IV. Revisiting the link between government debt and sovereign interest rates in the euro area

By Stéphanie Pamies, Nicolas Carnot and Anda Patarau

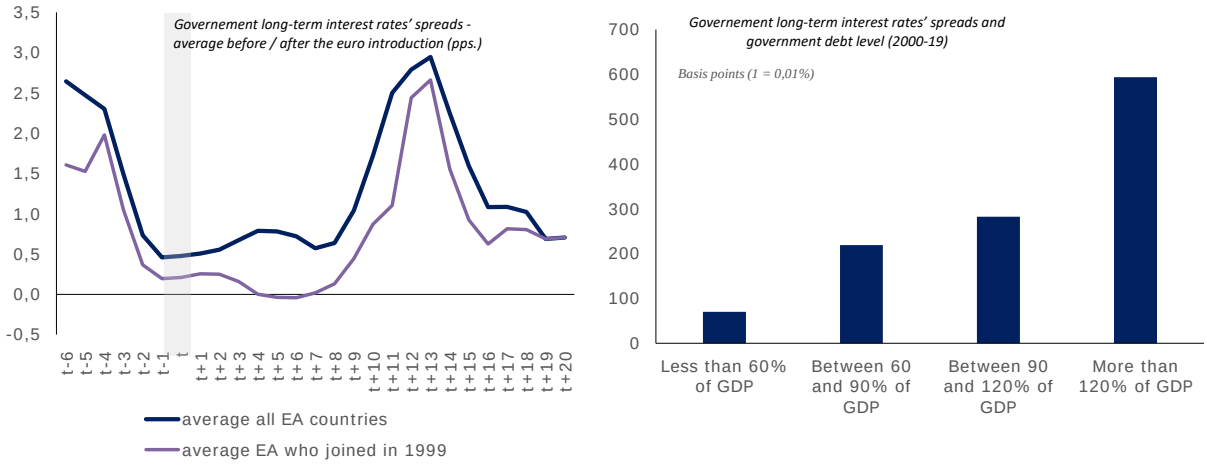
This section explores the determinants of sovereign interest rate spreads of euro-area countries (in relation to Germany). It focuses on the role of fiscal, macroeconomic and institutional fundamentals, considering also some contextual factors such as global risk aversion and controlling for the influence of central banks' asset purchases. Through extensive testing of various (fiscal) variables, interactions and non-linearities, the analysis confirms that sovereign spreads respond to fundamental variables, especially government debt, in non-linear fashion. The results also show that structural factors can largely mitigate the government debt impact on spreads, as the marginal effect of government debt on spreads would be close to zero in countries with the highest potential growth and strongest institutions. From a policy angle, the results remind us that, even in an environment of persistently low rates, governments with less solid fundamentals pay more than others to borrow and are exposed to higher risks. They highlight that policies reinforcing potential growth and government effectiveness can be expected to improve investors' perception of sovereign risk and their forbearance of higher debt.

IV.1. Developments in interest rates and spreads

Interest rates paid by governments on their debts have fallen for decades, but cross-country differentials between such rates (bond yields), also known as spreads, have behaved idiosyncratically. This is conspicuous in Europe, particularly within the euro area. Differentials between yields on euro-area government bonds fell already in the years preceding the Economic and Monetary Union (EMU), shot up in the global financial and euro-area debt crises, and since then have hovered at non-negligible levels (see Graph IV.1 – left panel). There are recurrent market spikes such as those affecting Greece in 2015, Italy in 2018, and vulnerable countries across the board at the onset of the COVID-19 crisis in March 2020.

In this study, we investigate the relationships between spreads on euro-area government bonds and fundamental factors. A casual look at the data suggests that spreads are correlated with fundamental characteristics, such as public debt levels (see Graph IV.1 – right panel). However, that influence is unlikely to obey simple laws, making it a challenge to capture it in empirical work. Building on the existing literature, we conjecture that fundamental conditions likely to affect spreads (called 'spread fundamentals') are of

Graph IV.1: **Government spreads' developments and their relation to government debt level, euro-area countries**



(1) The left panel graph represents the (non-weighted) average nominal spreads on 10-year government bonds (in relation to German yields) calculated, respectively, over all euro-area members and those who joined the euro area in 1999, i.e. Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain. Year t represents the year when the euro was introduced. The right panel graph represents the average spreads depending on the government debt-to-GDP ratio level (calculated over all euro-area countries on data since 2000).
Source: Ameco, ECB, authors' calculations.

three main kinds: fiscal, macroeconomic (including external), and institutional. Moreover, we also consider 'context' variables, measuring financial market conditions (e.g. through indicators capturing international risk aversion, liquidity proxied by the size of the sovereign debt market) and the role of monetary policy, including the Eurosystem programme of government securities purchases ([134]).

IV.2.A glance at the literature

The literature finds significant effects of fundamental factors on spreads, starting with fiscal variables such as the stock of government *debt* or 'flow' fiscal determinants, such as the *primary balance* or *gross financing needs* ([135]), with evidence of non-linearity ([136]), possibly connected to debt limits ([137]).

Some papers also find non-fiscal imbalances to be an important determinant of government spreads. These include the *net international investment position* (NIIP) ([138]), *current account* and the *real effective exchange rate* ([139]).

More generic variables such as GDP growth or the quality of institutions are also considered. The strength of growth as a proxy of future taxes and as such of earning and repayment capacity appears in different forms - potential growth ([140]), actual growth, unemployment rate ([141]). More recently, some papers have explored the incidence of institutional factors such as environmental, social and governance indicators ([142]), better fiscal institutions (measured by the Commission's fiscal rule index ([143]), governance or political factors, with a focus on emerging countries ([144]). Chen and Chen (2018) and Jeanneret (2018) ([145]) find that the quality of public institutions has an effect on default probability. Gomez-Puig et al. (2014) ([146]) tests the impact of economic policy uncertainty on spreads. These variables may capture aspects of the government's ability or willingness to collect revenues and preserve fiscal discipline.

In addition to fundamental variables, financial and monetary conditions too contribute to explaining spreads. These comprise indicators of *liquidity* such as the market size of the national government debt or bid-ask spreads ([147]), *global risk sentiment*, captured e.g. by the VIX or VSTOXX index ([148]), the potential 'catalytic effect' of *official lending* on countries such as Greece, Ireland,

([134]) The full set of specifications, results and robustness checks in this study is available in Pamies, S., Carnot, N., and A. Patarau (2021), 'Do Fundamentals Explain Differences between Euro Area Sovereign Interest Rates?', *European Economy Discussion Paper*, No. 141, June. For instance, the approach adopted and variables chosen are more extensively explained in this Discussion Paper.

([135]) See Afonso, A., Arghyrou, M. G. and A. Kontonikas (2015), 'The determinants of sovereign bond yield spreads in the EMU', *ECB Working Paper series,* No. 1781; Capelle-Blancard, G., Crifo, P., Diaye, M.-A., Oueghlissi, R. and B. Scholtens (2019), 'Sovereign bond yield spreads and sustainability: an empirical analysis of OECD countries', *Journal of Banking and Finance*, No. 98.

([136]) See De Grauwe, P. and Y. Ji (2012), 'Mispricing of sovereign risk and multiple equilibria in the eurozone', *CEPS working document*, No. 361; Afonso et al. (2015), op. cit.

([137]) Gosh, A. R., Kim, J. I., Mendoza, G., Ostry, J. D. and Qureshi, S. (2013), 'Fiscal fatigue, fiscal space and debt sustainability in advanced economies', *The Economic Journal*, Vol. 123, Issue 566, Fournier, J.-M. and F. Fall (2017), 'Limits to government debt sustainability in OECD countries', *Economic modelling*, Vol. 66; Cerovic, S., Gerling, K., Hodge, A. and P. Medas, P. (2018), 'Predicting Fiscal Crises', *IMF Working paper*, No. 18/181; and Berti, K., M. Salto and M. Lequien (2012), 'An Early-Detection Index of Fiscal Stress for EU Countries', *European Economy Economic Paper*, No. 475.

([138]) See Ben Salem, M. and B. Castelletti Font (2016), 'Which combination of fiscal and external imbalances to determine the long-run dynamics of sovereign bond yields?', *Document de travail Banque de France*, No. 606.

([139]) See De Grauwe and Ji (2012), *op. cit.*; Afonso et al. (2015), *op. cit.*; and Capelle-Blancard et al. (2019), *op. cit.*

([140]) Poghosyan, T. (2012), 'Long-run and short-run determinants of sovereign bond yields in advanced economies', *IMF working paper,* No. WP/12/271.

([141]) See Gomez-Puig, M., Sosvilla-Rivero, S. and M. del Carmen Ramos-Herrera (2014), 'An update on EMU sovereign yield drivers in time of crisis: a panel data analysis', *Research Institute of Applied Economics working paper*, No. 07; D'Agostino, A. and M. Ehrmann (2012), 'The pricing of G7 sovereign bond spreads – the times, they are a-changing,' *MPRA Paper* 40604, University Library of Munich, Germany.

([142]) See Capelle-Blancard, G., Crifo, P., Diaye, M.-A., Oueghlissi, R. and B. Scholtens (2019), 'Sovereign bond yield spreads and sustainability: an empirical analysis of OECD countries', *Journal of Banking and Finance*, No. 98.

([143]) See Jalles, J.T. (2019), 'How Do Macroeconomic Fundamentals Affect Sovereign Bond Yields? New Evidence from European Forecasts', *CESifo Economic Studies*, Vol. 65, No. 1, pp. 44–67. Monteiro, D. and B. Vasicek (2019), 'A retrospective look at sovereign bond dynamics in the euro area', *Quarterly Report on the Euro Area*, Vol. 17, No. 4.

([144]) See Presbitero, A. F., Ghura, D., Adedeji, O. S. and L. Njie (2015), 'International sovereign bonds by emerging markets and developing economies: driver of issuance and spreads', *IMF working paper*, No. WP/15/275; Eichler, S. (2014), 'The political determinants of sovereign bond yield spreads', *Journal of International Money and Finance*, No. 46.;

([145]) Chen, H-Y. and Chen, S-S. (2018), 'Quality of government institutions and spreads on sovereign credit swaps', *Journal of International Money and Finance*, no. 87 and Jeanneret, A. (2018), 'Sovereign credit spreads under good/bad governance', *Journal of Banking and Finance*, no. 93.

([146]) Gomez-Puig, M., Sosvilla-Rivero, S. and M. del Carmen Ramos-Herrera (2014), 'An update on EMU sovereign yield drivers in time of crisis: a panel data analysis', *Research Institute of Applied Economics working paper*, No. 07.

([147]) Codogno, L., Faveri, C. and Missale, A. (2003), 'Yield spreads on EMU government bonds', *Economic Policy*, Vol. 18, Issue 37.

([148]) See Monteiro, D. and B. Vasicek (2019), *op. cit.*; Afonso et al. (2015), *op. cit.*

Portugal and Cyprus ([149]), the *incidence of monetary policy*, in particular unconventional measures such as the outright monetary transactions (OMT) and the purchase of government securities under quantitative easing (QE) ([150]).

IV.3. Empirical strategy

We rely on a gradual empirical strategy, while paying attention to pitfalls in estimations. We analyse the role of fundamentals using data from the inception of the euro until 2019 included, which makes for a longer sample than earlier studies and includes the interesting 'post-financial crisis' period (but pre-COVID-19). We run the main estimates for euro-area countries (results shown in this section), and check their robustness on a sample with all EU countries, as background (see Annex IV to the paper referenced above) Moreover, this study considers the variety of ways through which fundamental factors, involving, e.g., government debt, the external position, potential growth, and the quality of institutions, can affect spreads. Relying on a large range of specifications and robustness checks, it recognises that the influence of fundamentals may be non-linear and context-dependent ([151]).

The variables retained in the estimations are selected based on the literature and complemented with specific fiscal variables that constitute the focus of this research. In particular, the choice of stock and flow fiscal variables – government debt, primary balance, change in the debt ratio, gross financing needs and average maturity of debt are driven by the paper's fiscal angle ([152]).

We start with a 'benchmark model' in static form and then estimate alternatives, testing for non-linearities, dynamic formulation, sample selection and time-sensitivity of parameters ([153]) and additional variables.

Step 1: **Benchmark estimation:**

$$spr_{it} = \alpha + \beta.NIIP_{it} + \gamma.GDPp_{it} + \delta.geff_{it} + \varepsilon.D_{it} + \theta.size_{it} + \mu.vix_t + \rho.PSPP_t + \alpha_i + u_{it} \quad (1)$$

where $i = 1\ to\ n$ (countries) and $t = 1\ to\ T$ (years). Spreads (spr_{it}) on 10-year government bonds (in relation to German government bonds) are regressed on key fundamental variables namely, general government gross debt-to-GDP ratio (D_{it}), country net international investment position-to-GDP ratio ($NIIP_{it}$), potential real GDP growth ($GDPp_{it}$) and an index of government effectiveness ($geff_{it}$) ([154]), as well as variables capturing liquidity risk ($size_{it}$ measuring the relative country size), international risk aversion (vix_t), and the (potential) effect of the Eurosystem public sector purchase programme ($PSPP_t$). α_i measures country random effects ($\alpha_i \approx iid(0, \sigma^2)$) ([155]), ([156]), ([157]).

([149]) See Corsetti G., Erce, A. and Uy, T. (2019), 'Official lending in the euro area: lessons for debt sustainability', *VOX CEPR*, Official lending and debt sustainability in the euro area | VOX, CEPR Policy Portal (voxeu.org).

([150]) Monteiro, D. and B. Vasicek (2019), *op. cit.*; Afonso, A. and M. Kazemi (2018), 'Euro area sovereign yields and the power of unconventional monetary policy', *Czech Journal of Economics and Finance*, Vol. 68, No. 2.

([151]) Our paper extends the existing literature where many articles examined the behaviour of interest rate spreads following the sovereign debt stresses of the early 2020s. For references, see the main paper.

([152]) For improvements of the fit, we also tested, in addition to the regressions presented in the paper, variables such as actual GDP growth, total factor productivity growth, current account balance, alternative institutional variables to government effectiveness, GDP per capita, world GDP growth, credit ratings agencies' sovereign ratings and sovereign crisis history. These alternative variables were generally not found to improve the results.

([153]) To acknowledge that, even in the relatively homogeneous sample studied (euro-area countries), different 'structural breaks' affected the estimations, thus making it necessary to test the robustness of the results to the time sample.

([154]) Government effectiveness is measured by the index constructed by the World Bank (extracted from the Worldwide Governance Indicators database). It captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Thus, this indicator differs from a variable measuring the quality of public finances, in terms of composition of public spending, design of the tax system, or efficiency measures. Values range from -2.5 (weak government effectiveness) to 2.5 (strong).

([155]) In macroeconometric panels (as opposed to microeconometric panels), the more parsimonious random effects (RE) model is often superior to the fixed effects (FE) model (Bell, A. and Jones, K. (2015), 'Explaining fixed effects: random effects modelling of time-series cross-sectional and panel data', *Political Science Research and Methods*, Vol. 3, No. 1).
Having tested both, we favoured RE, differently from the approach commonly followed in the empirical literature, for several reasons. First, the model includes explanatory variables that already capture structural differences between countries varying very slowly over time (such as a country's relative size or government effectiveness). Then, the remaining features that are not captured in our model and that could influence spreads (e.g. the specific performance of a DMO, the results of specific elections, etc.) are unlikely to be correlated with the explanatory variables, and represent instead non observable statistical 'noise'. Last, a Hausman test tends to confirm that an RE model is more appropriate than an FE model. Reassuringly, regressions using FE

Step 2: **Debt level non linearities**

$$spr_{it} = \alpha + \beta.NIIP_{it} + \gamma.GDPp_{it} + \delta.geff_{it} + \varepsilon_1.D_{it} + \varepsilon_2.nl(D_{it}) + \theta.size_{it} + \mu.vix_t + \rho.PSPP_t + \alpha_i + u_{it} \quad (2)$$

where $nl(D_{it}) = D_{it}^2$ or $(D_{it}\_T).\Delta_T$ depending on the specification tested, with Δ_T representing a dummy variable taking value 1 when debt is above a certain threshold (60% and 90% of GDP are tested). Hence, different forms of non-linearities are tested to account for non-linear effects depending on the debt level: a quadratic debt term (as in De Grauwe and Ji, (201**2**) ([158])) and a debt-threshold term. ([159])

Step 3 : **Debt dynamics and structure**

$$spr_{it} = \alpha + \beta.NIIP_{it} + \gamma.GDPp_{it} + \delta.geff_{it} + \varepsilon_1.D_{it} + \varepsilon_2.D_{it}.flow_{it} + \epsilon.flow_{it} + \theta.size_{it} + \mu.vix_t + \rho.PSPP_t + \alpha_i + u_{it} \quad (3)$$

where $flow_{it} = PB_{it}$ or ΔD_{it} or GFN_{it} or $maturity_{it}$ depending on the specification tested, with PB_{it} representing government primary balance as a share of GDP, ΔD_{it} representing the change in the government debt-to-GDP ratio, GFN_{it} representing government gross financing needs as a share of GDP, and $maturity_{it}$ the average maturity of government debt. Such specification includes separate effects from and a possible interaction between fiscal stocks (debt), fiscal flows (primary balance, change in the debt ratio or GFN), and the term structure (GFN or average maturity). The latter variables are potentially particularly relevant in countries that benefited from official lending with very long repayment maturity (and where GFN are limited compared with what could be expected – given the debt burden – for an average market access country). Additional regressions further explore the effect of the (holders) structure of debt on spreads by directly testing a government debt variable net of debt held by the Eurosystem and official lenders (DM_{it}). ([160]).

Step 4: **Debt interactions with other macro-structural features and 'context' variables**

$$spr_{it} = \alpha + \beta.NIIP_{it} + \gamma.GDPp_{it} + \delta.geff_{it} + \varepsilon_1.D_{it} + \varepsilon_2.D_{it}.X_{(i)t} + \theta.size_{it} + \mu.vix_t + \rho.PSPP_t + \alpha_i + u_{it} \quad (4)$$

where $X_{(i)t} = NIIP_{it}$ or $GDPp_{it}$ or $geff_{it}$ or $size_{it}$ or vix_t or $PSPP_t$, ([161]) depending on the specification tested.

Equations (1) to (4) are estimated using the Generalised Two-stage Least Squares (G2SLS) method and endeavouring to address potential endogeneity issues by means of instruments, stationarity and cointegration tests. The *government debt-to-GDP ratio* ([162]), the *primary balance*, *GFN, average maturity* and *PSPP* are instrumented by their lag ([163]). The *net international investment position-*

show similar results/coefficients. See Section IV of the annex in Pamies *et al.* 2021.

([156]) In line with standard practice, we only consider the determinants of the country of interest, and not the ones of the benchmark country (here Germany). However, some part of the spread dynamics is likely to be driven also by the dynamics of German yield. For instance, in times of uncertainty, German yields tend to decrease due to a 'flight to safety', while other euro-area yields jointly increase. The latter phenomenon should, however, be captured through the VIX variable. Other phenomena such as spillover and contagion effects, which effectively partially de-link the sovereign yields from their country fundamentals, could also be at play. Afonso, A. and Ramos Félix, A. C. (2013), 'Contagion in EU sovereign yield spreads', *Working Paper Lisboa School of Economics & Management*, no. 04/2014/DE/UECE show that countries with worse macro and fiscal fundamentals are in fact more vulnerable to contagion effects.

([157]) In the regressions, a crisis dummy variable to capture the spike of spreads in 2012 is also included. This choice is supported by alternative regressions, including time-fixed effects.

([158]) See De Grauwe, P. and Y. Ji (2012), *op. cit.*

([159]) This type of specification is most often found in the literature on fiscal reaction functions (see Celasun, O., Debrun, X. and Ostry. J. D. (2006), 'Primary surplus behaviour and risks to fiscal sustainability in emerging market countries: a "fan-chart" approach', *IMF Working Paper*, No. 06/67). In the case of interest rate spreads, it can also be justified by Afonso, A., and J. T. Jalles, (2019), 'Quantitative easing and sovereign yield spreads: Euro-area time-varying evidence', *Journal of International Financial Markets, Institutions and Money*, Vol. 58, pp. 208-224. , which show that spreads are sensitive to the Commission releases of the excessive deficit procedure (and releases of higher debt forecasts). Hence, we expect an (additional) sensitivity of spreads when the debt ratio crosses the Stability and Growth Pact reference value of 60% of GDP. In addition, as the 90% of GDP threshold is used as a reference value, notably in EU debt sustainability analysis frameworks, this level is tested.

([160]) Such a measure is akin to the 'free float' measure used by the ECB.

([161]) PSPP variable represents net cumulated purchases of government bonds by the Eurosystem under the public sector purchase programme ('at historical purchase value') (% of GDP)

([162]) Nonetheless, as the debt dynamic responds only slowly to changing market yields, this potential problem should not be overstated. This slow response reflects a relatively long debt maturity of debt. In the euro area, the average maturity of debt (securities) is around 7½ years, ranging from 6.3 years in Luxembourg to more than 11 years in Austria (ECB, 2020).

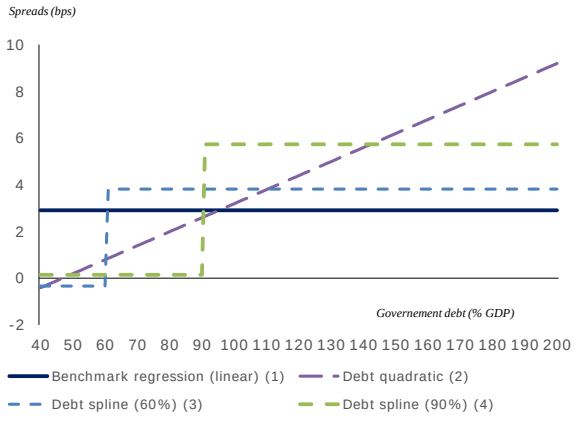
([163]) To deliver consistent estimators, a valid instrument (IV) must satisfy both exogeneity (instrument uncorrelated with the disturbance term) and relevance (IV correlated with the regressor instrumented). Since all fiscal variables and debt interacted variables are instrumented by their lag, exogeneity can be credibly

to-GDP ratio can be assumed as essentially exogenous (by definition, the NIIP is a measure affected by both the assets and liabilities' positions of the public and the private sector). The use of *potential GDP growth* (rather than actual growth, which is also tested) should also limit the endogeneity of the growth variable (as well as multicollinearity issues). The *relative country size*, used as a proxy of the liquidity of its bond market, is preferred to other indicators such as bid-ask spreads or the overall outstanding amount of government debt to limit endogeneity and multicollinearity issues with the government debt ratio. Also, with a view to mitigate endogeneity problems, the *VIX index*, a global US-based risk factor, is preferred to the VSTOXX index, an EU-specific variable. Stationarity and cointegration tests run on the main variables (spreads, NIIP, real potential GDP growth, the government debt ratio, government effectiveness, and size) show these are cointegrated.

IV.4.Findings

We find clear evidence that euro-area spreads respond to fundamentals through several channels, especially the level of government debt. Higher government debt significantly contributes to higher spreads, with strong indications that this effect is non-linear. That is, the marginal effect of additional debt on spreads increases with the level of debt. In a linear regression (equation in Step (1)), an additional one percent of GDP of debt increases the spread by around 3 basis points. However, once non-linearity is taken into account (equation in Step (2)), the marginal impact of additional debt can be twice that at higher debt levels (See Graph IV.2 and Table IV.1). Importantly, the marginal effect of government debt on spreads is found to be close to zero in countries with the highest potential growth (see the next paragraphs).

Graph IV.2: **Marginal impact of an increase in the government debt-to-GDP ratio on spreads (bps), as a function of the level of the government debt ratio**



(1) the graph reports the marginal impact of government debt on spreads as a function of the government debt ratio. The quadratic form suggests that the reaction of spreads to government debt becomes positive only for debt ratios above about 50% of GDP, but the marginal impact strongly increases after that and is higher than in the benchmark regression for debt ratios beyond 95% of GDP. Other non-linear forms, with a debt spline function (above 60% and 90% of GDP) also corroborate a higher responsiveness of spreads to changes in the debt ratio beyond these levels. At debt levels exceeding 100 percent of GDP, the marginal impact is typically in the high part of the range of estimates found in the rest of the literature.
Source: See Table IV.1 for the specifications represented in the graph – specifications (1), (2), (3) and (4),respectively.
Source: Authors' calculations

assumed (with lags of these variables and the current level of spreads not being co-determined). Similarly, using lags as instruments also insures relevance, given fiscal variables' autoregressive properties.

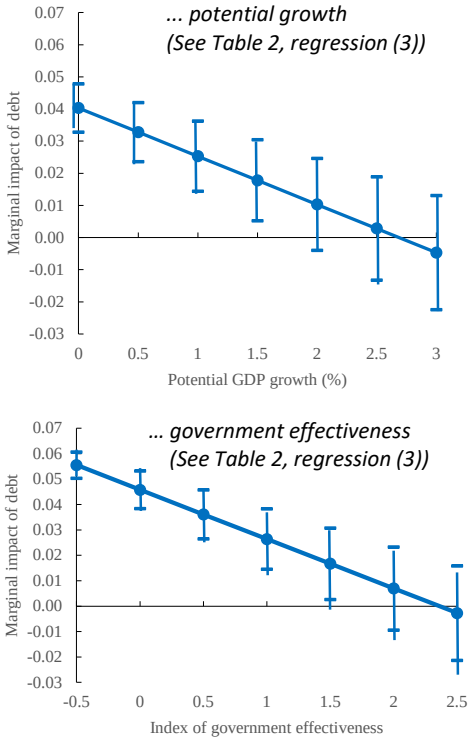
Table IV.1: **Estimation results: benchmark and non-linear forms (debt level). Dependent variable is nominal spreads on 10-year government bond yields (in relation to German bonds), Euro-area countries, 2000-19**

VARIABLES (expected sign)	(1) Benchmark	(2) Debt quadratic	(3) Debt spline (60)	(4) Debt spline (90)
niip_gdp (-)	**-0.00602****	**-0.00780*****	**-0.00673****	**-0.00718****
	(0.00276)	(0.00274)	(0.00300)	(0.00279)
GDPgp (-)	**-0.207****	**-0.170****	**-0.199****	**-0.174****
	(0.104)	(0.0777)	(0.0993)	(0.0776)
gee (-)	**-0.613***	**-0.395**	**-0.492**	**-0.371**
	(0.314)	(0.333)	(0.337)	(0.338)
relative_size (-)	**-0.151*****	**-0.0889****	**-0.126*****	**-0.0936****
	(0.0529)	(0.0350)	(0.0473)	(0.0410)
vix (+)	**0.0154*****	**0.0138***	**0.0160****	**0.0128***
	(0.00504)	(0.00721)	(0.00655)	(0.00773)
pspp_gdp (-)	**-0.0255***	**-0.0202**	**-0.0232***	**-0.0228***
	(0.0136)	(0.0128)	(0.0128)	(0.0128)
gdebt_gdp (+, linear)	**0.0291*****	**-0.0281****	**-0.00335**	**0.00143**
	(0.00840)	(0.0128)	(0.0134)	(0.00653)
debt_sq (+)		**0.000300*****		
		(7.55e-05)		
debt_60 (+)			**0.0415***	
			(0.0228)	
debt_90 (+)				**0.0559*****
				(0.0175)
crisis (+)	**2.289*****	**2.537*****	**2.360*****	**2.483*****
	(0.825)	(0.920)	(0.866)	(0.896)
Constant	**0.307**	**1.830****	**1.486***	**1.254***
	(0.594)	(0.738)	(0.820)	(0.720)
Observations	261	261	261	261
Number of cty_num	17	17	17	17
Country RE	YES	YES	YES	YES
R2	0.572	0.643	0.602	0.647
RMSE	1.294	1.227	1.260	1.205

(1) Model estimated through generalised two-stage least squares, with debt and PSPP instrumented by their lag. Random effects are included. Robust standard errors in parentheses. ***, ** and * denote p-values less than or equal to 1%, 5% and 10%. Countries include all euro-area countries except for Germany (benchmark country) and Estonia (the country joined the euro area in 2011, date as from which there is no market long-term interest rate data for this country).
Source: Authors' calculations.

Specifically, the marginal impact of government debt on spreads varies with potential growth and government effectiveness (See Graph IV.3). A high *potential growth* mitigates the impact from government debt on spreads. Taken at face value, the estimates suggest that the responsiveness of spreads to government debt would be close to zero when potential growth exceeds 2.5 %. By contrast, for countries with a weak potential growth, spreads are more sensitive to government debt. Effectively, the marginal impact of debt on spreads is higher than in the benchmark regression when potential growth falls below 0.75 %. Similarly, in countries with the highest *government effectiveness* index value (e.g. countries where the government effectiveness index is around 2), the marginal effect of government debt on spreads would be close to zero according to regression (4), while countries deemed to have less strong institutions (e.g. countries where the government effectiveness index is less than 0.5), the marginal effect of government debt on spreads is far higher (an increase of government debt of 1 pp. of GDP raises spreads by close to 4 bps.) The NIIP is also found to explain spreads (by itself and interacted with debt), confirming that investors take concerns about sustainability of the external account into account. A common interpretation is that private sector imbalances eventually weigh on the government accounts through subsequent recessions and the implicit liabilities of the government sector, as observed in the boom and bust cycle of several euro-area countries in the 2000s/2010s. These results are obtained after controlling for the influence of context variables such as global risk aversion, sovereign bond market size and central banks' asset purchases.

Graph IV.3: **Marginal impact of government debt on spreads, depending on…**



(1) the graphs report the (total) marginal impact of government debt on spreads conditional to a given level of potential growth (left panel) and government effectiveness (right panel). Bars represent the confidence interval of the estimated coefficients. The graphs plotting the impact on potential growth and government effectiveness represent regressions (3) and (4) in Table IV.2, respectively.
Source: Authors' calculations.

Some 'context' variables such as international investors' risk aversion also play a role. The sensitivity of spreads to government debt increases with international investors' risk aversion according to the study (See regression (5) in Table IV.2). On the other hand, spreads' responsiveness to debt would not be more acute in smaller countries assumed to have less liquid sovereign bond markets, as shown by the not significant interactive term between debt and the relative economic size (See regression (6) in Table IV.2). ([164])

These results dovetail with earlier empirical findings but give a complementary insight on political challenges. From a policy angle, the results are a reminder that even in an environment of persistently low rates, governments with less solid fundamentals pay more than others to borrow and are exposed to higher risks. Such findings echo previous research that establishes that more indebted countries generally experience less favourable interest–growth rate differentials. Importantly, our results highlight that policies aimed at reinforcing potential growth and government effectiveness can be expected to improve investors' perception of sovereign risk and their forbearance of higher debt.

Yet the behaviour of spreads can only partly be explained by fundamental variables. Even in a relatively homogenous panel focusing on euro-area economies only, it remains empirically difficult to determine one specification of fundamentals with superior explanatory power. The results also suggest that there have been already several 'regimes' in the euro area with specific incidences of fundamentals on spreads ([165]). Observed volatility factors such as global risk aversion only help to some extent in capturing these regime changes. While the latter part of the 2010s featured a regime of persistent, though contained spreads, the 2020s may see another regime occur, influenced by the high level of debt due to the COVID-19 crisis and the response at European and Member State level, including the concerted efforts to increase potential growth via investments and reforms.

([164]) The regressions also point to an influence of the Eurosystem's interventions on government long-term interest rates' spreads; yet, these interventions are not found to weaken the relationship between spreads and debt, suggesting that markets still pay attention to fundamentals, in particular public debt (See regression (7) in Table IV.2).

([165]) See Discussion Paper quoted in footnote (134) for a more extensive discussion of these results.

Table IV.2: **Estimation results: non-linear forms due to interaction with other macro-structural features and contextual variables. Dependent variable is nominal spreads on 10-year government bond yields (in relation to German bonds), Euro-area countries, 2000-2019**

VARIABLES (expected sign)	(1) Benchmark	(2) Debt & NIIP	(3) Debt & growth	(4) Debt & gvt. effectiveness	(5) Debt & VIX	(6) Debt & size	(7) Debt & PSPP
niip_gdp (-, linear)	**-0.00602****	**0.00644***	**-0.00776*****	**-0.00752****	**-0.00844*****	**-0.00530***	**-0.00726*****
	(0.00276)	(0.00349)	(0.00223)	(0.00293)	(0.00311)	(0.00299)	(0.00277)
GDPgp (-, linear)	**-0.207****	**-0.167****	**0.914*****	**-0.192****	**-0.208****	**-0.206****	**-0.198****
	(0.104)	(0.0809)	(0.292)	(0.0922)	(0.105)	(0.104)	(0.0946)
gee (-, linear)	**-0.613***	**-0.691*****	**0.0306**	**0.851***	**-0.432**	**-0.714****	**-0.512**
	(0.314)	(0.231)	(0.373)	(0.472)	(0.353)	(0.297)	(0.319)
relative_size (-, linear)	**-0.151*****	**-0.0872*****	**-0.0707****	**-0.132*****	**-0.141*****	**-0.0470**	**-0.136*****
	(0.0529)	(0.0274)	(0.0299)	(0.0494)	(0.0502)	(0.0872)	(0.0488)
vix (+, linear)	**0.0154*****	**0.0183*****	**0.0241*****	**0.0126****	**-0.168**	**0.0157*****	**0.0159*****
	(0.00504)	(0.00510)	(0.00856)	(0.00544)	(0.105)	(0.00496)	(0.00464)
pspp_gdp (-, linear)	**-0.0255***	**-0.0229***	**-0.00508**	**-0.0220***	**-0.0187***	**-0.0242***	**0.0541**
	(0.0136)	(0.0124)	(0.0145)	(0.0130)	(0.0112)	(0.0130)	(0.0459)
gdebt_gdp (+, linear)	**0.0291*****	**0.0118*****	**0.0403*****	**0.0458*****	**-0.0210**	**0.0323*****	**0.0321*****
	(0.00840)	(0.00291)	(0.00751)	(0.00738)	(0.0178)	(0.00950)	(0.0115)
debt_niip (-)		**-0.000180*****					
		(2.63e-05)					
debt_growth (-)			**-0.0150*****				
			(0.00341)				
debt_gee (-)				**-0.0194*****			
				(0.00448)			
debt_vix (+)					**0.00264****		
					(0.00130)		
debt_size (-)						**-0.00124**	
						(0.000889)	
debt_pspp (-)							**-0.000987**
							(0.000606)
crisis (+)	**2.289*****	**2.430*****	**2.440*****	**2.434*****	**2.289*****	**2.313*****	**2.271*****
	(0.825)	(0.895)	(0.789)	(0.865)	(0.802)	(0.841)	(0.797)
Constant	**0.307**	**1.104****	**-2.636***	**-1.276**	**3.453****	**0.222**	**-0.198**
	(0.594)	(0.499)	(1.422)	(0.883)	(1.575)	(0.588)	(0.938)
Observations	261	260	261	240	261	261	261
Number of cty_num	17	17	17	17	17	17	17
Country RE	YES	YES	YES	YES	YES	YES	YES
R2	0.572	0.633	0.702	0.621	0.531	0.577	0.583
RMSE	1.294	1.277	1.131	1.291	1.380	1.286	1.279

(1) Model estimated through generalised two-stage least squares, with debt and PSPP instrumented by their lag. Random effects included. Robust standard errors in parentheses. ***, ** and * denote p-values less than or equal to 1%, 5% and 10%. Countries include all euro-area countries except for Germany (benchmark country) and Estonia (as the country joined the euro area in 2011, there is no market long-term interest rate data for this country).

Source: Authors' calculations.