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## Euro Membership and Fiscal Reaction Functions

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# Euro Membership and Fiscal Reaction Functions

by

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10 February 2013

## **Abstract**

Using fiscal reaction functions for a panel of actual euro-area countries the paper investigates whether euro membership has reduced the responsiveness of countries to increases in the level of inherited debt compared to the period prior to succession to the euro. While we find some evidence for such a loss in prudence, the results are not robust to changes in the specification, as for example an exclusion of Greece from the panel. This suggests that the current debt problems may result to a large extent from pre-existing debt levels prior to entry or from a larger need for fiscal prudence in a common currency, while an adverse change in the fiscal reaction functions for most countries does not apply.

**Keywords:** debt sustainability, fiscal reaction function, euro area

**JEL classification:** H62, E62

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# 1 Introduction

The debt crisis in Europe has put renewed emphasis on the sustainability and prudence of fiscal policies. The fiscal problems of countries like Portugal and Greece, which entered the crisis with high debt levels, suggest that excessive deficits under the common currency and frequent non-compliance with the deficit limits have been major factors that contributed to the severity of the debt crisis. This view had sufficient support to produce a series of political activities that led to more stringent fiscal rules. Among other things, a new fiscal compact requires euro members to introduce debt brakes into national legislation, preferable at a constitutional level. While some countries started out with already high public debt, countries like Ireland and Spain had comparatively sound levels before the financial crisis and banks' balance sheet problems and public bailouts of banks have been prominent reasons for exploding public debt levels and reduced investor confidence.<sup>1</sup>

In this paper we look for evidence whether euro membership indeed has changed fiscal behavior in a systematic way and made it less prudent. We do so by using panel data of European countries to estimate fiscal reaction functions. From the intertemporal budget constraint of governments a higher stock of public debt must be associated with a higher level of discounted aggregated primary surpluses in the future. While it is unclear when exactly such a reaction of the primary surplus should happen, previous studies have found significant immediate reactions (Bohn 1998, Mendoza and Ostry 2008) that document governments' efforts towards financial sustainability.

In our panel data of European countries, we compare three different time periods. We may consider the time before the signing of the Maastricht Treaty as the

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<sup>1</sup> In the case of Ireland, for example, the IMF (2011) has estimated the preliminary budgetary cost of bank bailouts at 38% of GDP.

period during which countries were neither influenced by a common currency, nor by the aspirations to be accepted to the common currency. In the period between signing of the Maastricht Treaty and the start of the common currency (aspiration period), countries had to work towards the Maastricht criteria for acceptance into the European Monetary Union (EMU) and may therefore have been subject to increased fiscal responsibility. Finally, we consider the time since full membership as a separate period which is of special interest. While the stability and growth pact required continued efforts to contain government deficits, the frequent infringements of the 3%-deficit rule, the weakening of the rules and the moral hazard effects from implicit bailout guarantees (i.e., a non credible no-bailout clause) may have reduced government efforts below the aspiration period or even below the pre-Maastricht period.

Using fiscal reaction functions for a panel of actual euro-area countries the paper investigates whether euro membership has reduced the responsiveness of countries to increases in the level of inherited debt compared to the period prior to succession to the euro. While we find some evidence for such a loss in prudence, the results are not robust to changes in the specification, as for example an exclusion of Greece from the panel. This suggests that the current debt problems may result to a large extent from pre-existing debt levels prior to entry or from a larger need for fiscal prudence in a common currency, while an adverse change in the fiscal reaction functions for most countries does not apply.

The remainder of the paper is as follows. Section 2 briefly reviews the intertemporal budget constraint of the government as a starting point for the analysis of sustainability issues. Section 3 introduces the concept of the fiscal reaction functions. Section 4 provides some descriptives before Section 5 presents the main empirical results. Section 6 provides some conclusions.

## 2 The Sustainability of Government Debt

The assessment of the sustainability of government finances usually starts from the intertemporal budget constraint of the government. Assuming a time invariant interest rate, the governmental budget constraint can be expressed as:

$$D_t = (1 + i) \cdot D_{t-1} + S_t \quad (1)$$

where  $D_t$  denotes the actual stock of real debt,  $i$  stands for the nominal interest rate,  $D_{t-1}$  represents the pre-existing stock of debt and  $S_t$  is the primary (non-interest) balance, with  $S_t < 0$  representing a primary surplus. Normalizing the stock of public debt and the primary deficit by nominal GDP and solving equation (1) forward in time yield the following intertemporal budget constraint

$$d_T = \left[ \frac{1+i}{(1+\beta)(1+\pi)} \right]^T d_0 + \sum_{t=1}^T s_t \left[ \frac{1+i}{(1+\beta)(1+\pi)} \right]^{(T-t)}, \quad (2)$$

where  $\beta$  and  $\pi$  are the real growth rate and the inflation rate (that for simplicity are assumed to be time invariant). Discounting equation (2) to time zero, i.e. multiplying both sides by  $\left[ \frac{1+i}{(1+\beta)(1+\pi)} \right]^T$ , and taking the limit as  $T \rightarrow \infty$  yields the present value budget constraint:

$$\lim_{T \rightarrow \infty} \left[ \frac{1+i}{(1+\beta)(1+\pi)} \right]^{-T} d_T = d_0 + \lim_{T \rightarrow \infty} \sum_{t=1}^T s_t \cdot \left[ \frac{1+i}{(1+\beta)(1+\pi)} \right]^{-t} \quad (3)$$

Fiscal sustainability for  $(1 + i) > (1 + \beta)(1 + \pi)$  requires that the government does not engage in a Ponzi scheme, where all the interest payments are covered by new debt. The no-Ponzi or transversality condition is technically stated by the fact that the present discounted value of the government debt-to-GDP ratio converges to zero in the limit:

$$\lim_{T \rightarrow \infty} \left[ \frac{1+i}{(1+\beta)(1+\pi)} \right]^{-T} d_T = 0 . \quad (4)$$

Inserting this transversality condition into equation (3) yields a formal definition for sustainability:

$$d_0 = - \lim_{T \rightarrow \infty} \sum_{t=1}^T s_t \cdot \left[ \frac{1+i}{(1+\beta)(1+\pi)} \right]^{-t} . \quad (5)$$

From equation (5), a sustainable fiscal policy requires that the value of the initial debt-to-GDP ratio equals the negative present value of all future primary deficit ratios. Equation (5) is only satisfied if the transversality condition, equation (4), is fulfilled (see e.g. Ley 2010).

There exists a large body of empirical studies that examines whether (4) and (5) are fulfilled. Hamilton and Flavin (1986) was an early study using a direct empirical approach to test the presence of no-Ponzi games. Employing annual U.S. data over the period 1960 – 1984 they find evidence for a sustainable fiscal policy in the US. Numerous studies followed which conducted empirical tests on the intertemporal budget constraint mostly for the US but also for other countries; yielding partly different conclusions concerning the fiscal sustainability of the respective states (see e.g. Wilcox 1989, Kremers 1989, Haug 1990, Hakkio and Rush 1991 or Trehan and Walsh 1991).

These standard test procedures are conducted under the strong assumption of certainty. However, Bohn (1998) as well as Perotti (2007) emphasize that expectations and uncertainty, surrounding prospect fiscal variables, play an important role in the assessment of fiscal policy. In the presence of uncertainty an adequate solvency test requires a correct discount factor, which is determined by the marginal

rate of substitution between consumption at time  $t$  and time  $t+1$ , rather than the “*safe interest rate*”. The possibility that some of the existing empirical tests rest on incorrect discount factors casts doubt on their reliability. However, since the correct discount factor is based on several assumptions about prospective states of nature that are hard to estimate Bohn (1998) suggests the alternative concept of a fiscal reaction function (“model-based sustainability” approach i.e. MBS), to assess fiscal sustainability. In contrast to the standard empirical methods, the MBS approach tests for particular time series properties of fiscal data and does not require any assumptions about the appropriate discount factors. In addition, the MBS approach neither requires specific assumptions about the debt structure in terms of its composition nor does this approach require any particular information on the design of fiscal policy.

### **3 Fiscal Reaction Functions**

The idea of Bohn’s (1998) MBS approach rests on the analysis of how the primary fiscal balance (i.e. fiscal balance excluding the interest payments on public debt) reacts to variations in the sovereign debt caused by economic shocks. In such a framework, fiscal policy is considered sustainable once the government reacts systematically to a change in public debt by adjusting the primary fiscal balance. The intuition is, that if a fiscal policy is considered sustainable prior to a certain economic shock, the absence of any systematic policy reaction to this shock would cause the additionally issued debt to be uncovered by future surpluses, thus violating the no-Ponzi condition. Therefore, the government has to react systematically to the

extended debt-to-GDP ratio by increasing the primary surplus-to-GDP ratio, in order to maintain fiscal sustainability.

In the simplest and most common version it assumes a linear connection between the inherited debt level and the primary surplus of period  $t$ .

$$s_t = \rho \cdot d_t + \mu_t, \quad (6)$$

where  $s_t$  is the primary surplus of period  $t$  as a fraction of GDP,  $d_t$  is the initial debt in terms of GDP, and  $\mu_t$  is representing other influences of the primary surplus. According to Proposition 1 in Bohn (2008), if  $\mu_t$  is bounded as a share of GDP and the present value of GDP is finite, then  $\rho > 0$  satisfies the economy's intertemporal budget constraint and the no-Ponzi condition. Hence, a significantly positive  $\rho$  is a strong indicator for fiscal sustainability.

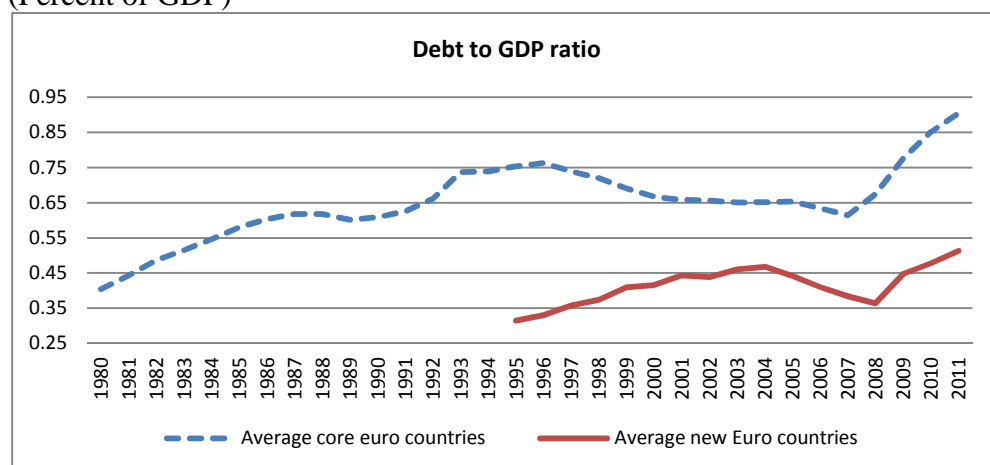
Using historical annual U.S. fiscal data, Bohn (1998) finds significant response coefficients for the period 1916 – 1995 as well as for the period 1793 – 2003 and thus concludes that U.S. fiscal policy has been in line with sustainability for these particular periods. Similarly, Greiner et al. (2007) investigate whether several Euro-area countries (Germany, France, Italy and Portugal) have restored the fiscal imbalance by appropriately adjusting its fiscal policy. Applying Bohn's MBS approach on annual fiscal data over the period 1960-2003 they find positive and robust response coefficients, thus concluding that fiscal policy in these European countries follows a sustainable path.

Mendoza and Ostry (2008) apply Bohn's approach to inspect fiscal sustainability in both emerging economies and advanced economies. Analyzing annual fiscal data over the periods 1970-2005 (for industrial countries) and 1990-2005 (for emerging countries) to a panel of 34 emerging and 21 industrial countries they conclude that both, emerging and industrial countries operate a sustainable fiscal policy.

## **4 Descriptive Statistics**

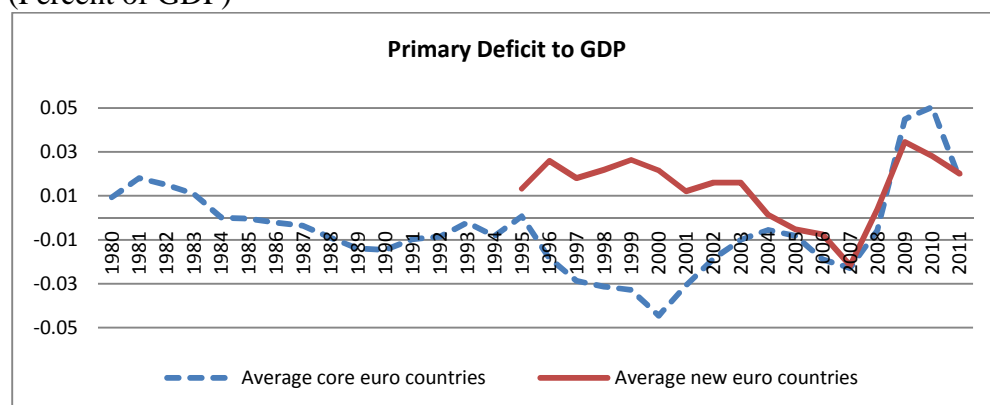
Before turning to regressions we look at public debt and primary deficit ratios over time. Figure 1 and Figure 2 illustrate the development of public debt and primary deficits for all countries that currently are members of the euro area. From the mid-1990s the countries now comprising the euro area pursued a policy of fiscal consolidation in order to fulfill the requirements for the start of the European Monetary Union in 1999. While during the period 1995–2006 public debt ratios and primary deficit ratios were decreasing, the financial crisis triggered a period of significant increases in deficit and debt ratios. In 2011, only five (Estonia, Finland, Luxembourg, Slovak Republic and Slovenia) out of 17 euro-area countries were below the Maastricht debt ratio of 60% of GDP. Only six (Austria, Estonia, Finland, Germany, Luxembourg and Malta) euro-area countries had a deficit below 3% of GDP. At the same time, after four years of large primary deficits, the euro area on average showed a primary surplus in 2011.

Figure 1: Public Debt: Time Series  
(Percent of GDP)



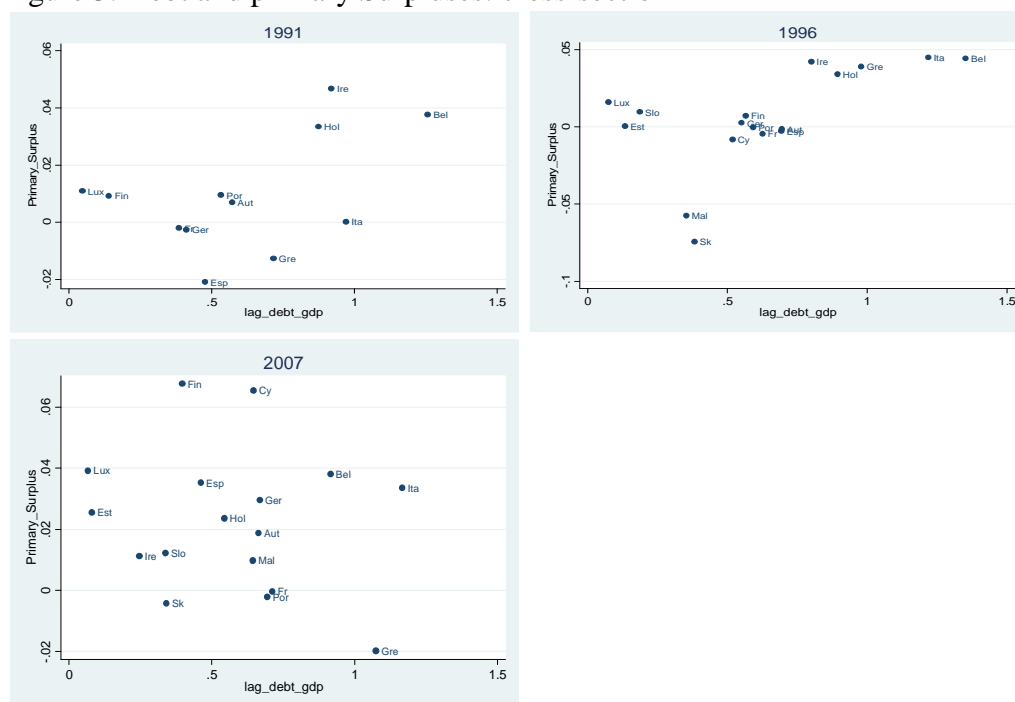
Note: Core euro countries are Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands Portugal and Spain. New euro countries are Estland, Slovak Republic, Slovenia, Malta and Cyprus. Source: Own calculations based on the OECD Analytical Database

Figure 2: Primary Deficits: Time Series  
(Percent of GDP)



Note: Core euro countries are Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands Portugal and Spain. New euro countries are Estland, Slovak Republic, Slovenia, Malta and Cyprus. Source: Own calculations based on the OECD Analytical Database and OECD Economic Outlook Database.

Figure 3: Debt and primary Surpluses: cross-section



Note: Figure 3 plots the primary surplus as a share of GDP versus the inherited level of debt to GDP for the years 1991, 1996 and 2007 respectively. Source: Own calculations based on the OECD Analytical Database and OECD Economic Outlook Database

The simple arithmetic of the intertemporal budget restriction discussed in Section 2 suggests a positive relationship between inherited debt levels and the primary surplus of countries. Figure 3 shows scatter plots of the primary balance-GDP ratio against the lagged debt GDP-ratio for selected years. 1991 represents the period before the signing of the Maastricht Treaty. 1996 is part of the aspiration period and the period during the Euro membership is covered by the figure for 2007. The scatter plots indeed suggest that the positive correlation has become weaker over time. It will be the purpose of the next section to investigate the existence of a systematic influence of euro membership on countries' fiscal reaction functions.

## 5 Empirical Analysis of Fiscal Adjustments

Our cross-country application of Bohn's (1998) MBS approach is based on an unbalanced panel data set for the presently 17 euro-area countries during the period 1970–2011. While for most of the founding countries of the euro data are available for the period 1970–2012, the corresponding data for some euro-area countries, in particular the eastern European countries start later.<sup>2</sup> Important variables are the total public debt ratio the primary fiscal balance, real GDP, and total government expenditures. We use information from the OECD Analytical Database on general government gross financial liabilities, government deficit / surplus, real GDP at current prices, and total expenditure of general government. For the gross government interest payments we use data from the OECD Economic Outlook Database. Since fiscal data for Germany prior to reunification are not available in the OECD and IMF databases, we collect the required data from the German Federal Statistical Office. Table 2A of the Appendix contains summary statistics for the variables under consideration for the full sample period as well as the samples corresponding to period before the Maastricht Treaty, the samples corresponding to the aspiration period and the period after the Maastricht Treaty, respectively.

Similar to Mendoza and Ostry (2008) we estimate a cross-country panel version of Bohn's (1998) MBS approach. We will start by examining how the primary surplus to GDP ratio in the EMU reacts to variations in the debt-to-GDP ratio by estimating variants of the equation

$$s_{i,t} = \rho d_{i,t-1} + \alpha V_{i,t} + \varepsilon_{i,t} , \quad (7)$$

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<sup>2</sup> Table 1A in the appendix gives an overview of data availability for all countries included in our study.

where  $s_{i,t}$  is the primary surplus,  $d_{i,t-1}$  denotes the lagged debt to GDP ratio,  $V_{i,t}$  is a vector which includes a set of determinants of the primary surplus and  $\varepsilon_{i,t}$  represents an error term. Following Greiner et al. (2007) we use lagged values of debt to GDP rather than actual values to avoid simultaneity problems. Depending on the model specification the vector  $V_{i,t}$  includes different regressors following the relevant literature (e.g., Bohn 1998, Mendoza and Ostry 2008).

Table 1 reports results for variants of equation (7). All regressions include country fixed effects; the  $t$ -statistics are corrected for potential heteroskedasticity and country-specific serial correlation in the residuals. Column I presents a regression that uses the lagged debt to GDP ratio as the only regressor. Column II displays the results for a specification that adds a measure of the output deviation as an explanatory variable. Among other things, it may capture the resistance against high primary surplus in times of a flat economy. Column III, following Bohn (1998), and Mendoza and Ostry (2008), adds the expenditure deviation along with a measure of the output deviation. The variables *output deviation* and *expenditure deviation* are derived as percentage deviations of output and government expenditures from their respective trends using the Hodrick-Prescott filter and a standard smoothing parameter,  $\lambda=100$ .

Table 1. Debt Sustainability Regression (1970-2011)  
(dependent variable: primary surplus as share of GDP)

	I	II	III
<i>debt-gdp ratio</i> ( $\rho$ )	0.042 (0.011)***	0.048 (0.011)***	0.049 (0.017)***
<i>output deviation</i>		0.086 (0.056)	0.306 (0.092)***
<i>expenditure deviation</i>			-0.291 (0.102)***
R2	0.2668	0.2982	0.4351
No. of observations	512	511	404

Note: All regressions include unreported country fixed effects. The sample is unbalanced and covers years 1970-2011. Standard errors in parentheses are corrected for heteroskedasticity and serial autocorrelation in the errors. “\*”, “\*\*” and “\*\*\*” denote significance at the 10, 5 and 1 percent confidence level, respectively. *Output deviation* and *expenditure deviation* are calculated from the cyclical components from the Hodrick-Prescott filter and included in percent of the trend figures.

All regressions provide evidence for a positive and statistically significant parameter  $\rho$  that captures the fiscal reaction behavior. The result in column I indicates that the euro-area countries in that period reacted to a one percentage point increase in the lagged debt to GDP ratio by increasing the primary surplus to GDP ratio by 0.042 percentage points. This systematic response provides evidence for overall sustainable fiscal policies. Adding cyclical fluctuations in output to the set of explanatory variables (column II) leaves the coefficient largely unchanged ( $\rho = 0.047$ ). The estimated coefficient of the *output deviation* is positive as expected, i.e. a good economy is good for primary surpluses, but insignificant in column II. The estimated coefficient  $\rho$  is largely robust to this inclusion of our measures of the *expenditure deviation* along with the *output deviation* (column III). The estimates of the response coefficients in Table 1, ranging from 0.042 to 0.049, are in line with the findings of Bohn (1998), Bohn (2008), Greiner et al. (2007), and Mendoza and Ostry (2007) for other sets of countries.

In a next step, we ask whether the prudence of fiscal policies has been thwarted by euro membership and euro-area countries have changed their fiscal behavior. In particular, we are interested in the possibility that fiscal reaction functions differ across different periods. We may consider the time before the signing

of the Maastricht Treaty (*pre*) as a stage during which countries were neither influenced by having a common currency, nor by the aspirations to be accepted to the common currency. In the period between signing of the Maastricht Treaty and the start of the common currency countries faced the Maastricht criteria that were important for acceptance into EMU with possibly stronger incentives for fiscal responsibility. More precisely, from 1992 we define a country to be in this aspiration period once it is also an official member of the European exchange rate mechanism, but not a euro member yet. Finally, we consider the time since full membership (*eur*) as a separate time period that is of special interest. Table 3A in the appendix contains the exact classification of *pre* and *eur* for each country in the sample. A plausible hypothesis may be that the attainment of a *de jure* irrevocable membership status has reduced the prudence of fiscal policies. This leads us to estimate variants of the equation

$$s_{i,t} = \rho d_{i,t-1} + \beta_1 pre + \beta_2 eur + \beta_3 pre \cdot d_{i,t-1} + \beta_4 eur \cdot d_{i,t-1} + \alpha V_{i,t} + \varepsilon_{i,t} , \quad (8)$$

where again  $V_{i,t}$  is a vector that includes a set of determinants of the primary surplus. The dummy variable *pre* equals one for the time before the signing of the Maastricht Treaty and the dummy variable *eur* equals one since full euro membership (i.e. 1999 for most countries). In addition,  $pre \cdot d_{i,t-1}$  ( $eur \cdot d_{i,t-1}$ ) represent interaction terms between the debt-to-GDP ratio in the previous period and the *pre* dummy (the *eur* dummy). Depending on the model specification,  $V_{i,t}$  also includes the percentage deviation of real GDP from its trend and the percentage deviation of total government expenditures to its trend like in Table 1. As we want to test for the change in fiscal behavior within the three periods the coefficients of interest are  $\rho, \beta_3$  and  $\beta_4$ . The coefficient  $\rho$  determines whether the primary surplus reacts systematically to variations in the lagged debt to GDP ratio in the aspiration period, which econometrically serves as the default period. The coefficient  $\beta_3$  shows whether the response of the primary surplus to changes in the inherited debt to GDP ratio is

different within the aspiration period and the pre-Maastricht period. The main coefficient of interest is  $\beta_4$  that captures a possible difference between the aspiration period and the period of euro membership.

Table 2. Debt Sustainability Regressions (1970-2011)  
(dependent variable: primary surplus as share of GDP)

	I	II	IV
<i>debt-gdp ratio</i> ( $\rho$ )	0.06 (0.012)***	0.071 (0.013)***	0.078 (0.016)***
<i>pre</i> ( $\beta_1$ )	0.017 (0.007)**	0.020 (0.007)***	0.027 (0.008)***
<i>eur</i> ( $\beta_2$ )	0.008 (0.010)	0.006 (0.009)	-0.0006 (0.007)
<i>pre_lagged_debt</i> ( $\beta_3$ )	-0.051 (0.011)***	-0.054 (0.011)***	-0.075 (0.013)***
<i>eur_lagged_debt</i> ( $\beta_4$ )	-0.029 (0.014)**	-0.026 (0.013)*	-0.025 (0.011)**
<i>output deviation</i>		0.09 (0.057)	0.358 (0.084)***
<i>expenditure deviation</i>			-0.33 (0.098)***
R2	0.3147	0.3489	0.5375
No. of observations	512	511	404

Note: All regressions include unreported country fixed effects. The sample is unbalanced and covers years 1970-2011. Standard errors in parentheses are corrected for heteroskedasticity and serial autocorrelation in the errors. “\*”, “\*\*” and “\*\*\*” denote significance at the 10, 5 and 1 percent confidence level, respectively. *Output deviation* and *expenditure deviation* are calculated from the cyclical components from the Hodrick-Prescott filter and included in percent of the trend figures.

The results that derive from this exercise seem to be in line with a popular view that, while governments undertook efforts to secure entry into EMU, the fiscal rules of EMI were insufficient to produce a similarly high level of fiscal prudence after countries were admitted to the euro: in all three specifications, the relevant interaction term *eur\_lagged\_debt* is negative, twice at the 5 percent level, once at the 10 percent level. At the same time, in all three regressions the inclusion of the coefficients *debt-gdp ratio* and *eur\_lagged\_debt* continues to yield a significant positive reaction to debt shocks, which can be interpreted in favor of an overall

sustainable policy. This is in contrast to what can be said for the pre-Maastricht period; the addition of *debt-gdp ratio* (.78) and *pre\_lagged\_debt* (-.75) leads to an overall effect indistinguishable from zero. It may be noted, however, that the levels of primary surpluses were somewhat higher in the pre-Maastricht period than in the aspiration period, as indicated by the positive estimates for *pre*.

Fiscal reactions of euro members to debt shocks, according to Table 2, have been less pronounced than in the period before euro membership. While this may conform with popular believes, there may be doubt about the robustness of this result. One possible reason for such doubt is the inclusion of the crisis years 2008-2011, which may have a decisive influence on the results. Another issue is that the regressions presented in Table 2 ignore country heterogeneity. While the short experience with fiscal policies in the euro era suggests using panel data, the results reflect the fiscal reactions of quite heterogeneous countries. A special concern may be related to Greece. While the data used in our regressions are based on revised data, the political process in Greece had to rely on cross misstatements of the budget deficit.

To investigate the robustness of our results, Table 3 presents results based on omission of the crisis years 2009-2011. As can be seen, this severely reduces the significance of the interaction term *eur\_lagged\_debt*, which turns insignificant in two out of three regressions and is only significant at the ten percent level in column III. While this reduced significance could result from a reduction in the relevant observations for euro members, it may also be seen as a warning against premature conclusions from Table 2.

Table 3. Debt Sustainability Regression (1970-2008)  
(dependent variable: primary surplus as share of GDP)

	I	II	III
<i>debt-gdp ratio</i> ( $\rho$ )	0.068 (0.010)***	0.07 (0.011)***	0.067 (0.011)***
<i>pre</i> ( $\beta_1$ )	0.019 (0.008)**	0.020 (0.008)**	0.021 (0.008)***
<i>eur</i> ( $\beta_2$ )	0.015 (0.009)	0.015 (0.009)	0.011 (0.006)*
<i>pre_lagged_debt</i> ( $\beta_3$ )	-0.052 (0.011)***	-0.052 (0.011)***	-0.066 (0.012)***
<i>eur_lagged_debt</i> ( $\beta_4$ )	-0.015 (0.012)	-0.015 (0.012)	-0.018 (0.010)*
<i>output deviation</i>		0.042 (0.029)	0.271 (0.056)***
<i>expenditure deviation</i>			-0.236 (0.082)***
R2	0.5079	0.5141	0.6348
No. of observations	461	461	354

Note: All regressions include unreported country fixed effects. The sample is unbalanced and covers years 1970-2011. Standard errors in parentheses are corrected for heteroskedasticity and serial autocorrelation in the errors. “\*”, “\*\*” and “\*\*\*” denote significance at the 10, 5 and 1 percent confidence level, respectively. *Output deviation* and *expenditure deviation* are calculated from the cyclical components from the Hodrick-Prescott filter and included in percent of the trend figures.

As noted, another issue is that the results about a reduced fiscal reaction to debt shocks may come from heterogeneity or may rest only on a small subgroup of countries. Therefore we ran robustness checks by in turn leaving out one country after the other. Results are reported in Table 4 which is based on regressions using years 1970-2011. Again, we are particularly interested in the robustness of the negative *eur\_lagged\_debt* coefficient. We find that the results are pretty stable for all exclusions but one: leaving Greece out of the sample, the magnitude of the coefficient drops by two-thirds and its significance is lost. The result of the regressions in Table 2, which suggested euro membership has significantly decreased fiscal reactions to debt, seems to be very strongly based on the change in Greek fiscal policy compared to pre-euro years.

There are two potential explanations that come to mind. A first one is that the data we are using is not the data that was available to Greek parliament and the wider

public at the time budgets were drafted. The extensive fabrication of Greek budget deficit numbers has been extensively documented.<sup>3</sup> Interestingly, rerunning the regression III of Table 3 with the initially reported Greek deficit figures for the years 2000-2008 using the data provided by European Commission (2010) implies that *pre\_lagged\_debt* loses even significance at the 10 percent level.

Another possible explanation is that due to the weak political governance, Greece was particularly prone to consume the increased fiscal leeway from reduced interest rates after euro accession, blocking out the need to react to increases in debt levels.

Table 4. Debt Sustainability Regressions with Country Exclusions (1970-2011)  
(dependent variable: primary surplus as share of GDP)

Excluded Country	<i>debt-gdp ratio</i>	S.E	<i>pre_lagged_debt</i>	S.E	<i>eur_lagged_debt</i>	S.E	R2	Observations.
Austria	0.077	(0.017)***	-0.075	(0.013)***	-0.025	(0.011)**	0.5373	368
Belgium	0.09	(0.019)***	-0.1	(0.013)***	-0.046	(0.012)***	0.5515	372
Cyprus	0.077	(0.016)***	-0.075	(0.013)***	-0.025	(0.011)**	0.5321	388
Estonia	0.083	(0.016)***	-0.081	(0.015)***	-0.027	(0.012)**	0.5402	388
Finland	0.086	(0.016)***	-0.062	(0.012)***	-0.024	(0.011)**	0.5779	367
France	0.083	(0.016)***	-0.073	(0.013)***	-0.023	(0.011)**	0.5435	371
Germany	0.075	(0.016)***	-0.074	(0.013)***	-0.023	(0.011)**	0.5403	383
Greece	0.077	(0.016)***	-0.069	(0.013)***	-0.008	(0.01)	0.5492	380
Ireland	0.057	(0.015)***	-0.074	(0.014)***	-0.027	(0.011)**	0.5791	378
Italy	0.073	(0.018)***	-0.069	(0.015)***	-0.027	(0.014)*	0.5244	372
Luxembourg	0.083	(0.017)***	-0.08	(0.014)***	-0.029	(0.014)**	0.5341	382
Malta	0.078	(0.016)***	-0.075	(0.013)***	-0.025	(0.011)**	0.5345	392
Netherlands	0.079	(0.016)***	-0.076	(0.013)***	-0.026	(0.011)**	0.5342	387
Portugal	0.081	(0.016)***	-0.076	(0.013)***	-0.024	(0.011)**	0.5352	387
Slovak Republic	0.076	(0.016)***	-0.075	(0.013)***	-0.024	(0.011)**	0.5097	388
Slovenia	0.078	(0.016)***	-0.075	(0.013)***	-0.027	(0.011)**	0.5323	388
Spain	0.076	(0.016)***	-0.077	(0.013)***	-0.024	(0.011)**	0.5396	373

Note: All regressions include a constant. The sample is unbalanced and covers years 1970-2011. Standard errors in parentheses are corrected for heteroskedasticity and serial autocorrelation in the errors. “\*”, “\*\*” and “\*\*\*” denote significance at the 10, 5 and 1 percent confidence level, respectively. While the regression includes output and expenditure deviation, Table 4 does not report the respective results. *Output deviation* and *expenditure deviation* are calculated from the cyclical components from the Hodrick-Prescott filter and included in percent of the trend figures.

<sup>3</sup> See, e.g., European Commission (2010). The doctoring of deficit figures also led to comparatively large stock-flow adjustments which are needed when the development of the debt stock cannot be explained by accumulated deficits. See Moutos and Tsitsikas (2010).

Table 5. Debt Sustainability Regressions with Country Exclusions (1970-2008)  
(dependent variable: primary surplus as share of GDP)

Excluded Country	<i>debt-gdp ratio</i>	S.E	<i>pre_lagged_debt</i>	S.E	<i>eur_lagged_debt</i>	S.E	R2	No. of observations
Austria	0.067	(0.012)***	-0.066	(0.012)***	-0.017	(0.01)*	0.6335	321
Belgium	0.072	(0.012)***	-0.088	(0.011)***	-0.034	(0.01)***	0.6574	325
Cyprus	0.067	(0.011)***	-0.065	(0.012)***	-0.017	(0.01)*	0.6327	341
Estonia	0.073	(0.012)***	-0.073	(0.014)***	-0.021	(0.01)**	0.6377	341
Finland	0.074	(0.01)***	-0.05	(0.01)***	-0.017	(0.009)*	0.7044	320
France	0.069	(0.012)***	-0.062	(0.012)***	-0.017	(0.01)*	0.6407	324
Germany	0.065	(0.012)***	-0.065	(0.012)***	-0.017	(0.01)*	0.635	336
Greece	0.062	(0.011)***	-0.060	(0.012)***	-0.004	(0.009)	0.6538	333
Ireland	0.057	(0.015)***	-0.065	(0.013)***	-0.022	(0.010)**	0.6289	330
Italy	0.06	(0.013)***	-0.059	(0.014)***	-0.013	(0.012)	0.6179	325
Luxembourg	0.07	(0.012)***	-0.069	(0.013)***	-0.023	(0.013)*	0.6325	335
Malta	0.067	(0.011)***	-0.066	(0.012)***	-0.017	(0.010)*	0.6285	345
Netherlands	0.068	(0.012)***	-0.066	(0.012)***	-0.018	(0.010)*	0.633	340
Portugal	0.068	(0.011)***	-0.066	(0.012)***	-0.018	(0.010)*	0.6326	340
Slovak Republic	0.068	(0.011)***	-0.067	(0.012)***	-0.018	(0.010)*	0.6134	341
Slovenia	0.067	(0.011)***	-0.067	(0.012)***	-0.018	(0.010)*	0.6328	341
Spain	0.065	(0.012)***	-0.068	(0.012)***	-0.014	(0.01)	0.6366	326

Note: All regressions include a constant. The sample is unbalanced and covers years 1970-2011. Standard errors in parentheses are corrected for heteroskedasticity and serial autocorrelation in the errors. “\*”, “\*\*” and “\*\*\*” denote significance at the 10, 5 and 1 percent confidence level, respectively. While the regression includes output and expenditure deviation, Table 4 does not report the respective results. *Output deviation and expenditure deviation* are calculated from the cyclical components from the Hodrick-Prescott filter and included in percent of the trend figures.

It is worth emphasizing that, unlike the exclusion of Greece, other exclusions have only mild effects. Dropping Italy increases the standard error of *eur\_lagged\_debt* and the significance level of this variable is consequently somewhat reduced. However, the point estimate is largely unaffected in this case. A country that has some importance for the size of the estimated coefficient *eur\_lagged\_debt* is Belgium. Dropping Belgium from the sample, but keeping Greece, indicates a larger differential effect compared to the aspiration period.

Table 5 presents evidence on the same robustness test using years up to 2008 only. Again, exclusion of Greece defeats the significance of *eur\_lagged\_debt*. Excluding the years after 2008, the same now applies to exclusion of Italy or Spain,

but the loss in significance is accompanied by a much smaller change in the point estimate than in the case of excluding Greece.

Table 6. Debt Sustainability Regression for individual Countries (1970-2011)  
(dependent variable: primary surplus as share of GDP)

Country	<i>debt-gdp</i>		<i>pre_lagged_debt</i>		<i>eur_lagged_debt</i>	
	<i>ratio</i>	S.E		S.E		S.E
Austria	0.052	(0.099)	-0.069	(0.104)	-0.126	(0.139)
Belgium	-0.077	(0.188)	0.153	(0.188)	0.313	(0.192)
Cyprus	-0.22	(0.070)**	0.278	(0.091)**	0.436	(0.067)***
Finland	0.115	(0.042)***	-0.402	(0.109)***	0.061	(0.158)
France	0.119	(0.029)***	-0.145	(0.085)	-0.26	(0.053)***
Germany	0.079	(0.090)	0.14	(0.081)*	-0.091	(0.130)
Greece	0.194	(0.019)***	0.051	(0.153)	-0.388	(0.065)***
Ireland	-0.151	(0.054)**	0.151	(0.172)	0.04	(0.434)
Italy	0.151	(0.019)***	-0.073	(0.025)***	0.133	(0.092)
Luxembourg	0.941	(0.335)***	-0.892	(0.343)**	-1.159	(0.323)***
Malta	-0.025	(0.093)	0.156	(0.087)	0.107	(0.099)
Netherlands	0.02	(0.181)	0.013	(0.182)	0.216	0.209
Portugal	0.228	(0.068)***	-0.052	(0.078)	-0.252	(0.103)**
Spain	0.275	(0.055)***	-0.103	(0.063)	0.251	(0.142)*

Note: All regressions include a constant. Standard errors in parentheses are corrected for heteroskedasticity and serial autocorrelation in the errors. “\*”, “\*\*” and “\*\*\*” denote significance at the 10, 5 and 1 percent confidence level, respectively. While the regression includes output and expenditure deviation, Table 4 does not report the respective results. *Output deviation* and *expenditure deviation* are calculated from the cyclical components from the Hodrick-Prescott filter and included in percent of the trend figures. The shaded rows mark those countries with a significantly negative estimate for *eur\_lagged\_debt*.

The sensitivity of the results to exclusion of countries suggests looking at all individual country’s reaction functions to check for further country particularities. Table 6 provides the relevant results for the panel from 1970-2011. In total we find four countries in the sample that have a significantly negative coefficient for *eur\_lagged\_debt*. Apart from low-debt Luxembourg, these countries are France, Greece, and Portugal.<sup>4</sup> Belgium has a large positive coefficient, but it is insignificant. The results from Estonia, Slovenia, Cyprus and Malta are reported, but due to their very recent euro membership these countries have only very few observations for

<sup>4</sup> We have also performed individual regressions for years up to 2008. In this case, *pre\_lagged\_debt* is (weakly) significant and negative only for two countries (Portugal and France), but given the few observations per country with *eur* = 1 these results are not reported. .

which *eur* equals one and no stark conclusions should be drawn from their coefficient for *eur\_lagged\_debt*, in particular as these observations are almost exclusively from crisis years.

While Greece, Portugal and France have significantly negative coefficients for *eur\_lagged\_debt*, in all three cases the fiscal reaction coefficients for the aspiration period (*debt-gdp ratio*) has been very large. The coefficients estimated for *pre\_lagged\_debt* indicate that the fiscal reaction functions in the aspiration period for France, Greece and also, at least to some extent, for Portugal have been much more responsive to the debt level than in the pre-Maastricht period. Here the individual country results suggest that the efforts were not maintained after acceptance into EMU.

## 6 Conclusions

In this study we made use of fiscal reaction functions, which measure the budgetary reactions to countries' debt levels, to evaluate debt sustainability. Our consideration of different regimes (pre-Maastricht, aspiration period, EMU membership) has shown no clear evidence for a systematic reduction in fiscal prudence. While a panel regression for all Euro member countries suggests such a reduction has taken place, this result is not robust to the exclusion of a single country (Greece) and to the exclusion of crisis years. At the same time, individual country regressions suggest that for a group of three highly indebted countries (France, Greece, and Portugal) the strong reactions of primary deficits to changes in debt levels prior to accession to EMU could not be preserved within EMU.

Clearly, the analysis of fiscal reaction functions, like other statistical measures, is just one tool among several to gauge the prudence of fiscal policies. As the European debt crisis suggest, many aspects are important for the overall

evaluation of a country's debt sustainability. Nevertheless, the exercise sheds light on the overall deficit incentives within EMU and provides additional evidence for the very special character of Greece's budget policy after EMU accession.

According to our analysis of fiscal reaction functions, the reduction of fiscal prudence is not a general feature of the first years of EMU. A strong caveat applies. Our results do not imply that fiscal policies are necessarily commensurate with a currency union. Notwithstanding our analysis, countries may have admitted with too large debt levels and membership in a currency union may require lower debt levels as countries lose monetary policy to handle public debt and competitiveness problems.

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## Appendix

Table 1A. Data availability

Country	Variable				
	Debt to GDP ratio	Primary balance to GDP	real GDP	Unemployment rate	total government expenditure to GDP
<b>Austria</b>	1970 - 2011	1970 - 2011	1970- 2011	1970 - 2011	1976 - 2011
<b>Belgium</b>	1970 - 2011	1970 - 2011	1970 - 2011	1970 - 2011	1980 - 2011
<b>Estonia</b>	1995 - 2011	1995 - 2011	1995 - 2011	1993 - 2011	1995 - 2011
<b>Finland</b>	1970 - 2011	1970 - 2011	1970 - 2011	1970 - 2011	1975 - 2011
<b>France</b>	1970 - 2011	1978 - 2011	1970 - 2011	1970 - 2011	1978 - 2011
<b>Germany</b>	1970 - 2011	1974 - 2011	1970 - 2011	1970 - 2011	1991 - 2011
<b>Greece</b>	1980 - 2011	1988 - 2011	1995 - 2011	1995 - 2011	1980 - 2011
<b>Ireland</b>	1970 - 2011	1985 - 2011	1970 - 2011	1989 - 2011	1980 - 2011
<b>Italy</b>	1970 - 2011	1970 - 2011	1970 - 2011	1970 - 2011	1980 - 2011
<b>Luxembourg</b>	1970 - 2011	1970 - 2011	1970 - 2011	1970 - 2011	1990 - 2011
<b>Netherlands</b>	1970 - 2011	1970 - 2011	1970 - 2011	1970 - 2011	1995 - 2011
<b>Portugal</b>	1973 - 2011	1977 - 2011	1970 - 2011	1970 - 2011	1995 - 2011
<b>Slovak Republic</b>	1995 - 2011	1995 - 2011	1990 - 2011	1994 - 2011	1995 - 2011
<b>Slovenia</b>	1995 - 2011	1995 - 2011	1995 - 2011	1992 - 2011	1995 - 2011
<b>Spain</b>	1980 - 2011	1980 - 2011	1970 - 2011	1977 - 2011	1980 - 2011
<b>Cyprus</b>	1995 - 2011	1995 - 2011	1970 - 2011	1995 - 2011	1995 - 2011
<b>Malta</b>	1995 - 2011	1995 - 2011	1970 - 2011	1990 - 2011	2000 - 2011

Table A2. Period Classification by Country

Country	Pre Maastricht Treaty ( <i>pre</i> = 1)	Aspiration period	Euro Membership ( <i>eur</i> = 1)
Austria	1970 - 1991	1992 - 1998	1999 - 2011
Belgium	1970 - 1991	1992 - 1998	1999 - 2011
Estonia	1995 - 2003	2004 - 2010	2011
Finland	1970 - 1991	1992 - 1998	1999 - 2011
France	1978 - 1991	1992 - 1998	1999 - 2011
Germany	1974 - 1991	1992 - 1998	1999 - 2011
Greece	1988 - 1991	1992 - 2000	2001 - 2011
Ireland	1985 - 1991	1992 - 1998	1999 - 2011
Italy	1970 - 1991	1992 - 1998	1999 - 2011
Luxembourg	1970 - 1991	1992 - 1998	1999 - 2011
Netherlands	1970 - 1991	1992 - 1998	1999 - 2011
Portugal	1977 - 1991	1992 - 1998	1999 - 2011
Slovak Republic	1995 - 2004	2005 - 2008	2009 - 2011
Slovenia	1995 - 2003	2004 - 2006	2007 - 2011
Spain	1980 - 1991	1992 - 1998	1999 - 2011
Cyprus	1995 - 2004	2005 - 2007	2008 - 2011
Malta	1995 - 2004	2005 - 2007	2008 - 2011

Table A3      Summary Statistics

<b>Full sample</b>					
<b>Variable</b>	<b>Obs.</b>	<b>Mean</b>	<b>SD</b>	<b>Min</b>	<b>Max</b>
Primary Surplus	498	0.0117056	0.0590181	-0.2802633	0.2639207
lagged debt to GDP	494	0.6112865	0.3277643	0.061	1.700068
real GDP	646	2.93E+05	4.98E+05	0.245014	2.48E+06
Government expenditure to GDP	440	0.4621246	0.0636362	0.27655	0.6678635
Unemployment rate	575	0.0737983	0.0425735	0.0001501	0.2529919

<b>Before Maastricht Treaty</b>					
<b>Variable</b>	<b>Obs.</b>	<b>Mean</b>	<b>SD</b>	<b>Min</b>	<b>Max</b>
Primary Surplus	221	-0.0022736	0.0372469	-0.0822298	0.2176089
lagged debt to GDP	201	0.4879915	0.2711116	0.0799428	1.257202
real GDP	367	133085.9	251839.7	0.245014	1534600
Government expenditure to GDP	153	0.452921	0.0655769	0.27655	0.6
Unemployment rate	269	0.0608128	0.0406273	0.0001501	0.1930314

<b>Aspiration period</b>					
<b>Variable</b>	<b>Obs.</b>	<b>Mean</b>	<b>SD</b>	<b>Min</b>	<b>Max</b>
Primary Surplus	103	0.027195	0.0614806	-0.058903	0.2411876
lagged debt to GDP	90	0.6755618	0.3485286	0.0731141	1.406451
real GDP	106	366159.7	519575.6	4.81723	1959700
Government expenditure to GDP	100	0.469983	0.072431	0.3360032	0.6486522
Unemployment rate	103	0.0923681	0.0429845	0.0137625	0.1910761

<b>After Maastricht Treaty</b>					
<b>Variable</b>	<b>Obs.</b>	<b>Mean</b>	<b>SD</b>	<b>Min</b>	<b>Max</b>
Primary Surplus	174	0.0202917	0.0744782	-0.2802633	0.2639207
lagged debt to GDP	203	0.7048703	0.3318579	0.061	1.700068
real GDP	173	587234.1	695331.2	5.81083	2476800
Government expenditure to GDP	187	0.4654526	0.0560109	0.3118289	0.6678635
Unemployment rate	203	0.0815834	0.0395757	0.0223295	0.2529919