I. Does market discipline enter governments' fiscal reaction functions in the euro area?

Section prepared by Eric Meyermans

This section assesses the role that markets have played in disciplining governments' behaviour across the euro area since the euro was launched. Discipline is measured by market interest rates, while governments' behaviour is measured by adjustments in primary budget balances. Using real-time data derived from DG ECFIN's forecast vintages released between 2002 and 2018 this section assesses the fiscal response of governments to changes in interest rates, conditioned by a variety of factors such as the maturity composition of public debt and other country characteristics.

The main finding is that bond markets exerted limited pressure on sovereign issuers in the run-up to the crisis. In contrast, during the crisis and afterwards Member States recorded a notable adjustment in their primary balances in response to interest rates soaring; this adjustment was more noticeable in those countries hardest hit by the crisis. The econometric analysis also suggests that the EU fiscal framework (e.g. national fiscal councils), the maturity structure of public debt and parliamentary elections have been significant factors affecting this responsiveness of fiscal policies. ([1])

I.1. Introduction

Markets normally play a very useful role in modern economies by scrutinising the activities of public and private entities and individuals which can ultimately affect their incentives and actions. The extent to which markets exert such pressure and market participants respond is an empirical question. This section attempts to throw some light on this question by focusing on governments and fiscal policies.

A number of conditions have to be met for market discipline to be effective. First, the interest rate at which lenders lend to fiscal authorities has to correctly reflect default risk premiums specific to each of the sovereign issuer. ([2]) Second, on the fiscal side public primary balances have to respond in an appropriate way to the risk premiums set by markets. ([3])

This section examines econometrically how public primary balances responded to interest rates – or more precisely to Bund spreads – in the euro area over 2002-2018. The analysis introduces two new components to the existing methodology for assessing fiscal reaction functions. First, the standard fiscal reaction function ([4]) is augmented by adding the marginal interest rate paid on newly issued bonds in private capital markets and its impact is conditioned by a variety of factors such as the maturity composition of public debt and other country characteristics. ([5]) Second, the fiscal reaction function is estimated using real-time data derived from DG ECFIN's forecast vintages released between 2002 and 2018. This is significant as this is the information that market participants had at their disposal when they made their assessments about sovereign risk.

This section does not touch upon the question of the determinants of bond yields themselves. ([6]) For financial discipline to be effective a necessary (although not sufficient) condition is that risk premiums are closely aligned to fundamentals across sovereign issuers and over time. However, available evidence suggests that bond prices across

([1]) This section was prepared in collaboration with Daniel Monteiro. The author wishes to thank Robert Markiewicz and Dris Rachik for their assistance with data collection as well as Sven Langedijk for his useful comments.

([2]) In the EMU a correct default risk premium requires among other things a credible no-bailout rule. However, ex-post this is less clear-cut to establish if the cost of not having a bailout would be substantial enough. See, for instance, Allard, A. et al. (2013), 'Toward a Fiscal Union for the Euro Area', *IMF Staff Discussion Note* 2013/09.

([3]) In turn, as argued by Lane, T. (1993), 'Market Discipline', *IMF Staff Papers,* Vol. 40, No. 1, pp. 53-88, this requires capital markets to be open (with, for instance, no preferential treatment of governments), information on the borrower's existing liabilities is readily available, and the no-bailout rule is credible.

([4]) A fiscal reaction function relates the primary balance to a variety of economic factors, especially the outstanding debt to GDP ratio – as pioneered by Bohn, H. (1998), 'The Behavior of U.S. Public Debt and Deficits', *The Quarterly Journal of Economics*, Vol. 113, No. 3, pp. 949-963.

([5]) This marginal interest rate is equal to the risk-free interest rate plus a risk premium. The former is the yield on an investment that carries zero risk and is set by general macro-economic conditions, while the latter is determined by the specific characteristics of the sovereign issuer.

([6]) However, as discussed below, the estimation of the fiscal reaction function takes into account that the interest rate on new government borrowing (i.e. the "marginal interest rate") and the primary balance are set simultaneously.

the euro area in recent decades have been driven by bouts of illiquidity and divergent and time-varying market sensitivities regarding the fundamentals as well as redenomination risk; this can to some extent be related to the incomplete economic and monetary union (EMU) architecture. (7)

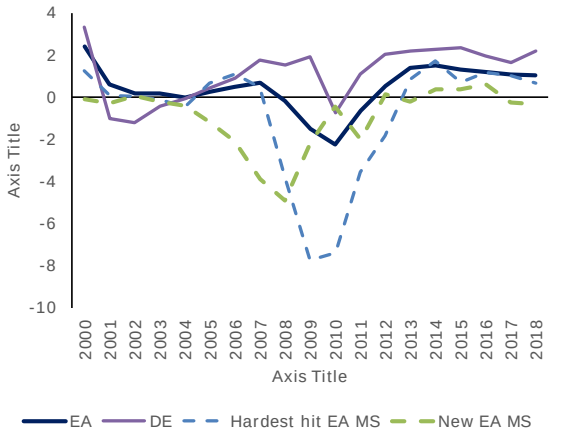
This section is structured as follows. In the second sub-section, a fiscal reaction function is specified with a view to estimate the general government primary balance's sensitivity to marginal interest rates and more particularly its risk premium component. This sensitivity is conditioned by various factors such as the maturity composition of the public debt, the national fiscal framework as well as elections. The third sub-section discusses the real-time data retrieved from various forecast vintages in DG ECFIN's AMECO database to estimate the fiscal reaction function. The policy reaction function is estimated with real-time data to isolate the information that policy makers had at their disposal when the primary balance and interest rates for new funding were set. (8) The fourth section simulates the impact of Bund spreads on primary balances since the early 2000s. The last sub-section draws some policy conclusions.

I.2. Financial market discipline and fiscal responsiveness

Since the onset of the global financial crisis, primary balances (net of interest payments and adjusted for the cyclical component as a percentage of potential GDP) have shown strong variation across the euro area countries - see Graph I.1.

For instance, while the primary balance in Germany recorded a deficit only in 2010, the aggregated primary balance of the Member States hardest hit showed a strong and persistent deficit since the onset of the crisis. At the same time, the Baltic Member States recorded a decrease earlier on but recovered faster than the Member States hardest hit.

Graph I.1: **Net public lending (+) and borrowing (-)**



(1) Net lending (+) or net borrowing (-) excluding interest of general government adjusted for the cyclical component, % of potential GDP.
(2) Euro area (EA) countries hardest hit covers Ireland, Greece, Spain, Cyprus and Portugal. New EA Member States covers Estonia, Latvia and Lithuania. Weighted averages.
Source: Author's estimates based on AMECO November 2018 forecast vintage.

At the same time, Bund spreads also showed strong differences closely linked to the observed differences in primary balances. For instance, Graph I.2 shows a positive unconditional correlation between the primary balance and the Bund spreads in 2012, while Graph I.3 shows a negative correlation in 2013.

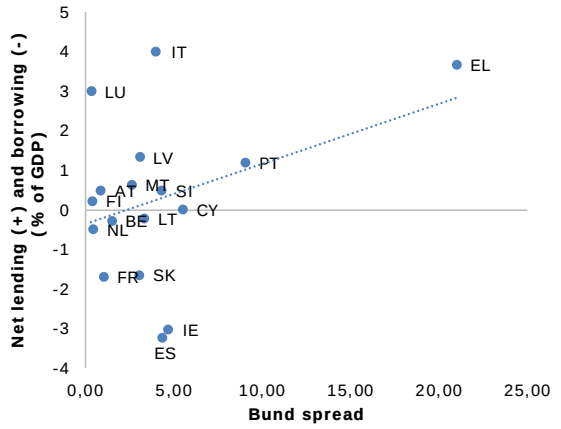
However, such unconditional correlations do not provide answers in terms of causality as the Bund spread and primary balances are simultaneously determined, and these correlations lack an unambiguous interpretation. For instance, the positive unconditional correlation in 2012 might suggest that a rise in the spread induced a rise in savings, while the negative unconditional correlation in 2013 might suggest that a rise in savings would induce a drop in the risk premium.

This section explores econometrically whether financial markets created incentives via the Bund spread to correct primary balances – taking into account possible reverse causality affected by other factors such as the outstanding debt level.

(7) This has been discusses elsewhere, see for instance, Monteiro, D. (2018), 'A retrospective look at sovereign bond dynamics in the euro area', *Quarterly Report on the Euro Area*, Vol. 17, No 4, pp. 7-26, or Favero, C., M. Pagano and E.-L. von Thadden (2010), 'How does liquidity affect government bond yields?', *Journal of Financial and Quantitative Analysis*, Vol. 45, No. 1, pp. 107 134.

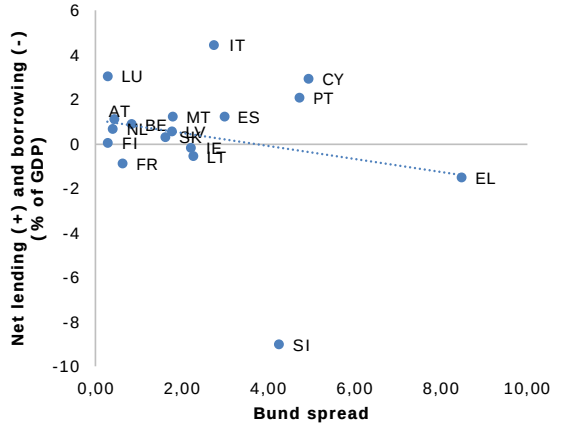
(8) An argument made forcefully by Orphanides A. (2003), 'Historical monetary policy analysis and the Taylor rule', *Journal of Monetary Economics*, Vol. 50, pp. 983-1022 when assessing the Taylor rule for the conduct of monetary policy highlighting that real-time measurement difficulties may cause policy errors. See, for instance, Croushore, D. (2011), 'Frontiers of Real-Time Data Analysis', *Journal of Economic Literature*, Vol. 49, No 1, pp. 72–100 for a review of issues related to real-data analysis.

Graph I.2: **Net public lending (+) and borrowing (-) and Bund spread - 2012**



(1) Net lending (+) or net borrowing (-) excluding interest of general government adjusted for the cyclical component, % of potential GDP. Yearly average Bund spread.
Source: AMECO

Graph I.3: **Net public lending (+) and borrowing (-) and Bund spread - 2013**



(1) Net lending (+) or net borrowing (-) excluding interest of general government adjusted for the cyclical component, % of potential GDP. Yearly average Bund spread.
Source: AMECO

I.2.1. The fiscal reaction function

Previous studies on public debt sustainability focused initially ([9]) on the public primary balances' responsiveness to the debt accumulated in the past. ([10]) In such a framework, an unconditional positive response is considered to be a sufficient condition to meet the public sector's intertemporal budget constraint. ([11]) Further extensions of the literature in these studies focused on nonlinearities in the feedback of the debt level on the primary balance whereby the primary balance becomes more responsive with rises in public debt but potentially weakens when an upper limit for feasible primary balance has been reached (i.e. fiscal fatigue) and default becomes inevitable. ([12])

While fiscal reaction functions were first estimated at the level of individual countries such as the US ([13]), later they were estimated with panel data covering several countries ([14]) to allow for more variation in some of the explanatory variables such as the debt-to-GDP ratios that often vary more intensively across countries than over time.

In addition, several alternative specifications of the fiscal reaction function have been proposed, including an error-correction model specification ([15]), a static panel data setting ([16]) as well as a dynamic panel data setting with heterogeneous parameter restrictions. ([17])

A common characteristic of most previous studies ([18]) is that, while they often include a measure of the interest paid on outstanding debt, they ignore the marginal cost of new borrowing in

([9]) See, for instance, Bohn (1998), *op cit.*
([10]) Which is closely related to the so-called snowball effect whereby if the nominal interest rate is larger than nominal GDP growth the outstanding debt on its own is a source of instability.
([11]) However, while positive feedback is sufficient to prevent the debt-GDP ratio from exploding (i.e. weak sustainability), it does not imply that the debt- GDP ratio converges to a desirable stable equilibrium value such as 60% of GDP target. See, for instance, Gosh, A. et al. (2013), 'Fiscal Fatigue, Fiscal Space And Debt Sustainability In Advanced Economies', *NBER Working Paper Series* Working Paper 16782. Checherita-Westphal, C. and V. Žďárek (2017), 'Fiscal reaction function and fiscal fatigue: evidence for the euro area', ECB Working Paper Series No 2036 report that over the 1970-2013 period the euro area countries recorded, on average, weak sustainability as the primary balance improved by about 0.03-0.05 for every 1 percentage point increase in the debt-GDP ratio.
([12]) See, for instance, Gosh et al. (2013), *op cit.*
([13]) See, for instance Bohn (1998), *op cit.*
([14]) See, for instance, Mendoza and Ostry (2008), 'International Evidence on fiscal solvency: is fiscal solvency 'responsible'?', *Journal of Monetary Economics*, Vol. 55, No. 6, pp. 1081-1093.
([15]) Whereby the dependent variable is in first differences and the explanatory variables include an error correction term as discussed in, for instance, Schoder, C. (2014), 'The fundamentals of sovereign debt sustainability: evidence from 15 OECD countries', *Empirica*, Vol. 41, No. 2, pp. 247–271 and Berti et al. (2016), 'Fiscal Reaction Functions for European Union Countries', *European Economy Discussion Paper* No. 28.
([16]) See, for instance, Gosh, A. et al. (2013), *op cit.*
([17]) Such as cross-country heterogeneity in the responsiveness of the primary balance to the outstanding debt. See, for instance. Everaert, G. and S. Jansen (2018), 'On the estimation of panel fiscal reaction functions: Heterogeneity or fiscal fatigue?', *Economic Modelling*, Vol. 70, pp. 331-337.
([18]) For a selected review of these papers, see, for instance, Checherita-Westphal, C. and V. Žďárek (2017), *op cit.* and Berti, K. et al. (2016), *op cit.*

private capital markets. Exploring the primary balances' responsiveness to marginal interest rates and specifically the marginal interest rates' risk premium component is the main focus of this brief section. ([19])

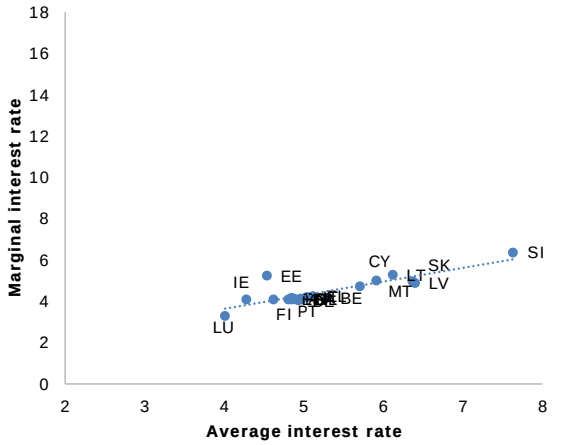
I.2.2. The marginal and average interest rate

The marginal interest rate is paid on newly issued bonds in private capital markets. This interest rate does not only apply to an increase in the stock of debt to GDP in period t (resulting from a primary deficit in period t), but would also apply to the part of outstanding debt that matures and has to be rolled over in period t. The average interest rate is paid on outstanding debt. Both interest rates may differ notably.

For instance, Graphs I.4 and I.5 show that before the crisis, e.g. 2003, both interest rates were closely aligned, but during the crisis, e.g. 2011, some Member States, such as Greece, Portugal and Ireland recorded marginal interest rates well above the average interest paid on outstanding debt. At the same time, other Member States such as Lithuania, recorded marginal interest rates well below the average interest rate. This divergent pattern reflects to some extent differences in recovery dynamics from the crisis. ([20])

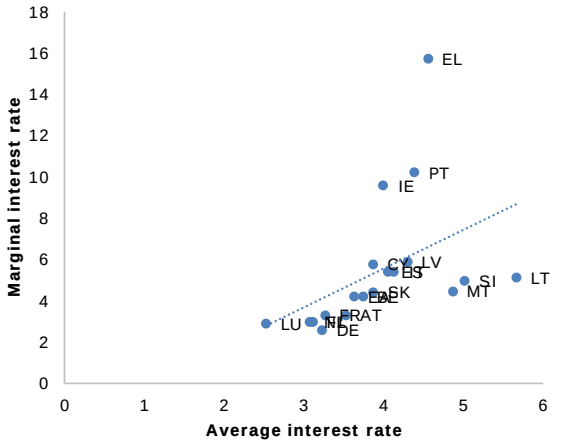
These interest rates have a different impact on the primary balance. While the marginal interest rate has a direct impact on the propensity to lend or borrow, the average interest rate paid on outstanding debt puts downward pressure on other expenditure or limits the room for tax cuts. With rising interest payments, governments may therefore want to improve the primary balance to avoid a deterioration of the overall balance. ([21])

Graph I.4: **Marginal and average interest rate -2003**



Source: Average interest rate AMECO indicator AYGD; Marginal interest rate (ex-post): AMECO indicator ILN.

Graph I.5: **Marginal and average interest rate -2011**



Source: Average interest rate AMECO indicators, AYGD; Marginal interest rate (ex-post): AMECO indicator ILN.

I.3. Yield spreads

The marginal nominal interest rate has two components, i.e. the risk-free nominal interest rate and a risk premium. The risk-free nominal interest rate is set by general macro-economic conditions affecting the risk-free real interest rate and expected inflation. In the regression analysis the risk free nominal interest rate is proxied by the 10-year German Bund yield.

([19]) I.e. AMECO variable implicit interest rate general government - Interest as percent of gross public debt of preceding year. Excessive deficit procedure (based on ESA 2010).

([20]) For instance, in Lithuania the 10 year bond yield stood at 14.5% from February 2009 to December 2009, but at about 5% in 2011.

([21]) The empirical evidence on the impact of the average interest rate on the primary balance is mixed. For example, Checherita-Westphal and Žďárek (2017), *op cit.,* examining a panel of 18 euro area countries covering 1970–2013, report that higher interest payments as measured as a ratio to lagged debt, current GDP or total revenues have a negative impact on the capacity of governments to maintain higher primary surpluses. Everaert, G. and S. Jansen (2018), *op cit.*, examining a panel of OECD countries over 1970-2014 report a positive impact, only significant in a panel specification with all countries (including EU Member States as well as non-EU countries such as Japan, South Korea, US and Norway) having the same parameter. Bertie et al. (2016), *op cit.*, estimating fiscal reaction functions for 13 EU Member States covering 1950–2013, report that the real interest rate paid on outstanding debt is statistically significant in a greater number of cases, but with a positive sign in about half of the cases.

The risk premium is related to investors' risk aversion, the relative supply of government bonds, and uncertainty driven by various factors including economic and political factors. When markets assess that a country's fiscal policy is too expansionary the risk premium will increase to compensate for the increased risk. ([22]) In turn, a higher risk premium increases the domestic interest rate which may provide incentives for governments to save at least if governments care about the future and would like to smoothen primary balances over time.

In the regression analysis the risk premium is proxied by the Bund yield spread at 10-year maturity, i.e. the difference between the national bond yield and the German Bund yield. While in the early 2000s the risk premiums were fairly low and did not vary much among sovereigns issuers, they increased dramatically during the crisis for some Member States such as Greece, Portugal and Ireland – see Graph I.6.

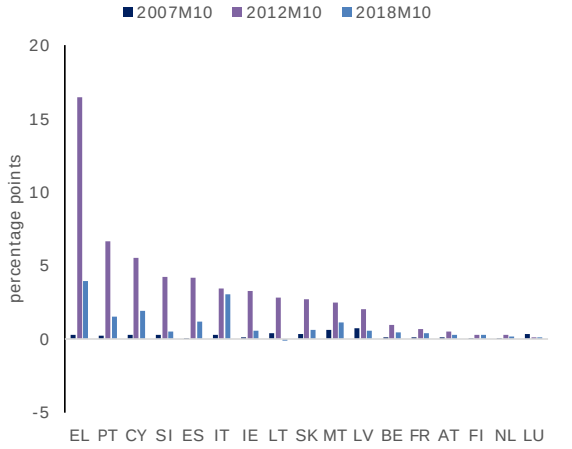
Such developments partly reflect changes in market participants' risk aversion which may be rooted in changes in the belief that countries would be bailed-out (or not) or that fiscal rules would suffice (or not) to promote sustainable fiscal policies. ([23])

I.3.1. Factors affecting the responsiveness to risk premiums

In this section, we test various factors that may affect the governments' responsiveness to market forces. More specifically, we estimate a fiscal response function that is supplemented by factors that affect the responsiveness of the primary balance to the risk premium. ([24])

First, the primary balances' responsiveness is affected by the short- and long-term debt stock (as percentage of GDP). The hypothesis is that governments show a stronger responsiveness to debt that has to be rolled over within the year than to debt with a long maturity.

Graph I.6: **10-year government bond spreads over the German Bund - before, during and after crisis**



Source: Author's estimate based on Eurostat data.

The responses conditioned by short-term debt are triggered by changes in the short-term risk premiums, while the responses conditioned by long-term debt are triggered by the risk premiums on long term debt. More specifically, in the case of short-term debt it is the short-term risk premium squared that has been modelled, not only to capture its more pressing nature but also to reduce collinearity between the short and long-term risk premiums channel during estimation.

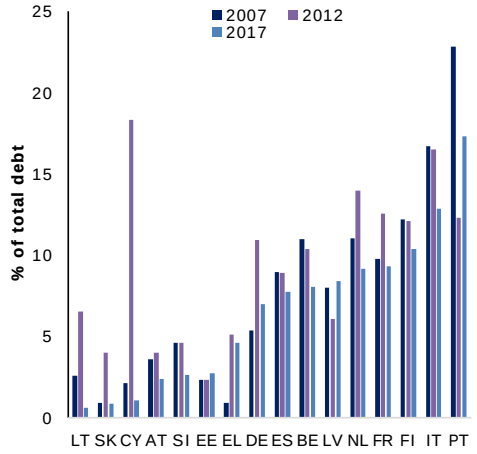
Graph I.7 shows some notable differences in maturity composition of public debt. For instance, in 2017, Estonia, followed by Greece and Austria, recorded the lowest share of short-term debt in total public debt, while Portugal and Italy recorded the highest.

Second, the regression analysis also makes it possible to assess any complementarity between fiscal rules and market discipline to be assessed by means of having responsiveness conditioned by a fiscal rule strength index. The hypothesis is that stricter fiscal rules should make the primary balance more responsive to developments in the risk premium as an increase in the risk premium induces a rise in interest payments and thus also in the overall fiscal deficit (if not compensated by increases in the primary balance). With stricter fiscal rules there is less room to let the primary

([22]) Such risk can take different forms such as default, a rescheduling of existing debt or redenomination risk.
([23]) See, for instance, Strauch, R. (2016), 'The future of the EU fiscal framework – rules, markets and what else?'.
([24]) Technically speaking, this means that the conditioning factor such as the short-term debt level as a percentage of GDP is multiplied with the Bund spread.

balance unchanged or reduce it only moderately. ([25])

Graph I.7: **Maturity composition of public debt – share in total debt of short-term original maturity (up to 1 year)**



(1) Short-term original maturity (up to 1 year).
Source: ECB statistical Warehouse: Government Finance Statistics, gross government debt (consolidated).

Although it should be recognised that dummy variables are crude indicators to measures categorical characteristics, three dummy variables have been included to capture some very specific features that may affect the primary balances' responsiveness.

- Elections: the regression analysis also includes a dummy variable that allows the impact of parliamentary elections to be assessed. The hypothesis is that in an election year the responsiveness to changes in the risk premium weakens. ([26])

- Vintage release: the sample size covers (at least) two forecast vintages for each year ([27]), i.e. one forecast released early in the year and one released later in the year. Between these releases the interest rates and risk premiums may change and responsiveness is expected to weaken as time progresses as most of the budget has already been implemented. In order to capture a possible difference in the sensitivity in the course of the year we added the risk premium multiplied with a vintage dummy which is equal to 1 when it concerns the last release of the year.

- Excessive deficit procedure. A dummy is added to capture whether the excessive deficit procedure (EDP) was applied. The Commission launches the EDP against Member States that exceed the budgetary deficit ceiling as imposed by the Stability and Growth Pact. The dummy takes a value equal to 1 when the Member State is subject to the EDP and equal to 0 otherwise.

I.3.2. The other macro-economic factors

The marginal nominal interest rate has a direct impact on a government's public balance as it increases the cost to service debt and affects the intertemporal trade-off between current and future. ([28])

However, looking beyond this channel it should be noted that interest rates may also affect the public balance indirectly. ([29]) For instance, as interest rates on government debt set the benchmark interest rate at which corporations can borrow, an increase may reduce interest rate sensitive private expenditures such as investments. This may in turn reduce output and subsequently tax revenues and public expenditures, affecting the numerator as well as the denominator of the primary balance as a percentage of GDP differently.

Moreover, while higher inflation lowers the real interest rate and the real value of the debt accumulated in the past that reduces the incentive

([25]) In the subsequent econometric analysis DG ECFIN's measure of fiscal rule strength is used. The Fiscal Rule Strength Index reflects a country's performance in terms of the following five criteria: 1) legal base ranging from political commitment to rules enshrined in the Constitution, 2) the binding character of targets ranging from a political commitment or annual budget law to very specific escape rules, 3) bodies monitoring compliance and the correction mechanism ranging from the rule not being publicly monitored on a regular basis to monitoring by an independent authority (i.e. fiscal council type of institution), 4) correction mechanisms ranging from governments not being obliged to take action to the correction mechanism being triggered automatically, and 5) resilience to external shocks. For more details see https://ec.europa.eu/info/business-economy-euro/indicators-statistics/economic-databases/fiscal-governance-eu-member-states/numerical-fiscal-rules-eu-member-countries_en

([26]) However, Alesina, A., Favero, C. and F. Givazzi ('2019), *Austerity, When it works and when it doesn't*, Princeton University Press, report evidence that in some cases voters might understand the necessity of austerity and at least not punish governments for it.

([27]) I.e., two until 2012, and 3 as of 2013.

([28]) Moreover, a higher interest rate decreases the market value of existing debt stock, which may provide incentives to save less. Changes in market value of public debt due to changes in the nominal interest rate are not explicitly modelled in the subsequent regression analysis.

([29]) See, for instance, Rommerskirchen, C. (2015), 'Debt and punishment: Market discipline in the Eurozone', *New Political Economy*, DOI: 10.1080/13563467.2014.999760 .

to save, in the case of partial inflation indexation of public expenditures and tax bases, higher inflation may give rise to additional channels affecting the primary balance and GDP differently. Similar changes may be related to changes in output if for instance public expenditures and tax revenues are not linked in the same way to output growth . ([30])

As a consequence, instead of including the nominal interest rate adjusted for nominal growth as a single explanatory variable in the reduced form regression equation ([31]) , the three components of this variable will be included separately, i.e. the nominal interest rate, GDP-deflator inflation and real GDP growth.

The outstanding debt level is also an important explanatory variable as governments are expected to take stronger corrective measures when facing an increase in the public debt-GDP ratio.

Finally, the regression equation also includes all factors separately that interact with the risk premium on their own (as described in the previous sub-section). ([32]) ([33])

I.4. Information constraints in real time

Estimating the fiscal reaction function with real time data (as opposed to ex post revised data) may improve the assessment of primary balances' responsiveness as it is these data that are available to market participants when they make their decisions. However, these data may be revised between the time when the market participants act and when the research is being prepared. ([34]) For this purpose, data retrieved from the AMECO forecast vintages released between 2002 and 2018 have been used to estimate the fiscal reaction function. ([35])

The data of past vintages may be revised when new information becomes available ('news' such as the unexpected United States subprime mortgage crisis), measurement errors are corrected ('noise') or the measurement methodology is changed (such as the major data revisions in gross fixed capital formation affecting real GDP and other macro-economic variables notably Ireland in 2015).

In addition, this section refers to net lending and borrowing as a percentage of potential GDP. However, potential GDP can not be observed and is estimated using real-time data and applying a production function approach – so that it can be subject to major revisions especially in the upswing phase of cycles. ([36]) As such overly optimistic real-time projections of conceptual variables such as potential GDP may lead to excessive weakening of the fiscal stance if compared with assessments making use of ex post data that revise potential GDP downwards. ([37])

([30]) The output gap is not included because the analysis focusses on net lending and borrowing adjusted for the cyclical component. Moreover, Checherita-Westphal and Žďárek (2017), *op cit.* report that the output gap does not have a significant impact in the setting of the cyclically-adjusted primary balance. The specification used in his section allows for interaction between changes in real GDP and the primary balance.

([31]) As suggested by the intertemporal budget constraints which reads as $d_t - d_{t-1} \cong (i_t - g_t)\, d_{t-1} - s_t$ with d the public debt-GDP ratio, i the nominal government bond yield, g nominal GDP growth and s the primary balance as a percentage of GDP. See, for instance, Blanchard, O. (1990), 'Suggestions for a New Set of Fiscal Indicators', *OECD Economics Department Working Papers*, No. 79.

([32]) Apart from its economic relevance, this inclusion is also needed in order to prevent possible omitted variables biases estimating the equation. See, for instance, Aitken and West (1991), *Multiple Regression: Testing and Interpreting Interactions*, SAGE Publications

([33]) Other studies include additional variables such as openness to international trade and crisis dummies (e.g. Checherita-Westphal and Žďárek (2017), *op cit.*) and the ratio of elderly (e.g. Everaert and Jansen (2018), *op cit*).

([34]) I.e. the November 2018 AMECO vintage.

([35]) AMECO vintages released in the beginning of year t include forecasts for the primary balance (as well as other relevant macro-economic variables) for the years t and t+1, while the vintages released at the end of the year also include forecasts for the year t+2.

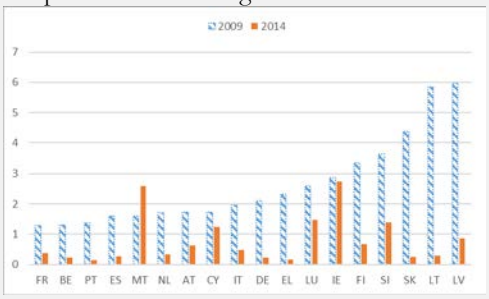
([36]) See, for instance, Morrow, K., Roeger, W., Vandermeulen, V. and K. Havik (2015), 'An Assessment of the Relative Quality of the Output Gap Estimates Produced by the EU's Production Function Methodology', European Economy Discussion Paper 020. As such, revisions of potential output are not triggered by revisions in the underlying historical data, but by revisions as more forward data become available.

([37]) For a discussion of problems related to revisions of conceptual variables, see for instance Croushore, D. (2011), 'Frontiers of Real-Time Data Analysis', *Journal of Economic Literature*, Vol. 49, No. 1, pp. 72–100.

Box I.1: **Real time versus ex post data**

Graph B.1 shows the standard deviation of real GDP growth across the euro area countries in 2009 and 2014, as reported in the various AMECO forecast vintages - highlighting that these revisions were especially strong in the Baltic Member States. For instance, the underlying data show that the second forecast vintage of 2007 projected real GDP growth for 2009 in Latvia and Germany to be, respectively, 6.2% and 2.2%, while the second vintage of 2009 assessed 2009 real GDP growth to be, respectively, -18.0% and -5.0%. Furthermore, the last vintage of 2018 established a -14.4% and -5.6% real growth in Latvia and Germany, respectively.

Graph B.1: Real GDP growth in 2009 and 2014 – real time estimates (standard deviation)

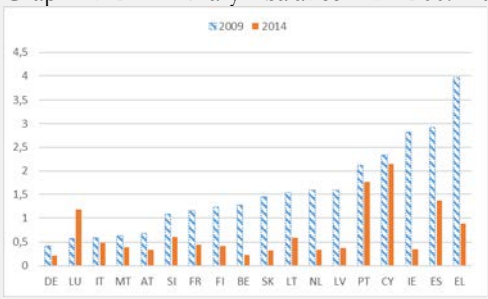


Note: The bars show per country the standard deviation of the 2009 and 2014 real GDP growth as reported in the AMECO forecast vintages released between late 2007 and late 2018.

Note: The bars should be compared across Member States for the same year and not across years for the same Member States as the standard deviation becomes smaller and smaller with more vintages included as less revisions are made over time.

Similarly, Graph B.2 shows the standard deviation in the 2009 and 2014 primary balances (as a percentage of potential GDP), showing more or less the same pattern as in Graph 4. For instance, in the second vintage of 2007 the 2009 primary balance (net of interest payments and cyclical components) was projected to be positive in all Member States except Slovakia. In the second vintage of 2009 it was projected that 14 euro area countries would have a deficit in 2009, with Greece recording a deficit of 7.7% of GDP. Finally, the last vintage of 2018 reported that 13 Member States recorded a deficit in 2009, with Greece recording a deficit of 10.0% of GDP. Overall, counting from the last vintage of 2007, the revisions of the 2009 primary balance were strongest in Greece, Spain, Ireland, Cyprus and Portugal, while they were weakest in Germany.

Graph B.2: Primary balance in 2009 and 2014 – real time estimates (standard deviation)



Note: The bars show per country the standard deviation of the 2009 and 2014 primary balance as reported in the AMECO forecast vintages released between late 2007 and late 2018.

Finally, while governments' fiscal decisions are based on the information they have at their disposal, the governments themselves are a primary source of transparent information on fiscal policies. ([38]) In other words, the well-functioning of bond markets also requires that the governments provide in a transparent and timely way the information needed to set risk premiums. ([39])

I.5. Estimation results

Box I.2 briefly describes the data and methodology that underpins the estimation of this section's fiscal reaction function. Table I.1 shows the estimation results that capture the impact of financing costs in period t on the budget in period t, i.e. adjustments to an already established budget. ([40])

The first column of Table I.1 shows estimation results of the base model (variant V1) The base model includes the main factors, i.e. the lagged public debt-GDP ratio, the risk-neutral interest rate proxied by the German 10-year Bund yield, the risk premium proxied by the 10-year Bund spread, GDP inflation, real GDP growth and the interest rate on outstanding debt. The point estimates show signs that are in line with the above narrative and literature. ([41])

Variant V2 shows the regression results including a lagged dependent variable to capture inertia in public sector behaviour. The parameter of the lagged dependent variable is highly significant and has the expected value between 0 and 1. ([42])

The following columns show different variants of the base specification V2 by adding a selected set of factors that are expected to affect the responsiveness of the primary balance to changes in the risk premium. ([43]) These interaction factors are the ones discussed in the previous subsection, including outstanding short-term public debt (as a percentage of GDP), outstanding long-term public debt (as a percentage of GDP) and a measure of fiscal rule strength([44]), as well as dummy variables that capture elections, the excessive deficit procedure and the vintage. The variant V9 shows estimation results for all interaction factors combined.

The point estimates of the stand-alone main effects not interacting with the risk premium are very similar across variants, with a high level of significance for the lagged debt level, the lagged primary balance, the risk-free interest rate and real GDP growth. ([45])

However, the average interest rate paid on outstanding debt is insignificant (i.e. a p-value higher than 5%) in most variants. The Bund spread on its own (i.e. the third explanatory variable in Table I.1) provides a mixed picture, with strong positive significance in most variants but insignificance for variants V3, V6, V7 and V9. It is worth remembering that it is the stand-alone Bund spread in combination with the interaction effects that determines the net impact of the risk premium.

([38]) For instance, IMF (2012), 'Fiscal Transparency, Accountability, and Risk', argues that fiscal transparency standards need to ensure that published fiscal reports (i) cover a wider range of public sector institutions; (ii) capture a broader range of direct and contingent assets and liabilities; (iii) recognise a wider range of transactions and flows; (iv) be published in a more timely manner; (v) take a more rigorous approach to fiscal forecasting and risk analysis; and (vi) present forecast and actual fiscal data on a consistent basis. Fiscal transparency refers to the clarity, reliability, frequency, timeliness, and relevance of public fiscal reporting.

([39]) Reviewing the literature for the euro area, Cimadomo, J. (2011), 'Real-Time Data and Fiscal Policy Analysis: A survey of the literature', *Federal Reserve Bank of Philadelphia Working Paper* No. 11-25 reports that strong fiscal rules and institutions tend to lead to relatively accurate releases of fiscal data.

([40]) The estimated equation is a reduced form equation (as is usually the case in the literature on fiscal reaction functions) and estimated with instrumental variables. As such, several specifications as well as instrumental variables have been tried out but it would be beyond the scope of this section to report them all.

([41]) For instance, Checherita-Westphal and Žďárek (2017), *op cit.* report that the primary balance improves by about 0.03–0.05 for every 1 percentage point increase in the debt-to-GDP ratio which is closely related to the point estimates reported in Table I.1. Available studies also report a positive and highly significant point estimate for real GDP.

([42]) I.e. varying from low inertia to very strong inertia in public policy making. The null-hypothesis that this parameter is equal to zero can be rejected with high confidence; even so, the null-hypothesis that this parameter is equal to 1 can be rejected with high confidence.

([43]) Technically speaking, in the regression analysis this is done by multiplying the interaction factor with the bund spread. These interaction factors are also include as stand-alone explanatory variables to avoid any possible estimation bias when leaving them out. See, for instance, Aitken and West (1991), *op cit.*

([44]) The fiscal rules strength indicator is a standardised index with an average of zero and a standard deviation of one. As such, negative values may be reported. In the regression analysis this indicator has been set strictly positive by adding 1 to its reported value.

([45]) The following sub-section will take a closer look at the magnitude of the point estimates).

Box I.2: **Estimating the fiscal reaction function**

The data

The sample covers the AMECO forecast vintages released between October 2002 and October 2018 covering 18 euro area countries. ([1]) In the years t between 2002 and 2012, the first AMECO vintage (usually released in April) provided forecasts for the year t and t+1, while the second vintage (usually released in October/November) provided forecasts for the years t, t+1 and t+2. Between 2013 and 2018 the first (usually released in January/February) and second (usually released in April) vintage provided estimates for t and t+1, while the third vintage (usually released in November) provides forecasts for t, t+1 and t+2. ([2]) The observations for year t released in the second or third vintages of year t are stacked into vectors per Member States. These vectors are then used in equation (1) below.

The marginal interest rates are the interest rates observed in the month of the vintage. ([3]) The average interest paid on outstanding debt is measured by dividing interest payments made in period t by outstanding public debt stock in period t-1. The risk premium on long-term debt is proxied by the 10-year Bund spread, while the risk premium on short-term debt is proxied by the 1-year Bund spread. The 10-year bond yields are retrieved from the Eurostat database for all Member Sates, while the short-term interest rates are retrieved from the Bloomberg database. ([4])

The data on the strength of fiscal rules at national level are retieved from DG ECFIN's webpage covering fiscal governance in the EU Member States. ([5])The data available in the Voter Turnout Database of IDEA International is used in creating the election dummy. ([6]) The data on the maturity composition of public debt is retrieved form the ECB Statistical Data Warehouse. The information retrieved from DG ECFIN's webpage covering the Excessive Deficit Procedure (EDP) is used in creating the excessive deficit procedure dummy variable. . ([7])

Specification

In the regression analysis, the dependent and explanatory variables are centred around their sample mean (i.e. observed value–sample mean). Without interaction terms, the point estimates of regressions with centred and original (untransformed) stand-alone variables (the "main effects") should be the same. When the data are centred, the addition of interaction terms does not affect the point estimates of the main effects. Centring also reduces collinearity between explanatory variables. ([8])

More specifically, the fiscal reaction function reads as

$$(1)\quad (pb_{i,t} - PB_i) = \gamma(r_{i,t} - R_i) + \rho(bs_{i,t} - BS_i) + \sum_{j=1}^{k} \alpha_j (z_{j,i,t} - Z_{j,i}) + \sum_{l=1}^{n} \beta_l \left[(x_{l,i,t} - X_{l,i})(bs_{i,t} - BS_i)\right] + \sum_{k=1}^{n} \sigma_k (x_{k,i,t} - X_{k,i}) + \mu_{it}$$

with pb signifying the primary balance (without interest payments and cyclical components), r signifying the risk-free interest rate, bs signifying the Bund spread, z_j signifying the factors directly affecting the primary balance (which include the lagged debt to GDP ratio, the risk neutral interest rate, the interest rate paid on outstanding debt, real GDP growth, GDP deflator growth) and with x_l signifying the factors

([1]) I.e. excluding Estonia for which harmonised data on marginal interest rate are not available in the EUROSTAT or ECB database.
([2]) The first vintage of 2018 is not included for technical reasons.
([3]) I.e. Eurostat series EMU convergence criterion series - monthly data [irt_lt_mcby_m].
([4]) However, complete data series for the short-term interest rates are not available for all euro area countries. Missing observations were interpolated adjusting the corresponding 10 year yield with the 1y-10y time spread observed in similar economies such as Slovenia and Slovakia, and Lithuania and Latvia (with missing data usually differing across countries), and Finland, Belgium and Germany (with data gaps only in Finland and Belgium). For Cyprus the German time spread was used, while the Portuguese time spread was used for Greece.
([5]) See https://ec.europa.eu/info/business-economy-euro/indicators-statistics/economic-databases/fiscal-governance-eu-member-states/numerical-fiscal-rules-eu-member-countries_en
([6]) See https://www.idea.int/data-tools/vt-advanced-search
([7]) See https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/eu-economic-governance-monitoring-prevention-correction/stability-and-growth-pact/corrective-arm-excessive-deficit-procedure/excessive-deficit-procedures-overview_en#overview-of-ongoing-and-closed-excessive-deficit-procedures
([8]) For more details, see, for instance, Aikin and West (1991), *Multiple Regression: Testing and interpreting interactions.* Sage Publications.

(Continued on the next page)

Box (continued)

conditioning the responsiveness of the primary balance to the Bund spread (which includes the short- and long-term public debt as % of GDP, fiscal rule strength and an elections dummy).

Variables denoted in lower case letters refer to the observed values while variables denoted in capital case letters denote the sample mean of this variable. Sample means are calculated for each Member State separately. The dummy variables, e.g. elections, are not centred. Country fixed effects are not necessary if dependent and explanatory variables are demeaned.

Furthermore, the subscripts i= BE, DE, …, FI and t =2002, … 2016 refer to the Member States and the time period respectively.

Estimation

Equation (1) is estimated by means of applying a least squares estimator with instrumental variables to take into account that the marginal interest rate and public balance are set simultaneously, as well as possible reverse causality between the risk premium and some of its conditioning factors. ([9]) The applied estimation technique also allows the variance of the random components to differ across countries (heteroscedasticity) and the random components to be correlated across Member States.

Simulation

The primary balances' responsiveness to the Bund spread (pb) over 2000-2018 ([10]) is simulated (deleting the sample means) as

$$pb_{i,t} = \sum_{l=1}^{n} \widehat{\beta}_l \quad x_{l,i,t}\, bs_{l,i,t}$$

([9]) In particular, the nominal marginal interest rate has been instrumentalised using the one-year lagged nominal marginal interest rate.
([10]) Missing 2017-2018 values for the fiscal rules variable have been set equal to the 2016 observed values.

Table I.1: **A fiscal reaction function for the euro area**

Dependent variable: Net lending (+) or net borrowing (-) excluding interest of general government adjusted for the cyclical component - Adjustment based on potential GDP - Excessive deficit procedure - Percentage of potential GDP at current prices	V1	V2	V3	V4	V5	V6	V7	V8	V9
Lagged public debt (% of GDP)	0.03 **	0.02 **	0.04 **	0.08 **	0.02 **	0.03 **	0.02 **	0.02 **	0.04 **
	(10.78)	(7.13)	(8.27)	(8.09)	(2.87)	(6.71)	(6.83)	(6.68)	(7.99)
Risk-free interest rate (i.e. DE interest rate)	0.08	0.15 **	0.17 **	0.26 **	0.44 **	0.05	0.08	0.16 **	0.36 **
	(1.83)	(3.50)	(3.19)	(7.35)	(3.43)	(0.95)	(1.96)	(3.93)	(5.90)
Spread (i.e. national - DE interest rate)	0.11 **	0.28 **	0.07	0.18 **	0.40 **	0.02	0.01	0.25 **	0.03
	(3.13)	(10.48)	(1.79)	(5.97)	(6.24)	(0.31)	(0.17)	(3.59)	(0.33)
Inflation (GDP deflator)	0.11 **	0.07 **	0.08 **	0.01	0.13	0.06 *	0.11 **	0.05	-0.03
	(4.24)	(3.10)	(2.63)	(0.91)	(1.96)	(2.21)	(2.96)	(1.91)	(-0.66)
Real GDP growth	0.37 **	0.21 **	0.15 **	0.19 **	0.27 **	0.22 **	0.15 **	0.19 **	0.24 **
	(11.03)	(8.75)	(6.62)	(7.88)	(6.53)	(12.98)	(6.64)	(6.63)	(10.76)
Average interest rate	0.10 *	0.01	0.09	0.01	0.07	0.16	0.07	0.00	0.13
	(2.56)	(0.44)	(1.88)	(0.78)	(0.57)	(1.93)	(1.91)	(0.10)	(1.80)
Lagged dependent variable		0.51 **	0.49 **	0.52 **	0.45 **	0.48 **	0.55 **	0.52 **	0.38 **
		(31.46)	(20.33)	(27.38)	(14.63)	(31.18)	(28.47)	(26.12)	(11.03)
(ST Spread * ST spread) * ST debt (% of GDP)			1.54 **						1.26 *
			(2.75)						(2.26)
Spread * debt LT (% of GDP)				-0.06					-0.19
				(-0.48)					(-0.56)
Spread * fiscal rules					-0.01				0.22 *
					(-0.14)				(2.08)
Spread * EDP dummy						0.28 **			0.51 **
						(5.44)			(4.06)
Spread * parliamentary elections dummy							0.68 **		-0.87 **
							(4.27)		(-3.37)
Spread * vintage								0.00	0.02
								(0.02)	(0.27)
ST Debt (% of GDP)			-0.08 **						-0.10 **
			(-5.66)						(-5.14)
LT Debt (% of GDP)				-0.05 **					
				(-5.04)					
Fiscal rules					0.75 **				0.43 **
					(4.24)				(4.37)
EDP dummy						-0.24 **			-0.35 **
						(-5.81)			(-4.33)
Parliamentary elections							-0.01		-0.10
							(-0.12)		(-1.38)
Vintage								-0.08	0.06
								(-1.68)	(0.94)
Unweighted R-squared	0,18	0,52	0,6	0,61	0,48	0,53	0,49	0,52	0,47
Number of observations	641	641	505	539	551	641	641	641	430
Number of explanatory variables	6	7	9	9	9	9	9	9	18

(1) Data available from second AMECO vintage 2002 until the last AMECO vintage of 2018 (except first vintage of 2018). Sample size varies across variants! The sample covers all EA countries (except EE) in all variants that do not include the maturity composition of public debt. The sample does not include IE, LU and MT for variants with debt maturity composition. Data on fiscal rule strength are available up to 2016.
(2)For each Member State separately the dependent and explanatory variables are centered around their sample mean (i.e. observed value – sample mean).
(3) Instrumental variables include lagged explanatory variables including GDP growth, inflation, primary balance, fixed effects . The applied estimation technique allows for heteroskedasticity of and contemporaneous correlation between error terms of the panel.
(4) Point estimates with their significance level: * for p<0.05 and ** for p<0.01. Differences in the R-squared diagnostic statistics are also affected by differences in the sample size.
(5) Not all estimated variants are shown in this table. Not reported because it did not show a significant estimate is the interaction of the spread with a dummy variable equal to 1 if the country is under a programme, and 0 if not affected by programme.
Source: Author's estimates based on data and methodology described in Box I.1.

Focussing on the significance of the point estimates of the interaction factors, variant V9 in Table I.1 shows that the point estimate of the short-term public debt as a percentage of GDP is significant (a p-value less than 5%), but the long-term public debt is not. The election and EDP dummies show a very significant point estimate (a p-value less than 1%) with the signs as explained above.

The interaction between fiscal rules strength and the Bund spread is insignificant in variant V5 but significant at 5% level in variant V9. This mixed result may be due to problems of reverse causality and weak instrumental variables. ([46]) All in all, a significant positive point estimate suggests that credible fiscal rules may affect the responsiveness to changes in these spreads – in addition to their impact on the spreads themselves. ([47]) Stricter rules provide fewer opportunities to limit the contraction of other public expenditures when the debt service cost increases.

The interaction of the Bund spread with the dummy variable that captures the timing of the vintage release (i.e. beginning or end of the year) does not show a significant impact.

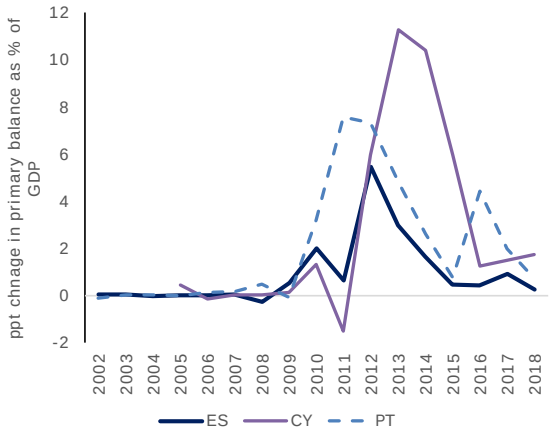
I.6. The primary balances' responsiveness to Bund spreads

This sub-section shows simulations of the primary balances' responsiveness to the risk premium conditioned by the factors with a p-value less than 5% - as identified in variant V9 of Table I.1. These factors include short-term debt as a percentage of GDP, the fiscal rules as well as the elections and EDP dummies.

Graphs I.8 to I.10 show how changes in the risk premium affected the primary balances of the euro area countries (for which sufficient data are available ([48])) between 2002 and 2018. ([49])

Until the onset of the crisis the financial markets' risk assessment of Member States' public finances exerted little pressure on the primary balance. However, focussing on the Member States hardest hit by the crisis, Graph I.8 shows that as of the onset of the global financial crisis, the budgetary correction induced by changes in the risk premium intensified greatly - peaking in Cyprus in 2013. ([50])

Graph I.8: **Primary balance adjustment triggered by changes in Bund spread – hardest hit Member States**



(1) Estimates obtained multiplying the point estimates of the interaction factors (i.e. variant 9 in Table I.1) with the observed value of the interaction factors and the Bund spread.
Source: Author's estimates.

Graph I.9 shows that among the old Member States, developments in the Bund-spread had the

([46]) Recent research raises doubts about the feasibility of estimating the interaction between fiscal rules and a country's fiscal stance due to reserve causality in combination with a failure to identify an appropriate set of instruments. For instance, implementing a meta-regression-analysis for the budgetary impact of numerical fiscal rules based on 30 studies published in the last decade, Heinemanna, F., M.-D. Moessinger and M. Yeter (2018), 'Do fiscal rules constrain fiscal policy? A meta-regression-analysis', European Journal of Political Economy, Vol. 51, pp 69–92 report that any type of fiscal rules have no statistically significant impact on the fiscal balance once properly taking into account the endogeneity of fiscal rules. Caselli, F. and J. Reynaud (2019), 'Do Fiscal Rules Cause Better Fiscal Balances? A New Instrumental Variable Strategy', IMF Working Paper WP/19/49 report that while the inclusion of fixed effects as a proxy for heterogeneity in fiscal preferences across countries does not make a systematic difference, the use of fiscal rules in neighbouring countries as instrumental variables leads to notable lower levels of significance.

([47]) For instance, analysing euro area countries, Iara, A. and G. Wolff (2014), 'Rules and risk in the Euro are', *European Journal of Political Economy*, Vol. 34, pp. 222-236 and Heinemann, F., Moessinger, M. and M. Yeterb (2018), 'Do fiscal rules constrain fiscal policy? A meta-regression-analysis', *European Journal of Political Economy*, Vol. 51, pp. 69-92 report that in "normal" times fiscal rules have only a limited impact on bond spreads, but that in periods of extremely high risk aversion their impact can be strong.

([48]) Not included IE, LU and MT because no data on debt maturity, EE because no data on interest rates, and DE which has by definition a Bund spread equal to zero.

([49]) While the sample size for the estimation of the fiscal reaction function was 2002-2016 because fiscal rule data for 2017 and 2018 are not available when the section was prepared, the simulations are performed for the 2002-2018 period, with the level of the fiscal rules for 2017 and 2018 set equal to those of 2016.

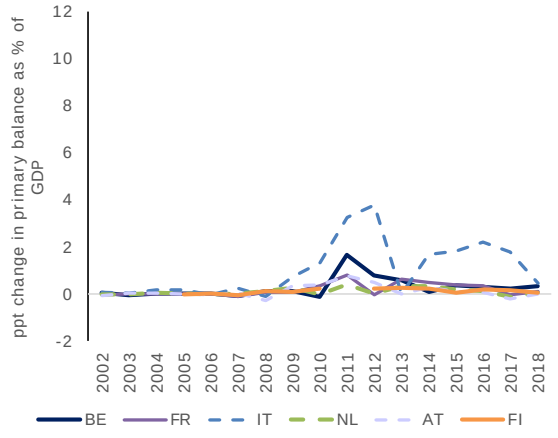
([50]) Greece is not included in the simulations as the very high spreads during the 2010-2015 period created a virtual economic environment that would have triggered budget surpluses well above 20%. Exceptional one-off adjustment mechanisms where in place during that period.

strongest impact in Italy in 2011, with a notable relaxation in the election year 2013. Graph I.10 shows that in the Baltic Member States, the correction under the impulse of financial markets had already reached its peak in 2009 as these countries were hit earlier by the crisis.

All in all, comparing the simulations across countries shows that the Member States hardest hit also recorded the sharpest correction in their primary balance.

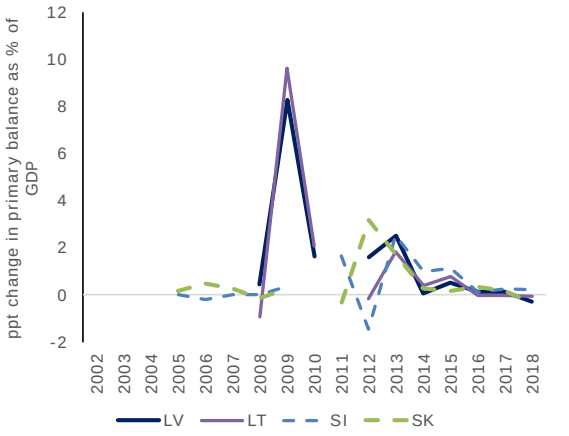
Graph I.11 shows the unweighted average impact of each of the factors that condition the primary balances' responsiveness to the risk premium between 2002 and 2018. The maturity composition of the public debt had a notable impact at the peak of the crisis. The impact of national fiscal rules started to matter only as of 2012-13 but their impact seems to be persistent afterwards; this suggests a complementarity between market forces and fiscal rules. The launching of the excessive deficit procedure exerted a disciplinary force as of the onset of the crisis.

Graph I.9: **Primary balance adjustment triggered by changes in Bund spread - old Member States**



(1) Estimates obtained multiplying the point estimates of the interaction factors (i.e. variant 9 in Table I.1) with the observed value of the interaction factors and the Bund spread.
Source: Author's estimates.

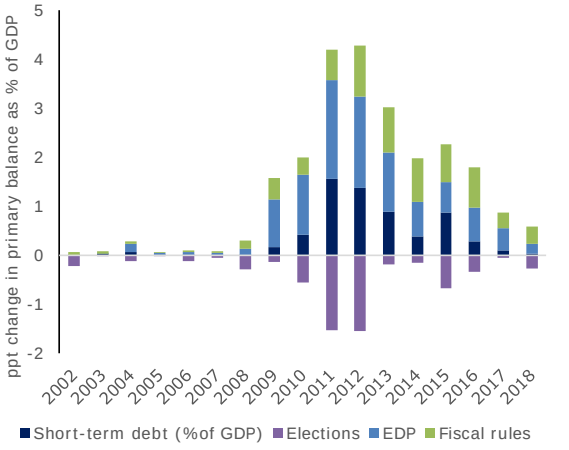
Graph I.10: **Primary balance adjustment triggered by changes in Bund spread - new Member States**



(1) Estimates obtained multiplying the point estimates of the interaction factors (i.e. variant 9 in Table I.1) with the observed value of the interaction factors and the Bund spread.
(2) Discontinuity in fit: for the years that no short-term interest rates data are available (i.e. between 2009 and 2012) no simulation result possible. See Box I.1 for the discussion on data availability.
Source: Author's estimates.

Finally, reading these graphs it is worth remembering that they measure impacts. It would require a more detailed analysis to assess how these changes in risk premiums and primary balances affect the rest of the economy such as private investment, confidence etc.

Graph I.11: **Contribution breakdown of sensibility to Bund spread (sample average)**



(1) Estimates obtained multiplying the point estimates of the interaction factors (i.e. variant 9 in Table I.1) with the observed value of the interaction factors and the Bund spread.
Source: Author's estimates.

I.6.1. Conclusions

Using real-time data, this section investigated econometrically the euro area primary balances' responsiveness to risk premiums since the early 2000s.

The empirical analysis suggests that public debt – particularly its maturity structure – the electoral timetable, the national fiscal framework and the ongoing excessive deficit procedures are important conditions that affect the effectiveness of financial market discipline. More specifically, governments appear to react more to market pressures the higher the share of their short-term debt, whether the country is under an excessive deficit procedure and the more developed their national fiscal framework. However, the empirical analysis also suggests that governments tend to pay less attention to market signals when they are facing national elections.

Overall, the empirical analysis suggests that financial markets exerted limited pressure on sovereign issuers in the run-up to the crisis. This appears to have changed during the crisis and subsequently with the role of market discipline becoming much more evident in governments' fiscal reactions.

While the absence of any pressure from the markets prior to the crisis was problematic, the increased sensitivity since then is a useful disciplining mechanism. However, market discipline alone is not a sufficient condition to prevent the build-up of unsustainable fiscal positions and avert crises. This is particularly the case as markets tend to remain dormant or sometimes overshoot – driven by herd behaviour. Past large and sudden movements in interest rate spreads may reflect various factors such as the existence of multiple equilibria and an incomplete capital markets union. ([51]) Hence, market discipline seems to be more effective when it is complemented by appropriate fiscal frameworks and rules. As a consequence, and in view of the ongoing discussions to deepen EMU, it will be important to carefully consider the complementarity between rules, institutions and the role of market discipline in combination of a further deepening of the EMU architecture.

Finally, the analysis presented in this section could be extended by using, for instance, more refined indicators for categorical features such as elections and ongoing excessive deficit procedures, and by expanding the sample to a larger number of countries. A more detailed analysis could also shed some light on the feedbacks of changes in Bund spreads and primary balances on the rest of the economy.

([51]) For instance, when yields increase sharply and bond prices fall the demand for these bonds will not necessarily increase as sharp increases in government bond yields may adversely affect the government's solvability.