Currency Risk in Corporate Bond Spreads in the Eurozone

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We estimate the determinants of corporate bond spreads in the euro area relative to a safe German sovereign bond of similar maturity. As in other countries such as the United States and the United Kingdom, bond-specific factors such as the coupon, issuer credit rating and expected default frequency derived from equity prices are important, but so also are macroeconomic factors such as redenomination risk associated with a possible split in the euro. We compare the determinants for two relatively strong euro-area countries (France and the Netherlands) and three relatively weak ones (Italy, Portugal and Spain).

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1. Introduction

Considering how ancient the market for government debt is, corporate bond markets have been rather slow to develop. Data on the United States go back to the early 1970s (Gilchrist and Zakrajšek, 2012); on the United Kingdom to 1994 and on the Eurozone to 1999 (e.g. Bleaney et al., 2016). A market for emerging-market corporate debt denominated in foreign currency (generally the US$) developed in the 1990s (e.g. Durbin and Ng, 2005). In emerging markets, sovereign debt normally carries a risk premium relative to a US government bond of the same maturity, and except in a few cases corporate bond spreads tend to follow sovereign spreads. In other words, in emerging markets spikes in corporate bond yields tend to coincide with spikes in sovereign bond yields (Borensztein et al., 2013; Durbin and Ng, 2005; Peter and Grandes, 2005). The historical evidence from the US bond market shows a very different picture (Gilchrist and Zakrajšek, 2012). In the US, corporate bond yields have peaked in major recessions (1991, 2001), at a time when sovereign bond yields have been very low as monetary policy seeks to combat the recession. In short, in the United States, sovereign bonds have been seen as carrying negligible default risk at all times, but corporate bonds have been viewed as subject to significant default risk in bad times. This raises the interesting question of the relationship between corporate bond yields and sovereign bond yields in a currency union such as the euro area. Is there a significant correlation, as in emerging markets, or not, as in the United States?

In a currency union, bonds are issued in a particular national jurisdiction. This is significant if there is a possibility that individual countries might leave the union and return to a national currency, or if a group of countries might collectively adopt a different currency from the rest of the union. In that case euro-denominated debt issued in some countries may effectively promise a lower payout than euro-denominated debt issued in other members of the currency union, because of the possible depreciation of one currency relative to another. This possibility is usually referred to as "redenomination risk". This redenomination risk should apply equally to sovereign and corporate debt. In their study of sovereign spreads in the euro area, Krishnamurty et al. (2018) use this argument as a justification for treating the spread on relatively safe corporate debt as a measure of this redenomination risk. This assumes, however, that the risk of sovereign default does not affect corporate bond spreads (for otherwise some of the spread on corporate debt would reflect sovereign default risk rather than redenomination risk). This may be true, but it is somewhat at odds with the standard explanation for the correlation between corporate and sovereign foreign-currency spreads in emerging markets, which is that, when sovereign debt is high, governments raise taxes, depressing corporate profits either directly through corporate taxes, or indirectly through the impact on aggregate demand (e.g. Bedendo and Colla, 2015, p. 34; De Santis, 2017, p.3). The literature on sudden stops in capital inflows to emerging markets tends to suggest that there may be an alternative explanation for this correlation more in line with the Krishnamurty et al. (2018) view, which is that the reversal of capital inflows triggers a currency crisis that results in a large real devaluation, making foreign-currency debt much more expensive to service as well as cutting off supplies of new debt (Calvo et al., 2004; Frankel, 2005). This alternative explanation suggests that corporate defaults are not made more likely by sovereign defaults, but merely that a common factor (a sudden stop) makes both more probable.

These considerations suggest that the determinants of corporate bond spreads in a currency union are not exactly the same as in the case of a national currency. If we take as the risk-free interest rate in a currency union the rate on government bonds issued by the strongest member, then the spread on corporate bonds issued in other countries may be related to the spread on sovereign bonds of the same country because of redenomination risk (but not sovereign default risk, if that is perceived to be unrelated to corporate default risk). We investigate this after taking full account of bond-specific factors that have been shown to be important in other countries (Gilchrist and Zakrajšek, 2012; Bleaney et al., 2016).

The remainder of the paper is structured as follows. Previous research is reviewed in Section Two, and the data are discussed in Section Three. The empirical model is set out in Section Four, and results are presented in Section Five.

2. Literature Review

Structural models value a risky bond as a contingent claim on the firm's resources. In good states of the world, the bond pays out in full as promised; in bad states it pays out something less, possibly zero. The bond's value is a weighted average of the full payment and of what the investor expects to receive in the event of default; the weights are respectively one minus the probability of default and the probability of default. Different models estimate the probability of default differently, as discussed by Anderson and Sundaresan (2000). For listed firms, it is possible to use data on the level and historical volatility of the share price in an option pricing model to value bonds (Merton, 1974); the model requires certain assumptions about the laws of motion of stock prices and the costs of default. Bharath and Shumway (2008) show that the Merton "distance-to-default" measure performs well as a predictor of future defaults in US corporate bonds.

If structural models can explain default probabilities, then they should also be able to explain the spreads of corporate bond yields over the yield on a safe bond. Empirical studies such as those of Collin-Dufresne et al. (2001), Driessen (2005), King and Khang (2005), Bharath and Shumway (2008) and Gilchrist and Zakrajšek (2012) confirm this for US bonds, as do Bleaney et al. (2016) for European bonds. In addition to measures of default risk, variables related to the liquidity of the bonds and tax effects are also found to be significant (Houweling et al., 2005). A substantial proportion of bonds in the US market are callable, and Gilchrist and Zakrajšek (2012) modify the model to allow for this.

An important issue is the role of macroeconomic risk in the pricing of corporate bonds. Safe bonds offer portfolio diversification benefits because in recessions, when equity prices tend to be low, interest rates fall and bond prices rise. This effect operates in corporate bonds as well, but it may be swamped by rising default risk, which is likely to cause corporate bond prices to co-move with equity prices. This co-movement introduces systematic risk into corporate bond pricing for which investors require compensation. As Elton et al. (2001, p. 267) express it, "if expected default loss were to move with equity prices, so while stock prices rise default risk goes down and as stock prices fall default risk goes up, it would introduce a systematic factor." Of course in the Merton distance-to-default model stock price movements have precisely this effect. Gilchrist and Zakrajšek (2012) and Bleaney et al. (2016)

extract this macroeconomic risk component as the residual from a structural model of corporate bond yields, and show that it predicts business cycle fluctuations.

Matters are different in the market for sovereign debt issued by emerging markets and targeted at international investors. Because contracts are difficult to enforce against sovereign entities, the literature has centred on whether other sanctions, such as a trade embargo or merely a loss of reputation, can support lending. Two features of the sovereign debt market are salient: defaults have not infrequently occurred, and the debt is usually denominated in foreign currency (typically US dollars) to attract foreign investors. These two features are not unconnected, because capital flows to emerging markets are volatile and subject to surges followed by "sudden stops", causing sharp real exchange rate movements that directly affect the burden of debt denominated in foreign currency (Calvo et al., 2004; Frankel, 2005). Grossman and van Huyck (1988) provide a model in which investors condone "excusable defaults" in recognisably bad states of the world, but require a risk premium for doing so. Bleaney (2008) shows that such an arrangement can support lending that would not otherwise occur.[2] Klingen *et al*. (2004) and Lindert and Morton (1989) find the empirical evidence to be consistent with this model, in the sense that long-run returns on risky debt are similar to those on safe debt.

The countries that make up the euro area have historically issued most of their debt in domestic currency, and then in euros after 1999. By itself, this observation would tend to suggest an absence of currency or default risk, as in the United States or the United Kingdom. But as interest rates converged, there was a surge of lending to peripheral countries that appreciated their real exchange rates. When, in an episode reminiscent of emerging-market experience, there was a sudden stop in capital flows after the global financial crisis, the real exchange rates of peripheral eurozone countries were revealed to be seriously overvalued (Fidora et al., 2017). Fears that the recession might create enough political pressure for countries to leave the euro, or alternatively for a number of peripheral countries to band together in a 'soft' eurozone that would devalue relative to the 'hard' eurozone centred on Germany, caused holders of 'soft' euro debt (debt issued by peripheral countries) to demand a risk premium relative to 'hard' euro debt. Such a currency risk premium of the sort normally associated with debt denominated in foreign currencies appeared in this case, despite the debt being denominated in domestic currency, because of doubts about the future value of Italian, Spanish or Portuguese euros. This currency risk premium would apply to corporate as well as sovereign debt, and would be additional to any eurozone-wide macroeconomic risk premium.

In this paper we explore the role of bond-specific factors, currency risk and other macroeconomic risks in the pricing of corporate bonds in the eurozone outside Germany. Bond-specific factors have been shown to be important in Europe as well as in other countries (e.g. Bleaney et al., 2016; King and Khang, 2005). The literature investigating the market effects of sovereign risk in the euro zone is limited to only a few papers. Bedendo and Colla (2015) compare spreads on credit default swaps (CDSs) on sovereign and corporate debt for eight Eurozone countries and 118 companies over the period January 2008 to December 2011. They find that ratings changes on sovereign debt affect corporate spreads, but not *vice versa*, and they examine which types of firm exhibit the greatest

[2] See Panizza et al. (2009) for a survey of the literature on sovereign debt.

sensitivity. Krishnamurthy et al. (2018) use an event study approach to investigate the channels through which ECB quantitative easing policies affected sovereign bond spreads relative to German sovereign bonds; they point out that that a CDS does not always insure against currency risk, and they use the difference between the spread on a safe corporate bond and the CDS spread to distinguish currency risk from default risk. Finally, De Santis (2017) uses the Bank of America Merrill Lynch corporate bond index to investigate the spillover of sovereign risk to corporate bonds. He finds a pass-through elasticity from sovereign spreads to corporate spreads of 0.3 and 0.5 for eurozone non-financial and financial corporations, respectively, with a larger impact for investment grade bonds and for non-financial corporations in Ireland, Italy and Spain.

The main differences between our paper and De Santis is that we use sovereign bond yields rather than sovereign CDS rates to capture exchange rate movements, as the latter may not necessarily trigger CDS payouts and can underestimate the true currency risk (Krishnamurthy et al., 2017). We also use all outstanding senior unsecured corporate bonds available on Bloomberg rather than an aggregated bond index, which allows us to control appropriately for firm-specific and bond-specific factors that affect the spread along the lines of Gilchrist and Zakrajšek (2012).

3. Data

We collect end-of-the-month spread information on all outstanding non-financial senior unsecured corporate bonds, (i.e. those that are not subordinate to other bonds), with a remaining maturity of at least one year, for a set of seven Euro-area countries (France, Greece, Ireland, Italy, Netherlands, Portugal and Spain) over the period January 2002 to December 2015 from Bloomberg. The countries were chosen to represent the largest economies in the euro area[3], and the sample period was driven by data availability. The spread, as calculated by Bloomberg, is the amount that must be added to the benchmark euro zero- coupon swap curve so that a security's discounted cashflows equal its mid-price, with each dated cashflow discounted at its own interpolated rate, which is equivalent to Gilchrist and Zakrajsek's (2012) bottom-up approach of constructing the spread from individual bond-level data. Our selection criteria remove bonds that are illiquid or have nonstandard features; thus, we only include bonds denominated in Euros, with a fixed coupon schedule, with an amount outstanding of at least one million Euros, and with a maturity at issue of less than 30 years, and we also exclude bonds with call and put options. The above selection criteria yielded 1999 corporate bonds, and after removing the 1st and 99th percentile of the distribution to mitigate the effect of outliers, we obtained a sample of 1619 bonds and 365 firms. We also obtained other data from Bloomberg on coupon, issue and maturity date, amount outstanding, Macaulay duration, and the Standard & Poor's issuer rating, market of issue, issuer name and the issuer's industry sector.

In order to capture the default risk of the bond issuers in our sample, we obtained access to Moody's KMV firm-level database of Expected Default Frequencies (EDFs).[4] We used the Moody's-specific

[3] Other smaller euro-area countries were not included due to very limited corporate bond spread data availability.

[4] Moody's KMV provides the Expected Default Frequency measure—a forward-looking probability of default metric—which is available for quoted firms and sovereigns and is the market standard bond risk measure. The EDF measure is

Personal Firm Identifier code, the firm's unique international SEDOL code and full company name to manually match the bond issuers in our sample and assign a monthly EDF measure for all bonds issued by a given firm. As the EDF measure is available only for publicly listed companies and the SEDOL code was not available for all issuers covered by the Moody's dataset, this yielded a final matched sample of 434 corporate bonds and 118 firms across 9 industry sectors in five countries.[5]

Figure 1 shows the evolution of the corporate bond spread for the five individual countries. The correlation between the series is remarkably high, especially up to the financial crisis of 2007-09. After that France and the Netherlands have lower spreads than the other three countries. All countries peak in 2008Q4 and then again at the start of 2012, in the context of the Euro sovereign debt crisis. Portugal follows a similar pattern to the other countries from January 2013 when it is available. Spain is a particular case in the sense that it peaks in four stages, the first being as early as August 2010 (followed by December 2010, December 2011, and June 2012) and the magnitude is also highest at just above 5%. Compared to France and the Netherlands, we can also note that Italy, Portugal and Spain have a much higher corporate bond spread during the sovereign debt crisis period. Figure 2 shows the sovereign bond spread of each of the sampled countries relative to Germany. Here too there is a sharp contrast between the core and peripheral Euro countries, with Italy, Portugal and Spain reaching a spread of over 5% during the sovereign debt crisis while Netherlands and France remain below 1.5%. In Figure 3, we plot the European Commission's Eurobarometer survey measuring attitudes for and against the euro currency within the Eurozone. We can note a high negative correlation between the sovereign spread and support for the single currency within the Eurozone.

What cannot be determined from these graphs of sovereign spreads is how much is redenomination risk and how much is default risk. We adopt the approach of Krishnamurty et al. (2018) that redenomination risk will affect corporate bond spreads to the same extent as sovereign spreads, but sovereign default risk will not.

Table 1a reports data on bond characteristics in aggregate across all the countries in our sample, and Table 1b reports the breakdown by country. There are 20,478 bond-month observations in our data sample. The mean firm in our sample has between nine and ten senior unsecured issues outstanding in any given month, with a maximum of 33 issues from a single firm trading in the secondary market at any point in time. On average a corporate bond in our sample has an expected spread of 1.23% over the comparable Euro swap curve, with a standard deviation of 1%, reflecting the relatively wide range of bond quality in our sample. The average comparable corporate bond spread in Germany is 0.94% with a considerably lower standard deviation of 0.3% and a maximum of 2.2%. The average coupon rate in the sample is 4.5% with a maximum of 8.5%.

compiled using Moody's default database and leverages market data, industry, volatility, financial statement data, and historical default information in a proprietary financial model.

[5] The distribution of industries across countries shows some wide distribution; for example, the most prominent industries in the countries in our sample are Utilities (25% of the sample), Industrial and Consumer non-cyclical, Communications, Consumer cyclical followed by Financial (4% of the sample). Greece and Ireland drop out due to data availability.

In terms of default risk, as measured by the S&P bond ratings, our sample spans almost the entire spectrum of bond quality from financially vulnerable firms rated B+ to secure firms rated AA. The distribution of the amount of debt outstanding of these issues is positively skewed, with the range running from €6 million to €2.5 billion. The maturity of the issues in our sample is long, with an average maturity at issue of 10 years and an average remaining term-to-maturity of 7.3 years. The average duration is equal to approximately 6 years; this is less than the average maturity since all bonds in our sample pay regular non-zero coupon payments over their life.

A notable feature of Table 1b is that the market appears to have assigned much lower sovereign risk to France and the Netherlands than to the other countries, to judge by their much lower and less volatile sovereign spreads. We shall examine these two "hard euro" countries separately from the "soft euro" countries (Italy, Portugal and Spain).

Table 1c presents the cross-correlations across all the sampled countries. We can note that the corporate bond spread is positively correlated with the following variables: the sovereign bond spread relative to Germany, the average German comparable corporate bond spread, the expected default frequency and the option market Euro volatility, and negatively correlated with the S&P rating. These observations are in line with our hypothesis that corporate default risk is positively associated with sovereign default risk and currency volatility.

4. Estimation Methodology

Our empirical methodology follows the lines of Gilchrist and Zakrajšek (2012) and Berndt et al. (2008), in that the corporate bond spread on bond *k* issued by firm *j* in country *i* at time *t*, S_{itk}, is assumed to be related linearly (in logarithms) to a firm-specific measure of expected default, EDF_{jit}, and a set of baseline explanatory variables to allow for liquidity and tax premiums, V_{itk}, as in King and Khang (2005), Gilchrist and Zakrajšek (2012) and Bleaney et al. (2016). We also include the sovereign spread relative to Germany, $SOV\ SPRD_{it}$, which we interpret as a measure of currency risk, as discussed below. The model is as follows:

$$\ln(1 + S_{itk}) = a_1 + b_1 * \ln(1 + SOV\ SPRD_{it}) + c_1 * \ln(1 + EDF_{itj}) + d_1 * \ln(V_{itk}) + e_{1itk} \quad (1a)$$

The sovereign spread, $SOV\ SPRD_{it}$, is defined as the country-specific government spread between the 10-year government bond yield and the 10-year German government bond yield. We interpret this as a measure of currency risk for the following reason. The euro sovereign debt crisis generated fears that a number of peripheral countries might band together in a 'soft' eurozone that would devalue relative to the 'hard' eurozone centred on Germany. This induced holders of 'soft' euro debt (debt issued by peripheral countries) to demand a currency risk premium relative to 'hard' euro debt (i.e. bonds issued by governments other than Germany might turn out to be worth less than German bonds despite being

repaid in full, but in a depreciated currency). This risk applies equally to corporate bonds issued outside Germany, which would create a correlation between sovereign spreads and corporate bond spreads, as in emerging markets. If, however, the coefficient turns out to be significantly less than one, that suggests that only part of the sovereign spread is reflected in corporate spreads. The natural interpretation of this is that a portion of the sovereign spread reflects default rather than denomination risk.

EDF_{jit} is the Moody's KMV firm-specific time-varying Expected Default Frequency and is our measure of credit risk. It is essentially a measure of the probability of the share price hitting zero over a given period. A firm with a higher EDF value is more likely to default over the next year, and would therefore have a higher spread over the corresponding risk-free rate to compensate the buyer for the increased risk. We expect a positive relationship between EDF_{itj} and the bond spread as a higher default risk probability will attract a higher spread in compensation for the increased risk of default.

The vector of bond-specific characteristics, V_{itk}, includes: Macaulay duration, DUR_{itk}, the amount outstanding, AOS_{ik}, the fixed coupon rate, CPN_{ik}, the age of the bond issue, AGE_{itk}, and the issuer Standard and Poor's rating, $S\&P\ rating_{itj}$. These variables have been shown to be correlated with corporate bond spreads in previous studies (e.g. King and Khang, 2005). The rating variable is an equivalent numeric variable assigned to each rating in the S&P scale, the poorest rating being one.

The Macaulay duration, $DUR_{jit}[k]$, is defined as the weighted average maturity of the bond's cash flows, where the weights are the present values of the cash flows. It is in effect the average maturity of all future payments to holders of the bond, weighted by their present value, and should have a positive coefficient. The coupon, $CPN_{ji}[k]$, is the ratio of annual interest rate payments to the face value of the bond. A higher coupon attracts a higher tax liability which in turn requires a higher yield in compensation, so we expect a positive sign on the CPN_{ik} coefficient. We consider only bonds with a fixed coupon. The amount of debt outstanding, $AOS_{ji}[k]$, is used to control for any liquidity effects, as large issues are likely to be more frequently traded in the market. Since this implies a lower spread, we expect a negative coefficient. Lastly, $AGE_{jit}[k]$ represents the years since the issue date of a bond and increases over time until maturity. The liquidity of bonds may vary with age (Elton and Green, 1998), but the coefficient could be of either sign. King and Khang (2005) find a significant positive coefficient for US corporate bonds. Finally the S&P credit rating may capture soft information that is complementary to the market-based measure of default risk (Löffler, 2007). A higher credit rating should attract a lower yield, so we expect a negative sign on the $S\&P\ rating_{jit}$ coefficient.

We apply a logarithmic transformation to all variables except the S&P rating. For a bond's age, duration and issue size the transformation is of the form *ln(variable)*, and for the remaining variables, including spreads, the transformation is of the form *ln(1+variable)*.[6]

[6] Natural logarithms of one plus the measures of the spreads and bond-level characteristics provide useful transformations to control for heteroscedasticity, given that the distribution of these variables is highly skewed. They also avoid negative values inherent in calculations with small values. In this case, the percentage change interpretations are closely preserved

We further evaluate whether other indicators of the euro currency's volatility, Z_{it}, are statistically significant for the corporate bond spread:

$$\ln(1 + S_{itk}) = a_1 + b_1 * \ln(1 + SOV\ SPRD_{it}) + c_1 * \ln(1 + EDF_{itj}) + d_1 * \ln(V_{itk}) + f_1 * \ln(1 + Z_{it}) + e_{1itk} \quad (1c)$$

The vector, Z_{it}, includes measures of euro volatility as captured by both the sovereign bond market and the currency options market, namely, the *EUR_USD DE Gvt yld spread* defined as the spread between Euro- and USD-denominated German sovereign bonds; the *3-month Delta 25 volatility*, which is Bloomberg's option market volatility of the Euro; and the *Average of DE Corp bond spreads*, defined as the average of all German corporate bond spreads measured in the same way and over the same time period as the rest of the corporate bond spreads in our sample from Bloomberg. The inclusion of the first two variables is motivated by Hui and Chang (2010) who find that the creditworthiness of countries is an important determinant of currency option prices. The *EUR_USD DE Gvt yld spread* reflects the perceived risk of denomination in hard euros relative to the dollar, and should mostly capture an interest rate differential as German bonds should have no more default risk than US bonds, given that Germany has a lower debt/GDP ratio compared to the US; hence the currency risk between the two countries could go in either direction. The Euro option market volatility reflects the market view of the likelihood of larger moves in the spot price over the next 3 months. It is a measure of a change in the option price with respect to a small change in the underlying exchange rate of the euro, and captures euro crash risk as anticipated by option market participants; the higher the value, the higher the crash risk, so we expect it to be positively related to the bond spread. Lastly, we include an average of German corporate bond spreads in order to capture general (non-currency) macroeconomic risk that is common to the whole Eurozone, on which we expect a positive coefficient. These controls are added sequentially to our model (1c); the *EUR_USD DE Gvt yld spread* is included in levels as it can take on negative values.

We estimate the models using OLS at bond level at monthly frequency, with firm fixed effects and standard errors clustered at country dimension and thus robust to arbitrary within-panel autocorrelation.

5. Results

We estimate the model of corporate bond spreads for two separate groups of countries – the countries where there is little perceived sovereign risk (France and the Netherlands), and the peripheral euro countries comprising Italy, Portugal and Spain. The results are presented in Table 2. Models 1 to 4 are alternative specifications for France and the Netherlands, and Models 5 to 8 are the same specifications for the other three countries. Model 1 contains all the bond-specific variables plus the sovereign spread. Only duration and coupon are statistically significant and of the expected positive

and it is acceptable to interpret the estimates as if we used the logarithm of the variable (Wooldridge, 2006, chapter 6.2, page 185).

sign. The sovereign spread is highly significant and indicates an elasticity of corporate spreads in France and the Netherlands of 0.835.

Model 2 adds the average corporate bond spread in Germany, as a measure of euro-wide macroeconomic risk. The coefficient is positive and highly significant, and its inclusion renders the sovereign spread coefficient insignificant. Model 3 includes the measure of expected euro volatility from the option market, which has a significant positive coefficient. Its inclusion reduces the German corporate spread coefficient by more than half, but makes the sovereign spread coefficient somewhat larger, at 0.488, both statistically insignificant. Finally, Model 4 adds the spread between euro-denominated and dollar-denominated German sovereign bonds, but this variable is insignificant. All explanatory variables improve the goodness of fit from 0.687 in model 1 to 0.574 in model 4 and 5, respectively, and this remains consistent for the different samples of countries, time periods and credit quality.

Models 5 to 8 repeat the exercise for the three peripheral countries. The results follow a similar pattern, however, corporate default risk as captured by the EDF variable is now significant in all models with a coefficient of approximately 2.5. Also, the coefficient of German corporate bond spreads is somewhat larger in models 7 and 8 and enters significantly in all models, while that of the sovereign spread is marginally larger compared to France and the Netherlands (except in the baseline specification, i.e. in model 5 where it is smaller at 0.625). Since we are assuming that redenomination risk implies a sovereign spread coefficient of one, and sovereign default risk implies a sovereign spread coefficient of close to zero, the smaller coefficient for the peripheral countries suggests a greater element of sovereign default risk, relative to redenomination risk, compared to France and the Netherlands. It might seem surprising that the coefficient is smaller in the more vulnerable countries, but that is the estimated effect of a given change in the sovereign spread. It can be seen from Table 1 that the sovereign spread is far more volatile in these countries, so that the estimated impact of sovereign spreads on corporate spreads in the peripheral countries, and therefore the overall degree of redenomination risk, is in fact considerably larger than in France and the Netherlands, once the coefficients are multiplied by the relevant sovereign spread.

In Table 3 we restrict our sample to corporate bonds of investment grade quality only. The general picture is largely consistent with the previous table, but the coupon now enters significantly for the 'soft' euro countries and the option market volatility is positively and significantly signed.

In a separate appendix available upon request, we further investigate whether there are any differences between the period before and after the euro sovereign debt crisis by splitting our sample period into two parts: January 2002 to March 2010 and April 2010 to December 2015. The results reveal an increasing element of sovereign default risk from 2010 in the 'soft' euro countries with strong statistical significance during the latter period while in France and the Netherlands the results are similar between the two periods. For robustness, we also test whether the results still hold for the slope or change in the corporate bond spreads and we report no significant differences.

Overall, our results suggest that corporate bond spreads in the Eurozone outside Germany are strongly correlated with sovereign spreads, after controlling for other macroeconomic risks and bond-specific and firm-specific factors, and we have argued that this reflects redenomination risk. If sovereign spreads purely reflected default risk, the correlation with corporate bond spreads would not be evident. In contrast to the US as previously mentioned, spikes in the corporate bond spreads are matched by spikes in the sovereign bond spreads of both 'soft' and 'hard' euro countries (see Figures 1 and 2), which are less pronounced for the latter group but still statistically significant. We have argued that this result is driven by the existence of currency risk that is priced in these euro-denominated corporate bonds, and which will remain as long as the market perceives a risk of a split in the Eurozone.

6. Conclusions

In this paper we have investigated the determinants of corporate bond spreads over a safe euro interest rate in five Eurozone countries outside Germany. We have sufficient data on bonds issued by firms in two "hard" euro area countries (France and the Netherlands) and three "soft" euro area countries (Italy, Portugal and Spain). With respect to firm-specific factors, the main findings are that spreads are: (a) positively related to Moody's expected distance to default (a measure of the likelihood of the share price hitting zero, based on its current level and recent volatility), particularly in the hard euro country group; (b) positively correlated with the coupon; (c) positively correlated with duration; and (d) negatively correlated with age. This last result contrasts with findings for the United States, where the correlation with age is positive (King and Khang, 2005). Corporate bond spreads are also strongly correlated with macroeconomic risk in the Eurozone as proxied by corporate bond spreads in Germany, and with country-specific sovereign spreads over Germany. We attribute this last factor to currency risk associated with the possible break-up of the Eurozone, in which case debts might be repaid in "soft" rather than "hard" euros. In this last respect, we show that Eurozone corporate bond spreads outside Germany have some emerging-market characteristics that do not apply to corporate bond markets where there is no perceived currency risk.

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Appendix

Figure 1. The Corporate Bond Spread (by country)

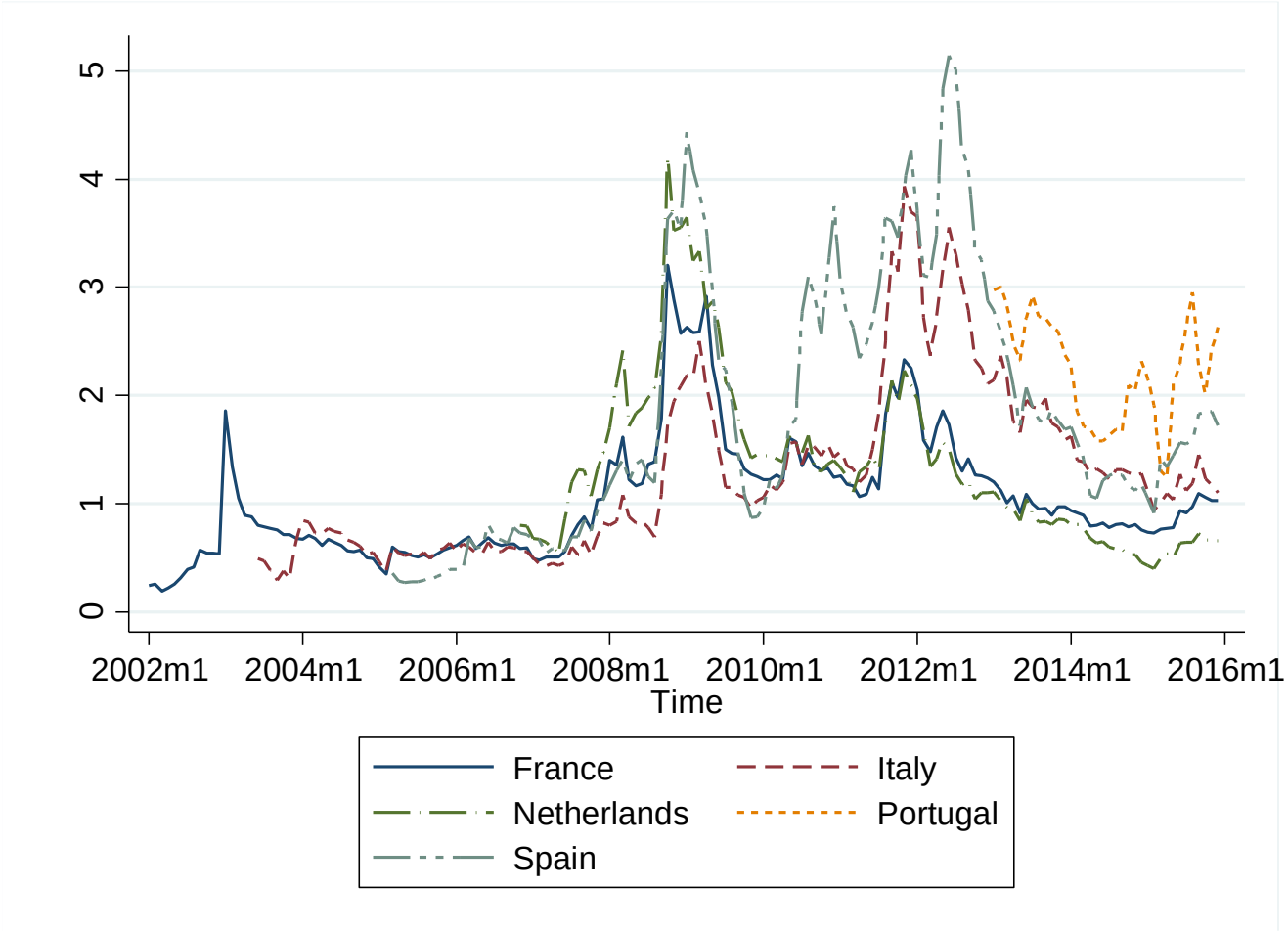


Figure 2. The Sovereign bond spread relative to Germany (SOV SPRD by country)

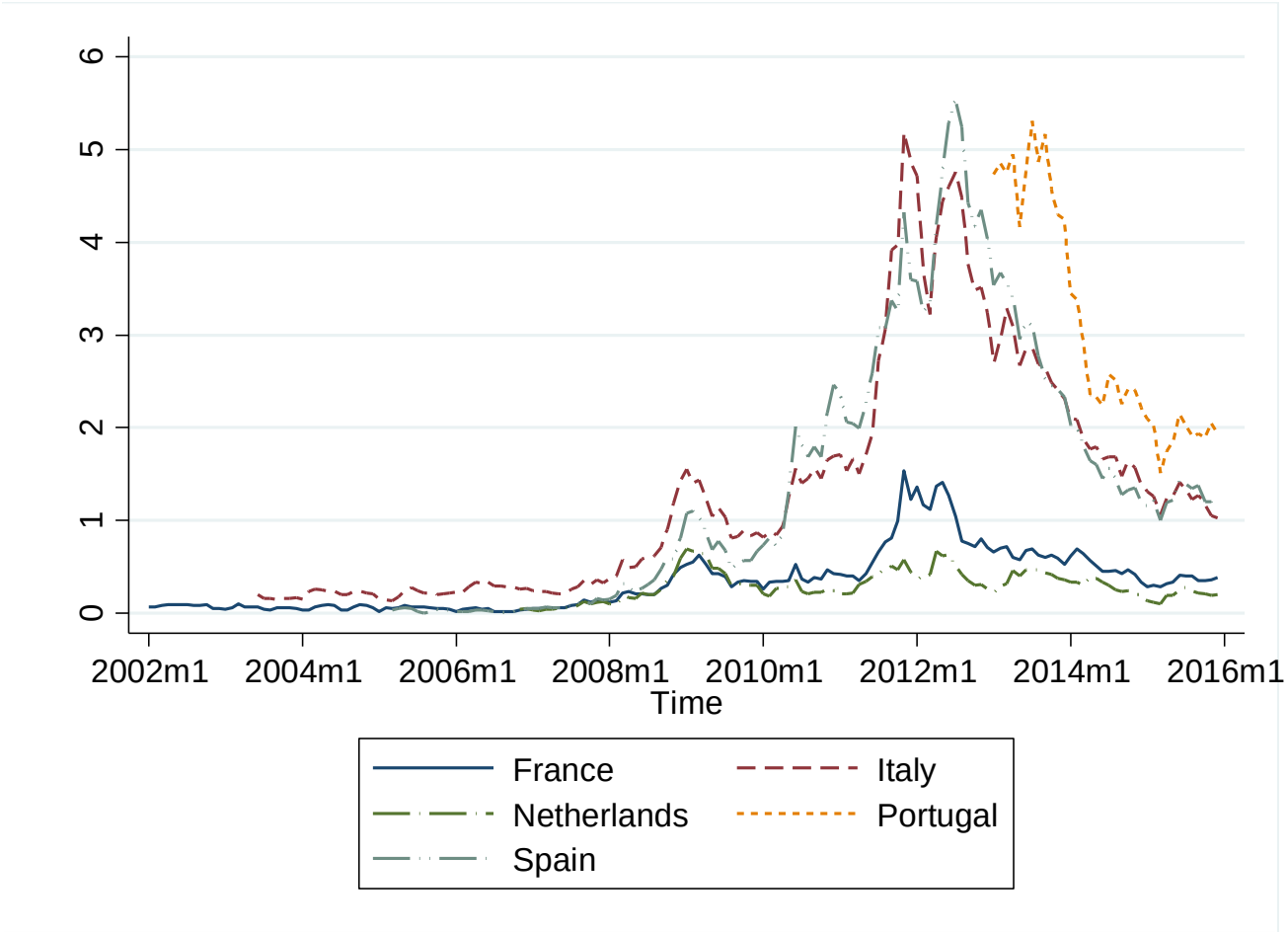
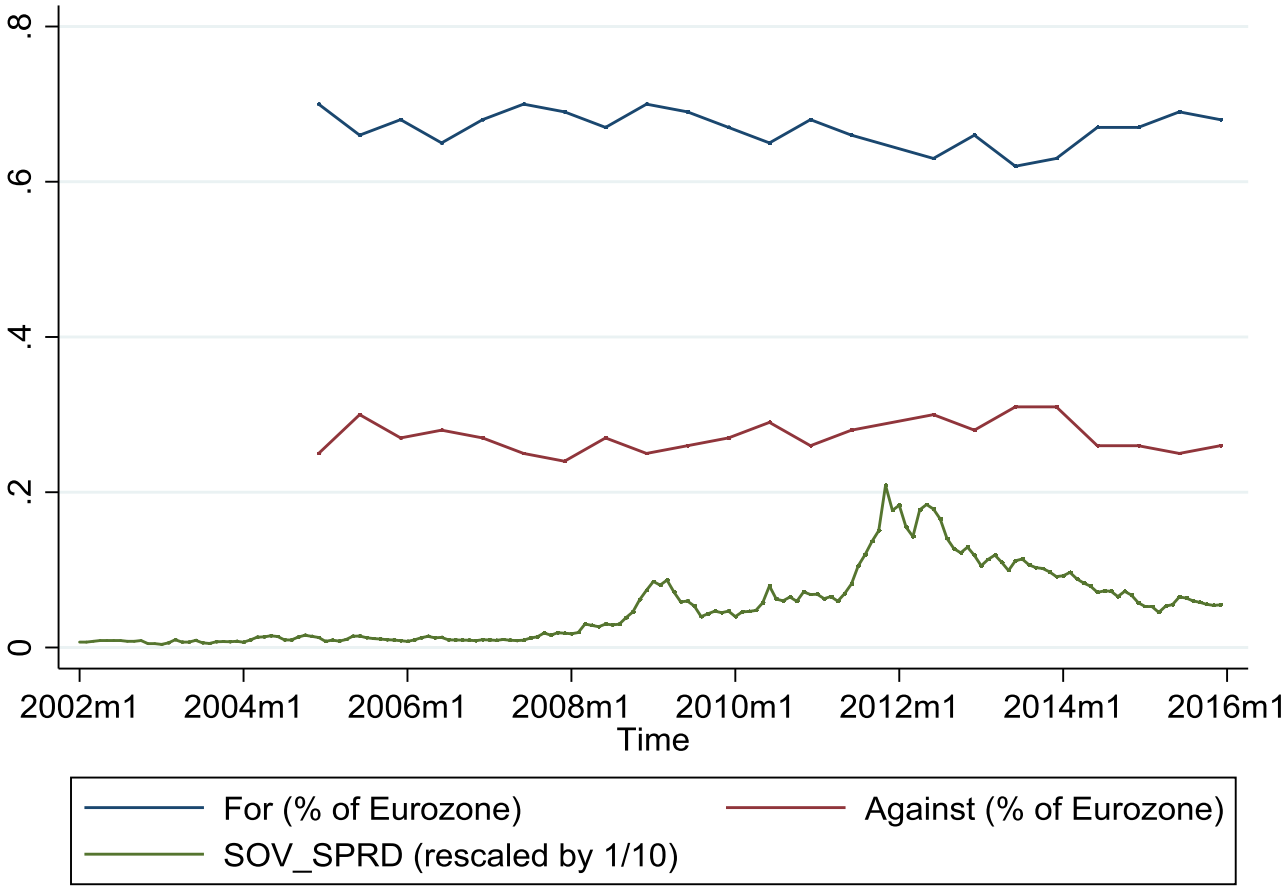


Figure 3. Eurobarometer survey[7] and the Sovereign bond spread relative to Germany (SOV SPRD)



[7] The survey measures the responses to the following question: "What is your opinion on each of the following statements? Please tell me for each statement, whether you are for it or against it: A European Monetary Union with one single currency, the euro", as a percentage of total responses within the Eurozone.

Table 1a. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Corporate bond spread (%)	20,478	1.231	1.004	0.030	6.700
Govt yld spread to DE (EUR) (%)	20,478	0.850	0.834	0.004	5.554
EUR_USD DE Gvt yld spread (%)	18,674	-0.021	0.105	-0.410	0.302
Average of DE Corp bond spreads (%)	20,450	0.935	0.318	0.033	2.213
3-month Delta 25 volatility (%)	20,423	29.693	10.895	11.880	88.500
Expected Default Frequency (%)	19,073	0.224	0.536	0.010	13.879
Coupon (%)	20,478	4.455	1.303	0.875	8.500
Amount outstanding (mln. euros)	20,478	628	413	6	2500
Amount issued (mln. euros)	20,478	692	428	6	2500
Term to maturity (yrs.)	20,478	7.341	4.866	0.077	30.014
Age (yrs.)	20,478	2.962	2.438	0.000	14.192
Maturity at issue (yrs.)	20,478	10.303	5.205	3.000	30.022
Duration (yrs.)	19,855	5.687	2.711	0.074	17.434
S&P rating	17,817	7.528	2.246	1	13

Notes: Sample period: 2002M1-2015M12. No. of bonds = 434; No. of firms = 118, No. of industry sectors = 9. Sample countries include France (FR), Netherlands (NL), Italy (IT), Spain (SP) and Portugal (PT). The Standard and Poor's issuer ratings have been converted to numerical values where 13 represents the highest rating AA and 1 the lowest rating B+ in the sample.

Table 1b. Descriptive statistics (by country)

Country	Statistic	Corporate bond spread (%)	Govt yld spread to DE (EUR) (%)	EUR_USD DE Gvt yld spread (%)	Average of DE Corp bond spreads (%)	3-month Delta 25 volatility (%)	Expected Default Frequency (%)	Coupon (%)	Amount outstanding (mln. euros)	Amount issued (mln. euros)	Term to maturity (yrs.)	Age (yrs.)	Maturity at issue (yrs.)	Duration (yrs.)	S&P rating
FR	Mean	1.11	0.54	-0.02	0.94	29.64	0.20	4.37	622.99	673.80	7.23	2.92	10.15	5.72	7.91
	SD	0.93	0.29	0.11	0.32	10.67	0.39	1.34	424.15	429.40	4.86	2.36	5.12	2.81	2.43
	Min	0.03	0.02	-0.41	0.03	11.88	0.01	1.00	10.00	10.00	0.09	0.00	3.67	0.07	1
	Max	6.70	1.54	0.30	2.21	88.50	12.93	8.50	2500.00	2500.00	30.01	14.19	30.02	17.43	13
IT	Mean	1.55	1.89	-0.02	0.91	29.38	0.31	4.67	709.56	809.52	7.26	3.11	10.38	5.55	6.51
	SD	1.12	1.09	0.10	0.32	11.06	0.80	1.06	425.17	453.24	4.49	2.73	5.32	2.55	1.71
	Min	0.04	0.14	-0.41	0.03	11.88	0.01	0.88	6.08	6.08	0.08	0.00	4.00	0.11	4
	Max	6.55	5.19	0.30	2.21	88.50	13.88	8.25	2500.00	2500.00	25.29	12.56	30.02	12.68	9
NL	Mean	1.11	0.32	-0.02	0.97	31.06	0.20	4.62	532.09	615.75	8.06	2.98	11.04	5.99	7.23
	SD	0.78	0.13	0.11	0.31	11.97	0.50	1.54	254.57	277.40	4.22	2.16	3.61	2.24	1.08
	Min	0.04	0.02	-0.41	0.17	15.00	0.01	1.25	36.00	36.00	0.78	0.00	5.00	0.76	6
	Max	6.41	0.69	0.30	2.21	88.50	6.89	7.50	1000.00	1000.00	19.97	9.14	20.01	13.92	9
PT	Mean	2.09	2.45	-0.01	0.79	25.75	0.91	4.45	334.57	334.75	3.70	1.30	5.00	3.41	6
	SD	1.19	0.89	0.09	0.14	4.63	2.03	1.01	145.80	145.59	1.37	0.87	0.82	1.14	0
	Min	0.29	1.51	-0.25	0.49	17.75	0.02	3.00	45.00	45.00	0.63	0.00	3.00	0.78	6
	Max	4.94	5.31	0.11	1.17	35.00	7.79	6.85	500.00	500.00	6.38	3.28	6.51	5.70	6
SP	Mean	1.89	1.73	-0.02	0.90	30.34	0.07	4.60	474.31	562.45	9.31	3.07	12.38	5.61	6.97
	SD	1.29	1.15	0.10	0.32	12.42	0.19	1.18	272.47	354.07	7.52	2.67	7.88	2.43	0.31
	Min	0.13	0.00	-0.41	0.16	11.88	0.01	2.50	13.00	13.00	0.58	0.00	3.00	0.77	4
	Max	5.59	5.55	0.30	2.21	88.50	2.83	7.80	785.10	1000.00	29.89	10.76	30.02	10.83	7

Notes: Sample period: 2002M1-2015M12. No. of bonds = 434; No. of firms = 118, No. of industry sectors = 9. Sample countries include France (FR), Netherlands (NL), Italy (IT), Spain (SP) and Portugal (PT). The Standard and Poor's issuer ratings have been converted to numerical values where 13 represents the highest rating AA and 1 the lowest rating B+ in the sample.

Table 1c. Cross correlations

	Corporate bond spread (%)	Govt yld spread to DE (EUR) (%)	EUR_USD DE Gvt yld spread (%)	Average of DE Corp bond spreads (%)	3-month Delta 25 volatility (%)	Expected Default Frequency (%)	Coupon (%)	Amount outstanding (mln. euros)	Amount issued (mln. euros)	Term to maturity (yrs.)	Age (yrs.)	Maturity at issue (yrs.)	Duration (yrs.)	S&P rating
Corporate bond spread (%)	1													
Govt yld spread to DE (EUR) (%)	0.4361	1												
EUR_USD DE Gvt yld spread (%)	-0.0467	-0.0743	1											
Average of DE Corp bond spreads (%)	0.4161	0.3893	-0.1145	1										
3-month Delta 25 volatility (%)	0.3474	0.0727	0.0162	0.4666	1									
Expected Default Frequency (%)	0.4424	0.1217	-0.0245	0.1193	0.0514	1								
Coupon (%)	0.3586	0.0713	0.0084	0.0886	0.1791	0.1199	1							
Amount outstanding (mln. euros)	-0.1387	0.1009	-0.0012	0.0308	0.0628	-0.0626	0.042	1						
Amount issued (mln. euros)	-0.1072	0.1369	-0.0016	0.0336	0.0767	-0.0477	0.0834	0.9379	1					
Term to maturity (yrs.)	0.1591	-0.1079	0.002	-0.0577	0.106	-0.0541	0.1773	0.074	0.0161	1				
Age (yrs.)	-0.0977	0.0034	0.0166	-0.065	-0.0703	0.0019	0.3384	0.0931	0.1244	-0.1361	1			
Maturity at issue (yrs.)	0.0987	-0.0989	0.0103	-0.0869	0.0632	-0.0495	0.3375	0.1164	0.0783	0.8637	0.3818	1		
Duration (yrs.)	0.1324	-0.1002	0.0015	-0.0371	0.0936	-0.0657	0.0511	0.0554	-0.0091	0.963	-0.2214	0.7858	1	
S&P rating	-0.4257	-0.1462	-0.0052	0.0251	0.0101	-0.4282	-0.1816	0.2426	0.1743	0.1595	0.0161	0.157	0.1882	1

Notes: Sample period: 2002M1-2015M12. No. of bonds = 434; No. of firms = 118, No. of industry sectors = 9. Sample countries include France (FR), Netherlands (NL), Italy (IT), Spain (SP) and Portugal (PT). The Standard and Poor's issuer ratings have been converted to numerical values where 13 represents the highest rating AA and 1 the lowest rating B+ in the sample.

Table 2. Explaining the corporate bond spread ('hard' versus 'soft' euro area countries) – all grades

VARIABLES	FR and NL ('hard' euro countries)				IT, PT and SP ('soft' euro countries)			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Ln[1+Govt yld spread to DE (EUR)]	0.835**	0.228	0.488	0.506	0.625***	0.485***	0.543***	0.546***
	(0.034)	(0.075)	(0.090)	(0.091)	(0.009)	(0.010)	(0.012)	(0.019)
Ln(1+EDF)	0.57	0.562	0.688	0.721	0.246***	0.249***	0.254***	0.254***
	(0.175)	(0.172)	(0.266)	(0.240)	(0.013)	(0.018)	(0.015)	(0.017)
Ln(1+Coupon)	0.116*	0.0962	0.0757**	0.0765**	0.0255	0.0081	-0.00177	-0.00208
	(0.018)	(0.018)	(0.006)	(0.005)	(0.029)	(0.024)	(0.018)	(0.020)
[Ln(Amount outst.)]/1000	-0.712	-0.785	-0.856*	-0.846*	0.319	0.198	0.0618	0.0513
	(0.160)	(0.133)	(0.132)	(0.132)	(0.189)	(0.155)	(0.091)	(0.085)
[Ln(Duration)]/1000	5.039***	4.937***	4.738***	4.734***	5.030**	4.829**	4.573***	4.577***
	(0.060)	(0.026)	(0.017)	(0.010)	(0.602)	(0.528)	(0.411)	(0.397)
[Ln(Age)]/1000	-0.458	-0.29	-0.143	-0.149	0.0192	-0.0244	-0.0342	-0.0187
	(0.272)	(0.295)	(0.181)	(0.183)	(0.226)	(0.202)	(0.173)	(0.161)
Ln(1+Average of DE Corp bond spreads)		0.689*	0.208	0.174		0.679**	0.307***	0.276**
		(0.077)	(0.104)	(0.111)		(0.127)	(0.027)	(0.044)
Ln(1+3-month Delta 25 volatility)			0.0238	0.0236			0.0183	0.0183
			(0.005)	(0.005)			(0.008)	(0.008)
EUR_USD DE Gvt yld spread				-0.000293				-0.000137
				(0.000)				(0.001)
Observations	13,855	13,847	13,835	12,907	4,591	4,584	4,581	4,254
R-squared	0.687	0.707	0.740	0.740	0.837	0.855	0.866	0.868

Notes: The dependent variable is ln(1 + corporate bond spread) which is defined as the spread that must be added to the benchmark euro zero coupon swap curve so that a security's discounted cashflows equal its mid price, with each dated cashflow discounted at its own interpolated rate. The Govt yld spread is the difference between the country-specific 10-year government bond yield and the 10-year Germany government bond yield (as an indicator of sovereign default risk). The 3-month Delta 25 volatility is the EUR currency option implied volatility (as an indicator of crash risk). The EUR_USD DE Gvt yld spread is the difference between Germany's 10-year government bond yield denominated in EUR and Germany's 10-year government bond yield denominated in USD (as an indicator of redenomination risk). The Average of DE Corp bond spreads represents a time-series average of all corporate bond spreads for Germany (calculated in

the same way as the dependent variable). The variables amount outstanding, duration, age and rating have been rescaled by dividing by 1000 due to small coefficient and standard errors. magnitudes. All models are estimated by OLS regression with a constant which is not reported, firm fixed effects and robust standard errors clustered at country level in parentheses. Sample countries include FR, NL, IT, SP and PT (GR and IE drop out). Sample period: 2002M1-2015M12. *** p<0.01, ** p<0.05, * p<0.1.

Table 3. Explaining the corporate bond spread ('hard' versus 'soft' euro area countries) – investment grade only

VARIABLES	FR and NL ('hard' euro countries)				IT, PT and SP ('soft' euro countries)			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Ln[1+Govt yld spread to DE (EUR)]	0.824**	0.21	0.474	0.49	0.587***	0.453***	0.516***	0.521***
	(0.048)	(0.096)	(0.097)	(0.098)	(0.023)	(0.004)	(0.026)	(0.034)
Ln(1+EDF)	0.429	0.415	0.578	0.628	0.334***	0.401***	0.408***	0.379***
	(0.167)	(0.157)	(0.351)	(0.358)	(0.033)	(0.021)	(0.015)	(0.021)
Ln(1+Coupon)	0.125**	0.107**	0.0835***	0.0840**	0.101*	0.0858**	0.0756**	0.0738**
	(0.008)	(0.008)	(0.001)	(0.002)	(0.024)	(0.017)	(0.009)	(0.012)
[Ln(Amount outst.)]/1000	-0.621	-0.695*	-0.791*	-0.782*	0.292	0.157	0.015	-0.000884
	(0.112)	(0.095)	(0.078)	(0.075)	(0.536)	(0.474)	(0.375)	(0.382)
[Ln(Duration)]/1000	4.857***	4.772***	4.561**	4.548**	4.618**	4.437**	4.218**	4.174**
	(0.045)	(0.004)	(0.077)	(0.079)	(1.029)	(0.930)	(0.775)	(0.748)
[Ln(Age)]/1000	-0.657	-0.504	-0.321	-0.326	-0.157	-0.2	-0.212	-0.21
	(0.224)	(0.229)	(0.128)	(0.126)	(0.369)	(0.335)	(0.291)	(0.271)
Ln(1+Average of DE Corp bond spreads)		0.688*	0.18	0.141		0.657*	0.251**	0.220*
		(0.085)	(0.066)	(0.066)		(0.173)	(0.033)	(0.056)
Ln(1+3-month Delta 25 volatility)			0.0250*	0.0249*			0.02	0.0199
			(0.004)	(0.004)			(0.011)	(0.011)
EUR_USD DE Gvt yld spread				-0.000632				-0.000531
				(0.000)				(0.001)
Observations	11,370	11,362	11,350	10,579	3,083	3,079	3,076	2,855
R-squared	0.654	0.682	0.728	0.728	0.756	0.786	0.809	0.811

See notes to Table 2.