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The European Debt Crisis
and Fiscal Reactions in Europe 2000-2014[*]

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Abstract: After the outbreak of the global financial crisis, some governments in the EU experienced serious fiscal problems, while others were less affected. This paper seeks to shed light on the divergent fiscal performance in the EU countries before and after the outbreak of the crisis. Fiscal reaction functions of the primary balance are estimated for different groups of EU countries using quarterly data for the pre-crisis period 2001-2008 and for the crisis period 2009-2014. The pre-crisis estimations reveal some differences in persistence and cyclical reaction between different groups of countries, but generally little feedback from the debt stock to the primary balance. The fiscal reaction functions of the countries that eventually developed fiscal problems do not stand out. The estimations on data from the crisis period show largely unchanged persistence and counter-cyclicality but much more feedback from the debt stock, and this applies both to the crisis countries and those less affected. In spite of large deficits and accumulation of debt, the underlying fiscal reaction has become more prudent after the outbreak of the European debt crisis.

JEL codes: E61, E62, H62, H63

Keywords: fiscal reaction function, global financial crisis, debt crisis, structural break

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1. Introduction

Fiscal policy is at the core of the European Union, as is witnessed in part by the fiscal criteria of the Maastricht Treaty and the Stability and Growth Pact. The central place of fiscal policy became even more apparent after the emergence of the global financial crisis in the autumn of 2008 and, shortly thereafter, the European debt crisis. In the wake of these events, several governments encountered problems borrowing from private capital markets. Interest rates on government debt shot up and for some countries, debt markets dried up altogether. Meanwhile, some of the core countries in the EU saw interest rates on government debt drop to historically low levels as investors saw them as safe havens.

The radically different developments between different groups of EU countries after the outbreak of the global financial crisis are striking and constitute the background for this paper. The paper aims to provide further insights into the reasons for the diverging fiscal performance across groups of EU countries. Data on deficits and debt accumulation generally provided no or little indication of emerging problems before the crisis (Lane 2012, Shambaugh *et al.* 2012). This paper takes the analysis one step further and contributes to the literature on the possible causes and consequences of the European debt crisis by comparing the fiscal reaction to macroeconomic developments in different groups of EU countries before and after the outbreak of the crisis. One issue of particular importance is whether the diverging fiscal performances are related to different fiscal reactions in the period *before* the global financial crisis. Another issue is whether the reactions of the fiscal stance changed in the years *after* the outbreak of the crisis.

Fiscal reaction functions are estimated for groups of EU countries using quarterly data for the period 2000-2014. Fiscal reaction functions are an important instrument for ascertaining the determinants of the fiscal stance. Until recently only annual fiscal variables were available in most countries, and this necessitated the use of either very long time horizons with the risk of many structural breaks or panel data with the risk of erroneous pooling. The advent of standardised quarterly data from Eurostat on fiscal variables makes it feasible to estimate reaction functions using data from the first quarter of 2000 and through the first quarter of 2014, but the short sample still requires the countries to be grouped or pooled. The dependent variable is the primary fiscal balance in percent of GDP and the explanatory variables include the lagged dependent variable, a proxy for the cyclical position, the accumulated debt stock, and interest payments in some specifications. This sort of modelling of the fiscal outcome bears a close resemblance to Taylor rules for monetary policy (Reicher 2012).

The time sample of the database ranges from 2000:1 through to 2014:1. This sample is chosen mainly due to data availability, but it also has some advantages. Although the outbreak of the global financial crisis is not right in the middle of the sample, there are still a substantial number of observation points on either side of the event. This facilitates an analysis of a possible structural break around the outbreak of the crisis. At the same time, the short time sample implies that the likelihood of major structural breaks in the fiscal reaction functions *other* than the break stemming from the financial crisis is limited. The years 2000-2014 are a period in which a large part of the institutional framework in Europe remained relatively stable and no major shocks besides the global financial crisis affected European economies.

Despite the relatively large number of observations that can be obtained from quarterly data, it is necessary to estimate the reaction functions using groups or panels of countries. This makes it possible to ascertain differences in the fiscal reaction among different groups of

countries. Two criteria are used for forming the groups. One division of the countries is based on their degree of integration into EU structures, while the other division is based on the severity of the fiscal and economic problems experienced by the countries after 2008.

The rest of the paper is organised as follows. Section 2 discusses the related literature and the research gaps that this paper seeks to fill. Section 3 specifies the groups of EU countries and the data used in the estimations. Section 4 presents the results of the estimations for the pre-crisis period, in which the fiscal reaction function includes only persistence and cyclical terms. Sections 5 and 6 present the main results for the pre-crisis period when measures of the debt stock and interest payments are included. Section 6 provides the results for fiscal reaction functions for the crisis period. Finally, Section 7 summarises the results and discusses avenues of further research.

2. Related literature

The literature on fiscal reaction functions is largely empirical, but it is possible to rationalise different fiscal reaction functions as the outcome of a problem where policy-makers minimise a loss function subject to constraints afforded by the economy, including the reaction of the private sector to different government policies (Gali & Perotti 2001, Ballabriga & Martiniez-Mongay 2003). The loss function may, for instance, comprise targets for the fiscal variable and short-term economic growth, but may also include a persistence component due to costs from rapid changes in the fiscal variable. The end result is a specification in which the fiscal variable of interest is a function of the persistence component, the cyclical position and possibly other factors.

In most empirical studies the explanatory variable is the *realised* fiscal outcomes, like the realised primary budget balance, which is also the focus of this paper. Some studies seek to ascertain the *policy intentions* of policy-makers and to that end focus on fiscal variables that reflect policy decisions such as tax rates or discretionary spending (Ilzetzki & Vegh 2008, Darvas 2010). Other studies use real-time data to provide a more realistic picture of fiscal policy-making (e.g. Bernoth *et al.* 2008).

Persistence of the fiscal stance may be due to a host of structural and political features, including information delays, constraints in policy-making and implementation lags. A high degree of persistence may reflect the difficulty in changing levels of spending or taxation. In general, persistence seems to be greater in advanced economies than in developing and transition countries (Fatas & Mihov 2001, 2008). For the euro area countries, Paloviita (2012) finds that persistence has been lower in the crisis countries in the periphery than in the rest of the euro area. The differences may be due to different structural and institutional features across the country groups. Afonso *et al.* (2010) find that the persistence of the fiscal stance is correlated with country income and the size of the government. This is in line with the conclusions of Friedman (2006) who finds from quarterly data for the USA between 1959 and 2003 that the persistence in the fiscal balance as a ratio of GDP has increased over time.

For the cyclical reaction of fiscal policy, there are also differences between advanced and developing countries. Many empirical studies find that fiscal policy is typically counter-cyclical in developed economies, while it is pro-cyclical in emerging economies (Ilzetzki & Vegh 2008, Afonso *et al.* 2008). Staehr (2008) shows that although the fiscal balance is

counter-cyclical in all parts of Europe, it is much more counter-cyclical in Western Europe than in the transition countries of Central and Eastern Europe.

Egert (2010) provides a detailed analysis of the cyclicality of the fiscal stance in the OECD countries and confirms that it is counter-cyclical in this group of countries. Sutherland *et al.* (2010) reach the same conclusion but also find that the size of the counter-cyclical response of discretionary fiscal policy depends on the initial fiscal stance and debt level. *Discretionary fiscal policy seems to be pro-cyclical in some countries and counter-cyclical in others, and it reacts to the cycle in a non-linear way, depending on the size of the debt stock.*

Inclusion of the debt-to-GDP ratio means that the reaction of the budget balance to the level of public debt can be examined. Bohn (1998) argues that the reaction of the primary balance to the government debt stock can be taken as an indicator of the prudence or "sustainability" of the fiscal stance. If an increase in the debt stock is followed by a strengthening of the primary balance, fiscal policy can be taken as prudent or sustainable, since more resources are made available to service the debt. Such estimations are evidently backward-looking and only uncover the feedback from the debt stock within the estimation sample, but they cannot predict the fiscal reaction of a government in future and hence whether the government will pay its debt back.

Bohn (1998) finds a positive and statistically significant coefficient for the USA in the 20th century and concludes that policy-makers have eventually reacted to the accumulation of large debt positions over this period of time. Wyplosz (2006), Staehr (2008) and others apply the same methodology to European datasets and find some evidence of positive feedback from the debt stock to the primary balance but also conclude that the feedback is difficult to estimate precisely because the data series are short. Piergallini & Postigliola (2012) find that the primary balance in Italy has exhibited a positive reaction to the debt stock and conclude that politicians have taken corrective measures to ensure the sustainability of public finances in Italy. Estimating a fiscal reaction function for Brazil using monthly data, de Mello (2008) finds that the primary balance reacts positively and strongly to the lagged debt stock.

A number of studies examine how fiscal reaction functions change after a well-defined event that may affect the economic structure or the policy-making environment. Bohn (1998) splits his century-long sample into subsamples and examines how the feedback from the lagged debt stock changes between different subsamples. Several papers consider the fiscal reaction of the countries that sought to satisfy the fiscal criteria of the Maastricht Treaty in order to join the euro. Gali & Perotti (2003) estimate fiscal reaction functions for eleven EMU countries for 1980-2002 and find that membership of the euro area did not cause discretionary fiscal policy to become less counter-cyclical than in the EU countries that did not seek to join the euro. Ballabriga & Martiniez-Mongay (2003) find that fiscal policies changed little with the introduction of the euro.

Wyplosz (2006) decomposes the overall fiscal balance into the cyclically adjusted balance and a discretionary policy component defined as the overall balance minus the cyclically adjusted balance. The cyclically adjusted balance reacted more strongly to the business cycle before the countries entered the euro area than afterwards, while the discretionary component was pro-cyclical prior to entry, as countries sought to satisfy the criteria, but became a-cyclical afterwards. However, Marinheiro (2005) finds that the introduction of the euro reinforced the counter-cyclicality of fiscal policy. Afonso *et al.* (2010) also find evidence of counter-cyclical reactions in the fiscal policy of euro countries.

3. Country groups and data

3.1. Country groups

The fiscal reaction functions are estimated for different groups of EU countries, since it is not feasible to estimate reaction functions for countries individually. Two different criteria are used for forming the groups. The first criterion is based on the geographical and economic position of the country as studies have shown that the fiscal reaction functions differ substantially across the mature market economies in Western Europe and the post-transition economies in Central and Eastern Europe. The second criterion is the severity of the public finance problems experienced after 2008. As discussed in Section 1, fiscal data provided little or no indication of problems for most of the governments that eventually faced financing difficulties. It is therefore of interest to ascertain whether the crisis countries exhibited structural problems that are visible from a comparison of the fiscal reaction functions of crisis and non-crisis countries.

The choice of panel data estimations on groups instead of individual countries hinges on three main concerns. First, the very short time sample in combination with the rather "noisy" quarterly fiscal data makes it difficult to estimate fiscal reaction functions for individual countries as the coefficients are often imprecisely estimated. Second, the use of panels makes it possible to carry out estimations for the short period after the autumn of 2008 when many European countries were severely affected by the global financial crisis and the European debt crisis. Third, estimation of individual reaction functions of each of the EU countries would make it difficult to attain an overview of the results obtained, especially since the standard errors of the estimated coefficients would be large in some cases.

Table 1 shows the different groups used in the empirical analysis. The EU27 consists of all EU countries except Croatia (for which data are not available). The majority of the countries are divided into groups using two different criteria. One division is based on their geographical location and their degree of integration into EU governance structures. The group EA12 consists of the first 12 countries to join the euro area, all of them in Western Europe, while the group CEE10 is the group of 10 countries from Central and Eastern Europe that joined the EU in either 2004 or 2007.

Table 1: Groups of EU countries

	Explanation	Countries
EU27	All 27 EU countries	All
EA12	The first 12 euro area countries from Western Europe	BE, DE, IE, EL, ES, FR, IT, LU, NL, AT, PT, FI
CEE10	The 10 EU countries from Central and Eastern Europe	BG, CZ, EE, LV, LT, HU, PL, RO, SI, SK
EAnon7	The 7 countries from EA12 with limited fiscal problems	BE, DE, FR, LU, NL, AT, FI
EAcris5	The 5 countries from EA12 with substantial fiscal problems	IE, EL, ES, IT, PT
CEEnon7	The 7 countries from CEE10 with limited fiscal problems	BG, EE, LT, CZ, PL, SI, SK
CEEcris3	The 3 countries from CEE10 with substantial fiscal problems	LV, HU, RO

Note: The country abbreviations are the official EU abbreviations; see http://publications.europa.eu/code/en/en-370100.htm.

The division into the EA12 and CEE10 groups is predicated on studies showing that the fiscal reaction functions differ across the two regions. Staehr (2008) finds that the budget balance is more persistent and more counter-cyclical in Western Europe than in Central and Eastern Europe. This is consistent with the finding that persistence is generally greater in advanced economies than in developing and transition countries (Fatas & Mihov 2001, 2008). Likewise, Afonso *et al.* (2010) find that persistence is an increasing function of country income and the size of the government; countries in Western Europe are generally richer and have larger governments than those in Central and Eastern Europe. Finally, the European Commission uses estimates of the sensitivity of the fiscal balance to the output gap for calculating the cyclically adjusted balance. The estimates are computed using annual data on disaggregated spending and revenue items. The semi-elasticities provided in European Commission (2013, p. 145) show a higher cyclical sensitivity for west European countries (typically 0.5 or 0.6) than for the EU countries from Central and Eastern Europe (typically 0.3).[1] In conclusion, the division into the EA12 and CEE10 group is not only geographically motivated but seeks to take into account well-documented heterogeneities across the two groups.

The other division facilitates the analysis of the main questions raised in this paper of whether there were differences between crisis and non-crisis countries before and after the outbreak of the global financial crisis. The division is based on the severity of the fiscal and financial problems after 2008 experienced by countries within each of the two main groups EA12 and CEE10.

The euro area countries in EA12 are divided into the groups EAnon7 and EAcris5. The group EAnon7 consists of the seven euro area countries in Northern Europe that experienced only relatively modest fiscal strain during the crisis, while the group EAcris5 consists of the five EA12 countries in the geographical periphery that experienced substantial fiscal problems after the global financial crisis, with all of them except Italy receiving bailouts.

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[1] A semi-elasticity of e.g. 0.6 implies that an increase in the output gap of 1 percent corresponds to an improvement of the fiscal balance by 0.6 percentage points of GDP. Notice that the semi-elasticities used by the European Commission to compute the cyclically adjusted balance are not *directly* comparable to sensitivity estimates from estimation of fiscal reaction functions, in part because the latter takes into account the persistence of the fiscal stance.

The CEE10 countries from Central and Eastern Europe are divided into the groups CEEnon7 and CEEcris3. The group CEEnon7 consists of the seven Central European countries that managed the crisis without requiring a government bailout. The group CEEcris3 consists of Latvia, Hungary and Romania, which all faced serious fiscal problems and received bailouts in 2008 or 2009. It is noticeable that the fiscal problems affecting the CEEcris3 countries occurred earlier than those in the ECcris5 countries.

In conclusion, the division of the sample countries into different groups is driven by two factors. The division of the countries into non-crisis and crisis countries makes it possible to shed light on the main question of the paper. The division into Western European countries and Central and Eastern European countries seeks to ensure sufficient homogeneity within the groups used in the panel estimations.

3.2 Data definitions

The dataset for the empirical analysis consists of quarterly data on public finances and output for each of the 27 EU countries. The data are taken from the Eurostat database.[2] The primary budget balance in percent of GDP, PRIM, is computed as the sum of the headline budget balance and the interest payments (Eurostat classifier: *gov_q_ggnfa*).

The variable DEBT is the general government gross debt stock in percent of GDP (classifier: *gov_q_ggdebt*). The numerator is a stock variable, while the denominator is a flow variable. The debt stock in percent of GDP is typically computed as the debt stock as a share of *annual* GDP. It is also a measure frequently referred to in EU agreements, including the Maastricht Treaty and the Fiscal Compact. To retain direct comparability between quarterly and annual measures of the debt stock in percent of GDP, Eurostat scales the quarterly GDP by a factor of four to attain an annualised GDP measure that is then used to compute the quarterly data series on debt in percent of GDP. This computation of the debt variable is important for the interpretation of the fiscal reaction functions estimated in Sections 5 and 6.

The dataset also contains the variable G4Y, which is the percentage growth of GDP from the same quarter of the previous year (classifier: *namq_gdp_k*). The variable is a straightforward measure of the cyclical stance. An output gap measure will also be computed using cyclically adjusted GDP data. The variable G4YEU denotes the percentage growth year-on-year of GDP in the whole group of EU countries in the sample (classifier: *namq_gdp_k*). The variable is used as an instrument in the instrumental variables estimations.

The first quarter of the data series is 2000:1, as the debt variable is only available from this quarter, and the last quarter is 2014:1. For some countries the primary budget balance exhibits extreme values for individual quarters when extraordinary expenses or revenue items are booked.[3] Banking sector bailouts led to extreme negative values for Ireland in 2010:1-2011:3, Greece in 2013:2, Spain in 2012:4 and Slovenia in 2113:4. Nationalisation of pension funds led to extreme positive values for Hungary in 2011:3 and Poland in 2014:1. To prevent these data points affecting the results disproportionately they have not been included in the primary

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[2] All data were downloaded on 1 August 2014 from the Eurostat database (http://epp.eurostat.ec.europa.eu/ portal/page/portal/statistics/search_database). The dataset is available from the authors upon request.
[3] Extraordinary expenses or revenue items appear particularly large when expressed in percent of *quarterly* GDP.

budget balance variable PRIM. Data on the debt stock are not available for Malta in 2000:1-2001:3. Although the panel is not balanced, relatively few observations are missing.

Filtering and adjustment of data are kept to a minimum to facilitate replication and to ensure that results are not affected unduly by such measures. One consequence of this choice is that data are not seasonally adjusted, but instead comparisons are typically made with the same quarter of the previous year. Another important factor to note is the choice of GDP growth, G4Y, as the proxy of the business cycle stance. The construction of an output gap is fairly complex and entails a number of somewhat arbitrary decisions. Egert (2010) shows that the results are usually quite similar when the GDP growth rate is used and when an output gap measure is used.

3.3 Summary statistics

Table 2 shows the average values for the main variables for each of the seven country groups. Data are shown for two time samples. The first sample is 2001:1-2008:2, where the end point corresponds to the last quarter before the bankruptcy of Lehman Brothers and the outbreak of the global financial crisis. The second time sample is 2009:1-2014:1, which is the period after the outbreak of the crisis. Note that the latter period does not include 2008:3 and 2008:4, as data are unusually volatile in these two quarters immediately after the bankruptcy of Lehman Brothers.

Table 2: Group-specific averages for the variables used in the analyses

	PRIM		DEBT		G4Y	
	2001:1-2008:2	2009:1-2014:1	2001:1-2008:2	2009:1-2014:1	2001:1-2008:2	2009:1-2014:1
EU27	0.8	-2.1	48.0	59.7	3.8	-0.3
EA12	1.6	-2.1	61.8	80.6	2.6	-0.7
CEE10	-0.4	-2.3	29.4	40.0	5.9	0.1
EAnon7	2.2	-1.0	56.6	67.7	2.4	0.1
EAcris5	0.7	-3.7	69.9	109.4	2.8	-1.9
CEEnon7	-0.1	-2.6	28.8	35.3	5.8	0.3
CEEcris3	-1.0	-1.8	30.8	50.8	6.0	-0.5

Notes: The averages are simple averages for the countries in the group. PRIM and DEBT are in percent of GDP, G4Y is the percentage change over the same quarter the year before.

Prior to the crisis, the average primary balance, PRIM, was positive for the EU27 group and for the Western European groups, but negative for the CEE groups. After the crisis the deterioration in the primary balance was substantial and the balance turned negative for all country groups. The smallest average primary deficits after the crisis were in the group EAnon7 and the largest was in the EAcris5 group, the group of euro area countries experiencing substantial fiscal problems.

The average government debt stock exhibits a lot of variation between the country groups. Before the crisis the debt stock was much larger for the EA12 group than for the CEE group and this was particularly pronounced for the EAcris5 group of countries that later experienced

fiscal problems. After the crisis a substantial increase in the debt stock is visible in most cases, particularly for the countries most affected by fiscal problems.

Finally, before the crisis the average rate of economic growth was much higher in the CEE countries than in the EA12 group, but within these groups there was little difference between the groups of countries that weathered the crisis well and those that experienced fiscal problems. The rate of growth fell markedly in all country groups after the outbreak of the global financial crisis, but the decline was most pronounced in the CEE countries.

The time series properties of the variables are examined using three panel unit root tests which all assume country-specific unit root processes, i.e. the Im, Pesaran and Shin test and the Augmented Dickey Fuller and Phillips-Perron Fisher χ^2 tests.[4] The unit root testing entails many challenges. First, the global financial crisis might have led to structural breaks in the time series properties of the fiscal variables and the GDP growth series, and it is therefore reasonable to run the testing separately for the two samples of interest, i.e. 2001:1-2008:2 and 2009:1-2014:1. Second, the very short samples and the low power of most unit root tests may make it difficult to reject the null hypothesis of a unit root. Finally, the time series properties must be examined separately for each of the different groups of countries.

Due to space constraints, the tests are not reported here. The results are relatively consistent between the three unit root tests and the different country groups. The null hypothesis of a unit root can generally be rejected for the budget balance BAL, the primary budget balance PRIM, and the output growth G4Y. The exception is that G4Y may not be stationary for the period 2009:1-2014:1 for the two groups of countries with fiscal problems. The null hypothesis could generally not be rejected for the gross debt stock DEBT, which is reasonable, given that it is a stock variable in large part aggregating BAL. It is evident that tests of time series properties should be interpreted with care when they are carried out on data with a very short time dimension as indeed is the case here. Nevertheless, the potential non-stationarity of the DEBT variable makes it important to evaluate the possibility of spurious correlation when the variable is included in fiscal reaction estimations.

4. Fiscal reaction to business cycles

4.1 Specification of quarterly reaction function

The very short time span necessitates the use of quarterly data, but this is challenging since fiscal reaction functions are typically estimated using annual data. The use of quarterly data implies a number of complications due to their seasonality and a high noise-to-signal ratio. We therefore begin the empirical investigation with the estimation of simple quarterly fiscal reaction functions including only persistence and a cyclical response, and estimated for the relatively calm pre-crisis period. The main aim is to ensure that the estimations using quarterly data provide results that are comparable to the results based on annual data; Section 5 presents the main results of the paper.

The dependent variable is the primary balance, PRIM. Interest payments are largely the result of earlier decisions on the accumulation of debt, and it is therefore appropriate to consider the

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[4] The test statistic of the Im, Pesaran and Shin test is the average of bias-adjusted t-statistics from country-specific Augmented Dickey Fuller (ADF) tests, while the test statistics of the Fisher χ^2 tests are combinations of *p*-values from country-specific ADF or Phillips-Perron tests.

reaction of the primary balance to different explanatory variables. The following panel specification, derived from Burger & Marinkov (2012, pp. 17-24), was chosen:

$$\text{PRIM} = \text{Country dummy} + \beta_1 \cdot \text{PRIM}(-4) + \beta_2 \cdot \text{G4Y} + \varepsilon \qquad (1)$$

The variables PRIM and G4Y are indexed by both country and time. Quarterly time dummies are also included but are not shown. The country-specific dummy is included to control for time-invariant unobserved heterogeneity across the countries, β_1 and β_2 are the coefficients of interest, and ε is an error term.

The coefficient β_1 depicts the marginal effect of the primary budget balance lagged four quarters and is thus a measure of the persistence of the fiscal balance. The coefficient β_2 depicts the marginal effect of the rate of economic growth, G4Y, measured as percentage GDP growth over the same quarter of the previous year. The specification coefficient β_2 captures all dependence on the business cycle stance, i.e. both the effect of automatic stabilisers and systematic discretionary measures taken in reaction to the business cycle stance. There is no attempt to distinguish between the two forms of cyclical dependence of the primary balance; cyclically adjusted budget data are not available at the quarterly frequency.

Using the year-on-year growth rate instead of the output gap as a proxy for the business cycle stance has many advantages. The variable is readily observable and does not require complex computation which rests on many essentially arbitrary assumptions. The output gap is typically computed as the logarithm of actual GDP minus the logarithm of trend GDP. Trend GDP can be computed in different ways but it would typically utilise information from periods ahead; this is for instance the case when trend GDP is computed using a Hodrick-Prescott filter. This is particularly unfortunate in the present case as estimates of the output gap in the pre-crisis period will be severely affected by the subsequent downturn.

The specification in (1) explains the development of the fiscal stance over four quarters with the development of economic growth over the same period. Experimentation with various alternative specifications of the estimations reveals that lagged values of G4Y generally have very little explanatory power. Likewise, if the estimations also include the primary budget balance lagged one, two and three quarters, the estimated coefficients of these lags are very small in numerical terms and never attain statistical significance.

Equation (1) can be rewritten to provide an interpretation more directly related to the implementation of fiscal policy in most countries.

$$\Delta_4 \text{PRIM} = \text{Country dummy} + (\beta_1 - 1) \cdot \text{PRIM}(-4) + \beta_2 \cdot \text{G4Y} + \varepsilon \qquad (2)$$

The dependent variable Δ_4PRIM is the change in the primary deficit from the same quarter of the year before; Δ_4PRIM is denominated in percentage points of GDP. All EU countries monitor their fiscal performance at the monthly and quarterly frequency and the outcome is typically compared with corresponding data from the year before. Equation (2) depicts how the primary balance changes over the year given the initial primary balance and the GDP growth during the year.

The specification in (1) and (2) is meant to account for data being quarterly and therefore containing a lot of noise and seasonal variation. The quarterly dummies will "absorb" the seasonality insofar as the seasonality affects the variables equally across the countries in the

group. We have experimented with the seasonally adjusted fiscal variables that are available for some countries. The main difference was that it is not only the seasonally adjusted primary balance lagged four quarters that attains statistical significance, but the variable lagged one, two and three quarters does so too. The sum of the four lagged variables, however, was in all cases close to the estimate of β_1 in (1) and the estimate of β_2 did not change much. The upshot is that although the quarterly dummies may not absorb all the seasonality effects, the qualitative results are broadly similar whether data are seasonally adjusted or not. This is also a result obtained in Ilzetki & Vegh (2008).

The panel specification in (1) is estimated using the two-stage instrumental variables method with country fixed effects. Celasun & Kang (2006) find this method to be appropriate for fiscal reaction functions estimated on panel data. The fixed effect estimation methodology implies that the effects of the explanatory variables are identified via the time dimension. The rate of economic growth over the last four quarters, G4Y, may be affected by the fiscal stance in the four quarters "covered" by the variable. Indeed, studies suggest that fiscal policy is effective, albeit to varying degrees, in all EU countries (Boussard *et al.* 2012).

To eliminate the effect from the fiscal stance to GDP growth, the explanatory variable G4Y is therefore instrumented. The total set of instruments used in all regressions are the primary balance lagged four quarters, PRIM(-4), the year-on-year rate of growth lagged four quarters, G4Y(-4), the year-on-year rate of growth in the EU not lagged and lagged one quarter, G4YEU and G4YEU(-1), the debt stock lagged four quarters, DEBT(-4), and quarterly dummies. The estimation results presented in this and the following section are generally robust to other choices of instruments.

4.2 Some results

The fiscal reaction function in (1) is estimated for each of the groups or panels in Table 1 using the time sample 2001:1-2008:2.[5] Table 3 shows the results for each of the seven country groups. For the whole EU27, the estimated persistence coefficient is 0.666 and the coefficient of cyclical dependence is 0.600. Both coefficients are estimated very precisely, in part due to the large number of observations, but as argued in Section 3 the full panel might be very heterogeneous; arguably more interesting results emerge when the Western European and Central and Eastern European groups are considered separately.

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[5] The four quarters 2000:1-2000:4 are used for lags of the explanatory variables.

Table 3: Fiscal reaction to business cycle, FE-IV estimation, 2001:1-2008:2

	PRIM(-4)	G4Y	R^2	No. obs.
EU27	0.652*** (0.039)	0.600*** (0.118)	0.601	806
EA12	0.677*** (0.053)	0.659*** (0.147)	0.649	360
CEE10	0.534*** (0.087)	0.264 (0.208)	0.585	300
EAnon7	0.690*** (0.075)	0.574*** (0.149)	0.688	210
EAcris5	0.586*** (0.063)	0.842** (0.336)	0.537	150
CEEnon7	0.606*** (0.102)	0.288 (0.177)	0.634	210
CEEcris3	0.451*** (0.125)	-0.271 (0.364)	0.525	90

Notes: The dependent variable is the primary budget balance, PRIM. Instrumental variable estimation with country fixed effects and quarterly dummies. The instruments are PRIM(-4), G4Y(-4), G4YEU, G4YEU(-1) and DEBT(-4) and quarterly dummies. Robust standard errors are shown in brackets. Superscripts ***, **, * denote that the coefficient estimate is statistically different from 0 at the 1, 5 and 10 percent levels of significance respectively.

The primary balance exhibits somewhat higher persistence for the EA12 group than for the CEE10 group, which is a result observed previously (Staehr 2008). This suggests that after episodes in which the primary balance has attained extreme realisations, it adjusts more slowly in the EA12 countries than in the CEE10 countries. The cyclical reaction varies substantially between the two groups. The primary balance is clearly counter-cyclical in the groups consisting of Western European countries, while it is close to being a-cyclical in the groups consisting of the EU countries from Central and Eastern Europe. The estimated coefficient of G4Y for the EA12 is 0.659 while it is 0.264 for the CEE10 countries. It is noticeable that these estimates are close to the estimates of the budget sensitivities published by the European Commission (2013), cf. the discussion in Section 3. Overall, the results for the cyclical reaction found from estimations using quarterly data correspond closely to the results found using annual data (Staehr 2008, Egert 2010, in't Veld *et al.* 2012).

The main conclusion is that the differences are relatively small when the fiscal reaction functions the non-crisis and crisis countries are compared within each main group. Within the EA12 group the degree of persistence is very similar, while the degree of counter-cyclicality was smaller in the group of countries experiencing little strain (EAnon7) than in the group that eventually experienced fiscal problems (EAcris5). In other words, the crisis countries in Western Europe did not react to the pre-crisis boom in a more imprudent manner than the countries that avoided large fiscal disruptions.

Within the CEE countries, the estimated coefficients of G4Y differ between the two country groups but neither the positive coefficient for the CEEnon7 group nor the negative coefficient for the CEEcris3 group are statistically significant. The numerical values of the estimated coefficients are in any case relatively small. The conclusion would be that although both groups of CEE countries experienced rapid economic growth in the sample period, this does not appear to have led to a substantial and statistically significant strengthening of the fiscal balance.

It might be useful to discuss the economic implications of the estimated fiscal reaction functions in more detail. The quarterly data complicate the interpretation and we will carry out a simple simulation exercise. We consider the case where the economy is initially in a steady state and then experiences a small boom in the form of growth increasing by 0.5 percent in one quarter and a further 0.5 in the following quarter, after which there are no more changes. Figure 1 shows the simulated change in the primary balance resulting from this stylised experiment using the estimated coefficients for the EA12 and CEE10 groups presented in Table 3.

Figure 1: Change in primary balance PRIM after GDP shock, percentage points
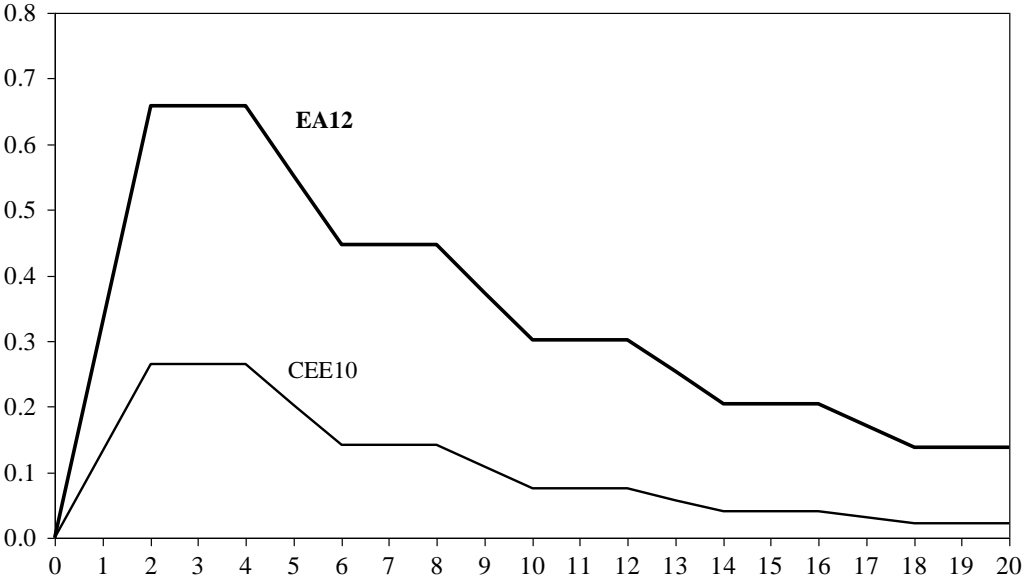
Note: Reaction of PRIM after an increase in GDP of 0.5 percent in periods 1 and 2. The reactions are computed using the coefficients in Table 3.

Figure 1 illustrates the different reactions to an output shock in the EA12 group of Western European countries and the CEE10 group of Central and Eastern European countries. The primary balance improves by 0.58 percentage point in the EA12 group but only 0.23 percentage point in the CEE10 group during the first year (quarters 1-4) and then by 0.47 and 0.16 respectively in the second year (quarters 5-8). Both the short-term reaction and the longer-term effect of an output shock are larger for the EA12 group than for the CEE group.

The cyclical variable in estimations in Table 3 is the GDP growth year-on-year. Egert (2010) shows in a study using annual data for the OECD countries that the results are quite similar whether the rate of GDP growth or an output gap measure is used. Appendix A discusses the computation of an output gap for the present quarterly GDP series and shows the results when this measure is used instead of the G4Y. The main difference is the estimated cyclical dependence for the EAcris5 group which is much lower when the output gap is used than when the growth rate G4Y is used. The somewhat unreasonable estimate and the large standard error of the coefficient of the output gap is in large part the result of the output gap

being computed using forward-looking data.[6] We see this as confirmation that it is most expedient to continue using the variable G4Y as a measure of the cyclical stance of the economy.

The results in Table 3 are obtained using fixed effect estimations in which G4Y is instrumented. This choice is predicted by the desire to isolate the effect *from the business cycle* to the primary balance and exclude the effect from the primary balance to the business cycle. Boussard *et al.* (2012) find that the latter effect can be substantial, in which case ordinary fixed effect estimations would presumably lead to lower estimates of the cyclical reaction. This is indeed the case as illustrated in Table B.1 in Appendix B where the results of estimating (1) using ordinary fixed effect least squares are presented. The coefficients are substantially smaller than those obtained from the instrumental variables estimation and this applies particularly to the sample of Western European countries, which is consistent with the finding that the fiscal multiplier is larger in these countries than in Central and Eastern European countries. It is noticeable, however, that the ordering or the relationship across the country groups remains unchanged.

The results in Table 3 are not sensitive to the specific choice of instruments. This is evident if for instance additional lags of DEBT(-4) or G4Y(-4) are included or if G4YEU is replaced by the corresponding variable for the USA. Likewise, including lags of real energy prices as instruments does not change the results in qualitative terms. The results in Table 3 are also robust to a number of other specification changes, including shortening of the time sample at the beginning or the end of the sample. Likewise, removing a country from the different country groups does not generally affect the results in qualitative terms, although there are, as expected, some changes in coefficient estimates and standard errors.

The findings of this section can be summarised in a few points. First, the estimations of fiscal reaction functions using quarterly data provide results that are broadly in line with the results in previous studies of fiscal reaction functions in Europe using annual data. Second, the primary balance exhibits substantial persistence, although it varies somewhat across the country groups. Third, the primary balance in percent of GDP is highly counter-cyclical for the groups of Western European countries but probably a-cyclical for the groups of Central European countries. Fourth, there are no clear differences between the countries that weathered the crisis without major fiscal problems and those that eventually experienced financing problems.

5. Fiscal reaction to debt before the crisis

The estimations in Section 4 showed that it is possible to estimate fiscal reaction functions on quarterly data and to obtain results that are qualitatively and quantitatively comparable to those obtained using annual data. This section extends the analysis of fiscal reactions in different parts of the European Union by including the debt obligations of the member countries.

As discussed in Section 2, Bohn (1998) suggests examining the fiscal prudence or fiscal sustainability of a country (or group of countries), which means the debt stock should be

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[6] The very large downturn from 2008:3 meant that very large positive output gaps are computed for the period *before* the crisis. These large positive output gaps were not observable in real time and were not followed by corresponding increases in the primary balance. See also Bernoth *et al.* (2008).

included in a reaction function in which the dependent variable is the primary balance. Positive feedback from the debt stock to the primary balance implies that higher debt is followed by an improved primary balance, making more resources available for debt servicing. Positive feedback may therefore be seen to indicate that the fiscal stance is prudent, or in a narrow sense sustainable.[7]

Table 4 shows the results when the debt stock lagged four quarters, DEBT(-4), is included in the fiscal reaction functions. The results for the fiscal persistence and the cyclical reaction are broadly the same as those presented in Table 3 and will not be discussed further.

Table 4: Fiscal reaction to business cycle and debt, FE-IV estimation, 2001:1-2008:2

	PRIM(-4)	G4Y	DEBT(-4)	R^2	No. obs.
EU27	0.656*** (0.040)	0.656*** (0.118)	0.050* (0.025)	0.643	806
EA12	0.676*** (0.053)	0.651*** (0.149)	0.026 (0.025)	0.650	360
CEE10	0.532*** (0.086)	0.378* (0.197)	0.045 (0.042)	0.576	300
EAnon7	0.690*** (0.075)	0.581*** (0.148)	0.032 (0.030)	0.688	210
EAcris5	0.587*** (0.063)	0.806** (0.342)	0.019 (0.037)	0.545	147
CEEnon7	0.606*** (0.103)	0.331** (0.149)	0.021 (0.044)	0.633	210
CEEcris3	0.447*** (0.133)	0.283 (0.449)	0.268*** (0.092)	0.531	90

Notes: The dependent variable is the primary budget balance, PRIM. Instrumental variable estimation with country fixed effects and quarterly dummies. The instruments are PRIM(-4), G4Y(-4), G4YEU, G4YEU(-1) and DEBT(-4) and quarterly dummies. Robust standard errors are shown in brackets. Superscripts ***, **, * denote that the coefficient estimate is statistically different from 0 at the 1, 5 and 10 percent levels of significance respectively.

With all the EU27 countries in the panel, the coefficient of the debt variable is estimated to be 0.050. Bohn (1998) uses annual data from 1916 to 1995 for the USA and obtains a coefficient of 0.054. The results are not directly comparable, however, since our results are based on estimations explaining the quarterly primary balance in percent of *quarterly* GDP by, among other variables, the debt stock in percent of GDP computed as the total debt stock divided by *annualised* GDP. The upshot is that the coefficient estimate of 0.050 attained for the full EU27 sample implies a much weaker short-term reaction of the primary balance to the debt stock than in Bohn (1998).[8] Moreover, despite a large number of observations, the coefficient is imprecisely estimated and statistically significant only at the 10 percent level. The weak or

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[7] Another means of studying the prudence or "sustainability" of fiscal policy is to test for stationarity of the debt or the fiscal balance. Cuestas *et al.* (2014) examine whether the global financial crisis has changed the debt dynamics in 12 euro area countries and finds that this is indeed the case except in Germany and France, the two core countries of the euro area. Cuestas & Staehr (2013) find that the fiscal balance may be stationary in most EU countries from Central and Eastern Europe, but it is characterised by numerous structural breaks.

[8] In the annual model of Bohn (1998), an increase in the debt stock of 1 percentage point would, ceteris paribus, increase the primary balance by 0.042 percentage points the following year. In our quarterly model a similar increase of the debt stock would increase the primary balance by 0.054/4 = 0.014 percentage points the following quarter.

non-existent feedback from debt to the primary balance persists when the regional country groups EA12 and CEE10 are considered individually.

Within the EA12 group there appears to be no statistically or economically significant difference between the debt feedback of the EAnon7 and EAcris5 groups. Within the CEE group, there appears be very strong feedback for the group of CEE countries that eventually received bailouts. The estimated coefficient for the CEEcris3 group is large and the short-term reaction from the debt stock to the primary balance is comparable to the results in Bohn (1998). The result is robust to a number of specification changes and seems to hold for all three countries in the group.[9] Within the pre-crisis sample period 2001:1-2008:2, the debt stock was stable in Latvia, increasing in Hungary and declining in Romania, so the positive feedback estimate has different implications for the overall development of the primary balance in the three countries.

The estimations in Table 4 use the dependent variable PRIM, which is stationary for all seven groups, while the explanatory variable DEBT may exhibit a unit root. This may lead to erroneous inference, an issue that we seek to address in a number of ways. First, a trend variable is introduced in all the estimations shown in Table 4, but the results are largely unchanged and are therefore not presented. Second, inclusion of time fixed effects (instead of the quarterly dummies and the trend) reduces the size of the coefficients of output growth markedly, but does not change the estimated coefficients of the lagged debt variable. Third, the country-specific debt variable *minus* the average debt for the 27 EU countries is borderline stationary in most cases, but when this variable is included instead of DEBT all results remain qualitatively unchanged (not reported; see also Baldi & Staehr 2013).

Table 4 reported the results from estimations on pre-crisis data of the reaction of the primary balance to its lagged value, the year-on-year growth and the debt stock. The results regarding the persistence and the cyclical dependence were similar to those of the simpler reaction functions reported in Table 3. The persistence and cyclical response are stronger in the Western European group than in the Central and Eastern European group, but within each of these two main groups the differences between countries weathering the crisis well and those facing fiscal problems were relatively small and had no clear pattern. There is generally only very modest or non-existent feedback from the debt stock to the primary balance with the exception of the crisis countries in Central and Eastern Europe, for which statically and economically significant feedback is found.

In broad terms, the fiscal reaction functions did not differ much across the groups of EU countries that eventually faced severe fiscal strain and the groups that did not encounter fiscal problems. The overall conclusion is therefore that it is not possible to link the pre-crisis fiscal reaction of different country groups to the subsequent performance after the outbreak of the global financial crisis.

6. Fiscal reactions during the crisis

The global financial crisis changed the conditions facing fiscal policy-making in numerous ways. Borrowing conditions tightened in some cases but eased in other cases and many EU

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[9] When the equation is estimated with country-specific coefficients of DEBT(-4), the point estimates of the coefficient are 0.102, 0.261 and 0.239 and the latter two coefficients attain statistical significance at the 10 percent level or better.

countries faced economic downturns of a severity not seen for decades. Extraordinary spending occurred in some countries as governments bailed out banks and other firms. This section examines how these fundamental changes in the financial and economic conditions affected the fiscal reaction in the seven groups of countries considered here. The idea is simply to re-estimate the reaction functions that include the lagged DEBT for the period after the outbreak of the global financial crisis. Table 5 shows the results for the crisis sample 2009:1-2014:1 and can be compared to those of the sample 2001:1-2008:2 in Table 4. The time sample is short so the results should be interpreted with caution.

Table 5: Fiscal reaction to the business cycle and debt, FE-IV estimation, 2009:1-2014:1

	PRIM(-4)	G4Y	DEBT(-4)	R^2	No. obs.
EU27	0.599*** (0.037)	0.327*** (0.054)	0.097*** (0.014)	0.645	544
EA12	0.743*** (0.064)	0.618** (0.103)	0.087*** (0.018)	0.654	236
CEE10	0.445*** (0.057)	0.207** (0.092)	0.118*** (0.041)	0.636	206
EAnon7	0.874*** (0.049)	0.431*** (0.073)	0.140*** (0.025)	0.798	146
EAcris5	0.462*** (0.151)	0.697** (0.325)	0.095*** (0.025)	0.535	90
CEEnon7	0.424*** (0.069)	0.227** (0.100)	0.140*** (0.034)	0.600	145
CEEcris3	0.497*** (0.114)	0.173 (0.236)	0.098 (0.139)	0.715	61

Notes: The dependent variable is the primary budget balance, PRIM. Instrumental variable estimation with country fixed effects and quarterly dummies. The instruments are PRIM(-4), G4Y(-4), G4YEU, G4YEU(-1) and DEBT(-4) and quarterly dummies. Robust standard errors are shown in brackets. Superscripts ***, **, * denote that the coefficient estimate is statistically different from 0 at the 1, 5 and 10 percent levels of significance respectively.

For the EA12 sample the persistence and the cyclical reaction were largely unchanged from the pre-crisis period, but the feedback from the debt position became much stronger. The estimated coefficient of the debt variable is much larger in the crisis sample than in the pre-crisis sample and is now statistically significant at the 1 percent level. The same pattern appears when the group of EA12 countries facing few fiscal problems is compared with the group with public problems in the crisis period. Persistence and the cyclical reaction changed little for both the EAnon7 group and the EAcris5 group, while the reaction to the debt stock is much stronger. Interestingly, the reaction to the debt stock is not stronger in the crisis group EAcris5 than in the non-crisis group EAnon7. It may be conjectured that the bail-out packages received by most of the EAcris5 countries relieved financing pressures and facilitated a moderate adjustment in the face of increasing debt stocks.

For the CEE10 group the persistence and the cyclical dependence appear to be largely unchanged or slightly weakened, while the reaction to the debt stock has become stronger and more precisely estimated. Within the CEE10 group there are only small differences between the non-crisis and crisis groups. The estimated coefficient of DEBT(-4) is 0.098 for the crisis group CEEcris3, which is lower than in the result for the pre-crisis sample, but the coefficient is estimated imprecisely. As for the EA12 countries it is noticeable that the reaction to the

debt stock is not larger for the countries receiving bailouts than for those that escaped the crisis without major fiscal problems.

The results point to a fundamental change in fiscal performance after the outbreak of the global financial crisis. The persistence of the primary balance is largely unchanged and the counter-cyclical response is also unchanged or slightly weaker, while the primary balance reacts much more strongly to the accumulated debt stock in essentially all country groups. The reaction to the debt stock is not stronger in the crisis countries than in those that have only modest problems and this may be interpreted as a sign of the bailouts being successful in avoiding excessive fiscal adjustment. The overall picture is that in spite of large deficits and the rapid accumulation of debt in the crisis period starting in the autumn of 2008, fiscal performance has become more prudent.

An interesting issue is whether the increased feedback from the debt stock is the result of the debt increasing during the crisis period. The lack of observations means that this issue cannot be fully investigated, but we have estimated the reaction functions for the cases when the debt is above the average of the group and the cases when it is below. For the EA12 group the estimated coefficient of DEBT(-4) is 0.152 when the debt is below the average of 80.6 percent of GDP and 0.124 when the debt is above the average. For the CEE10 group the estimated coefficient of DEBT(-4) is 0.102 when the debt is below the average of 40.0 percent of GDP and 0.087 when the debt is above the average. The conclusion is that the increased feedback from the debt stock is present both when the debt stock is relatively high and when it is relatively low. Experimentation with the non-crisis and non-crisis groups confirmed that there in the crisis period is a large positive feedback in all cases, but the limited number of observations means that the estimated reaction functions are not always well specified.

We subject the results in Table 5 to a number of robustness checks along the lines discussed in Section 5. First, when a trend variable is included in the estimations, all results remain essentially unchanged. Second, when the quarterly dummies are replaced by time fixed effects, the estimated persistence and debt feedback effects remain, while the estimated coefficient of G4Y becomes very small and statistically insignificant for all groups. The latter is a consequence of the business cycles in the EU countries being closely synchronised in the period after the global financial crisis. Third, when the debt stock DEBT is replaced by the difference between the country-specific debt stock and the EU27 debt stock, the estimated feedback from the new debt variable is somewhat smaller in all cases, but the qualitative results, including the relative position between the country groups, remain. Finally, the results remain essentially unchanged, even when the crisis sample is shortened and taken as starting in 2009:3 or 2010:1. This suggests that it is not specific events in the quarters immediately after the outbreak of the global financial crisis that are driving the results.

7. Concluding comments

This paper analyses the fiscal reactions of different country groups in the EU from 2000 up to the beginning of 2014, a period that covers the global financial crisis and the ensuing European debt crisis. The analyses are based on fiscal reaction functions for the primary balance estimated on quarterly data for the pre-crisis period and the crisis period. The short time dimension of the data series necessitates the use of panel data estimation, but data are pooled into seven different, partly overlapping, panels or groups. The paper aims to address

two main questions: First, are there differences in the fiscal reaction in the pre-crisis period that may explain why some countries developed severe debt financing problems while other countries were less severely affected? Second, how did the fiscal reaction functions change after the crisis?

The use of quarterly data for the estimation of fiscal reaction functions is relatively novel, but the initial analyses of a model with persistence and cyclical dependence of the primary balance show that the results conform with earlier studies that use annual data. For instance, the primary balance is more persistent and more counter-cyclical in the groups of countries from Western Europe than in the group of countries from Central and Eastern Europe.

Overall, the fiscal reaction functions estimated for the period *before* the outbreak of the global financial crisis differ little between the countries that escaped major fiscal problems and those that were less fortunate. Prior to the global financial crisis the feedback from the debt stock to the primary balance is modest and imprecisely estimated for almost all the groups considered, with the exception of the group of three Central and Eastern European countries which later developed fiscal problems. There is, however, a striking difference between the crisis countries in Western Europe and those in Central and Eastern Europe. In the former group the primary deficit was largely counter-cyclical and did not react to the debt stock, while in the latter group the primary deficit was largely a-cyclical but reacted to the accumulated debt stock. This suggests that fiscal crises took place against different backgrounds in the two regions as is also witnessed by the different timing of the fiscal crises.

The fiscal reaction functions changed *after* the outbreak of the global financial crisis. The main result is a much larger and more precisely estimated feedback from the debt stock to the primary balance. This applies both for the countries experiencing financing problems and for those less affected, and the conclusion is thus that the underlying fiscal reaction across Europe has become more prudent after the outbreak of the debt crisis. The fact that the change in the sensitivity to the debt stock does not differ much across the country groups may be interpreted as an indication that the bailout packages were successful in preventing excessive fiscal adjustment in the crisis countries.

The underlying reasons for the fiscal reactions uncovered in this paper cannot be inferred from the analyses, but two observations stand out. The first observation is that while the debt crises in Latvia, Hungary and Romania were resolved relatively fast, the crises in Western Europe lasted longer. The rapid crisis resolution in the crisis countries in Central and Eastern Europe may be related to the limited cyclical response which meant that the headline deficits in these countries were relatively modest in spite of deep downturns. The second observation is the change in the reaction to debt before and after the outbreak of the global financial crisis. This arguably most striking result is the absence of feedback from the debt stock before the crisis in (most of) the country groups. This may be associated with the ease with which countries could roll over debt and finance new debt in the pre-crisis environment of abundant credit and limited aware of risks (see also Lane 2012, Shambough *et al.* 2012). Increased risk awareness and lack of liquidity in government debt markets after the outbreak of the global financial crisis are likely among the factors which have enhanced fiscal prudence across Europe as witnessed by the increased feedback from the debt stock to the fiscal balance.

The estimation of reaction functions provides additional insights into the very different fiscal performance of the EU countries after the global financial crisis. A number of arguably novel results are found, in part due to quarterly data facilitating estimations on a short time sample.

More research is needed to provide better modelling of the dynamics of persistence and the cyclical reaction in fiscal reaction functions estimated on quarterly data. Vector autoregressive models may be useful in this context. A main drawback of the use of quarterly data is evidently the need to group the countries and run the estimations as panel data estimations. Estimating fiscal reaction functions for individual countries using the short time sample available will be an important but challenging area of future research.

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Appendix A: Estimations using the output gap

Seasonally adjusted data on real GDP are available for 23 of the countries in the sample. For the remaining four countries (Ireland, Greece, Portugal and Romania) the seasonal adjustment of GDP was carried out using the multiplicative Census X12 procedure on the sample 2000:1-2014:1. The logarithm of the seasonally adjusted GDP was subsequently computed for each of the 27 EU countries in the sample. The next step was the estimation of trend logarithmic GDP, which was produced using a Hodrick-Prescott filter with lambda $\lambda = 1600$. Finally the output gap YGAP was computed as 100 times the difference between log GDP and the HP filtered log GDP. The output gap variable YGAP can be interpreted as the percentage deviation of GDP from its trend value.

Table A.1 shows the results when the reaction function in (1) is estimated using the output gap measure YGAP instead of G4Y. The results for the EA12 and CEE10 groups are comparable to those in Table 3, i.e. the primary balance is much more counter-cyclical for the EA12 group than for the CEE10 group. For the EAcris5 countries the estimated coefficient of YGAP is, however, much lower than the coefficient of G4Y. The very low coefficient of the YGAP is in large part attributable to Ireland and follows from the computation of YGAP. The five crisis countries and in particular Ireland have very large positive output gaps towards the end of the sample 2001:1-2008:2, but they are in large part a consequence of the very large output drops in the period following 2008:2 (which substantially lowers trend log GDP at the end of the 2001:1-2008:2 sample). The results for CEEnon7 and CEEcris3 are comparable to those in Table 3.

Table A.1: Fiscal reaction to output gap, IV estimation, 2001:1-2008:2

	PRIM(-4)	YGAP	R^2	No. obs.
EU27	0.654*** (0.041)	0.235*** (0.081)	0.617	806
EA12	0.655*** (0.054)	0.414*** (0.107)	0.644	360
CEE10	0.557*** (0.080)	0.079 (0.109)	0.587	300
EAnon7	0.629*** (0.072)	0.668** (0.123)	0.691	210
EAcris5	0.644*** (0.072)	0.045 (0.173)	0.552	150
CEEnon7	0.619*** (0.112)	0.139 (0.160)	0.619	210
CEEcris3	0.424*** (0.121)	-0.120 (0.112)	0.531	90

Notes: The dependent variable is the primary budget balance, PRIM. Instrumental variable estimation with country fixed effects and quarterly dummies. The instruments are PRIM(-4), G4Y(-4), G4YEU, G4YEU(-1) and DEBT(-4) and quarterly dummies. Robust standard errors are shown in brackets. Superscripts ***, **, * denote that the coefficient estimate is statistically different from 0 at the 1, 5 and 10 percent levels of significance respectively.

Appendix B: OLS estimations

Table B.1: Fiscal reaction to business cycle, OLS estimation, 2001:1-2008:2

	PRIM(-4)	G4Y	R^2	No. obs.
EU27	0.658*** (0.038)	0.188*** (0.051)	0.632	810
EA12	0.673*** (0.052)	0.286*** (0.090)	0.670	360
CEE10	0.559*** (0.074)	0.079 (0.067)	0.595	300
EAnon7	0.670*** (0.072)	0.224** (0.107)	0.703	210
EAcris5	0.620*** (0.066)	0.371*** (0.139)	0.585	150
CEEnon7	0.619*** (0.094)	0.197** (0.077)	0.636	210
CEEcris3	0.437*** (0.123)	-0.152 (0.115)	0.530	90

Notes: The dependent variable is the primary budget balance, PRIM. Robust standard errors are shown in brackets. Superscripts ***, **, * denote that the coefficient estimate is statistically different from 0 at the 1, 5 and 10 percent levels of significance respectively.

Appendix C: Estimations with relative debt variable

Table C.1: Fiscal reaction to business cycle and relative debt, FE-IV estimation, 2001:1-2008:2

	PRIM(-4)	G4Y	DDEBT(-4)	R^2	No. obs.
EU27	0.656*** (0.040)	0.680*** (0.121)	0.047* (0.026)	0.591	806
EA12	0.676*** (0.053)	0.665*** (0.149)	0.023 (0.026)	0.649	360
CEE10	0.530*** (0.086)	0.396** (0.199)	0.044 (0.042)	0.572	300
EAnon7	0.690*** (0.075)	0.584*** (0.148)	0.020 (0.034)	0.687	210
EAcris5	0.587*** (0.063)	0.811** (0.345)	0.024 (0.036)	0.545	150
CEEnon7	0.605*** (0.102)	0.336** (0.146)	0.020 (0.043)	0.633	210
CEEcris3	0.446*** (0.137)	0.367 (0.047)	0.272*** (0.095)	0.507	90

Notes: The dependent variable is the primary budget balance, PRIM. The variable DDEBT is the difference between the country-specific debt stock DEBT and the corresponding debt stock for the EU27. Instrumental variable estimation with country fixed effects and quarterly dummies. The instruments are PRIM(-4), G4Y(-4), G4YEU, G4YEU(-1) and DDEBT(-4) and quarterly dummies. Robust standard errors are shown in brackets. Superscripts ***, **, * denote that the coefficient estimate is statistically different from 0 at the 1, 5 and 10 percent levels of significance respectively.