Predicting Economic Activity via Eurozone Yield Spreads: Impact of Credit Risk

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Abstract

A "lost decade" for the Eurozone is looming on the horizon. Under these circumstances, stable indicators for future economic activity are especially valuable to decision makers. This paper examines the predictive power of the yield spread, one of the most reliable indicators for gross domestic product (GDP) growth. Despite the continuously high level of yield spreads, growth is sparse in the Eurozone. We find this to be caused by default risks, which are distorting the long-term interest rates of many Eurozone countries. Therefore, a new method of risk adjustment is introduced. We employ credit default swap (CDS) spreads on sovereign bonds, which provide a direct measure of credit risk. Incorporating those spreads significantly enhances the in- and out-of-sample predictive power of the yield-spread approach. Ordinary least squares (OLS) and fixed-effects models are used to forecast GDP growth in the Eurozone, and a probit model is used for recession prediction. The results show that the accuracy of predicting growth and recessions using the yield spread is high, provided that biases associated with Eurozone sovereign default risk are considered.

JEL-Classification: G1, E37, E43, E44

Keywords: yield curve, CDS spreads, economic activity

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1 Introduction

After the Great Moderation ended with a hard landing at the end of the last decade, efforts to predict economic growth and recessions have attracted renewed scholarly and public attention (Hakkio (2013)). In this context, the predictive power of the yield spread for economic activity is well known, and the relationship has been proven to hold for many countries and times. According to these findings, recent yield spread data for the Eurozone, especially for the countries on its periphery, suggest a strong and ongoing growth period since 2009. In contrast, reality appears to be depressing. Many countries in the Eurozone are suffering under lasting or recurring recessions or economic stagnation. The real gross domestic product (GDP) of countries such as Italy or Spain is still below the level of 2008, although, on average, the yield spread in these countries has been close to 4% over the last five years.

Forecasting economic activity is an important area for scientists and politicians. Until 2008, growth prediction via yield spread data functioned effectively in the Eurozone. Thereafter, the relationship fell apart. Why did this happen? The results of this paper suggest that risk premia on government debt might be the reason. The integration of such premia in the estimation procedure might be sufficient to reestablish the yield spread as a highly reliable indicator for economic activity in the Eurozone.

The paper is structured as follows. Section two gives a literature review, and section three presents the data. Afterwards, the employed methodology is described. In section five, the results of ordinary least squares (OLS), fixed-effects and probit estimations are presented. Section six concludes.

2 Literature review

The yield spread as one of the primary indicators in GDP forecasting models was developed in the 1980s and 1990s (Fama (1986), Estrella and Hardouvelis (1991)). It was shown that the yield spread, defined as the difference between the interest rate on long-term treasury bonds and short-term treasury bills, contains information on future economic activity independent of the information contained in several other macroeconomic variables.

The yields of all maturities combined constitute the yield curve. Along this curve, differences between the long and short rate are supposed to have two theoretical causes: the term premia and, more important, the expectations hypothesis. Although the effect of the term premia on long-term interest rates is inconclusive[1], the expectations hypothesis states that the long-term interest rate consists of the average of the expected future short-term interest rates. Those future short-term rates should be set by the central bank consistent with the economic and inflationary environment. In other words, the yield spread is primarily a result of expectations for growth and inflation. As long as this setup of the yield curve holds, its predictive power seems to work. However, since 2009, the yield spread in many Eurozone countries is no longer determined solely by those expectations. Instead, because of possible sovereign defaults, long-term rates are strongly distorted by credit risk.

Since the 1990s, the forecasting approach using the yield spread has been frequently refined and expanded. Most recently, in the wake of the financial crisis, Gilchrist and Zakrajsek (2012) introduced a measure of credit risk, the so-called "GZ credit spread", defined as the difference between the interest rate on private debt instruments and the interest rate on theoretical risk-free government securities with comparable maturities, to account for financial instability. This additional variable leads to significant improvements in the fit of in-sample growth predictions not only for the United States but also for some European countries (Gilchrist and Mojon (2014), Bleaney et al. (2013), Guender and Tolan (2013)).

In contrast, in this paper, which extends the work of Schock (2014), we go beyond the existing literature by investigating the predictive power of the yield spread itself and introduce an alternative risk-adjustment method. For the Eurozone, where the ability of the yield spread to predict growth and recessions has not yet been examined[2], the yield spread is adjusted for default risk by accounting for credit default swap (CDS) spreads on long-term government bonds. We choose this alternative approach because we expect the yield spread to contain the most information on future economic activity. As mentioned above, in recent years, this information contained in the yield spread of the Eurozone has been contaminated by sovereign default risk, which must be considered to achieve proper predictions.

3 Data

Data on yield spreads and real GDP growth both in the Eurozone and in the considered member states[3] for the time horizon from the first quarter of 1990 through the third quarter of 2014 are provided by the Organization for Economic Cooperation and Development

[1] For an overview, see Cox et al. (1985).

[2] Bleaney et al. (2013), Guender and Tolan (2013), and Gilchrist and Mojon (2014) investigate only a subset of Eurozone countries and do not attempt to predict recessions.

[3] Because of missing data, Cyprus, Estonia, Greece, Latvia, Luxembourg, and Malta could not be considered.

(OECD)[4]. Throughout this paper, quarterly data are used. The yield spread is calculated by subtracting the short-term yield on the 3-month Euro Interbank Offered Rate (EURIBOR) from the long-term yield on government debt with a duration of 10 years. GDP growth is measured in growth rates compared to the same quarter of the previous year. Because the relationship between the yield spread and growth is given for a horizon of approximately 1 year, growth data compared to the same quarter of the previous year are more appropriate than quarter-over-quarter data. Thus, recessions are analogously defined by at least 2 consecutive quarters with negative growth rates compared to the same quarters during the previous year[5].

CDS data are taken from Datastream Thomson Reuters (Markit). CDS spreads are available for every considered country in the Eurozone. For most of the countries, CDS series start for the first quarter of 2008, and for the last country (the Netherlands), they start for the first quarter of 2010. The CDS data are taken for ten-year government bonds and denominated in Euros. CDS price premia in basis points are assumed equivalent to the risk premia of long-term government debt. Therefore, the long-term interest rate in the credit risk-adjusted yield spread is calculated by simply subtracting the CDS price premia from the given long-term rate.

4 Methodology

4.1 Growth prediction

The relationship between the yield spread and GDP growth in the Eurozone is first examined within an OLS design. GDP growth at time t is predicted solely by the yield spread 4 quarters earlier[6]:

$$GDP\ growth_{\mathrm{t}} = \alpha + \beta * yieldspread_{t-4} + \varepsilon_{\mathrm{t}} \quad (1a)$$

Parameter β in equation 1a is estimated for two datasets: the Eurozone alone as well as the entire panel[7]. Furthermore, for each dataset, two models were used: first, with the raw yield spread (equation 1a), and second, with the CDS-corrected yield spread (equation 1b):

[4] http://stats.oecd.org/index.aspx?#; GDP growth: National Accounts -> QNA -> QNA -> Real GDP and components; interest rates: Finance -> MFS -> MEI -> Interest Rates

[5] This method is the common way of defining recessions in Eurozone countries.

[6] The independence of the influence of the yield spread on economic activity from other macroeconomic variables is well known. Adding further explanatory variables such as the short-term interest rate did not substantially change the results.

$$GDP\ growth_{\mathrm{t}} = \alpha + \beta * yieldspread_{t-4}^{CDS} + \varepsilon_{\mathrm{t}} \quad (1b)$$

Equations 1a and 1b are estimated for the complete time horizon and separately for the three phases of the currency union: convergence, parallelism, and default risk-induced yield divergence (see section 5). Because the datasets for the three phases contain only a smaller number of data points, the robustness of the results for Eurozone time series is checked using a fixed-effects (FE) model on the data for the entire panel, which consist of 13 country/area time series. The FE model estimates the following equation(s):

$$GDP\ growth_{\mathrm{it}} = \beta_f * yieldspread_{i,t-4}^{[CDS]} + \propto_i + \varepsilon_{\mathrm{it}} \quad (2a/[2b])$$

In equations 2a (simple yield spread) and 2b (CDS-corrected yield spread), β_f is the country-independent coefficient for the effect of the yield spread on GDP growth, and $\propto_i$ is the individual intercept for each country/area i. In each model, the β coefficient is expected to be positive because of the theoretical relationship between the yield spread and GDP growth. The $\propto$ coefficient, however, represents something similar to the natural growth level of a country given a flat yield curve for which the focus is more on the differences between the countries and models than on the absolute value.

Several additional tests are performed to confirm that the resulting estimators are unbiased and that the standard errors are consistent. The stationarity of each time series is tested with an Augmented-Dickey-Fuller test, and Durbin-Watson tests are used to test for autocorrelation on the residuals. A Breusch-Pagan Lagrange multiplier (LM) test of independence is performed to check for cross-sectional dependence in the FE model. If significant autocorrelation and cross-sectional dependence are detected, a robust covariance matrix, which uses Driscoll-Kraay standard errors, is employed. The joint significance of all regressors is tested using an F test. To compare the results of the OLS and FE models, an F test for individual effects (pFtest) is performed. Furthermore, the Hausman test checks whether an FE model performs better than a random-effects (RE) model.

After these in-sample results are obtained, the out-of-sample forecasting quality of the model is tested. Here, following Stock and Watson (2003), an autoregressive model of order one (AR(1)) of GDP growth is used as a benchmark. The first lag of the GDP growth rate is thereafter added to equations 1a and 1b as a second explanatory variable. The performance of

[7] This consists of 13 country/area time series: the Eurozone plus twelve individual member states (Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, the Slovak Republic, Slovenia, and Spain).

these extended yield spread models is compared with the benchmark model using the root mean squared errors (RMSE) and the Diebold-Mariano test for forecast accuracy. For the out-of-sample predictions, all data until t-1 are used to estimate equations 1a and 1b. Thereafter, expected GDP growth in period t is calculated based on the resulting estimations. After this forecast, data on period t are added to the estimation set, and period t+1 is forecasted. This procedure is performed for the entire time horizon on the Eurozone data.

4.2 Recession prediction

Whether the occurrence of a recession in the Eurozone can be predicted by the yield spread is tested using a probit model. Because a recession is a binary event, the probit model is the appropriate method of estimating the probabilities[8]. The dependent variable is a binary variable that takes a value of 1 if a recession occurs in a given quarter and 0 otherwise.

$$y_{\mathrm{t}} = \begin{cases} 1, if\ a\ recession\ occurs\ in\ quarter\ t \\ 0, otherwise \end{cases}$$

The nonlinear model relates the probability of a recession in quarter t to the yield spread 4 quarters earlier:

$$Pr[y_{\mathrm{t}} = 1 \mid yieldspread_{\mathrm{t}-4}] = F(\alpha + \beta * yieldspread_{\mathrm{t}-4}), \quad (3)$$

where *Pr* denotes probability and *F* is the cumulative normal distribution function of a normalized Gaussian distribution where the residual standard deviation is normalized to 1. The log-likelihood function of the model, which is maximized with respect to α and β, is given as follows:

$$\log L = \sum_{y_t=1} \log F(\alpha + \beta * yieldspread_{t-4}) + \sum_{y_t=0} \log[1 - F(\alpha - \beta * yieldspread_{t-4})] \quad (4)$$

The accuracy of the model is measured in two ways. Pseudo-R^2 values are used to measure the overall fit of the resulting estimations, and an overview on correctly predicted recession and non-recession quarters is given.

5 Results

Although the Eurozone was established as a currency union in 1999, the decision to move toward a currency union was made earlier. In 1990, because of the expected parallelism of

[8] The method follows several earlier papers, such as Estrella and Hardouvelis (1991) and Estrella and Trubin (2006).

inflation rates across the union and an implicit bailout promise, long-term yields on the debt of projected currency union members began to converge. These expectations continued until the outbreak of the financial crisis in the autumn of 2008, when long-term yields diverged greatly (see figure 1).

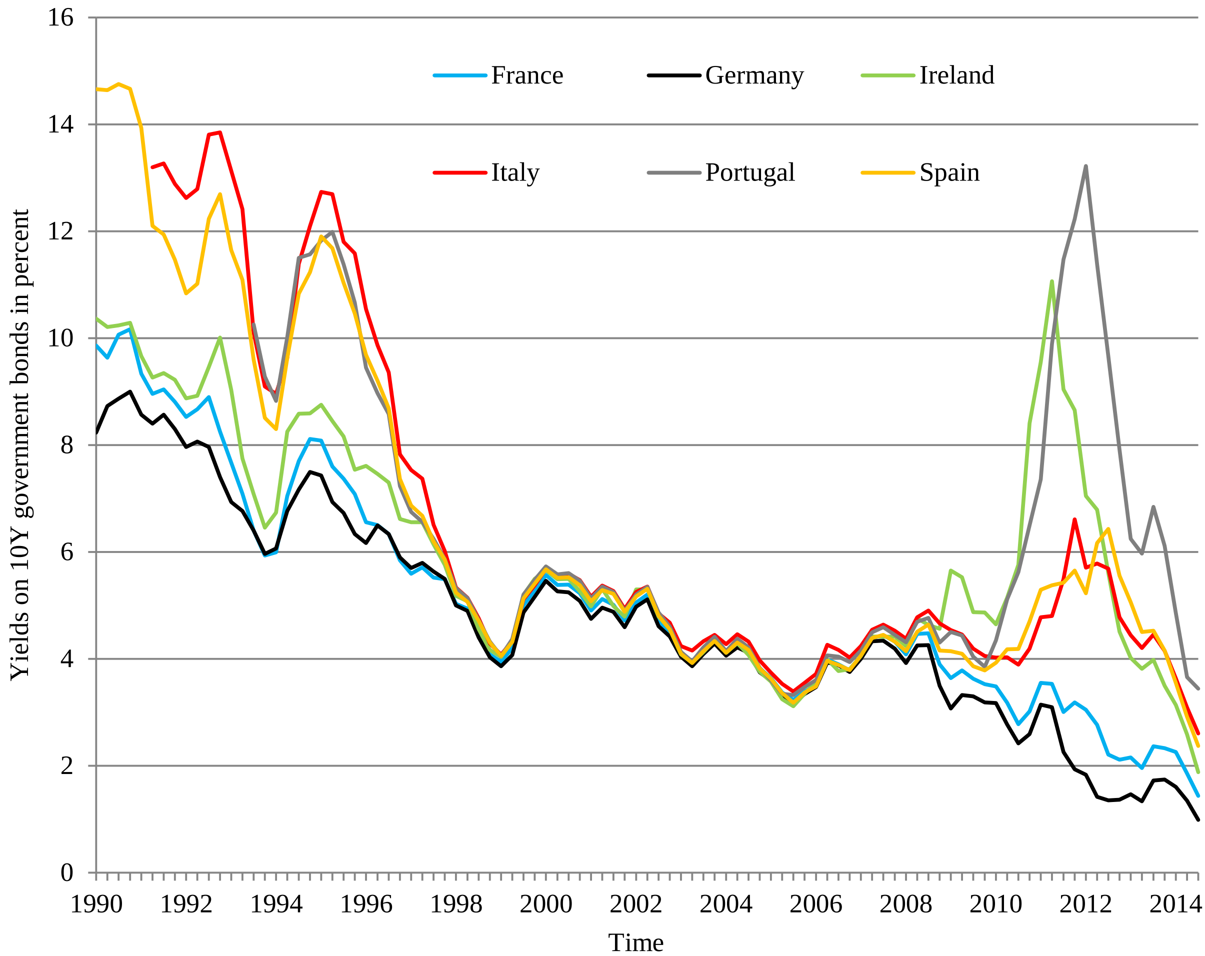

Figure 1: Long-term yields of selected countries from 1990 to 2014.

Combined with fixed short-term rates, several countries' imminent or actual payment difficulties led to considerably higher yield spreads. Thus, three distinct yield curve phases can be identified in the Eurozone: convergence, parallelism, and divergence. The convergence phase lasted until the end of 1999; the parallelism phase, in which short- and long-term yields were equal for all countries, lasted from 2000 until the third quarter of 2008; and the divergence phase lasted from the fourth quarter of 2008 until the third quarter of 2014 (see figure 1).

5.1 Growth prediction

Table 1 reports the results of the models from equations 1a and 2a. Over the entire period, the predictive power of the simple yield spread in the Eurozone is moderate. The coefficient of the yield spread (ys) is small, as is the explained variance (column 1). It can be observed, however, that the results vary widely over the three subsamples. Although no relationship exists in the convergence period[9] (column 3), it is substantial during the parallelism and divergence periods (column 5 and 7). The results for the entire panel (OLS and FE) are quite different. No relationship is observed for the entire period (column 2) or for the divergence phase (column 8), whereas the relationship is highly significant during the convergence and parallelism periods. All of the significant yield spread coefficients have the expected positive sign, and the constants indicate average higher growth rates during the first two phases.

Table 1: Results of OLS models without CDS correction

	Full time period		Convergence		Parallelism		Divergence	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	EZ	Panel	EZ	Panel	EZ	Panel	EZ	Panel
ys	0.484**	0.022	- 0.425	0.632***	1.763***	1.159***	1.093***	- 0.108
	(0.230)	(0.053)	(0.31)	(0.072)	(0.373)	(0.163)	(0.367)	(0.069)
Constant	0.639	1.701***	3.072***	1.726***	- 0.494	0.873***	- 2.365**	0.834***
	(0.430)	(0.118)	(0.534)	(0.131)	(0.510)	(0.211)	(0.998)	(0.247)
Adj-R²	0.045	0.000	0.052	0.219	0.359	0.093	0.301	0.006
n	73	1002	15	270	38	482	18	246
p	0.039	0.673	0.199	0.000	0.000	0.000	0.008	0.119

Notes: Standard errors in parentheses. The p-value is the result of the significance of an F-test on the joint significance of all regressors. The results of the FE regressions are very similar to the Panel-OLS results and are reported in table 5 in the appendix. *p ≤ .10, **p ≤ .05, ***p ≤ .01.

The nonexistent relationship between the non-risk-adjusted yield spread and growth in the divergence phase for the entire panel reflects divergent effects in individual countries of the Eurozone, which might offset each other. The positive relationship between the raw yield spread and growth remains significant in the economically stable core of the currency union (Austria, Finland, France, Germany, the Netherlands) but is not significant in the so-called periphery countries (Spain, Ireland, Italy, Portugal, Slovenia), which are typically most strongly affected by risk premia[10]. For the latter countries, the yield spread does not remain significant as a predictor of GDP growth[11]. Although the yield spread is strongly positive in these countries, GDP growth varies around zero. This result suggests that risk premia on long-term government debt deteriorate the relationship between the yield spread and GDP growth.

[9] This result seems logical because national central banks with individual monetary policies are still in place during this phase.

[10] The average difference in risk premia between countries in the first group and countries in the second group is 201 basis points.

[11] Detailed results for individual countries are available on request from the author.

Before showing the results of the models that include consideration of the CDS data, figure 2 shows the difference between the yield spread and the CDS-corrected yield spread for the Eurozone. CDS data are available from the beginning of 2008. Because the simple yield spread of the Eurozone is on average 2.2% in the years from 2008 to 2013, the differences are quite substantial.

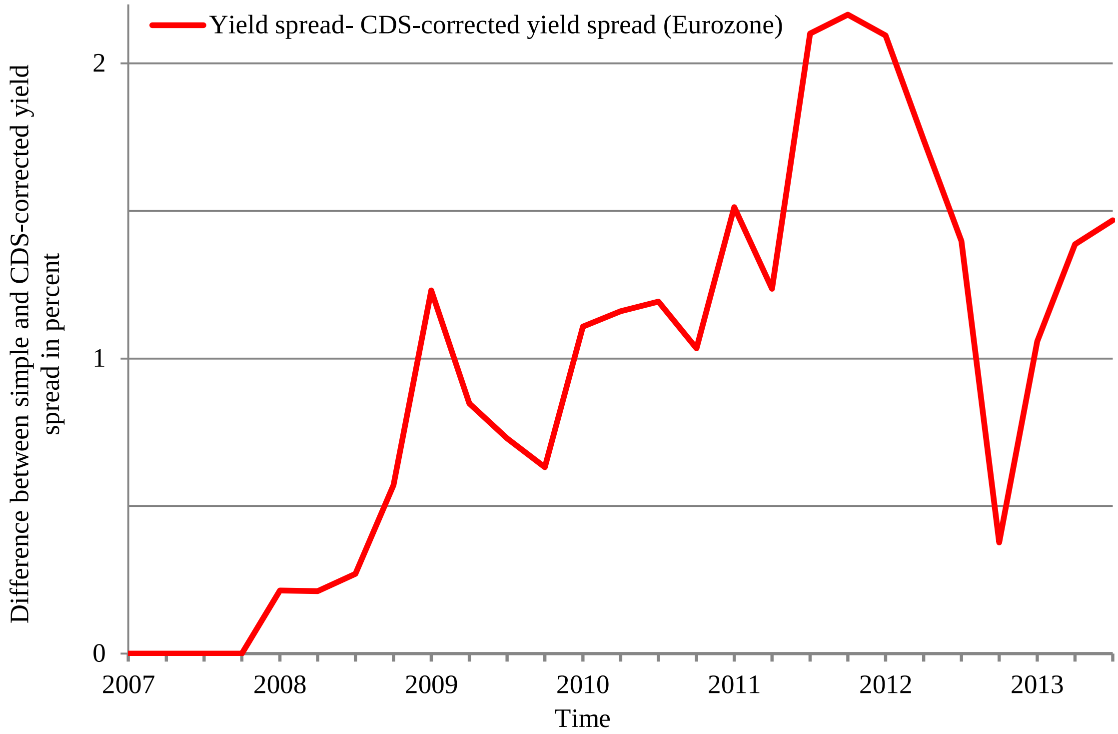

Figure 2: Difference between simple and CDS-corrected yield spreads in the Eurozone.

In addition to showing initial findings on the simple yield spread, table 2 shows the results from the estimation of equations 1b and 2b. The inclusion of the CDS correction in the yield spread data leads to significant improvements in the ability of the yield spread to predict economic activity. In addition, the results are more consistent across the three estimation methods and sample periods. The coefficient estimates of the CDS-corrected yield spread (yscds) for the Eurozone indicate a stable relationship over all sample periods. The significantly lower constant during the divergence phase reflects reduced growth potential in the Eurozone in recent years. The explanatory power of the CDS-corrected yield spread is high, especially for the divergence period, with 73.4% of the variance explained. This result is in line with earlier findings indicating that the yield spread forecasts economic activity better during economically volatile phases (Estrella (2005), p. 742, Benati and Goodhart (2008), p. 1237). Furthermore, the increase in the adjusted-R^2 value of the in-sample GDP growth prediction over the full time period after consideration of CDS spreads is approximately 0.28. This is an even higher increase compared to the effects of the introduction of (GZ-Type) credit spreads in four-quarter GDP growth predictions for the Eurozone (Gilchrist and Mojon (2014), Table 3).

Because the number of observations for the Eurozone alone is small in the parallelism and divergence phases, the OLS estimations on the entire panel, together with the results of the FE model, are used to verify the findings on a larger dataset. Overall, the results are similar to those of the Eurozone. The explained variance for a sample of twelve countries plus the Eurozone in just one OLS regression is, of course, smaller, but the coefficients are all positive, and the explained variance is highest for the divergence phase. The FE estimations also show a strong positive and highly significant relationship for all sample periods. Compared to OLS and the RE model, the pFtest and the Hausman test indicate that the FE model is the appropriate choice for all samples and phases (except for the full period without CDS correction [table 5, column 2 in the appendix], during which RE would be more appropriate).

Table 2: Results of OLS and FE model with CDS correction

	Full time period			Parallelism			Divergence		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	EZ	Panel	FE	EZ	Panel	FE	EZ	Panel	FE
yscds	1.411**	0.656*	0.695*	1.788**	1.231	1.838**	1.536***	0.821**	1.120***
	(0.508)	(0.347)	(0.343)	(0.693)	(0.953)	(0.721)	(0.158)	(0.325)	(0.287)
Constant	- 0.383	0.990	–	- 0.489	0.816	–	-1.621***	- 0.799*	–
	(0.875)	(0.711)	–	(1.033)	(1.416)	–	(0.234)	(0.405)	–
Adj-R^2	0.322	0.072	–	0.405	0.111	–	0.734	0.139	–
n	73	1002	1003	38	482	483	18	246	247
p	0.000	0.083	0.066	0.034	0.221	0.026	0.000	0.027	0.001

Notes: The results for the convergence period are not reported because they are unchanged compared to table 1 because CDS spreads are only available beginning in the first quarter of 2008. Heteroskedasticity and autocorrelated errors for the Eurozone regressions, along with Driscoll-Kraay standard errors for the panel and FE estimations, are in parentheses. The results with non-adjusted standard errors are reported in table 5 in the appendix. The p-value is the result of the significance of an F-test on the joint significance of all regressors. *p ≤ .10, **p ≤ .05, ***p ≤ .01.

Because the Durbin-Watson test shows autocorrelation for the residuals and the Breusch-Pagan LM test indicates serial correlation, the coefficient standard errors are reproduced with adequate covariance matrices. The resulting standard errors and p-values are reported in table 2 and show that the coefficients of the CDS-corrected yield spread in all models and samples remain significant, except for the whole-panel OLS estimation in the parallelism phase (the results of non-adjusted standard errors are reported in table 6 in the appendix).

The results for the out-of-sample forecasting performance for Eurozone GDP growth are reported in Table 3. The reported values are the ratios of the RMSEs of the yield spread and CDS-corrected yield spread models with one lag of GDP growth as an explanatory variable added and the AR(1) benchmark model. Compared to the AR(1) model, both yield spread forecasts produce lower RMSEs. For the full time period, along with the phases of parallelism and divergence, the CDS-corrected yield spread forecast produces the lowest RMSEs.

Table 3: Out-of-sample forecast RMSE ratios for Eurozone GDP growth prediction

	Full sample	Parallelism	Divergence
	(1)	(2)	(3)
Yield spread	0.891	0.780	0.939
	(0.275)	(0.036)	(0.387)
CDS-corrected yield spread	0.848	0.772	0.731
	(0.062)	(0.045)	(0.130)

Notes: One-sided p-values for the Diebold-Mariano test in parentheses. The null hypothesis of the Diebold and Mariano (1995) test is that the two models have the same forecast accuracy. The raw yield spread and the CDS-corrected yield spread model with one lag of GDP growth as an explanatory variable added are each tested against the AR(1) benchmark. The full sample is the time from the first quarter of 2000 to the second quarter of 2014.

5.2 Recession prediction

Yield curve inversion, usually considered the most reliable indicator of future recessions (Wheelock and Wohar (2009)), occurs before a recession both in the Eurozone and in other single-currency areas, as shown by the data for the phase of yield parallelism. An inversion of the yield curve occurs in the third quarter of 2007; the recession had begun one year later. In the phase of risk-induced yield divergence, the picture becomes less clear. Raw yield spread data do not show an inversion before the recession that began in the first quarter of 2012. In view of some countries' high risk premia, this result is unsurprising. After CDS spreads are taken into account, in the fourth quarter of 2011, the yield curves invert in some countries (Germany, the Netherlands) and generally flatten in all other countries, with the yield spread for the Eurozone as a whole decreasing to 0.5%[12]. The observed high yield spreads in the Eurozone during the divergence period are therefore a mere artifact. Reliable information about future growth can only be obtained from the risk-adjusted yield spread.

The results of the probit estimation (table 4) for the entire time horizon in which the Eurozone has existed as a currency area show a significant relationship between the risk-adjusted yield spread and the probability of a recession (column 1). The quality of prediction increases

[12] Author's own calculation; for details, see Appendix.

further when the two phases of yield parallelism and divergence are estimated separately (column 2 and 3). The negative coefficients on the CDS-corrected yield spread indicate an increasing probability of a recession when the yield spread is decreasing. Combined with a constant insignificantly different from zero, this corresponds to a situation in which a negative yield spread is required as an indicator for a recession. The higher constant for the divergence period reflects the poor economic situation of the Eurozone in recent years because, contrary to the parallelism period, a strong positive risk-adjusted yield spread is necessary to decrease the probability of a recession to zero.

Table 4: Results of the probit estimation of recession probability in the Eurozone

	Full sample	Parallelism	Divergence
	(1)	(2)	(3)
yscds	- 1.079***	- 3.216**	- 1.684**
	(0.290)	(1.358)	(0.702)
Constant	0.296	- 0.156	2.213**
	(0.327)	(0.505)	(1.033)
Pseudo-R^2	0.291	0.873	0.358

Notes: Standard errors in parentheses. Full sample is the time from the first quarter of 2000 to the second quarter of 2014. *p ≤ .10, **p ≤ .05, ***p ≤ .01.

The forecasting accuracy of the probit models is different between the samples. The full sample model estimates 47 of 58 quarters properly, with four false positives and seven false negatives. In contrast, the combination of the two subsamples leads to 55 properly predicted quarters, with only one false positive and two false negatives, which corresponds to a forecasting accuracy of 95%. A graphical comparison of the estimated probabilities of recession with actual recession quarters is presented in figure 2.

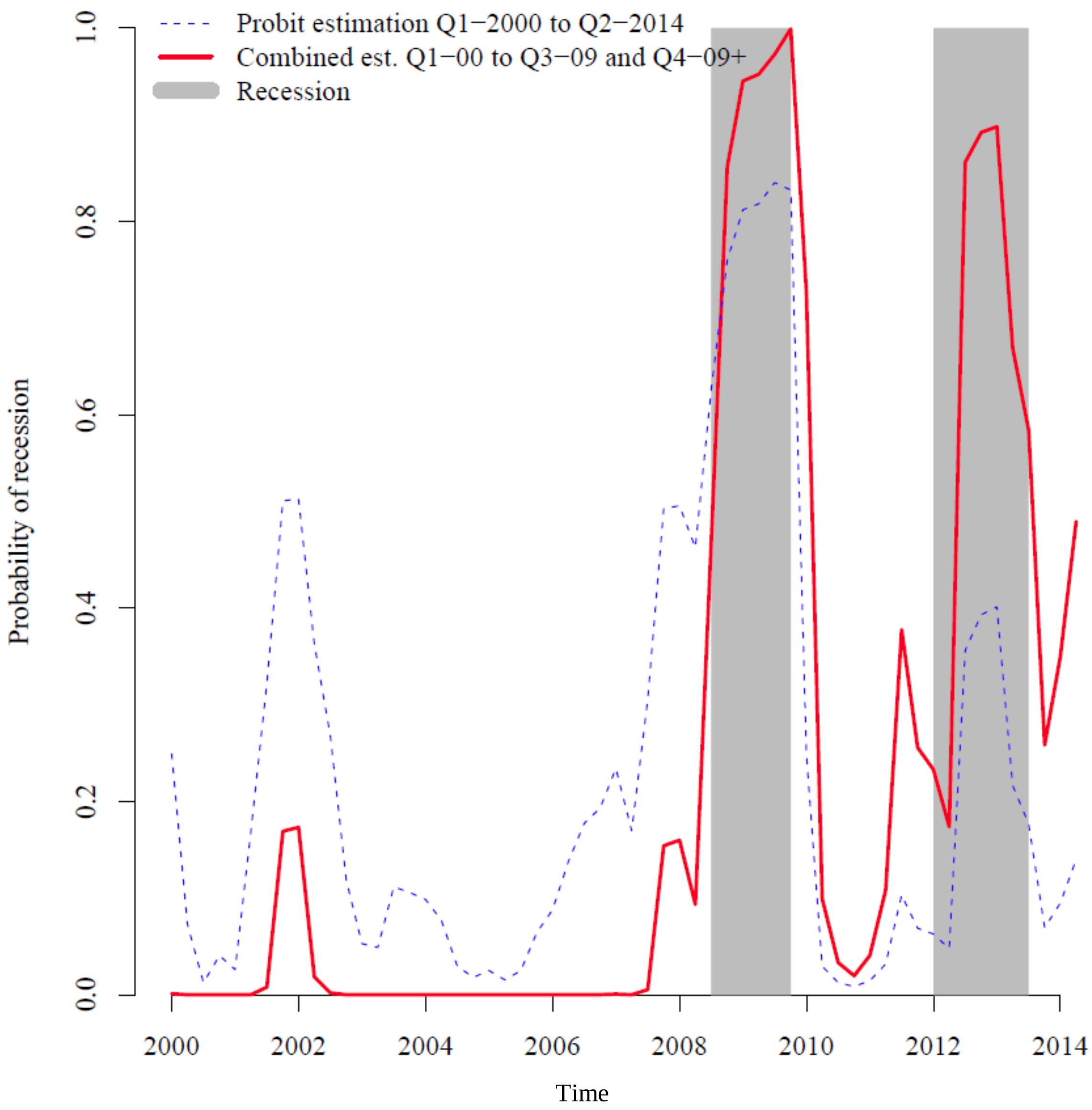

Figure 3: Predicted probabilities of recession and actual recessions in the Eurozone.

6 Conclusion

Classical yield spread theory would suggest an ongoing growth period for the Eurozone, especially for the countries in the periphery, over recent years. However, although yield spreads are permanently high and positive in that area, GDP growth is rare. In this paper, it is shown that the weakened forecasting relationship between yield spread and growth in the Eurozone in recent years is due to distortions in the long-term yields of sovereign bonds. These bonds are more or less strongly affected by sovereign default risks, which significantly increase long-term rates. Therefore, what can be observed in the yield curve is not an adequate picture of growth and inflation expectations, and forecasts based on a raw yield spread provide only moderate and somewhat inconclusive results. However, when the impact of credit risk is appropriately taken into account, the results indicate that the yield spread is a reliable tool to predict growth and recessions in the Eurozone.

As is becoming clear, the selected approach is particularly suitable for large and medium-sized open economies with a liquid CDS market. Yield spreads determined solely by expectations on inflation and growth can reliably forecast economic activity. Therefore, if the yield spread is distorted by credit risk, a risk adjustment method is necessary. It is shown that the yield spread itself, after considering CDS data, contains sufficient information and leads to higher forecast improvements in the Eurozone than does a credit spread of the GZ type.

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Appendix

Calculation of CDS-corrected Eurozone yield spreads:

The CDS-corrected Eurozone yield spread is calculated by multiplying individual countries' yield spreads by their extrapolated European Central Bank (ECB) capital shares. Capital shares are obtained by weighting the official shares of Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, the Slovak Republic, Slovenia, and Spain to sum to one. Luxembourg is excluded because of missing long-term debt data.

This method is used as a proxy for the OECD method of calculating Eurozone yield spreads, based on yield observations (in Euros) of the actively traded government bonds of Eurozone countries, weighted by the stocks of bonds issued by each country in Euros. The OECD method cannot be replicated because of missing data.

Table 5: Results of OLS and FE model without CDS correction

	Full time period		Convergence		Parallelism		Divergence	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel	FE	Panel	FE	Panel	FE	Panel	FE
ys	0.022	0.027	0.632***	0.635***	1.159***	1.788***	- 0.108	0.135
	(0.053)	(0.053)	(0.072)	(0.069)	(0.163)	(0.154)	(0.069)	(0.090)
Constant	1.701***	–	1.726***	–	0.873***	–	0.834***	–
	(0.118)	–	(0.131)	–	(0.211)	–	(0.247)	–
Adj-R²	0.000	–	0.219	–	0.093	–	0.006	–
n	1002	1003	270	271	482	483	246	247
p	0.673	0.613	0.000	0.000	0.000	0.000	0.119	0.137

Notes: Standard errors in parentheses. The p-value is the result of the significance of an F-test on the joint significance of all regressors. *p ≤ .10, **p ≤ .05, ***p ≤ .01.

Table 6: Results of OLS and FE model with CDS correction and non-adjusted standard errors

	Full time period			Parallelism			Divergence		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	EZ	Panel	FE	EZ	Panel	FE	EZ	Panel	FE
yscds	1.412***	0.656***	0.695***	1.788***	1.231***	1.838***	1.536***	0.821***	1.120***
	(0.237)	(0.074)	(0.072)	(0.345)	(0.158)	(0.147)	(0.216)	(0.128)	(0.114)
Constant	- 0.383	0.990***	–	- 0.489	0.816***	–	-1.621***	-0.799***	–
	(0.355)	(0.118)	–	(0.473)	(0.204)	–	(0.339)	(0.238)	–
Adj-R²	0.322	0.072	–	0.405	0.111	–	0.734	0.139	–
n	73	1002	1003	38	482	483	18	246	247
p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: The results for the convergence period are not reported because they are unchanged compared to table 1 because CDS spreads are only available beginning in the first quarter of 2008. Non-adjusted standard errors are in parentheses. The p-value is the result of the significance of an F-test on the joint significance of all regressors. *p ≤ .10, **p ≤ .05, ***p ≤ .01.