of most sovereigns, coupled with high private indebtedness, has weighed on the economic outlook. This further complicates the sustainability of public finances in the face of rising age-related payments and the expected trend decline in potential growth due to population ageing and changing sources of 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). This condition is usually tested empirically by running a regression of primary balance on lagged debt series. In case of a *linear relationship*, a positive and significant debt coefficient denotes a country that is committed to reduce or maintain steady debt-to-GDP ratios conditional on a set of other factors. Generally, studies applied to large panels of advanced economies find evidence that governments tend, on average, to meet fiscal sustainability constraints.

Our paper focuses on estimation of fiscal reaction function for euro area countries with a greater emphasis on debt sustainability. We analyse in detail the degree of fiscal responsiveness to debt shocks in the euro area and conduct robustness checks for various periods, sets of potential determinants, exclusion of individual Eurozone countries, and empirical estimators. Our dataset is adjusted for government support to the financial sector, which allows us to avoid peaks in primary deficits that would otherwise reflect unduly fiscal loosening and induce high data volatility. In this way, we also address the issue of extreme outliers. Most importantly, we propose a novel concept to investigate fiscal fatigue for the euro area sovereigns, which is based on the estimated coefficient of the 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. Hence, the projected primary balance can be compared with a country fiscal track-record adjusted for the change in the level of debt by the estimated FRF coefficient. If the projected fiscal path, say as an average for a period of 10 years, is better than the country's best performance in the past, adjusted for the change in the debt level, then the sovereign may be considered at risk of fiscal fatigue. 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).

The paper is structured as follows. Section 2 reviews the literature. Section 3 presents the data and our model. Section 4 discusses the results for the fiscal reaction function and fiscal fatigue, including extensive robustness checks. Section 5 concludes. The Appendix includes a comparative summary of literature and further robustness checks.

2. A brief review of literature

In contrast with the approach of Blanchard *et al.* (1990) and others in the older literature, Bohn (1998) proposes an alternative concept of fiscal sustainability, whose simple formal (theoretical) description can be written as follows:

$$pb_t = \kappa \cdot d_t + \xi_t, \tag{1}$$

where pb_t is the primary balance in terms of GDP, d_t is the government debt-to-GDP ratio, κ is the responsiveness of the primary balance to the debt ratio and ξ_t contains various other determinants of primary balance (economic, institutional, etc.).

Bohn (2008) shows 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. Therefore, for any positive value of the coefficient κ, fiscal sustainability should be guaranteed.

However, a problem associated with such a general definition is its implicit assumption of invariability. For example Daniel and Shiamptanis (2013) show that a positive coefficient κ cannot be viewed as sufficient to achieve sustainability if there is a limit for positive values of primary balances. Gosh *et al.* (2013) call this definition a "weak sustainability condition".

The empirical counterpart of equation (1) usually takes the following linear form:

$$pb_t = \kappa \cdot d_{t-1} + \sum_{i=1}^{k} \mathbb{B} X_{i,t} + \varsigma_{i,t}, \tag{2}$$

where pb_t is the variable measuring primary balance in terms of GDP, d_{t-1} is one period lagged debt-to-GDP ratio, κ represents the response of the primary balance with respect to the debt ratio, $X_{i,t}$ is a vector containing various determinants of primary balance (economic, institutional, etc.) and measurement errors and random shocks are captured by the error term $\varsigma_{i,t}$.

The literature on "fiscal reactions" has expanded in recent years and became rather heterogeneous. It covers various research objectives, mostly related to fiscal sustainability, inter alia:

(i) Testing sustainability under a debt rule, in line with Bohn (1998), Bohn (2008), with model extensions provided in Doi *et al.* (2011) for the fiscal balance components (tax revenue and expenditure ratios); this strand includes studies that focus on pure statistical tests (unit root) of underlying fiscal time series such as Fincke and Greiner (2012);
(ii) Estimation of fiscal policy rules following the literature on monetary policy rules, in line with Debrun and Wyplosz (1999); Favero (2002); Galí and Perotti (2003);
(iii) Fiscal reaction functions as input to stochastic DSA simulations in line with Celasun *et al.*, (2006); Medeiros (2012); Eller and Urvová (2012) or to the calculation of fiscal limits (maximum sustainable debt limits) in line with Gosh *et al.* (2013).

In general, most panel FRF studies tend to find evidence of fiscal sustainability for advanced economies ($\kappa > 0$). The intensity of the reaction (size of κ) varies between 0.01 and 0.10 (country, time and estimator dependent). See table A.1 in Appendix 1 for a literature review summary.[3]

[3] The inclusion of non-linear terms changes estimated response that may even become negative.

Analyses of individual countries find more mixed results, though evidence of "weak" sustainability condition tends to dominate, e.g. results for the US in Bohn's studies, for four euro area countries in Legrenzi and Milas (2013); the majority (9 out of 17) OECD countries in Wyplosz (2005); for Spain over 1996–2008 in Cuerpo *et al.* (2014), 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 a FRF estimation on country-specific very long time series and a stochastic debt simulation. On the other hand, Galí and Perotti (2003) find in only five out of eleven euro area countries a positive and statistically significant coefficient on lagged debt in a model using cyclically adjusted primary balance (CAPB) as a way to model the discretionary reaction of fiscal policy.[4]

The FRF literature has more recently focused on the investigation of non-linear behaviour conditional on various determinants of debt dynamics. In this context, the hypothesis of fiscal fatigue has also been tested.[5] Several studies used polynomial (quadratic or cubic) functional forms for the reaction of primary balance to debt. They 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.[6] 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 EU countries, with debt thresholds in the range of 80–90% of GDP.

On the other hand, Legrenzi and Milas (2013) estimate simple non-linear FRFs (without other debt determinants) over the period 1960/70–2012 for four euro area countries most affected by the sovereign debt crisis (Greece, Ireland, Portugal and Spain) and don't 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 for 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 verifies fiscal solvency for a panel of EU countries over the period 1975/1980–2010 and confirms a positive relationship between debt and primary balance.

Weichenrieder and Zimmer (2014) is, to our best knowledge, among the very few FRF studies (if not the only one), which explicitly focus on the euro area countries. The authors study the average fiscal reaction for 17 euro area sovereigns covering the period 1970–2011. Structural shifts during this

[4] 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 stabilization behaviour of fiscal policy, with a positive effect of fiscal rules, counter-cyclical reaction of fiscal policy and provide evidence of a political budget cycle (under favourable macroeconomic conditions). Similarly, Ayuso-i-Casals *et al.* (2007) use CAPB (and primary expenditures) and various fiscal rules in a panel of 25 EU countries over the period 1990–2005. They do find evidence for fiscal stabilisation function (in addition to the main finding that the design and coverage of fiscal rules matters for their outcomes).

[5] 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).

[6] However, a robustness check to correct for the inclusion of highly indebted advanced economies reveals that for most of the European countries fiscal fatigue cannot be confirmed for example for medium-debt-ratio countries such Belgium or Ireland, see online appendix Ghosh *et al.* (2013a).

period are controlled via a dummy shifter – before and after the Maastricht Treaty (introduction of the euro). Their results show overall support to the sustainable policy hypothesis and since 1999, a larger positive coefficient on the debt ratio is found. Nevertheless, the robustness of their results depends on (i) the exclusion of the crisis period and/or of Greece are excluded; (ii) the behaviour of three countries (France, Greece and Portugal), where strong reactions of primary deficits to changes in debt prior to EMU accession could not be preserved within EMU.[7]

3. Model and data

3.1. Panel model features

Our empirical model is an extension and specification of the relationship given by equation 2:

$$pb_{it} = \alpha + \varphi pb_{it-1} + k \cdot d_{i,t-1} + \sum_{i=1}^{k} \beta_i X_{i,t} + \delta_i + \vartheta_{i,t}, \qquad (3)$$

where pb_{it} is the variable measuring primary balance in terms of GDP, d_{it} is the lagged debt-to-GDP ratio, φ is the regression coefficient for the lagged dependent variable (primary balance) and $X_{i,t}$ is a vector containing various (macro)economic, institutional, political determinants of primary balance, δ_i are country fixed effects (in some specifications are replaced and/or complemented by γ_t time fixed effects) and measurement errors and random shocks are captured by the error term $\vartheta_{i,t}$.

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 completely 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

Dependent variable

There are two main policy variables CAPB or PB available and it is obvious that the use of dependent variable highlights the primary focus of a study, that is models with CAPB do not reflect business cycle and estimate "fiscal effort", while models with PB are connected with the output gap and show the total change (with the effect of automatic stabilisers supposed to be rather negligible apart from few EA countries). Similarly, 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 (for details see Golinelli and Momigliano, 2008). Given that the primary balance is the

[7] Results are also sensitive to the exclusion of Belgium and Italy; however, their effects are on the magnitude rather than on significance.

[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 19th member Lithuania is not included because of missing data and its entry as late as in 2015.

"observable" fiscal policy variable, less prone to ex-post revisions, and following most studies, our choice is for PB as a fraction of GDP.

Explanatory variables

Abiad and Baig (2005) list three main groups of determinants for the fiscal position: (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 views (depending on the type of political party – left wing aiming at a broader role of fiscal policy or right wing with focus on fiscal prudence) and (3) institutional factors (the role of law, type of political institutions) that shape both environment and put limits on the use of fiscal measures. Our analysis encompasses variables covering all three groups since each of them determines the willingness and ability of a government to use particular fiscal instruments and measures.

There are several key variables in our FRF model. The core is the lagged public debt whose coefficient indicates the average government response with respect to public debt (stabilization or solvency). Others are: the lagged PB (taking into account persistence), whose inclusion, following Galí and Perotti (2003), provides us with qualitative information (changes of its coefficient) rather than quantitative; the output gap (a proxy for cyclical conditions) and a political risk variable. The specification of the output gap is essential also given its well-known problem of potential endogeneity (both driving and driven variable by fiscal policy). In the literature, there are few approaches to overcome the endogeneity – lagged output gap recommended in case of sample splitting (see Golinelli and Momigliano, 2006, 2008) given the assumption of governments taking decision based on past cyclical conditions due to information/publication delays.[9] Other approaches include an artificial measure of global output gap (see Galí and Perotti, 2003), or measures of foreign demand (see IMF, 2004). As standard, country fixed effects are included so that they capture all remaining time-invariant country-specific factors that are not explicitly controlled for. The most robust variables from the extended FRF model (see below) are also kept in our basic specification.

In an extended FRF model, as given by equation 3, our choice of variables reflects the specifics of the euro area countries compared to samples of less and more advanced countries. In addition to the core model above, we also consider:

(i) A proxy for the institutionalization of fiscal policy – the Fiscal rules index (FRI, calculated by the European Commission, see EC, 2014) and a simple dummy variable for the existence of any fiscal rule based on the IMF fiscal dataset [10] (see IMF, 2013). In case of the FRI, its higher values indicate more strict fiscal rules and/or a broader coverage, lagged by one period to limit any effect of reverse causation. Our choice is only one out of many various indices that have been constructed and utilized in recent empirical investigations of FRF – for robustness checks one could use for example an index of budgetary institutions following the work of Hallerberg, 2004 or Hallerberg *et al.*, 2004. Alternatively, an indicator based on country-specific numerical rules (following the work of Ayuso-i-Casals *et al.*, 2007 that draws upon an early version of the FRI index computed by the EC, see EC, 2014).[11] However, they would significantly the time period for our analysis due the availability of underlying time series for their construction;

[9] Some studies have exploited the historical vs. real-time data issue in this context, for an example see Golinelli and Momigliano (2006).
[10] Even the IMF fiscal database goes back only to 1985. We use it as the main input in our model; since the country-year coverage of the FRI variable is shorter (1990 onwards), it is used for robustness checks.
[11] We decided to use the FRI index as well for comparability of our results. However, the problem of the index is that it captures both whether a rule is more/less strict and the broader the coverage is.

(ii) To control for cross-country spillovers and the hypothesis of twin deficits, current account balance is included (as a share of GDP);[12]

(iii) To allow for different behaviour of fiscal policy, various dummy variables are used: Maastricht period (1991), years of the debt crisis, etc.;

(iv) Price developments and their effects on the fiscal balance are captured by the GDP deflator growth;[13]

(v) General government final consumption expenditure (cyclical component approximated via its HP filtered cyclical component of yearly time series); this variable should work together with the output gap to capture the government's smoothing behaviour (output gap allows for business cycle fluctuations); [14]

(vi) A further check on the influence of political and institutional variables is carried out with help of variables from the PRSG database (PRSG, 2015) and from the World Bank Database of Political Institutions (WB DPI, see Keefer, 2012).

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 usually shorter. As a robustness check we extend the AMECO primary balance series (rather short for some countries) by means of IMF WEO series (growth rates) until the 1970's or at least until the 1980's (for details see Appendix). The dataset consist of variable covering both nominal and real party of the economy, institutional indices and further variable such as fiscal rules. Main sources are DG ECFIN (AMECO database and for fiscal index the FRI database), Eurostat databases, the IMF International Finance Statistics and IMF Fiscal Database (see description in Appendix).

3.3. Estimation techniques

Several estimators have been employed in the literature for FRF estimations. A particular choice reflects key problems one has to deal with in dynamic panel data setting, especially when a set of potentially endogenous variables is expected to be treated appropriately. This paper has to deal both with potential issues such as endogeneity and cross-sectional correlation and so, there is a need to show robustness of findings.[15]

Since our specifications are dynamic panels of euro area countries that include fixed effects (γ_i), we start with the fixed effect estimator allowing for the presence of potentially endogenous variables (IV estimation). We are aware of criticisms of its use in a dynamic panel setting, however, our panel is large in the time dimension compared to the cross-section dimension and the potential bias should not be large. GMM estimators would not alleviate the problem (Kiviet, 1995; Judson and Owen, 1999).[16] Therefore, they are left for robustness check because of their asymptotic properties being negatively

[12] The existence of a twin-deficit is explored by using current account balance (as % of GDP) in some specifications (Mendoza and Ostry, 2008). Due to possible endogeneity, current account is instrumented by its own (first) lag to avoid any biases in our estimation.

[13] Following Patinkin (1993), positive rates of inflation can affect primary balance via two channels: fixed expenditures in nominal terms and taxflation. Abiad and Ostry (1995) add that higher inflation rates may result in increased volatility of price changes affecting real interest rate. As a result, a higher primary surplus (lower primary deficit) is needed to meet debt sustainability. However, we expect rather moderate effects due to low inflation periods of 1990's and 2000's and given the fact that our sample consists of mostly highly advanced countries.

[14] All these variables are the core of the Barro model (Barro, 1979). Output gap is instrumented by the use of its own (first) lag and contemporaneous US output gap, following Galí and Perrotti (2004).

[15] For an early discussion on the topic and possible solutions, see Celasun *et al.* (2006); for more recent Medeiros (2012).

[16] 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.

affected by the dimensions (cross-sections and time) of our panel. To deal with potential inconsistency of fixed effect estimators for dynamic panel specifications, longer time periods for estimations are utilized to meet the 'rule of thumb' of Bond (2002). This study states that for cases when T is larger than 20, potential bias of the FE estimator (the Nickell's bias) should be negligible.[17] 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 used in the robustness section. Haque *et al.* (1999) do not recommend the use of first-differencing in IV cases with time dimension above 20 since it may even result in less efficient estimates. Another problem usually omitted is to check for the presence of cross-sectional or 'spatial' dependence that may severally affect estimation efficiency and even render some estimators inconsistent (mainly 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) or Hoyos and Sarafidis (2006). For the same reason standard errors should be treated accordingly, otherwise they will result in overoptimistic *t*-statistics and confidence intervals (see Petersen, 2008; Hoechle, 2007).[18]

In addition, in robustness section further estimators are included (to provide results comparable with the literature). Since in case of weak instruments a LIML estimator shows better properties in comparison with GMM estimators, it is utilized alongside the differenced GMM (Arellano and Bond) estimator.[19] For the sake of comparison with Ghosh *et al.* (2013) and other studies, a FE estimator allowing for the error term to follow an AR(1) process and cross-sectional dependence (TPCSE) is employed (however, the exact FE AR(1) or FGLS estimator cannot be used due to unbalanced panel structure in our case). To investigate further potential cross-sectional correlation and its effects, the Driscoll-Kraay estimator is also utilized. Since our results do not differ substantially, we consider our chosen estimators as robust.

In dynamic panel setting for a quite homogenous group of countries, serial correlation and heteroscedasticity are to be expected. They affect the choice for treatment of standard errors that have to be robust in both dimensions. Given the rather small cross-country dimension (N = 18), we opt for robust and/or clustered errors (following the Driscoll-Kraay approach).[20]

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[17] 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 utilized in robustness section to stability and (no biasedness) of our results.

[18] A test for the presence of cross-sectional dependence (Pesaran's CS test, see Pesaran, 2004) confirms the existence of dependence for all our specifications (longer/shorter time periods). This is another reason for the preference of FE estimators with cross-sectional-dependence corrections over GMM estimators in our case since standard errors can be treated accordingly. 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 with allowing for spatial dependence that 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 basis of efficiency has been questioned mainly for the $T > N$ case; see Reed and Webb (2010). Therefore, we prefer using an IV estimator to avoid any problems with endogeneity and robust standard errors to deal with both heterogeneity and serial correlation.

[19] In addition, the Driscoll-Kraay estimator (*xtscc*) is also utilized since it allows for cross-sectional dependence. However, there is a problem with the choice of lag length width for autocorrelation of residuals for this estimator a panel setting since this estimator was originally developed for time series applications (see Hoechle, 2007) and larger panels. We use the rule-of-thumb: $\ell = floor\left\{4 * \left(\frac{T}{100}\right)^{2/9}\right\}$ that gives us the value of 3 that is increased to 5 to eliminate effects of political-economy or standard business cycle dynamics and to avoid problems with ℓ rather small. The latter seems to be a reasonable value given our dataset with yearly observations; both estimates do not differ substantially.

[20] Since critical values for the Baltagi-Wu (1999) LBI test have not been tabulated, we also use a modified Durbin-Watson test of Bhargava, Franzini, and Narendranathan (1982). In both cases results seem to be pointing towards positive serial correlation. Sribney (1998) points out that serial correlation may be a result of omitted variable bias (misspecification) and

4. Empirical results

4.1. Baseline specification

Our baseline specification includes five most robust determinants of the primary balance: lagged dependent variable, lagged debt ratio, output gap, current account balance and election dummy. In the first step, we apply this specification for the whole EA-18 group of countries and the entire time span of more than 40 years (1970–2013). In this part, we use as a rule the country fixed-effect instrumental variable (FE IV) estimator with HAC standard errors (robust to heteroscedasticity and serial correlation). Output gap and current account are instrumented through their lagged value, potential or trend GDP growth, real oil price index and US output gap, while the lagged primary balance is instrumented through its own lag, in line with EC (2011) and Ayuso *et al.* (2008).[21]

Results are presented in Table 1 below. The four models alternate the inclusion of time fixed effects and a time trend (*m1–m3*), while the model *m0* is a simple pooled model with no country or time fixed effects. Model *m2*, which includes a time trend capturing common cross-country factors varying in time, is less costly in terms of degrees of freedom (controlled variables) and performs best in various robustness tests in terms of the Hansen test (a test of validity of instruments) and the Kleibergen-Paap test (a test for weak instruments).[22] This model will be shown as the basic specification for the forthcoming robustness tests.

Table 1: Main specification, EA-18, 1970–2013

	m0	m1	m2	m3
Lagged primary balance	0.491***	0.227	0.585***	0.547***
	0.125	0.196	0.073	0.154
Lagged debt	0.023***	0.077***	0.050***	0.064***
	0.007	0.025	0.009	0.023
Output gap	0.680**	1.337***	0.373***	0.887
	0.264	0.506	0.116	0.561
Current account	0.096***	0.249**	0.211***	0.231**
	0.031	0.108	0.051	0.09
Election dummy	-0.494**	-0.391	-0.559***	-0.464**
	0.195	0.269	0.151	0.207
Year			-0.088***	
			0.016	
Constant	-1.069**	-4.058***	-0.328	-1.544
	0.477	1.402	0.479	1.054
Observations	444	444	436	444
R-squared	0.498	0.460	0.705	0.605
Country FE	No	yes	yes	yes
Time FE	No	no	no	yes
Kleibergen-Paap LM statistic	8.901	6.389	19.78	3.063
Kleibergen-Paap p-val	0.012	0.041	0.000	0.080
Hansen test	1.602	2.525	0.012	0.000
Hansen p-val	0.206	0.112	0.913	

*Note: robust standard errors, country fixed-effects, FE (not reported) used in all but model m0. 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. 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.*

not the inherent property of correlations in the well-specified model. Nevertheless, there are studies such as Stock and Watson (2006) that recommend preferring in the presence of serial correlation cluster-robust estimators.

[21] We test our model and both variables individually (a test proposed by Davidson and MacKinnon, 1993) and the test confirms that IV estimator is the right choice.

[22] 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).

Across all models shown in Table 1, the coefficient of our variable of interest, the lagged debt ratio, is highly statistically significant and varies between 0.023 in model *m0* without any control for country and time heterogeneity to 0.064 when controlling for both. The highest coefficient is for model *m1*, but this does not control for time effects and performs rather poorly in terms of the Sargan test (especially when other explanatory variables are added, with the null of validity rejected in most cases at 5%). In our preferred model, model m2, the debt coefficient is 0.05.

The responses of the primary balance to other variables are also, overall, highly statistically significant and have the expected sign. Good cyclical conditions (higher positive output gaps) improve the primary surplus. Elections years have, on average, a negative effect on the fiscal positions. The positive coefficient of the current account balance underpins the twin-deficit hypothesis.

4.2. Extended models

Table 2a below shows various models consisting in both extended and full specifications of the basic model *m0*. Results are presented stepwise (*m4–m11*) to see effects of including individual determinants such as fiscal rule, a PRSG proxy for stability of government or consumption expenditures and interest costs of servicing public debt (see section 3).

In all specifications, including the full models, the lagged debt ratio remains statistically significant, with a coefficient ranging between 0.046 and 0.064. As regards other explanatory variables, higher interest payments (as a ratio of GDP or total revenues) 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 Kinga (2013) on the "squeezing feeling" of the interest burden. The election variable remains statistically significant, with a negative impact on the primary balance, in all specifications. Similarly, the cyclical component of government consumption, used in several FRF studies to capture stabilising effects of fiscal policy, is found to limit primary surpluses.[23] At the same time, higher inflation, stronger positive output gap, government stability or the existence of a fiscal rule[24] generally work in the opposite direction. However, several variables lose significance in the combined models (*mf–mf2*).

Expanding further the basic model, panel b) of Table 2 introduces interaction terms of four main explanatory variables. The aim is to check robustness and investigate the implications for fiscal policy of the monetary union (euro introduction) period (1999–2013) in contrast to previous periods.[25]

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

[24] As measured by a dummy based on the IMF database. Results for an alternative index (FRI) from the European Commission are less robust (statistically significant only in certain models, which can be due to its relatively short time span). 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).

[25] Results for a similar analysis from 1991, that is, covering the entire period of monetary integration, are very similar and not reported.

Table 2a: Extended specification, EA-18, 1970–2013

	m4	m5	m6	m7	m8	m9	m10	m11	mf	mf1	mf2
Lagged primary balance	0.596***	0.588***	0.543***	0.585***	0.587***	0.577***	0.554***	0.588***	0.513***	0.511***	0.503***
	0.112	0.072	0.078	0.073	0.073	0.075	0.078	0.07	0.081	0.082	0.084
Lagged debt	0.062***	0.056***	0.051***	0.049***	0.064***	0.059***	0.049***	0.046***	0.049***	0.067***	0.066***
	0.018	0.01	0.01	0.009	0.012	0.011	0.009	0.009	0.011	0.016	0.016
Output gap	0.650*	0.389***	0.381***	0.366***	0.368***	0.374***	0.362***	0.363***	0.392***	0.399***	0.406***
	0.374	0.119	0.117	0.114	0.113	0.117	0.113	0.113	0.115	0.117	0.12
Current account	0.199***	0.213***	0.221***	0.212***	0.228***	0.233***	0.209***	0.193***	0.206***	0.225***	0.236***
	0.07	0.053	0.051	0.05	0.052	0.054	0.052	0.05	0.053	0.056	0.058
Election dummy	-0.510***	-0.563***	-0.458***	-0.565***	-0.554***	-0.553***	-0.537***	-0.506***	-0.399***	-0.381**	-0.379**
	0.175	0.15	0.15	0.15	0.152	0.151	0.149	0.152	0.151	0.15	0.148
Lagged GDP deflator growth	0.110**	0.076*							0.071	0.070	0.101
	0.045	0.039							0.067	0.057	0.069
Government stability			0.095*						0.042	0.024	0.021
			0.056						0.057	0.058	0.059
iir (implicit int rate)				-0.079					-0.129		
				0.061					0.101		
iirg (interest payments to GDP ratio)					-0.251**					-0.293**	
					0.112					0.139	
iirr (interest payments) to revenue ratio)						-0.089**					-0.131**
						0.041					0.057
Lagged fiscal rule							0.864**		0.757**	0.864**	0.811**
							0.334		0.345	0.336	0.345
Gov't. final cons. exp.								-0.095***	-0.086***	-0.078***	-0.078**
								0.029	0.031	0.03	0.03
Year		-0.071***	-0.085***	-0.109***	-0.128***	-0.123***	-0.122***	-0.081***	-0.136***	-0.156***	-0.154***
		0.018	0.017	0.026	0.025	0.024	0.022	0.016	0.031	0.03	0.028
Constant	-2.509**	-1.334*	-1.244*	0.796	0.743	0.655	0.194	-0.253	0.92	0.726	0.589
	1.058	0.787	0.734	1.013	0.575	0.569	0.536	0.462	1.538	1.059	1.007
Observations	444	436	409	436	436	436	436	436	409	409	409
R-squared	0.709	0.708	0.704	0.706	0.71	0.708	0.71	0.715	0.72	0.721	0.721
Country FE	yes	yes	yes	yes	Yes	yes	yes	yes	yes	yes	yes
Time FE	yes	no	no	no	No	no	no	no	no	no	no
Kleibergen-Paap LM st.	4.541	19.09	17.74	19.74	20.49	20.33	20	19.85	17.89	19.09	19.88
Kleibergen-Paap p-val	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hansen test	x	0.096	0.072	0.000	0.373	0.173	0.218	0.012	0.214	0.068	0.012
Hansen p-val	x	0.756	0.788	0.985	0.541	0.678	0.64	0.914	0.643	0.794	0.912

*Note: Interest payments / lagged debt (iir), Interest payments / GDP (iirg), Interest payments / revenues (iirr). 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 not reported. Further explanations and source; see part b) of this table. Source: own calculation.*

The determinants from the basic model keep their signs and levels of significance across all specifications. Turning to the interactions, interest payments turn positive and significant at 10% level only for the EMU period. The interacted debt variable has a positive sign and is significant for the EMU period, denoting a stronger response of the primary balance to debt for the period after 1999, including the crisis. The EMU dummy, however, turns negative and statistically significant in several models, denoting, ceteris paribus, lower primary balances during this period. A declining trend in primary surpluses, partly the effect of the crisis, is also captured by the year variable, which is significant and negative across all models.

Table 2b: Extended specification with interaction terms for EMU period, EA18, 1970–2013

	Benchmark	int1	int2	int3	int4	int5
Lagged primary balance	0.585***	0.575***	0.594***	0.596***	0.567***	0.564***
	0.073	0.077	0.071	0.071	0.071	0.077
Lagged debt	0.050***	0.055***	0.041***	0.057***	0.050***	0.061***
	0.009	0.012	0.008	0.01	0.009	0.014
Output gap	0.373***	0.395***	0.409***	0.389***	0.326***	0.402***
	0.116	0.118	0.124	0.116	0.107	0.115
Current account	0.211***	0.225***	0.228***	0.208***	0.191***	0.224***
	0.051	0.054	0.055	0.05	0.048	0.054
Election dummy	-0.559***	-0.476***	-0.483***	-0.525***	-0.476***	-0.481***
	0.151	0.147	0.145	0.143	0.143	0.144
Lagged growth of gdp deflator				0.091***		0.106***
				0.033		0.035
Lagged fiscal rule					1.009***	1.102***
					0.338	0.36
iirg (int. payments)		-0.155				-0.16
		0.109				0.123
Dummy for emu (d_emu)		-1.188*	-1.557**	0.418	0.616	0.01
		0.622	0.673	0.433	0.535	0.856
iirg_emu (int. payments x d_emu)		0.258*				0.003
		0.151				0.25
debt_emu (lagged debt x d_emu)			0.023**			0.014
			0.010			0.018
prices_emu (deflator x d_emu)				-0.066		-0.043
				0.089		0.095
frules_emu (imf_rule x d_emu)					-0.529	-0.871
					0.52	0.584
Year	-0.088***	-0.085***	-0.087***	-0.080***	-0.124***	-0.126***
	0.016	0.024	0.021	0.022	0.026	0.027
Constant	-0.328	-0.069	0.082	-1.337**	0.084	-0.347
	0.479	0.482	0.420	0.646	0.464	0.692
Observations	436	454	454	450	454	450
R-squared	0.705	0.712	0.712	0.715	0.717	0.729
Country FE	yes	yes	Yes	yes	yes	yes
Time FE	no	no	No	no	no	no
Kleibergen-Paap LM statistic	19.78	19.47	19.09	19.38	20.43	21.08
Kleibergen-Paap p-val	0.000	0.000	0.000	0.000	0.000	0.000
Hansen test	0.012	0.053	0.707	0.368	0.691	0.310
Hansen p-val	0.913	0.818	0.400	0.544	0.406	0.577

*Note: robust standard errors, country FE not reported. Interest payments / GDP (iirg). Final government consumption expenditures variable represents their cyclical component obtained from HP filter. Jp reports the Hansen test's p-value, (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.*

4.3. Further robustness tests

Time periods

This section presents several robustness checks as follows. First, we focus on a ***period effect*** since studies in the literature have shown differentiated impact of some variables (such as rules or political cycle) over time. Three periods, with and without the crisis, are used: (i) 1970–2013 and 1970–2007; (ii) 1985–2013/2007 (covering the full span of the IMF fiscal rule database); (iii) the Maastricht treaty period (from 1991). Because of the relatively short period since the launch of the euro, we do not estimate a model covering the period 1999 onwards (results may be subject to bias). Results for the basic model are shown for comparison. The debt variable and all other explanatory variables keep their signs and levels of significance. More specifically in respect to our variable of interest, a stronger positive impact of the debt ratio seems to be associated with the inclusion of crisis years, clearly visible when comparing responses for models *m1* and *m2; m3* and *m4,* or *m5* and *m6.*

Excluding the crisis years, the reaction coefficient of the debt ratio drops below 0.04. At the same time, the fiscal reaction seems to remain relatively stable over time, when similar shortened periods are compared, in contrast with the results indicated by the negative EMU dummy.

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

	m1 1970–2013	m2 1970–2007	m3 1985–2013	m4 1985–2007	m5 1991–2013	m6 1991–2007
Lagged primary balance	0.585***	0.632***	0.552***	0.567***	0.441***	0.491***
	0.073	0.065	0.079	0.071	0.098	0.104
Lagged debt	0.050***	0.038***	0.051***	0.037***	0.055***	0.037***
	0.009	0.008	0.01	0.008	0.015	0.01
Output gap	0.373***	0.399***	0.381***	0.306***	0.504***	0.325***
	0.116	0.13	0.113	0.103	0.136	0.124
Current account	0.211***	0.168***	0.213***	0.147***	0.247***	0.144**
	0.051	0.062	0.051	0.054	0.06	0.063
Election dummy	-0.559***	-0.769***	-0.444***	-0.662***	-0.450***	-0.679***
	0.151	0.162	0.152	0.165	0.173	0.187
Year	-0.088***	-0.062**	-0.086***	-0.027	-0.116***	-0.033
	0.016	0.026	0.019	0.022	0.024	0.033
Constant	-0.328	-0.246	-0.446	-1.177	0.345	-0.98
	0.479	0.543	0.784	0.774	1.146	1.253
Observations	436	336	389	284	337	232
R-squared	0.705	0.728	0.699	0.726	0.684	0.731
Country FE	yes	yes	Yes	yes	yes	yes
Time FE	no	no	No	no	no	no
Kleibergen-Paap LM statistic	19.780	11.560	20.800	16.990	20.460	18.290
Kleibergen-Paap p-val	0.000	0.003	0.000	0.000	0.000	0.000
Hansen test	0.012	2.818	1.023	2.740	0.015	3.757
Hansen p-val	0.913	0.093	0.312	0.098	0.904	0.053

*Note: robust standard errors, country FE used in all specifications. Hansen p-val reports the Hansen test's p-value. 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.*

Cross-country robustness checks

The second type of robustness checks is implemented across ***the country dimension***. In this respect, two "standard" checks are performed. First, the basic specification is also estimated for four restricted groups of countries, which include only the "core" or "old" euro area members (founder member states and/or Greece), with some variation. The empirical results are presented in Table 4 below for the 12 oldest member states[26] (EA-12), for two EA-11 groups (EA-12 without Greece, replicating the EA-11 group after the euro launch, or without Luxembourg, which can be considered an outlier as the country with the lowest debt ratio in the group) and for EA-10 (EA-12 without both GR and LU, countries with the highest and lowest debt ratio in the restricted sample). Similar to previous robustness check, there are no major changes in the significance or signs of individual variables. For the entire period covering also crisis years, the exclusion of the new euro area member states does not seem to alter the results significantly. Over this long period of time, excluding GR seems to increase only marginally the reaction coefficient of primary balance to debt in the core EA countries, while excluding Luxembourg seems to lead to a lower reaction.

[26] Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, the Netherlands and Portugal.

Table 4: Main specification by groups of countries, 1970–2013

	M1 EA18	M2 EA12	M3 EA11a	M4 EA11b	M5 EA10
Lagged primary balance	0.585***	0.603***	0.506***	0.626***	0.505***
	0.073	0.081	0.105	0.083	0.121
Lagged debt	0.050***	0.049***	0.051***	0.046***	0.051***
	0.009	0.010	0.010	0.011	0.012
Output gap	0.373***	0.453**	0.710***	0.415**	0.746***
	0.116	0.184	0.224	0.208	0.286
Current account	0.211***	0.153***	0.144**	0.169***	0.152**
	0.051	0.051	0.06	0.061	0.075
Election dummy	-0.559***	-0.524***	-0.496***	-0.522***	-0.500***
	0.151	0.158	0.167	0.166	0.175
Year	-0.088***	-0.073***	-0.069***	-0.071***	-0.067***
	0.016	0.016	0.019	0.015	0.019
Constant	-0.328	-0.598	-0.735	-0.536	-0.789
	0.479	0.510	0.616	0.516	0.656
Observations	436	344	323	322	301
R-squared	0.705	0.726	0.701	0.731	0.699
Country FE	yes	yes	yes	Yes	yes
Time FE	no	no	no	No	no
Kleibergen-Paap LM statistic	19.78	13.41	15.00	10.28	11.70
Kleibergen-Paap p-val	0.000	0.000	0.000	0.000	0.000
Hansen test	0.012	1.176	1.168	2.823	2.564
Hansen p-val	0.913	0.278	0.280	0.093	0.109

*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 represents the EA-12 group without GR, and respectively, LU; EA-10 is EA12 without both countries GR and LU. Hansen p-val reports the Hansen test's p-value. 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.*

As a second robustness check in the cross-country category, we examine the issue of panel heterogeneity and control more extensively for outliers by running the benchmark specification always dropping one country at a time. Table 5 below summarises these results. The variation of estimated coefficients for the entire time period and the extended sample (EA-17) lies within a narrow range of 0.047 when Greece or Portugal are excluded and 0.055 when Slovenia is excluded. Next columns of Table 5 show results for the same exercise leaving out the crisis period (2008–2013) and implemented also for the more recent time periods, starting in 1985 and 1991 (as done in Table 3 for the whole sample of EA-18). Confirming the findings in Table 3, excluding the crisis years leads to lower fiscal reaction coefficients, which start at 0.032. Overall, the statistical significance of the debt coefficients remains unaffected by country exclusions.

Table 5: Fiscal reaction coefficient by time periods and excluding individual countries (main specification)

	1970–2013		1970–2007		1985–2007		1991–2007	
	$\hat{\beta}_{DEBT}$	SE	$\hat{\beta}_{DEBT}$	*SE*	$\hat{\beta}_{DEBT}$	*SE*	$\hat{\beta}_{DEBT}$	*SE*
AT	0.049***	0.009	0.033***	0.007	0.038***	0.008	0.037***	0.010
BE	0.049***	0.009	0.033***	0.007	0.037***	0.008	0.037***	0.010
CY	0.049***	0.009	0.033***	0.007	0.036***	0.008	0.036***	0.010
DE	0.053***	0.010	0.036***	0.009	0.041***	0.009	0.038***	0.011
EE	0.049***	0.009	0.032***	0.007	0.035***	0.008	0.033***	0.010
ES	0.051***	0.010	0.033***	0.007	0.037***	0.008	0.036***	0.010
FI	0.049***	0.009	0.033***	0.007	0.039***	0.008	0.041***	0.010
FR	0.049***	0.010	0.032***	0.007	0.034***	0.008	0.035***	0.010
GR	0.047***	0.009	0.032***	0.009	0.034***	0.011	0.039***	0.013
IE	0.049***	0.009	0.036***	0.007	0.040***	0.008	0.046***	0.009
IT	0.051***	0.010	0.035***	0.008	0.039***	0.009	0.038***	0.011
LU	0.051***	0.010	0.034***	0.007	0.037***	0.008	0.038***	0.012
LV	0.048***	0.009	0.035***	0.007	0.039***	0.008	0.041***	0.010
MT	0.051***	0.010	0.033***	0.008	0.039***	0.008	0.039***	0.011
NL	0.049***	0.009	0.032***	0.007	0.036***	0.008	0.034***	0.010
PT	0.047***	0.009	0.032***	0.007	0.036***	0.008	0.035***	0.010
SI	0.055***	0.011	0.035***	0.008	0.041***	0.009	0.039***	0.011
SK	0.048***	0.009	0.032***	0.007	0.037***	0.008	0.036***	0.010

*Note: Based on estimations of the basic model (table 1 model m2). Countries shown in column 1 are excluded one at a time from the respective sample by period; robust standard errors; country FE used in all specifications. 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.*

Robustness checks with various empirical estimators

As a last category of robustness check, we use a battery of estimators to check any potential biases in our estimates compared to the base estimator (FE IV estimator), as follows: (i) pooled OLS estimator; (ii) FE estimator with robust standard errors and time effects; (iii) a LIML estimator (that is preferred for weaker instruments); (iv) CUE estimator; (v) the bias corrected LSDVC estimator with boostrapped S.E. that has been favoured by some studies for dynamic panels models with long time dimension; (vi) two GMM estimators (two-step GMM and two difference GMM estimators – "standard" and with orthogonal deviations) that are well suited to correct for endogeneity, but less appropriate for our panel with rather small cross-sectional dimension and longer time series dimension; (v) the Driscoll-Kraay estimator explicitly controlling for cross-sectional dependence in the panel, and (vi) the PCSE estimator allowing for panel specific AR(1) processes in the error term. To mitigate endogeneity problems in case of several estimators, which do not allow for IV, we use one-period-lagged values for selected variable (lagged output gap and current account balance). Table 6 below summarises the results.

Regarding our variable of interest, the debt ratio remains highly statistically significant across all estimators. The only exception is a model estimated with Arellano Bond GMM (ABo GMM with orthogonal deviations), where the significance drops at 10% only. In terms of economic significance, the fiscal reaction coefficient generally drops with several other estimators. Leaving aside the pooled OLS results, the lower bound is found for the LSDVC, DK and PCSE estimators (between 0.030–0.035). An extreme upper bound (0.112) is given by the AB GMM estimator, but the coefficient declines to 0.046 when orthogonal deviations (ABo GMM) are used).[27] In both models with AB GMM estimators, the election dummy becomes insignificant, which is surprising and pointing to potential problems in the estimation. Otherwise, all other variables largely keep their levels of significance and signs.

[27] The instrument sets differ for GMM estimators: lagged potential GDP growth and lagged US output gap for the AB GMM and contemporaneous US output gap for Abo GMM.

Table 6: Main specification: robustness check with various estimators, EA-18, 1970–2013

	OLS	IV FE (basic)	IV FE+TE	LIML	CUE	LSDVC	IV GMM 2s	AB GMM	ABo GMM	DK	PCSE
Lagged primary balance	0.860***	0.593***	0.720***	0.593***	0.593***	0.807***	0.593***	0.319***	0.658***	0.746***	0.724***
	0.032	0.069	0.056	0.073	0.069	0.039	0.069	0.095	0.11	0.039	0.039
Lagged debt	0.003***	0.050***	0.035***	0.050***	0.050***	0.030***	0.050***	0.112***	0.046*	0.035***	0.034***
	0.001	0.008	0.008	0.007	0.008	0.007	0.008	0.022	0.024	0.008	0.007
Output gap		0.359***	0.204	0.359**	0.360***		0.360***	0.543***	0.269**		
		0.112	0.139	0.134	0.111		0.111	0.143	0.119		
Current account		0.203***	0.150***	0.203***	0.203***		0.203***	0.350*	0.133***		
		0.049	0.038	0.043	0.049		0.049	0.196	0.033		
Election dummy	-0.637***	-0.500***	-0.617***	-0.500***	-0.500***	-0.600***	-0.500***	-0.546	0.018	-0.590***	-0.660***
	0.133	0.145	0.149	0.132	0.145	0.148	0.145	0.632	0.716	0.148	0.17
Lagged output gap	-0.176***					-0.045				-0.032	-0.036
	0.031					0.034				0.055	0.038
Lagged current account	0.019***					0.103***				0.112***	0.120***
	0.006					0.022				0.035	0.027
Year	0.000	-0.085***		-0.085***	-0.085***	-0.054***	-0.085***	-0.104**	-0.051**	-0.061**	-0.055***
	0.000	0.016		0.023	0.016	0.013	0.016	0.046	0.019	0.024	0.015
Constant	0.013	-0.435	-0.866*	-0.435	-0.44		-0.44			34.735**	-0.259
	0.152	0.395	0.493	0.476	0.386		0.386			13.863	0.433
Observations	472	454	436	454	454	472	454	423	424	472	472
R-squared	0.605	0.709	0.782	0.709	0.709	..	0.709	..	..	0.601	0.696
Country FE	No	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time FE	No	no	yes	no	no	no	yes	no	no	no	no
Kleibergen-Paap LM statistic	..	19.4	13.98	8.378	19.4	..	19.4	..	..	..	..
Kleibergen-Paap LM p-val	..	0.000	0.000	0.015	0.000	..	0.000	..	..	..	..
Hansen test	..	0.003	x	x	0.003	..	0.003	8.113	13.920	..	..
Hansen p-val	..	0.957	x	x	0.958	..	0.957	0.995	0.306	..	..
AR(1) p-val	..	..	..	..	..	..	..	0.000	0.000	..	..
AR(2) p-val	..	..	..	..	..	..	..	0.122	0.212	..	..

*Note: robust standard errors or clustered standard errors for FE), robust standard errors for GMM estimators; bootstrapped S.E. for LSDVC estimators. AB GMM (xtabond2, collapsed), ABo GMM (xtabond2, orthogonal, collapse). Jp reports the Hansen test's p-value, x – exactly identified model. Specification of instruments between estimators may change. For estimators without IV option, the closest specification was used and/or first lag of the variable. .. – not available/not calculable. Lagged output gap and lagged current account are not instrumented. 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.*

5. Fiscal fatigue

The concept of fiscal fatigue has so far been investigated in the literature using non-linear fiscal reaction functions in line with Ghosh *et al.* (2013).[28] In this paper, we first propose a novel approach to measure fiscal fatigue building on the linear FRF. We then investigate the fiscal fatigue across euro area countries using the non-linear approach.

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 constraint by a multitude of economic and political factors, denoting fiscal fatigue. The linear FRF literature provides the size of the estimated coefficient for the reaction of primary balance to debt. This can be used to calculate upper limits for the primary balance and thus provide a useful input for debt sustainability analyses (DSA).[29] 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 upper for the fiscal fatigue, an estimated linear FRF coefficient can be used. For instance, taking a prudent coefficient of 0.04 based on our analysis of the euro area FRF, any 10 pp increase in the debt ratio (ΔD) would add 0.4 pp to the primary balance. The "adjusted primary balance Benchmark" (B_{adj}) would then be derived as follows:

$$B_{adj} = B + 0.04*(\Delta D) \tag{4}$$

One could assign for instance a heat map of the fiscal fatigue risk as follows:

- Low risk (green) if the simulated primary balance (say average over 5 or 10 years over the DSA horizon) is lower than the benchmark B of the recent past;
- Medium risk (yellow) is 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 (red) if the simulated primary balance is above the debt-adjusted benchmark (B_{adj}).

Turning to the ***non-linear FRF***, we also investigate fiscal fatigue in line with Ghosh *et al.* (2013) by means of the following specification:

$$pb_t = \varphi pb_{t-1} + \beta_0 d_{t-1} + \beta_0' d_{t-1}^2 + \beta_0'' d_{t-1}^3 + \sum_{i=1}^{k} \beta_i X_{i,t} + \delta_i + \gamma_t + \vartheta_{i,t}, \tag{5}$$

where pb_t is the variable measuring primary balance in terms of GDP, d_{t-1} (d_{t-1}^2, d_{t-1}^3) is the lagged debt-to-GDP ratio (squared and cubic term), φ is the regression coefficient for the lagged dependent variable (primary balance) and $X_{i,t}$ is a vector containing various (macro)economic,

[28] Empirical evidence of primary balances and the sustainability of positive balances in a sample of 54 developed and emerging economies over the period 1974–2013 can be found in Eichengreen and Panizza (2014).

[29] For details regarding this novel approach of assessing sustainability of public finances see for example IMF (2011).

institutional, political determinants of primary balance, δ_i are country fixed effects (in some specifications are replaced and/or complemented by γ_t time fixed effects) and measurement errors and random shocks are captured by the error term $\vartheta_{i,t}$.

The results for the benchmark specification over the entire period 1970–2013, as well as for its extension (with interest payments) are presented in table 7. In total nine specifications are included, where *m0* is our basic specification, *m1* includes the squared term and *m2* includes also the cubic term. As we move across specifications, the lagged debt term loses somewhat significance while further non-linear terms remain overall insignificant. Other explanatory variables keep their signs and levels of significance.

Table 7: Extended benchmark model and fiscal fatigue, EA-18, 1970–2013

	m0	m1	m2	m0	m1	m2	m0	m1	m2
Lagged primary balance	0.585***	0.564***	0.566***	0.587***	0.513***	0.524***	0.577***	0.499***	0.511***
	0.073	0.081	0.083	0.073	0.093	0.095	0.075	0.096	0.097
Lagged debt	0.050***	0.023	0.04	0.064***	0.062**	0.118*	0.059***	0.054*	0.112*
	0.009	0.020	0.057	0.01200	0.03100	0.06300	0.01100	0.03100	0.06500
Lagged debt2		0.0002	-0.00006		0.0001	-0.0010		0.0001	-0.0010
		0.0001	0.00073		0.0002	0.0010		0.0002	0.0010
Lagged debt3			1.01E-06			0.0000			0.0000
			2.86E-06			0.0000			0.0000
Output gap	0.373***	0.395***	0.399***	0.368***	0.600***	0.600***	0.374***	0.611***	0.610***
	0.116	0.13	0.133	0.113	0.117	0.116	0.117	0.119	0.117
Current account	0.211***	0.222***	0.219***	0.228***	0.268***	0.254***	0.233***	0.275***	0.259***
	0.051	0.054	0.057	0.05200	0.06800	0.06900	0.05400	0.07000	0.07000
Election dummy	-0.559***	-0.560***	-0.565***	-0.554***	-0.524***	-0.542***	-0.553***	-0.524***	-0.543***
	0.151	0.152	0.152	0.152	0.165	0.164	0.151	0.165	0.164
Iirg (debt payment)				-0.251**	-0.312**	-0.308**			
				0.112	0.133	0.133			
Iirr (debt payment)							-0.089**	-0.107**	-0.106**
							0.041	0.050	0.049
Year	-0.088***	-0.085***	-0.085***	-0.128***	-0.145***	-0.145***	-0.123***	-0.138***	-0.138***
	0.016	0.017	0.017	0.025	0.031	0.031	0.024	0.03	0.03
Constant	-0.328	0.507	0.178	0.743	1.135	0.021	0.655	1.065	-0.090
	0.479	0.666	1.241	0.575	0.822	1.394	0.569	0.826	1.397
Observations	436	436	436	436	436	436	436	436	436
R-squared	0.705	0.704	0.704	0.71	0.663	0.667	0.708	0.658	0.662
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Time FE	no	no	no	no	no	no	no	no	no
Kleibergen-Paap LM statistic	19.78	16.67	17.09	20.490	26.430	27.030	20.330	26.260	26.880
Kleibergen-Paap p-val	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hansen test	0.012	0.131	0.092	0.373	0.308	0.161	0.173	0.140	0.051
Hansen p-val	0.913	0.717	0.762	0.541	0.579	0.688	0.678	0.708	0.821

*Note: Interest payments / GDP (iirg), Interest payments / revenues (iirr). Robust standard errors, country FE used in all specifications. Output_gap and current account are instrumented. Lagged debt 2 (debt3) represent the quadratic and cubic term of public debt variable. 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*

Our results inspired by the approach of Ghosh *et al.* (2013) reveal a lack of fiscal fatigue defined with the help of both cubic and a simple quadratic term. No matter how surprising these results can be, they only confirm problems with stability and robustness checks because of country/period coverage.[30] When investigating potential fiscal fatigue effects, table 8 presents the effect of shortening time period for selected models with interest payments included.[31] The evidence is again weak. In

[30] Ghosh *et al.* (2013a) robustness checks offer a comparable picture since only few (high-debt) countries including some non-European can be viewed as "suffering" from the fiscal fatigue (in Europe Greece and Italy, but the estimated coefficients are statistically insignificant for Greece when estimated individually). Conversely, medium-debt European countries such as Belgium or Ireland are found without signs of fiscal fatigue.

[31] Table 8 shows results for interest payments as a fraction of GDP (*iirg*). Since results for interest payments as a fraction of total revenues (*iirr*) are similar, they are not reported as it is done in table 7 (available upon request from authors).

selected models, a debt turning point of around 115–120% of GDP is found to indicate fiscal fatigue (maximum debt limit beyond which the reaction of primary balance to debt become negative).

Table 8: Fiscal fatigue and the effect of time, EA-18

	nl m1	nl m2	nl m1	nl m2	nl m1	nl m2	nl m1	nl m2
	1970-2007		1991-2007		1970-2007		1991-2007	
Lagged primary balance	0.570***	0.556***	0.450***	0.448***	0.571***	0.555***	0.507***	0.511***
	0.077	0.079	0.134	0.140	0.083	0.078	0.100	0.100
Lagged debt	-0.015	-0.082	0.115***	0.448	0.011	-0.083	0.067**	0.241**
	0.02	0.053	0.044	0.279	0.031	0.054	0.026	0.117
Lagged debt2	0.0004**	0.001*	-0.0005*	-0.00500	0.00000	0.001*	-0.00000	-0.003*
	0.0002	0.001	0.00025	0.00400	0.00000	0.00100	0.00000	0.00200
Lagged debt3		-4.88E-06		0.00002		0.00000		0.00000
		3.61E-06		0.00001		0.00000		0.00000
Output gap	0.284*	0.293*	0.896***	0.923***	0.521***	0.304**	0.393***	0.357***
	0.161	0.164	0.279	0.276	0.169	0.139	0.111	0.104
Current account	0.155**	0.177**	0.291**	0.274**	0.230***	0.180**	0.144*	0.119
	0.067	0.074	0.112	0.116	0.075	0.076	0.077	0.073
Election dummy	-0.787***	-0.777***	-0.197***	-0.193***	-0.745***	-0.775***	-0.676***	-0.676***
	0.159	0.161	0.074	0.071	0.167	0.163	0.189	0.189
Iirg (debt payment)					-0.108	0.004	0.125	0.152
					0.128	0.124	0.141	0.138
Year	-0.03	-0.03	-0.737***	-0.754***	-0.092**	-0.031	-0.031	-0.008
	0.027	0.027	0.23	0.234	0.045	0.04	0.055	0.054
Constant	0.771	1.989	0.996	-6.272	1.411	2.022*	-2.362	-6.741**
	0.761	1.222	2.259	5.914	0.881	1.221	1.96	3.012
Observations	331	331	241	241	331	331	237	237
R-squared	0.746	0.745	0.572	0.569	0.713	0.745	0.729	0.736
Country FE	yes	yes	yes	yes	yes	yes	yes	yes
Time FE	no	no	no	no	no	no	no	no
Kleibergen-Paap LM statistic	13.04	12.64	12.38	11.61	20.290	15.550	14.340	14.830
Kleibergen-Paap p-val	0.001	0.002	0.002	0.003	0.000	0.000	0.001	0.001
Hansen test	3.481	2.502	0.095	0.246	0.171	2.338	2.448	3.488
Hansen p-val	0.062	0.114	0.758	0.620	0.679	0.126	0.118	0.062
Fiscal fatigue?								
–Approx	21.8	x	119.1		x		134.7	
– Exact								114.8

*Note: robust standard errors, country FE used in all specifications. Output_gap and current account are instrumented. Lagged debt2 (debt3) represent the quadratic and cubic term of public debt variable. Jp reports the Hansen test's p-value. P-value: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Approx. – approximate solution (omitting the absolute term), exact – exact solution. Source: own calculation.*

Conclusions

The paper dealt with two research questions. First, we estimate a fiscal reaction function for the euro area countries. Second, we explore the problem of fiscal fatigue in greater depth. We use various dynamic panel techniques and find evidence that euro area sovereigns abide, on average, by sustainability constraints. The positive reaction of primary surpluses to higher debt strengthened over the crisis. We show that the FRF estimates are rather robust across various specifications, time periods and inclusion of individual countries. The primary balance improves by about 0.03–0.06 for every 1 percentage point increase in the debt-to-GDP ratio after controlling for other relevant factors. 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 rather weak.

Our study is subject to caveats associated with a panel approach when investigating the fiscal fatigue hypothesis. A natural response seems to be in more data-demanding country specific models that can be estimated with a battery of econometric techniques allowing for various types of non-linearities and natural patterns, so that they may better capture the underlying processes. This would come, though, at the cost of reduced comparability and applicability to more recent economic, institutional and political conditions.

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Appendix

Table A.1: Summary of FRF literature review

Study	Model specification	Coefficient on lagged debt	Further notes
Bohn (1998)	Primary balance Country study: US economy, period 1916–1995	0.054	OLS estimator with Newey-West S.E., GVAR and YVAR fiscal variables, extensions: fiscal fatigue (second and third polynomial terms, break at 34%); subsamples,
Debrun and Wyplosz (1999)	primary balance (with one lag) 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, Period: 1980–2002, EU-11+OECD-5 (individual, pooled estimation)	-0.06 -0.07 (only EU-11) -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 (2003)	general government primary balance (with one lag) Panel: 54 emerging and industrial countries, 1990–2002;	0.039–0.047 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%);
IMF (2004)	general government cyclically adjusted primary balance (with one lag) Panel (unbalanced): EA-12 (without Luxembourg), period 1971–2003	0.00–0.08	2SlS IV estimator, model with monetary gaps; country specific FRF;
Abiad and Baig (2005)	Primary balance Panel: 34 emerging market countries, country-specific effects, 1990–2002	0.034 0.055–0.086 (with debt spline) 0.063–0.089 (extended model with debt spline) 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 Panel: 31 emerging market countries, country-specific effects, 1990–2002	0.05–0.10 0.04–0.06 (extended model)	FGLS estimator, debt spline at 50%; extensions: alternative fiscal institution measures;
Annett (2006)	Cyclically adjusted primary balance (with one lag)	0.01–0.03 (EU-14)	Pooled and 2SLS estimator with and without country fixed effect, extensions: dummy for

	Panel: EU-14 countries (without Luxembourg) over 1980–2004	0.01–0.02 (EU-11)	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;
Celasun *et al.* (2006)	general government primary balance Panel: 34 emerging economies over 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;
Golinelli and Momigliano (2006)	Change of cyclically adjusted primary balance, lagged primary balance included Panel: 19 OECD, 11 Euro area countries, 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) Panel: 22 EU countries over the period 1990–2005	0.00–0.03 -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.
Bohn (2008)	Primary balance Country study: US economy, period 1792–2003	0.094 – 0.121	OLS estimator with robust standard errors, with time trend; extensions: debt squared, AR(1) process for outlays, public debt is not lagged.
Debrun *et al.* (2008)	General government and cyclically adjusted balance (with one lag), Panel: EU-25 countries, over period 1990–2005	0.02-0.04 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) Change in cyclically adjusted primary balance (lagged primary balance) Change in primary balance (one lag added) Panel: 11 EA countries, period 1978–2006	0.008–0.080 0.009–0.011 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);
Mendoza and Ostry (2008)	Primary balance Panel: 22 industrial and 34	0.033–0.072 0.020-0.038 (only industrial	FE estimator with country-fixed effects, robust S.E. with country AR(1) coefficients; extensions:

	emerging countries, period 1980/1990–2005	countries)	subsamples (high/low debt countries); spline regression (threshold at 48%); shorter periods for most emerging countries; YVAR and GVAR government expenditure variables;
Afonso and Jalles (2011)	Primary balance (with one lag) Panel: 18 OECD countries over the period 1970–2010	0.01–0.15 -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 Panel: EU-27 countries, over 1975/1980–2010	0.027 – 0.031 0.033 – 0.038 (extensions)	FE IV estimator with country fixed effects; extensions: with the FRI variable for the period 1990–2008;
Ghosh *et al.* (2011)	general government primary balance Panel: 23 developed countries, period 1970/1985–2007	-0.2080 (long) -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;
Eller and Urvová (2012)	General government primary balance (with one or two lags) 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) Panel: EU-27 countries, over period 1990–2008	0.0367 0.0455–0.0563 (for CAPB) 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 Panel: EU-27/-21 countries, 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) Panel: 10 EA countries, time dummies for selected years, 1988–2009	0.0240–0.0426; 0.064 (non-linear model with a squared term) 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 Panel: 11 EA countries, 1970–2011, pre-EMU (1970–1998) and post-EMU (1999–2011)	0.0727	Panel cointegration estimators (DOLS) allowing for heterogeneity,

Debrun and Kinda (2013)	primary balance Panel: advanced (28) and emerging (26) countries, period 1980–2010	0.035–0.040 (FE) 0.032–0.037 (LSDVC)	FE and LSDVC estimator; extensions: interest payments, and interest payments thresholds (linear);
Ghosh *et al.* (2013)	general government primary balance panel: 23 developed countries (EU-14), period 1970/1985–2007	-0.208– -0.225 (long) -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;
Legrenzi and Milas (2013)	Primary surplus Country specific models for Greece, Ireland, Portugal and Spain over the period 1960(1970)–2012.	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 Country specific – Spain only, period 1986q1–2012q4 (quarterly data)	-0.032 – 0.018	Bayesian time-varying coefficients technique (TVC)
Debrun and Kinda (2014)	primary balance Panel: advanced (28) and emerging (26) countries, period 1990–2011	0.015–0.023	LSDVC estimator; extensions: exploring fiscal rules and fiscal councils;
Schoder (2014)	Primary balance Panel: 15 OECD countries, period 1981–2010 (quarterly observations)	0.041 (1980–1996) 0.011 (1997–2010)	MG and PMG estimators, extensions: various subperiods and subgroups,
Weichenrieder and Zimmer (2014)	general government primary balance Panel: EA countries, 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.
Cordes *et al.* (2015)	Primary balance (with one lag) Panel: 57 advanced and developing economies, 1985–2012	0.013	LSDVC estimator, expenditure rule index/dummy, extensions: model specified for primary expenditures

Source: studies listed above, own adaptation.

Table A.2: Robustness check, EA-18, 1970–2013

	benchmark	r1	r2	r3	r4	r5	r6	r7	r8	r9	r10	r11	r12	r13	r14	r15	r16	r17
Lagged primary balance	0.585***	0.517***	0.542***	0.543***	0.559***	0.588***	0.590***	0.585***	0.587***	0.586***	0.575***	0.586***	0.513***	0.466***	0.554***	0.575***	0.570***	0.422***
	-0.073	-0.079	-0.079	-0.078	-0.076	-0.075	-0.074	-0.074	-0.074	-0.076	-0.078	-0.074	-0.08	-0.082	-0.078	-0.076	-0.078	-0.121
Lagged debt	0.050***	0.051***	0.053***	0.051***	0.050***	0.050***	0.050***	0.050***	0.050***	0.049***	0.051***	0.050***	0.052***	0.054***	0.049***	0.049***	0.049***	0.078***
	-0.009	-0.01	-0.01	-0.01	-0.01	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.012	-0.013	-0.009	-0.009	-0.009	-0.019
Output gap	0.373***	0.331**	0.388***	0.381***	0.397***	0.405***	0.375***	0.381***	0.377***	0.374***	0.456***	0.379***	0.421***	0.462***	0.362***	0.372***	0.373***	0.974***
	-0.116	-0.129	-0.121	-0.117	-0.119	-0.117	-0.119	-0.12	-0.12	-0.115	-0.143	-0.12	-0.108	-0.115	-0.113	-0.118	-0.117	-0.285
Current account	0.211***	0.190***	0.222***	0.221***	0.227***	0.224***	0.229***	0.232***	0.226***	0.224***	0.208***	0.228***	0.226***	0.233***	0.209***	0.210***	0.210***	0.309***
	-0.051	-0.048	-0.052	-0.051	-0.052	-0.054	-0.055	-0.055	-0.055	-0.055	-0.056	-0.055	-0.052	-0.055	-0.052	-0.052	-0.051	-0.089
Election dummy	-0.559***	-0.448***	-0.458***	-0.458***	-0.464***		-0.595***	-0.593***	-0.586***	-0.573***	-0.598***	-0.593***	-0.426**	-0.428***	-0.537***	-0.557***	-0.548***	-0.460**
	-0.151	-0.147	-0.149	-0.15	-0.15		-0.157	-0.158	-0.159	-0.161	-0.159	-0.157	-0.166	-0.162	-0.149	-0.15	-0.151	-0.206
Total risk rating score		0.085**																
		-0.04																
Political risk rating score			0.029															
			-0.024															
Government stability				0.095*														
				-0.056														
Bureaucratic quality					-0.241													
					-0.279													
System of checks						-0.003												
						-0.068												
Government system							-0.265											
							-0.288											
Largest government party orientation								0.078										
								-0.102										
Rule of majority									0.93									
									-1.14									
Index of fractionalization										0.937								
										-1.964								
Index of polarization											0.106							
											-0.136							
Economic policy												-0.008						
												-0.101						
FRI fiscal rule													0.101					
													-0.179					
Lagged fiscal rule														0.354*				
														-0.208				
Imf fiscal rule															0.864**			
															-0.334			
Lagged imf fiscal rule																0.237		
																-0.404		
Maastricht dummy																	0.021	
																	-0.302	
SGP dummy																	-0.31	
																	-0.406	
SGP dummy 05																		0.635
																		-0.862
Financial crisis dummy		-0.071***	-0.089***	-0.085***	-0.088***	-0.094***	-0.094***	-0.095***	-0.094***	-0.094***	-0.091***	-0.094***	-0.094***	-0.122***	-0.122***	-0.096***	-0.074***	-0.131***
		-0.018	-0.018	-0.017	-0.017	-0.017	-0.017	-0.017	-0.017	-0.017	-0.017	-0.017	-0.023	-0.024	-0.022	-0.021	-0.026	-0.042
year	-0.088***	-0.071***	-0.089***	-0.085***	-0.088***	-0.094***	-0.094***	-0.095***	-0.094***	-0.094***	-0.091***	-0.094***	-0.094***	-0.122***	-0.122***	-0.096***	-0.074***	-0.131***
	-0.016	-0.018	-0.018	-0.017	-0.017	-0.017	-0.017	-0.017	-0.017	-0.017	-0.017	-0.017	-0.023	-0.024	-0.022	-0.021	-0.026	-0.042
Constant	-0.328	-8.054**	-2.943	-1.244*	0.601	-0.354	0.297	-0.444	-0.807	-0.808	-0.526	-0.185	-0.164	0.7	0.194	-0.24	-0.566	-0.86
	-0.479	-3.552	-2.108	-0.734	-1.266	-0.587	-0.681	-0.558	-0.923	-1.362	-0.574	-0.557	-1.035	-1.041	-0.536	-0.501	-0.57	-0.867
Observations	409	409	409	409	4.17E+02	418	418	418	408	404	418	365	356	436	436	436	444	391
R-squared	0.713	0.703	0.704	0.701	0.701	0.708	0.707	0.709	0.702	0.719	0.708	0.697	0.692	0.71	0.705	0.706	0.461	0.712
Kleibergen-Paap LM st.	15.460	18.110	17.740	18.810	18.320	17.890	18.070	18.060	18.900	14.390	17.770	24.330	23.310	20.000	19.670	18.950	9.994	18.310
Kleibergen-Paap p-val	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000
Hansen test	0.948	0.033	0.072	0.137	0.023	0.008	0.008	0.002	0.002	0.314	0.000	2.453	0.508	0.218	0.076	0.774	0.209	1.213
Hansen p-val	0.330	0.855	0.788	0.712	0.880	0.931	0.930	0.968	0.964	0.575	0.983	0.117	0.476	0.640	0.783	0.379	0.648	0.271

*Note: country FE included in all specifications but not reported. P-value: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Robust standard errors. Source: own calculations.*

Table A.3: Robustness check II, EA-18, 1970–2013

	benchmark	r16	r17	r18	r19	r20	r21
Lagged primary balance	0.585***	0.497***	0.498***	0.461***	0.470***	0.460***	0.466***
	-0.073	-0.089	-0.086	-0.092	-0.087	-0.096	-0.091
Lagged debt	0.050***	0.049***	0.049***	0.052***	0.051***	0.072***	0.071***
	-0.009	-0.01	-0.01	-0.011	-0.011	-0.015	-0.016
Output gap	0.373***	0.411***	0.394***	0.383***	0.352***	0.389***	0.354***
	-0.116	-0.118	-0.12	-0.127	-0.125	-0.123	-0.124
Current account	0.211***	0.240***	0.235***	0.187***	0.181***	0.222***	0.214***
	-0.051	-0.055	-0.055	-0.053	-0.052	-0.057	-0.055
Election dummy	-0.559***	-0.458***	-0.463***	-0.405***	-0.409***	-0.446***	-0.450***
	-0.151	-0.157	-0.156	-0.155	-0.155	-0.154	-0.153
Total risk rating score				0.082*	0.089**	0.083*	0.092**
				-0.044	-0.041	-0.048	-0.044
Government stability		0.089	0.093*				
		-0.055	-0.056				
system		-10.787***	-12.473***	-7.922**	-8.582***	-12.274***	-13.227***
		-3.174	-2.403	-3.176	-2.426	-3.53	-3.23
Lagged .imf fiscal rule		0.883**	0.880**	0.705*	0.709*	0.797**	0.686
		-0.367	-0.404	-0.364	-0.424	-0.375	-0.419
Maastricht dummy			0.112		0.071		0.285
			-0.458		-0.483		-0.488
SGP dummy		-0.132		0.077		0.056	
		-0.299		-0.334		-0.366	
SGP dummy05		-0.284		-0.104		-0.118	
		-0.433		-0.462		-0.465	
Financial crisis dummy							
Lagged GDP deflator growth				0.066	0.059	0.104*	0.101*
				-0.054	-0.053	-0.058	-0.06
Cyclical component of gov't. final consumption expenditures				-0.082**	-0.085**		
				-0.034	-0.035		
lirg (interest payments)						-0.256*	-0.257*
						-0.139	-0.135
year	-0.088***	-0.117***	-0.135***	-0.084**	-0.091***	-0.131***	-0.141***
	-0.016	-0.035	-0.025	-0.034	-0.026	-0.039	-0.036
Constant	-0.328	20.930***	24.617***	7.783	8.748	17.187*	18.628**
	-0.479	-6.983	-5.156	-7.976	-7.215	-9.14	-9.072
Observations	436	391	391	391	391	391	391
R-squared	0.705	0.712	0.713	0.729	0.731	0.724	0.725
Kleibergen-Paap LM st.	19.780	18.310	17.160	16.750	15.930	18.810	17.410
Kleibergen-Paap p-val	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hansen test	0.012	1.213	0.711	1.915	1.128	1.713	1.088
Hansen p-val	0.913	0.271	0.399	0.166	0.288	0.191	0.297

*Note: country FE included in all specifications but not reported. P-value: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Robust standard errors utilized. Source: own calculations.*

Table A.1. Data description and sources (main series)

Variable	Definition	Transformation(s)	Main source
Primary balance	General government primary balance (ESA 1995, EDP);	Series extended using ESA79 growth rates from IMF WEO. Adjusted from GAFS.	AMECO, IMF WEO, ECB
Debt ratio	General government debt (EDP, ESA 1995);	Series extended using ESA79 growth rates of non-EDP series	AMECO
Price index	GDP deflator (ESA 1995); HICP;		AMECO, ECB [HICP]
Output gap		Trend GDP growth-based	AMECO
Current account		Relative (as % of GDP)	AMECO
Election dummy	Binary variable (1 = election);		Electionresources.org
FRI	Fiscal rules index ;		EC database, 1990–2013
IMF fiscal rules index	Binary variable (1 = any fiscal rule is applicable);		IMF's Fiscal Rules database, 1985–2013
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. The risk rating assigned is the sum of three subcomponents: Government Unity, Legislative Strength, and Popular Support;		PRSG
Total risk rating score	Composite Political, Financial, Economic Risk Rating for a country (CPFER) = 0.5 ((Political Risk + Financial Risk + Economic Risk) Ranging from Very High Risk (00.0 - 49.5) to Very Low Risk (80.0 - 100). The higher the points, the lower the risk		PRSG
Political risk rating score	A means of assessing the political stability of a country on a comparable basis with other countries by assessing risk points for each of the component factors of government stability, socioeconomic conditions, investment profile, internal conflict, external conflict, corruption, military in politics, religious tensions, law and order, ethnic tensions, democratic accountability, and bureaucracy quality. Risk ratings range from a high of 100 (least risk) to a low of 0 (highest risk), though lowest de facto ratings generally range in the 30s and 40s.		PRSG
Bureaucratic quality	Institutional strength and quality of the bureaucracy is a shock absorber that tends to minimize revisions of policy when governments change. In low-risk countries, the bureaucracy is somewhat autonomous from political pressure. (Refer to ICRG Methodology for maximum points for this variable, as well as for related formulas for calculating risk.)		PRSG
System of checks	Checks – countries where legislatures are not competitively elected are considered countries where only the executive wields a check.		
Government system	Parliamentary (2), Assembly-elected President (1), Presidential (0);	Only non-missing observations used.	WB DPI
Rule of majority	This is the fraction of seats held by the government. It is calculated by dividing the number of government seats by total (government plus opposition plus non-aligned) seats.	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. Equals NA if there is no parliament. If there are any government parties where seats are unknown (cell is blank), GOVFRAC is also blank. No parties in the legislature results in NA.	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, using the following criteria: Right (1); Left (3); Center (2); No information (0); No executive (NA)	Only non-missing observations used.	WB DPI
Interest payments	Absolute volume of payments (ESA 1995);	Relative (as % of GDP, lagged debt or total revenues)	AMECO
Government final consumption expenditures	Final government consumption expenditures, ESA 1995;	HP filtered cyclical component (lambda = 100)	AMECO