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We regress long-term private sector interest rates on a money market rate, a term premium and credit risk. As a contribution to the current debate about European safe assets, our interest is in quantifying domestic spillover effects from euro area sovereign bond spreads. Panel estimates show significant, albeit rather small long-run effects. Our findings indicate large cross-country differences but no evidence that the effect has become stronger over time. Using linear country-specific estimates, we find the effect to be significant in only some countries, the size of the maximum effect exceeding the average effect more than three-fold. For one country, we find an asymmetrical effect with positive spread changes having greater impact on private-sector borrowing costs than negative ones. Overall, we conclude that contagion costs in the euro area are substantial and will remain so until an effective form of European safe assets is created.

Euro area sovereign yield spreads as determinants of private sector borrowing costs

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Keywords: autoregressive distributed lag, composite cost of borrowing, sovereign spread

JEL CLASSIFICATION SYSTEM: E43, G10, F36

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1 Introduction

Bonds of different issuers with the same maturity are often remunerated with different rates of interest. A key factor for this difference is the credit risk premium that reflects the expectations and uncertainty of financial markets with regard to the fulfillment of debt service obligations. Government bonds of developed economies are generally considered to be virtually risk-free in this respect, because they are ultimately backed by the sovereign's ability to raise funds by taxing private income and wealth. Furthermore, the central bank of developed economies generally acts as a lender of last resort so that a mere shortage of liquidity need not translate into higher sovereign bond yields.

By most standards, the euro area qualifies as a developed economy. Nonetheless, subsequent to the financial crisis, several euro countries experienced a substantial increase in their sovereign risk premia. This gave rise to a vicious cycle of rising public borrowing costs, plunging economic activity, capital flight and further soaring risk premia. In part, this effect was probably driven by the benchmark function that government bond yields feature with respect to private sector borrowing costs. As a result, a surge in the sovereign risk premium potentially weighed on the evolution of private sector investment. At the height of the euro crisis, the risk premium on 10-year government bonds issued by Portugal, for example, exceeded Germany's by 14 percentage points and Portugal regained its production level of 2008 only in 2018.

Studies investigating the determinants of sovereign yield spreads differ in whether they emphasize changes in macroeconomic fundamentals or in the valuation of financial markets. Reinhart and Rogoff (2011) find that banking crises often precede sovereign debt crises. Here, the presumed transmission channel runs along the fundamentals, from the cost of bank resolution to an increased government debt-to-GDP ratio. Other studies underline that, apart from the actual change in the fundamentals, the valuation function in financial markets can change. DeGrauwe and Ji (2013) find evidence that "a significant part of the surge in the spreads of the peripheral Eurozone countries during 2010-2011 was disconnected from underlying increases in the debt-to-GDP ratios and fiscal space variables, and was associated with negative self-fulfilling market sentiments". Correspondingly, the coefficients Caggiano and Greco (2012) estimate for the influence of fiscal and financial variables in ten euro area countries after 2007 are up to four times higher than those before the financial market crisis. Moreover, they find statistical significance for interaction terms between fiscal and financial variables which points to strong nonlinearities in the financial market valuation of fundamental data.

European safe asset constructions can limit an excessive variation in the valuation function of financial markets (Brunnermeier et al., 2016, *inter alia*). This is particularly relevant as sovereign spreads not only influence public but also private sector financing conditions. The objective of this paper is to quantify the effect of this contagion. At the macroeconomic level, the magnitude of the contagion-effect is by no means clear-cut. If specific information about a particular company is available, the credit-risk premium demanded by investors should in principal be determined by this specific information. Country risk as an additional factor or as a substitute is justifiable only to the extent that it correlates with the earnings and repayment prospects of the company. The same applies to consumer or mortgage loans, for which repayment depends on household income. If sovereign bond spreads are found to play a significant role as proxy for private sector credit risk at the macroeconomic level, it is worthwhile comparing their impact relative to the impact of a macroeconomic control variable, as substantial differences in the coefficients can point towards the existence of financial market valuation effects.

Furthermore, if sovereign risk premia are found to impact substantially on private borrowing costs, this contagion would be an important argument for limiting the riskiness of sovereign bonds in the euro area, for example by introducing some version of the controversially debated European Safe Bonds. The estimated relationship indirectly allows for an evaluation of the potential of safe sovereign assets to limit contagion effects that negatively impact on the real economy, first and foremost, investment. The paper at hand aims to provide a proper estimation of spillover effects within euro countries while taking into account cross-country heterogeneity.

2 Data and Methodology

In order to estimate the impact of sovereign yield spreads on private-sector borrowing rates, we decompose long-term private borrowing rates into (i) a short-term interest rate, (ii) a term premium capturing the expected future changes in short-term interest and inflation rates as well as the corresponding risk premia (interest-rate risk, inflation risk) and (iii) credit-risk premia.

The data set contains monthly observations of the respective series for ten euro countries for the period 2003:1 - 2017:12.[1] The long-term composite costs of borrowing, CCB, calculated by the European Central Bank stands for aggregate private-sector bank lending rates. The short-term interest rate is proxied by the EONIA money market rate (EONIA) and the term premium (TERM) by the spread between the French 5-year government bond yield and the EONIA. The

[1] The sample includes ten of the original twelve euro countries. Luxembourg and Greece are not included because their government bonds with 5-year maturity lack liquidity. Five years is the presumed average maturity of the ECB data for the dependent variable.

latter is based on the assumption that markets consider French bonds as risk-free, whereas German sovereign bonds are recurrently overpriced on account of safe-haven effects. As proxies for the country-specific credit risk premia, we employ the spread between the respective country's sovereign bond yield and the yield on French 5-year sovereign bonds, GS5Y, as well as the unemployment rate, U. The unemployment rate seems to be the best macroeconomic proxy for fundamental credit risk that is available on a monthly basis and not directly influenced by financial market valuation. Unemployment affects both household incomes and the sales opportunities of enterprises. Under certain conditions, the variable U therefore allows for a meaningful comparison with credit risk as measured by the bond spread.[2]

The overall effect of sovereign bond spreads on private sector borrowing costs can be described by the interaction of long-run and short-run coefficients in an autoregressive distributed lag (ARDL[p,q]) model. This refers to the the dynamic multiplier

$$m_h^k = \sum_{j=0}^{h} \frac{\partial CCB_{t+j}}{\partial x_t^k}, \quad h = 0, 1, 2, \ldots \tag{1}$$

which, by construction, converges to the long-run coefficient β^k, if $h \to \infty$. For the sake of brevity, our analysis therefore primarily focuses on the long-run coefficients of different ARDL specifications. Only in the case of nonlinear specifications do we explicitly refer to the dynamic multiplier. All time series used show a unit root when applying Augmented Dickey-Fuller test. In addition, in order to justify a well-specified ARDL design, the co-integration relation between the variables must comprehensively be tested for.

Our estimation strategy involves three stages. We start with panel data models (Table 1), employ the co-integration tests by Westerlund (2007), and then apply the pooled mean group (PMGE) estimator, developed by Pesaran et al. (1999)

$$\Delta CCB_{i,t} = \alpha_i + \rho_i \left(CCB_{i,t-1} - \sum_{k=1}^{m} \beta^k x_{i,t-1}^k \right) + \sum_{j=1}^{p-1} \gamma_{i,j} \Delta CCB_{i,t-j} + \sum_{i=1}^{m} \sum_{j=0}^{q-1} \phi_{i,j}^k \Delta x_{i,t-j}^k + \epsilon_{i,t} \tag{2}$$

for different sub-samples, both in terms of time and country dimensions. We robustify the results by applying dynamic fixed effects and mean-group (MG) estimations, as is common in the literature (Blackburne and Frank, 2007). Since the MG-estimator, unlike the PMG estimator, does

[2]The unemployment rate may not always be a good proxy for credit risk. A negative coefficient could theoretically emerge if an increase in unemployment lowers inflation expectations and induces the central bank to reduce nominal interest rates. The same applies to safe-haven effects. Hence, we only interpret the unemployment rate as a credit risk premium, if its coefficient is positive. Given our interest rate decomposition, endogeneity issues may arise, but our results are roughly the same when using only lagged values for the explanatory variables including the short-run dynamics.

not require homogeneity of the long-run coefficients, we use the Hausman test to evaluate PMG as the preferred model. We find evidence for strong heterogeneity across countries, leading us to turn to a country-specific estimation strategy in the second stage (Table 2).

To identify the most robust co-integration relation, we employ three different co-integration tests: (i) The Bounds test developed by Pesaran et al. (2001) examines whether the ARDL model contains a level relationship between the dependent variable and the regressors using non-standard critical values as bounds that also cover the case of regressors being a mixture of I(0) and I(1). (ii) The Hansen (1992) instability test uses Lagrange multiplier theory to explore time-variation in the scores of the estimated equation. For the scores, the residuals of the level estimation are essential. Here we use fully modified ordinary least squares (FMOLS) and check whether the long run-coefficients of the ARDL are close to the FMOLS results. (iii) The Phillips and Ouliaris (1990) test examines whether the residuals of the OLS level estimation are integrated. Overall, the test results indicate no stable co-integration relation for three countries, the inclusion of all regressors for four countries and the exclusion of GS5Y for the remaining three countries. Based on the these results, we estimate single equation error correction models

$$\Delta CCB_t = \alpha + \rho\left(CCB_{t-1} - \sum_{k=1}^{m}\beta^k x_{t-1}^k\right) + \sum_{j=1}^{p-1}\gamma_j \Delta CCB_{t-j} + \sum_{i=1}^{m}\sum_{j=0}^{q-1}\phi_j^k \Delta x_{t-j}^k + \epsilon_t \tag{3}$$

using the Schwarz information criterion for the lag selection.

In the third stage, we estimate country-specific nonlinear autoregressive distributed lag (NARDL) models developed by Shin et al. (2014)

$$\begin{aligned}\Delta CCB_t = \alpha + \rho\left(CCB_{t-1} - \sum_{k=1}^{m-1}\beta^k x_{t-1}^k - \left(\beta^{*+} x_{t-1}^{*+} + \beta_j^{*-} x_{t-1}^{*-}\right)\right) + \sum_{j=1}^{p-1}\gamma_j \Delta CCB_{t-j} \\ + \sum_{i=1}^{m-1}\sum_{j=0}^{q-1}\phi_j^k \Delta x_{t-j}^k + \sum_{j=0}^{q-1}\left(\phi_j^{*+}\Delta x_{t-j}^{*+} + \phi_j^{*-}\Delta x_{t-j}^{*-}\right) + \epsilon_t\end{aligned} \tag{4}$$

to identify possible asymmetries between positive and negative changes in the credit risk variables for those countries found to have a stable co-integration relation (Table 3).[3] Figure 1 shows the estimated cumulative dynamic multiplier effects. We evaluate the overall effect on CCB after one year (12 periods).

[3]More precisely, x_t^{*+} accumulates positive changes of the variable x, x_t^{*} negative changes.

3 Results

As shown in Table 1, the Westerlund test rejects the null hypothesis of 'no cointegration' for all of the following panel data models. Furthermore, the speed of adjustment, the coefficient of the co-integration relation COINT, is significantly negative as was to be expected. Model 1 is based on the sample 2009M1 to 2017M12 and includes both credit risk proxies, GS5Y and U, in addition to the structural interest components EONIA and TERM. All regressors show a significant long-run coefficient. As would be expected from our interest rate decomposition, the long-run coefficients of EONIA and TERM premium are close to 1. More precisely, in Model 1 a 100 basis point increase in EONIA or TERM causes an increase in the private sector borrowing rate of 75 basis points and 80 basis points, respectively. The long-run coefficients of the two credit risk proxies are almost identical. The aggregate effect is located slightly above 20 basis points. This changes when we look at the results for the entire sample (Model 2). The coefficient for the unemployment rate is now negative and close to 0; the coefficient of the sovereign bond spread is now 18 basis points and the coefficients of EONIA and TERM rise to 84 and 96 basis points, respectively. Since the coefficient of the unemployment rate can no longer be interpreted as a credit risk premium, we omit it in Models 3 and 4 despite its previous significance, and re-estimate using both the reduced and the entire sample. The impact of the credit risk premium as measured by a 100 basis point increase of the sovereign bond spread is now 15 basis points irrespective of the sample size. Given our interest rate decomposition, we can draw a first conclusion: We find no evidence for an increasing spillover impact from sovereign bond spreads to private sector borrowing rates after 2009.[4] As we are interested in the maximum spillover effect, in the following, we focus on estimates for the entire sample.

We robustify the results of models 3 and 4 by changing the estimation methodology (models 5 and 6). Using dynamic fixed effects and the mean-group estimator, the coefficients of EONIA and TERM decline somewhat, but the GS5Y-coefficient remains in the range of 10 to 20 basis points. Although the Hausman test does not reject PMG as the preferred model over MG, the p-value of 10.6% is rather low. It is slightly higher once the unemployment rate is reintroduced as an additional credit risk proxy (Model 7). Nonetheless, we interpret the overall low p-value as an indication of cross-country heterogeneity. This reading is confirmed when comparing the

[4]Country-specific results for the reduced sample 2009M1 to 2017M12 are available on request. While the number of observations decreases, the finding of our first conclusion does not change. If there is any time-variation, then it runs in the other direction. The coefficient of U slightly increases, while that of GS5Y decreases somewhat. The fact that the coefficient of GS5Y does not increase, does not imply that the corresponding credit risk, i.e. the coefficient times the data, has not increased since 2009.

results of PMG models 8 and 9 (or MG models 10 and 11). Model 8 is based on a sample of European countries less affected by the euro crisis (Belgium, Finland, Germany, Netherlands) and the coefficient of sovereign bond spreads is again within the range mentioned above. Model 9, on the other hand, samples countries severely affected by the euro crisis (Ireland, Italy, Spain) and the coefficient of sovereign bond spreads is now 35 basis points and hence significantly above the range. Compared to the MG models 10 and 11, the p-value of the Hausman test is higher. Therefore, these panel data models are more homogeneous than those including all euro countries. The low R^2 and the low long-term coefficient of the term premium in Model 9 (and 11 respectively) indicate that the structural interest rate model is not optimally specified leading us to estimate country-specific models. Nevertheless, we can already draw our second conclusion: The average impact of sovereign bond spreads on private sector borrowing rates is between 10 and 20 basis points, while we suspect that the impact differs significantly across countries.[5]

Turning to the country-specific results in Table 2, note that the selected estimation design is based, first, on optimizing the co-integration test results and, second, on selecting lags according to Schwarz information criterion. This is why we first discuss the test results. The bounds test suggests for all countries that our variables are bounded together in the long run, as the test statistic exceeds the critical values as provided by Pesaran et al. (2001). Merely in the case of Ireland and an assumed I(1) bound, the null hypothesis ('No long-run relationship exists') can only be rejected at a 5 percent instead of a 1 percent significance level. By contrast, the Hansen instability test is more selective. Based on a 5 percent significance level, it reports 'no stable co-integration relation' for Belgium, France, Italy and Netherlands. The situation is similar when looking at the results of the Phillips-Ouliaris test. This is not surprising in the case of France as, by construction, we can use only U as a credit risk proxy to avoid singularity in the estimated equation. For the other countries experiencing problems with the stability of the co-integration relation, the Italian case is most borderline. Indeed, if the sample size is reduced, the tests actually confirm a stable co-integration relation for the Italian specification in contrast to the Belgian and Dutch specifications. Overall, we therefore accept the Italian model as well-specified.

Having excluded Belgium, France and the Netherlands, we look at the long-run coefficients of the structural interest components in the remaining countries. For the long-run coefficient of EONIA, the values range from 50 to 120 basis points, the TERM premium from 30 to 120 basis points with the exception of the models for Ireland and Spain. Surprisingly, the Spanish coeffi-

[5]Strong heterogeneity among euro countries has also been found for other interest rate relations. For instance, see Bernhofer and van Treeck (2013) for the bank interest pass-through.

cient for the term premium is insignificant and the Irish one negative. The long-run coefficients of U for Austria, Germany and Finland are also negative. In all other cases, where a change in the unemployment rate can be interpreted as a change in the credit risk premium, the values of the long-term coefficient are within a range of 10 to 25 basis points and hence quite similar to the average credit risk impact we obtained from the panel estimates.

Given our country-specific estimation design, the sovereign bond spread only plays a role for some countries, specifically Finland, Italy, Portugal and Spain. A 100 basis point increase in the government bond spread causes a 78 basis point increase in private sector financing conditions in Finland, a 73 basis point increase in Italy, but only an 8 basis point increase in Portugal and a 34 basis point increase in Spain. Even though the results should be read with caution in the Spanish case, where the long-run coefficient of the term premium is rather low, values of the adjusted R^2 being above 0.8 for each country estimation guarantee a minimum of statistical power. Our third conclusion therefore is that the maximum impact of a 100 basis bond increase in the sovereign bond spread on private sector borrowing rates is about 70 basis points. This is more than three times the average impact we previously found.

Finally, we turn to the results of the non-linear ARDL estimates (Table 3). Overall, the results for the structural interest rate components (EONIA and TERM), for which we do not allow asymmetric effects, are similar to those previously discussed. With the exception of Finland, both long-run coefficients of positive and negative changes in sovereign bond spreads are significant for all countries for which the spread has been identified as part of the co-integration relationship. The coefficients differ numerically in all cases with the one belonging to the positive spreads being larger for Finland, Italy and Spain. This means that a positive change of 100 basis points has a greater impact on private sector financing conditions than a negative one. For Portugal, surprisingly, hints of asymmetry go in the other direction. In order to find out whether the differences in the long-run coefficients, including the short-term dynamics, produce significant effects, it is useful to consider the dynamic multiplier (Figure 1).

As can be seen from Figure 1, there is no evidence for asymmetries in countries with only the unemployment rate as a 'fundamental' credit risk proxy in the co-integration relation. For Portugal, the difference between positive and negative spread changes is significant, but the overall impact is small. For Spain, the impact of a changing positive spread level is at the upper end of the range we observed for the euro area average (+24 basis points as measured by the long-term coefficient). There is evidence of (temporary) asymmetry, but after 12 periods the difference between the effects of positive and negative spread changes is no longer significant. For Finland and Italy we observe the strongest effects. While in the case of Finland it is still questionable whether the difference between the impact of positive and negative spread changes is significant, the existence of an asymmetric influence in the case of Italy is clearly identified. Based on the non-linear estimates, the maximum effect of a 100 basis point increase in the government bond spread is about 50 basis points in the private sector borrowing rate.

At first glance, it is vexing that we do not find higher coefficients for Portugal and Spain. However, a more detailed analysis reveals other factors at work that are in line with our interpretation but cannot be accounted for within the present econometric framework. Portugal experienced a decline in the volume of outstanding loans to nonfinancial corporations of 32 % from July 2011 to July 2016 which can be interpreted as an alternative reaction to the higher yield spread weakening the impact on borrowing rates. In addition, the duration of loans underlying the ECB's composite interest rate shifted markedly as the share of loans with a duration of over 5 years increased by almost 8 percentage points. This further mitigated the rise in the composite interest rate because interest rates on longer-term loans were on average 1.9 and 1.2 percentage points lower than those on short- and medium-term loans, respectively. To some extents similar factors affected the econometric outcome for Spain.

4 Conclusion

We empirically analyzed the impact of euro area sovereign bond spreads on private sector borrowing rates. Using panel estimates, we find a long-run impact of the sovereign bond spread. This finding underlines a stabilizing potential of an effective European safe asset construction on private sector interest rates and real economic dynamics in the member states. Moreover, there are large cross-country differences. Using country-specific estimates, significance of the effect is reduced to only some countries, but at the same time the size of the maximum effect reaches more than three times the average in linear specifications and up to two times in nonlinear specifications. For one country, we identify an asymmetrical effect so that positive spread changes have a larger impact on private sector borrowing costs than negative ones.

We carefully interpret the existence of cross-country heterogeneity and asymmetry as an indication that the effect of government bond spreads on private credit risk is subject to financial market valuation effects, as otherwise the coefficients would not change so much even though credit risk changes. Such an interpretation is also in line with the fact that the heterogeneity of the spread coefficient across countries is not reflected by a corresponding heterogeneity of a more 'fundamental' credit risk proxy, i.e. the unemployment rate in our model. Future research should investigate this influence using microdata sets. In any case, the present analysis suggests that the cost of contagion effects in the euro area are substantial and will remain so until an effective form of European safe assets is created.

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Table 1: Panel ARDL estimates

Model Method	(1) PMG	(2) PMG	(3) PMG	(4) PMG	(5) DFE	(6) MG	(7) MG	(8) PMG	(9) PMG	(10) MG	(11) MG
Regressor	Cointegrating Form										
$COINT$	-0.235***	-0.142***	-0.162***	-0.154***	-0.155***	-0.244***	-0.313***	-0.139***	-0.203*	-0.244**	-0.308***
	(0.06)	(0.047)	(0.053)	(0.05)	(0.014)	(0.051)	(0.064)	(0.063)	(0.125)	(0.107)	(0.097)
$\Delta CCB(t-1)$	-0.09	-0.106	-0.116	-0.087	-0.217***	-0.068	-0.053	0.061	-0.28***	0.08	-0.245***
	(0.086)	(0.087)	(0.091)	(0.085)	(0.024)	(0.079)	(0.077)	(0.161)	(0.084)	(0.144)	(0.094)
$\Delta CCB(t-2)$									-0.184***		-0.173**
									(0.069)		(0.082)
$\Delta EONIA$	-0.164**	-0.06	-0.112	-0.048	-0.035	-0.112	-0.183**	0	0.035	-0.083*	-0.03
	(0.07)	(0.031)	(0.075)	(0.08)	(0.05)	(0.079)	(0.092)	(0.065)	(0.106)	(0.044)	(0.08)
$\Delta TERM$	-0.175*	-0.115	-0.156	-0.111	-0.086**	-0.13	-0.149	-0.013	-0.001	-0.072*	-0.002
	(0.093)	(0.087)	(0.102)	(0.086)	(0.041)	(0.095)	(0.106)	(0.051)	(0.029)	(0.039)	(0.039)
$\Delta GS5Y$	-0.002	0.009	0	0.01	0.036*	-0.018	-0.022	-0.002	0.04	-0.066	0.022
	(0.041)	(0.038)	(0.038)	(0.038)	(0.02)	(0.053)	(0.06)	(0.062)	(0.049)	(0.135)	(0.035)
ΔU	-0.07	-0.118					-0.082*	-0.061***	-0.147	0.023	-0.171**
	(0.051)	(0.031)					(0.049)	(0.019)	(0.105)	(0.039)	(0.09)
$constant$	0.284***	0.329**	0.358**	0.335**	0.373***	0.583***	0.524**	0.282**	0.066**	0.688*	0.097
	(0.11)	(0.139)	(0.147)	(0.142)	(0.042)	(0.13)	(0.223)	(0.13)	(0.026)	(0.362)	(0.36)
Regressor	Long Run Coefficients										
$EONIA$	0.751***	0.843***	0.796***	0.805***	0.681***	0.694***	0.814***	0.87***	1.085***	0.722***	1.034***
	(0.038)	(0.019)	(0.042)	(0.012)	(0.038)	(0.057)	(0.097)	(0.021)	(0.073)	(0.063)	(0.257)
$TERM$	0.811***	0.946***	0.965***	0.88***	0.51***	0.483***	0.568***	0.977***	0.085	0.744***	0.175
	(0.032)	(0.032)	(0.029)	(0.028)	(0.086)	(0.174)	(0.192)	(0.036)	(0.085)	(0.131)	(0.467)
$GS5Y$	0.112***	0.18***	0.149***	0.146***	0.176***	0.103	0.068	0.143*	0.347***	-0.075	0.333*
	(0.031)	(0.035)	(0.033)	(0.029)	(0.036)	(0.195)	(0.19)	(0.089)	(0.074)	(0.429)	(0.175)
U	0.113***	-0.03***					0.025	-0.047***	0.11***	-0.064***	0.211**
	(0.015)	(0.013)					(0.069)	(0.015)	(0.02)	(0.022)	(0.086)
Test	Cointegration and Homogeneity Tests										
Westerlund	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman						0.106	0.279			0.402	0.514
adjusted R^2	0.841	0.929	0.849	0.929	0.754	0.861	0.822	0.139	0.044	0.545	-0.230
Observations	972	1602	972	1602	1602	1602	1602	712	531	712	531

*Notes: The dependent variable is always long-term composite cost of borrowing from the ECB. Robust standard errors are reported in parantheses. *, **, and *** denotes significance at 10%, 5%, and 1% levels, respectively. For statistical tests p-values are reported. The null hypothesis of the Westerlund test(s) states 'no co-integration', the one of the Hausman test that PMG relative to MG is effecient and hence preferred. Model (1) refers to a PMG estimation including all countries and both proxies of credit risk premia since 2009; Model (2) denotes the same since 2003. Model (3) and (4) are the corresponding estimations including only GS5Y. All other estimations are based on the entire sample. Model (5) and (6) are dynamic fix effects and MG robustifications including only GS5Y. Model (6) is the MG estimation including both credit risk premia. Model (8) and (9) are PMG estimation using either a sample of northern European countries (Belgium, Finland, Germany, Netherlands) or peripheral ones (Ireland, Italy, Spain). Model (10) and (11) refer to the corresponding MG robustifications.*

Table 2: Country-specific ARDL estimates, 2003-2017

	OE	BE	DE	FI	FR	IE	IT	NL	PT	SP
Regressor					Cointegrating Form					
$COINT$	-0,298***	-0,044***	-0,296***	-0,563***	-0,054***	-0,186***	-0,183***	-0,077***	-0,601***	-0,529***
	(0,042)	(0,008)	(0,021)	(0,061)	(0,01)	(0,046)	(0,027)	(0,012)	(0,065)	(0,066)
ΔCCB_{t-1}	-0,224***		-0,159***		0,08	-0,344***	-0,4***	0,18***		
	(0,065)		(0,058)		(0,069)	(0,07)	(0,066)	(0,068)		
ΔCCB_{t-2}					0,181***	-0,238***	-0,288***			
					(0,066)	(0,067)	(0,066)			
ΔCCB_{t-3}					0,262***					
					(0,066)					
$\Delta EONIA$	-0,124	0,072**	0,084***	0,195*	0,001	0,217**	0,27***	0,037	-0,281	0,369**
	(0,08)	(0,029)	(0,029)	(0,1)	(0,028)	(0,1)	(0,1)	(0,029)	(0,302)	(0,144)
$\Delta EONIA_{t-1}$		0,272***				0,28***				
		(0,029)				(0,087)				
$\Delta EONIA_{t-2}$		0,181***				0,479***				
		(0,021)				(0,077)				
$\Delta EONIA_{t-3}$		0,083***								
		(0,023)								
$\Delta TERM$	0,052	0,002	0,132***	0,172**	0,017	-0,145*	0,035	0,051**	-0,25	0,013
	(0,064)	(0,023)	(0,023)	(0,084)	(0,022)	(0,08)	(0,082)	(0,024)	(0,248)	(0,11)
$\Delta TERM_{t-1}$		0,11***								
		(0,023)								
$\Delta GS5Y$		0,034		-0,037			0,189***	0,049	0,083	0,124*
		(0,037)		(0,149)			(0,051)	(0,07)	(0,053)	(0,069)
$\Delta GS5Y_{t-1}$		-0,113***					-0,165***			-0,071
		(0,038)					(0,052)			(0,068)
$\Delta GS5Y_{t-2}$		-0,187***					-0,142***			-0,279***
		(0,036)					(0,053)			(0,068)
$\Delta GS5Y_{t-3}$		-0,096**								0,087
		(0,038)								(0,072)
$\Delta GS5Y_{t-4}$										-0,182***
										(0,067)
ΔU	-0,15*		-0,029	0,099	-0,11**	-0,087	-0,001		-0,139	0,047
	(0,088)		(0,053)	(0,149)	(0,055)	(0,082)	(0,074)		(0,248)	(0,091)
Regressor					Long Run Coefficients					
$EONIA$	0,464***	0,799***	0,888***	0,642***	0,834***	0,541***	1,239***	0,663***	0,971***	1,035***
	(0,038)	(0,095)	(0,021)	(0,036)	(0,169)	(0,101)	(0,17)	(0,063)	(0,075)	(0,062)
$TERM$	0,298***	0,336*	0,983***	0,538***	0,938***	-0,53***	0,702***	0,855***	1,208***	0,035
	(0,073)	(0,2)	(0,023)	(0,053)	(0,187)	(0,179)	(0,213)	(0,112)	(0,143)	(0,073)
$GS5Y$		1,453***		0,783***			0,732***	-0,949*	0,079**	0,335***
		(0,542)		(0,243)			(0,118)	(0,594)	(0,031)	(0,076)
U	-0,37***		-0,049***	-0,129**	0,163	0,171***	0,237**		0,177***	0,104***
	(0,101)		(0,013)	(0,06)	(0,264)	(0,039)	(0,113)		(0,046)	(0,02)
$constant$	4,361***	1,908***	2,024***	3,383***	0,152	2,42***	-0,988	2,407***	0,701	0,253
	(0,57)	(0,289)	(0,061)	(0,538)	(2,687)	(0,471)	(1,347)	(0,185)	(0,563)	(0,382)
Test					Cointegration Tests					
Bounds	11,18	5,96	40,95	15,07	5,63	3,98	7,30	9,28	14,08	8,80
Hansen	0,0933	0,0361	> 0,2	> 0,2	< 0,01	0,1606	0,0198	< 0,01	> 0,2	> 0,2
Phillips	0,0101	0,6857	0,0012	0,0000	0,6755	0,0000	0,2492	0,4631	0,0000	0,0000
adj. R^2	0,9529	0,9959	0,9972	0,9577	0,9965	0,8991	0,9538	0,9942	0,8001	0,9238
Observ.	178	176	178	179	176	177	177	178	179	175
#Models	2058	2058	2058	14406	2058	2058	14406	2058	14406	14406

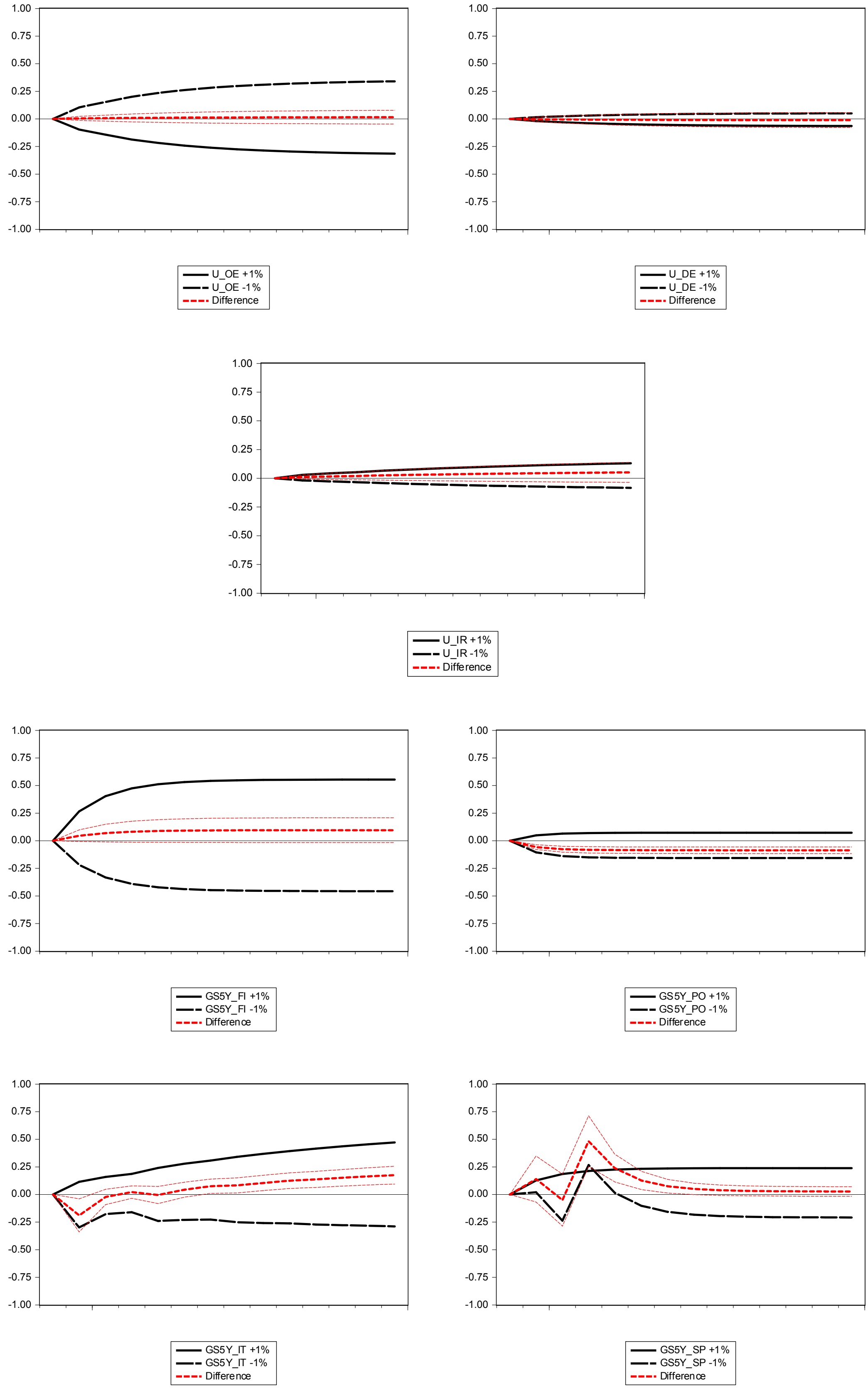
*Notes: The dependent variable is always the first difference of the long-term composite cost of borrowing from the ECB. Robust standard errors are reported in parantheses. *, **, and *** denotes significance at 10%, 5%, and 1% levels, respectively. In case of the Bounds test, we report the test statistic, whereat values larger 4 indicate a cointegration relation. In case of the other co-integration tests, p-values are reported. In case of Phillips-Ouilliaris test, the null states that series are not co-integrated, in case of Hansen instability the null states that they are. $COINT$ denotes the cointegration relation, the corresponding coefficient is the speed of adjustment and #Models stands for the number of models evaluated using Schwarz information criterium with six as the maximum number of lags.*

Table 3: Country-specific NARDL estimates, 2003-2017

	OE	DE	FI	IE	IT	PT	SP
Regressor				Cointegrating Form			
$COINT$	-0,293***	-0,292***	-0,573***	-0,207***	-0,186***	-0,695***	-0,535***
	(0,041)	(0,021)	(0,062)	(0,047)	(0,024)	(0,069)	(0,064)
ΔCCB_{t-1}	-0,228***	-0,159***		-0,342***	-0,43***		
	(0,065)	(0,058)		(0,07)	(0,061)		
ΔCCB_{t-2}				-0,242***	-0,337***		
				(0,066)	(0,062)		
$\Delta EONIA$	-0,117	0,082	0,231**	0,209**	0,313***	-0,384	0,325**
	(0,081)	(0,029)	(0,1)	(0,1)	(0,096)	(0,296)	(0,147)
$\Delta EONIA_{t-1}$				0,244***			
				(0,089)			
$\Delta EONIA_{t-2}$				0,451***			
				(0,078)			
$\Delta TERM$	0,059	0,13***	0,218***	-0,126	0,161**	-0,565**	0,062
	(0,064)	(0,023)	(0,084)	(0,079)	(0,078)	(0,242)	(0,111)
$\Delta GS5Y^{+}$			-0,038		0,09	0,052	0,202**
			(0,181)		(0,068)	(0,074)	(0,098)
$\Delta GS5Y^{-}$			-0,225		0,303***	0,074	-0,023
			(0,252)		(0,075)	(0,075)	(0,109)
$\Delta GS5Y^{-}_{t-1}$							0,141
							(0,112)
$\Delta GS5Y^{-}_{t-2}$							-0,485***
							(0,109)
ΔU^{+}	-0,14	-0,119		-0,17			
	(0,118)	(0,1)		(0,107)			
ΔU^{-}	-0,147	-0,003		-0,029			
	(0,131)	(0)		(0,119)			
ΔU			0,135		0,078	-0,535**	0,011
			(0,209)		(0,074)	(0,25)	(0,093)
ΔU_{t-1}					0,273***		
					(0,074)		
Regressor				Long Run Coefficients			
$EONIA$	0,502***	0,887***	0,804***	0,702***	1,83***	0,319**	1,108***
	(0,1)	(0,021)	(0,11)	(0,202)	(0,239)	(0,155)	(0,089)
$TERM$	0,337***	0,985***	0,675***	-0,302	1,856***	0,075	0,122
	(0,118)	(0,034)	(0,108)	(0,298)	(0,362)	(0,258)	(0,145)
$GS5Y^{+}$			0,557**		0,624***	0,071**	0,236***
			(0,236)		(0,119)	(0,028)	(0,063)
$GS5Y^{-}$			0,463		0,348***	0,156***	0,212***
			(0,245)		(0,125)	(0,03)	(0,06)
U^{+}	-0,337***	-0,065		0,18***			
	(0,13)	(0,053)		(0,041)			
U^{-}	-0,354***	-0,052***		0,113*			
	(0,11)	(0,016)		(0,064)			
U			-0,035		0,003	0,272***	0,106***
			(0,083)		(0,13)	(0,045)	(0,019)
constant	2,504***	1,58***	1,944*	2,511***	-1,943	2,592***	-0,119
	(0,473)	(0,1)	(1,001)	(0,873)	(1,265)	(0,631)	(0,405)

*Notes: The dependent variable is always the first difference of the long-term composite cost of borrowing from the ECB. Robust standard errors are reported in parantheses. *, **, and *** denotes significance at* 10%, 5%, *and* 1% *levels, respectively. COINT denotes the cointegration relation.*

Figure 1: Dynamic Multiplier of country-specific NARDL



Notes: For the three countries (Austria [OE], Germany [DE], Ireland [IR]) at the top, we examine asymmetries of the unemployment rate, as the co-integration relation does not include the sovereign bond spread. For the four countries (Finland [FI], Portugal [PO], Italy [IT], Spain [SP]) at the bottom, we explore asymmetries of the sovereign bond spread. In most cases, we do not find asymmetry. In two cases (Finland, Spain), it is debatable. Here, asymmetric effects are rather small, or temporary. In one case (Italy), there is strong evidence for asymmetry.

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