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Redenomination risk in eurozone corporate bond spreads

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ABSTRACT

We investigate the risk spillover from euro area government bond spreads (relative to a safe German government bond of similar maturity) to nonfinancial corporate bonds in France, the Netherlands ('hard' euro-area countries), and Italy, Portugal and Spain ('soft' euro-area countries). In addition to standard firm- and bond-specific determinants of corporate bonds (capturing liquidity and tax effects, and other euro area macroeconomic risks), we show that there is significant risk transfer from government bonds to the nonfinancial corporate sector. After decomposing the government bond spread into a default risk and a currency redenomination risk component, associated with a possible split in the euro, we find that redenomination risk has been a significant factor in the pricing of corporate bonds, particularly in the 'soft' euro-area countries.

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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, Mizen, and Veleanu 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 (Durbin and Ng 2005; Peter and Grandes 2005; Borensztein, Cowan, and Valenzuela 2013). 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 always been perceived as carrying negligible default risk, but corporate bonds have been viewed as subject to significant default risk, particularly in bad times. The onset of the European sovereign debt crisis has brought to the forefront the importance of credit risk not only for the private but also for the public sector, and interest has shifted more towards the relation between sovereign and corporate credit risk in developed economies. In this paper, we show that there are significant interlinkages between sovereign and corporate bonds, as in the case of emerging markets, and in contrast to the case of the United States. We further decompose the government spread into a component attributed to currency redenomination risk (based on the methodology proposed by De Santis (2019) using sovereign quanto-CDS spreads to Germany) and a residual component capturing default and other risks and show that particularly for the weaker European economies the spillover of sovereign risk to corporate bonds is driven mainly by the redenomination risk component.

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

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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, even though there is no default in the sense that the holders get what was promised. This possibility is usually referred to as 'redenomination risk' (the risk that a euro asset will be redenominated into a devalued legacy currency after a partial or total euro breakup). This redenomination risk should apply equally to sovereign and corporate debt issued in the same country. In their study of sovereign spreads in the euro area, Krishnamurthy, Nigel, and Vissing-Jorgensen (2018) use this argument as a justification for treating the spread relative to German government bonds on relatively safe corporate debt issued in other countries 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; De Santis 2019). 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 Krishnamurthy, Nigel, and Vissing-Jorgensen (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, Izquierdo, and Meija 2004; Frankel 2005; de Grauwe and Ji 2013). 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 firm- and bond-specific factors that have been shown to be important in other countries (Gilchrist and Zakrajšek 2012; Bleaney, Mizen, and Veleanu 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, results are presented in Section Five, and conclusions are drawn in Section Six.

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, Goldstein, and Martin (2001), Driessen (2005), King and Khang (2005), Bharath and Shumway (2008) and Gilchrist and Zakrajšek (2012) confirm this for US bonds, as do Bleaney, Mizen, and Veleanu (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, Mentink, and Vorst 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, 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, Mizen, and Veleanu (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 in the U.S. and Europe, respectively.

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, Izquierdo, and Meija 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.[1] Klingen, Weder, and Zettelmeyer (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 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, Giordano, and Schmitz 2018). 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 euros, due to doubts over 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.

Sovereign risk may spill over to corporate bond issuers through two main channels: first, a fiscal channel whereby increased sovereign risk may force a government to take fiscal actions that affect corporations by increasing taxation, reducing subsidies, or lowering the value of implicit and explicit government guarantees (Acharya, Drechsler, and Schnabl 2014); and second, a financial channel, whereby increased sovereign risk worsens the health of the domestic financial sector (Gennaioli, Martin, and Rossi 2014; Becker and Ivashina 2018), which in turn is passed on to nonfinancial corporations via less favourable bank lending conditions or contracting loan supply.

Our paper fits closely within the literature investigating the market effects of sovereign risk in the euro zone, which is limited to only a few papers. Bedendo and Colla (2015) use changes in weekly credit default swaps (CDSs) to investigate the effect of variations in sovereign risk on corporate credit in eight Eurozone countries and 118 companies over the period January 2008 to December 2011. They conclude that a 10% increase in sovereign CDS spreads is associated with a 0.5% increase in corporate credit spreads. Augustin et al. (2018) use CDS to capture daily changes in credit risk on a sample of 226 firms across 15 European countries (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom) between 15 February and 25 June 2010 to investigate the credit risk

transmission between sovereigns and firm by exploiting the announcement of the first Greek bailout on 11 April 2010. Their results support the existence of a risk transfer from sovereigns to the corporate sector, namely, a 1% increase in sovereign credit risk over the sample period is associated with a 0.11% increase in corporate credit risk. In terms of risk transmission channels, they find evidence in favour of a fiscal channel (namely, public ownership and state-dependence) and a financial channel (banking sector's exposure to the domestic government, and a firm's bank dependence), and find no evidence that risk may be transmitted indirectly through a deterioration of macroeconomic fundamentals. De Santis (2019) proposes sovereign quanto-CDS spreads relative to Germany to measure currency redenomination risk in the euro area to explain the dynamics of daily sovereign yield spreads in single country VARs over 2011–2013. He finds that at the peak of the crisis, redenomination risk accounted for 0.2, 0.4, and 0.5 percentage points of French, Italian, and Spanish sovereign yield spreads, respectively. Krishnamurthy, Nigel, and Vissing-Jorgensen (2018) use an event study approach to analyse the effect of ECB policies on sovereign bond yields from 2010 to 2012. They measure redenomination risk as the difference between corporate bond yields and CDS rates, and USD-denominated sovereign bond yields to capture default risk. They conclude that the default risk premium and sovereign bond segmentation effects are the dominant channels through which ECB policies affected sovereign bond yields.

Our paper complements the above literature in that we find a statistically significant impact of sovereign risk on nonfinancial corporate bonds in the euro area outside Germany, after controlling for various bond- and firm-specific characteristics and other macroeconomic risks in the pricing of corporate bonds (e.g. King and Khang 2005; Bleaney, Mizen, and Veleanu 2016). By decomposing sovereign risk into a default and redenomination risk component, we show that redenomination risk appears to be the dominant driver behind the transfer of sovereign risk to corporate credit risk, particularly for the 'soft' euro-area countries (e.g. Italy, Spain and Portugal).

3. Data

We collect end-of-the-month spread information on all outstanding non-financial senior unsecured corporate bonds, (i.e. not subordinate to other bonds), with a remaining maturity of at least one year, for a set of five Euro-area countries (France, 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,[2] and the sample period was driven by data availability. The corporate bond spread 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 from Bloomberg, which is equivalent to Gilchrist and Zakrajšek's (2012) and Bleaney, Mizen, and Veleanu's (2016) bottom-up approach of constructing the spread from individual bond-level data. Our selection criteria remove bonds that are illiquid or have non-standard 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).[3] We used the Moody's-specific 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.[4]

Figure 1 shows the evolution of the corporate bond spread in the five individual euro area countries marked by three significant macroeconomic events captured by our sample period, namely, the Global Financial Crisis in September 2008, the first Greek austerity package in May 2010, and the introduction of the ECB's Outright

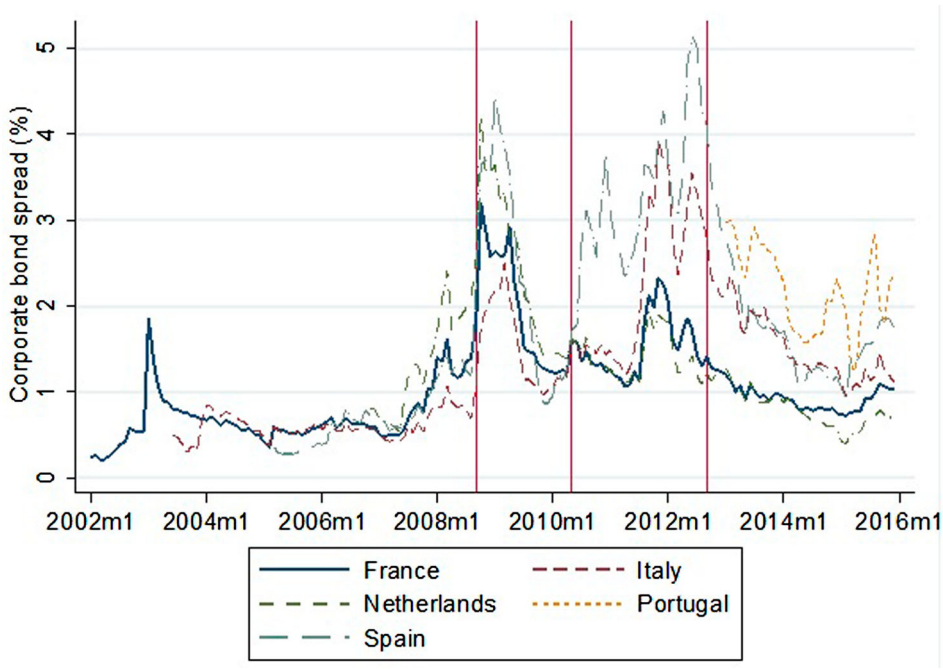

Figure 1. The corporate bond spread – all grades (by country).

Monetary Transactions Program in September 2012 (following Mario Draghi's 'whatever it takes' speech on redenomination risk on 26 July 2012 in London). The correlation across the sample countries is remarkably high, especially up to the financial crisis of 2007–2009. Following 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 peak 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 10-year euro-denominated government bond spread of each of the sampled countries relative to Germany. Here too there is a sharp contrast between the 'soft' and 'hard' euro countries, with Italy, Portugal and Spain reaching a spread of over 5% at the peak of the sovereign debt crisis while Netherlands and France remain below 1.5%. This figure is suggestive of the fact that the market appeared to have assigned much lower sovereign risk to France and Netherlands, which is what we will examine in the next sections for the 'soft' and 'hard' euro countries separately.

Figures 3 and 4 depict the quanto CDS spread to Germany and the redenomination risk component (the estimation of which will be explained in section 6.2) and exhibit similar trends. It is evident in both figures that redenomination risk associated with a possible split in the euro currency was non-existent before 2010 and emerges in the early months of that year in the context of increase market anxiety about excessive national debt burdens after which we see a clear divergence between the 'soft' and 'hard' euro countries which remains until the end of the sample. We can also note that redenomination risk for Spain and Italy peaks at the height of the sovereign debt crisis in the summer of 2012.

Table 1 reports data on bond characteristics in aggregate across all the countries in our sample, and Table 2 reports the breakdown by country. There are 20,478 bond-month observations in our data sample. The mean firm in our sample has between eight and nine senior unsecured issues outstanding in any given month, with a maximum of 19 issues from a single firm trading in the secondary market at any point in time. On average

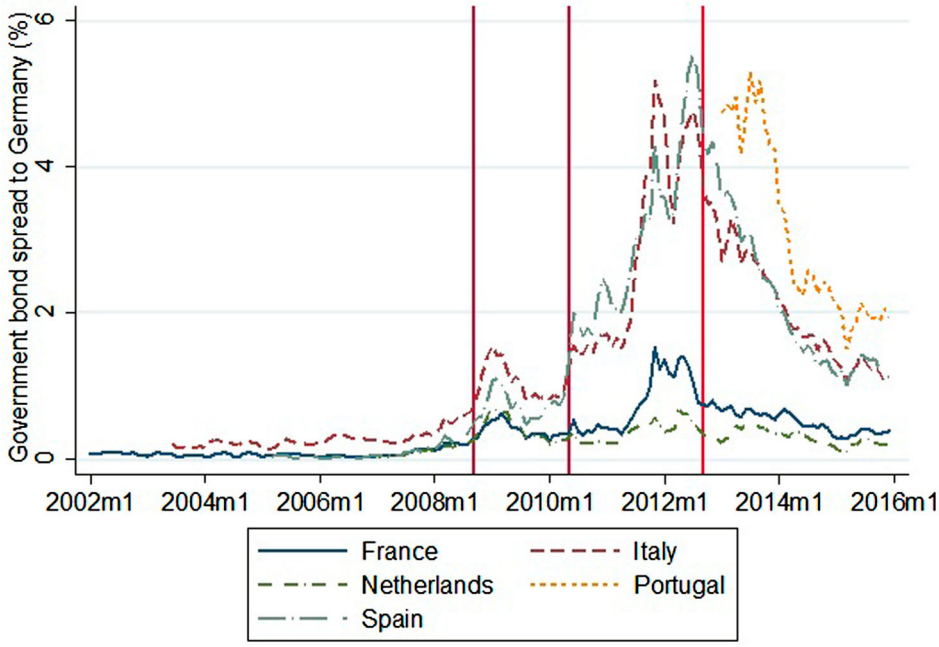

Figure 2. The government bond spread relative to Germany – all grades (GOVT SPRD by country).

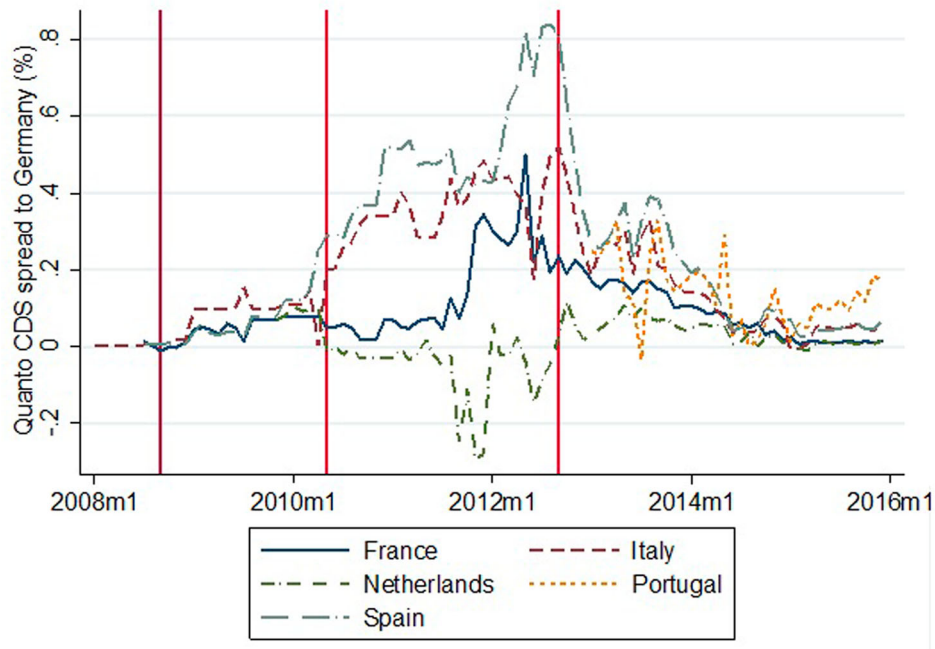

Figure 3. The quanto spread to Germany by country.

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 bid-ask spread in the sample is 0.01% with an equal standard deviation and a maximum of 0.67%. The average comparable corporate bond spread in Germany is 0.94% with a considerably lower standard deviation of 0.3% and a

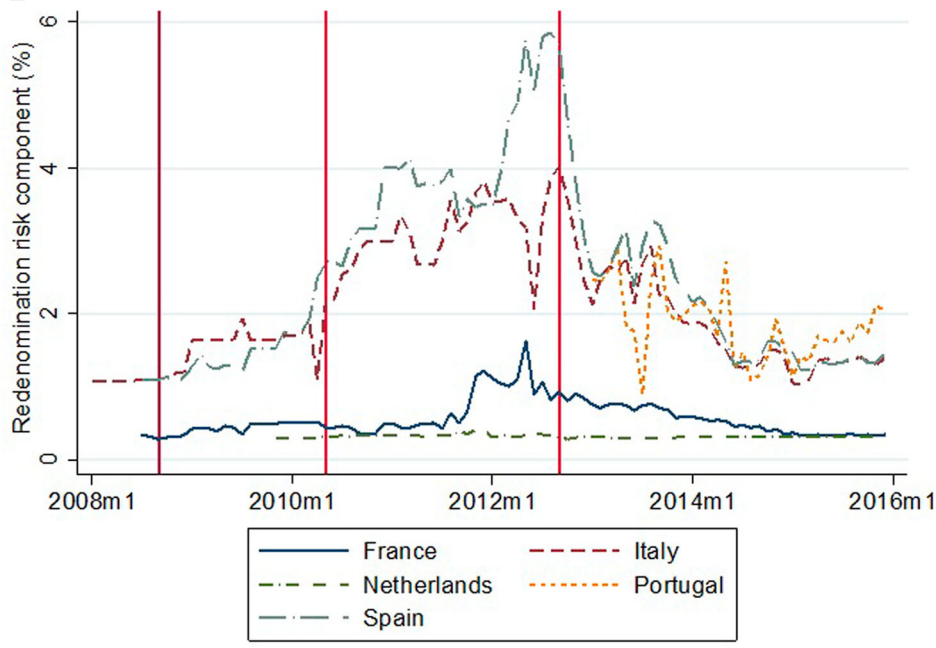

Figure 4. The redenomination risk component by country.

Table 1. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Corporate bond sprd (%)	20,478	1.23	1.00	0.03	6.70
Govt yld sprd to DE (%)	20,478	0.85	0.83	0.00	5.55
EUR_USD DE Govt yld sprd (%)	18,674	−0.02	0.11	−0.41	0.30
Average of DE Corp yld sprd (%)	20,450	0.94	0.32	0.03	2.21
Bid-Ask sprd (%)	19,121	0.01	0.01	0.00	0.67
No. of bonds per firm	20,478	8.27	4.84	1	19
Expected Default Frequency (%)	19,073	0.22	0.54	0.01	13.88
Coupon (%)	20,478	4.46	1.30	0.88	8.5
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	7.34	4.87	0.08	30.01
Age (yrs.)	20,478	2.96	2.44	0	14.19
Maturity at issue (yrs.)	20,478	10.3	5.21	3	30.02
Duration (yrs.)	19,855	5.69	2.71	0.07	17.43

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).

maximum of 2.2%. The average coupon rate in the sample is 4.5% with a maximum of 8.5%. 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. Finally, in terms of S&P credit ratings, our sample spans almost the entire spectrum of bond quality from financially vulnerable firms rated B+ to secure firms rated AA.

A notable feature of Table 2 is that the market appears to have assigned much lower sovereign risk to France and the Netherlands than to the other countries, judging by their much lower and less volatile government

Table 2. Descriptive statistics (by country).

Country	Statistic	Corporate bond sprd (%)	Govt yld sprd to DE (%)	EUR_USD DE Govt yld sprd (%)	Average of DE Corp bond sprd (%)	Bid-ask sprd (%)	No. of bonds per firm	Expected Default Frequency (%)	Coupon (%)	Amount outstanding (mln. euros)	Amount issued (mln. euros)	Term to maturity (yrs.)	Age (yrs.)	Maturity at issue (yrs.)	Duration (yrs.)
France	N	14,033	14,033	12,808	14,012	12,985	14,033	12,789	14,033	14,033	14,033	14,033	14,033	14,033	13,730
	Mean	1.110	0.540	−0.021	0.942	0.006	8.643	0.198	4.365	622.995	673.797	7.228	2.923	10.151	5.720
	Std. Dev.	0.932	0.289	0.106	0.319	0.005	5.197	0.386	1.340	424.146	429.396	4.860	2.364	5.125	2.809
	Min	0.030	0.020	−0.410	0.033	0.000	1	0.01	1	10.000	10	0.088	0	3.671	0.074
	Max	6.700	1.540	0.302	2.213	0.395	19.000	12.927	9	2500	2500	30.014	14.192	30.022	17.434
Italy	N	4,191	4,191	3,802	4,184	4,063	4,191	4,085	4,191	4,191	4,191	4,191	4,191	4,191	4,069
	Mean	1.547	1.890	−0.020	0.908	0.006	7.933	0.314	4.675	709.560	809.521	7.260	3.115	10.375	5.547
	Std. Dev.	1.121	1.088	0.104	0.317	0.004	3.961	0.798	1.059	425.171	453.242	4.494	2.729	5.324	2.547
	Min	0.043	0.137	−0.410	0.033	0.000	1	0.01	1	6.078	6.078	0.077	0	4.003	0.115
	Max	6.551	5.187	0.302	2.213	0.047	14.000	13.879	8	2500	2500	25.288	12.562	30.022	12.679
Netherlands	N	1,476	1,476	1,351	1,476	1,354	1,476	1,451	1,476	1,476	1,476	1,476	1,476	1,476	1,398
	Mean	1.110	0.317	−0.021	0.975	0.010	6.089	0.203	4.624	532.090	615.748	8.060	2.983	11.043	5.988
	Std. Dev.	0.785	0.130	0.108	0.308	0.042	3.092	0.505	1.535	254.566	277.398	4.224	2.155	3.607	2.241
	Min	0.042	0.024	−0.410	0.170	0.000	1	0.01	1	36.000	36	0.778	0	5.003	0.762
	Max	6.408	0.693	0.302	2.213	0.670	10.000	6.891	8	1000	1000	19.973	9.137	20.014	13.916
Portugal	N	119	119	108	119	109	119	114	119	119	119	119	119	119	115
	Mean	2.088	2.446	−0.011	0.791	0.008	2.118	0.911	4.445	334.573	334.748	3.696	1.302	4.998	3.408
	Std. Dev.	1.194	0.889	0.089	0.138	0.004	0.415	2.034	1.011	145.799	145.593	1.372	0.871	0.815	1.140
	Min	0.289	1.512	−0.246	0.490	0.004	1	0.02	3	45.000	45	0.633	0	3.000	0.784
	Max	4.935	5.309	0.111	1.167	0.028	3.000	7.788	7	500	500	6.384	3.277	6.510	5.705
Spain	N	659	659	605	659	610	659	634	659	659	659	659	659	659	543
	Mean	1.892	1.732	−0.016	0.898	0.008	8.402	0.073	4.603	474.312	562.451	9.307	3.073	12.380	5.609
	Std. Dev.	1.290	1.151	0.105	0.320	0.006	3.309	0.186	1.179	272.470	354.065	7.516	2.665	7.878	2.434
	Min	0.125	0.004	−0.410	0.157	0.001	1	0.01	3	13.000	13	0.584	0	3.003	0.772
	Max	5.587	5.554	0.302	2.213	0.041	10.000	2.827	8	785	1000	29.890	10.762	30.019	10.829

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).

Table 3. Cross correlations.

	Corporate bond sprd (%)	Govt yld sprd to DE (%)	EUR_USD DE Govt yld sprd (%)	Average of DE Corp bond sprd (%)	Bid-ask sprd (%)	Expected Default Frequency (%)	Coupon (%)	Amount outstanding (mln. euros)	Amount issued (mln. euros)	Term to maturity (yrs.)	Age (yrs.)	Maturity at issue (yrs.)	Duration (yrs.)
Corporate bond sprd (%)	1												
Govt yld sprd to DE (%)	0.418	1											
EUR_USD DE Govt yld sprd (%)	−0.040	−0.074	1										
Average of DE Corp bond sprd (%)	0.356	0.390	−0.115	1									
Bid-ask sprd (%)	0.136	0.075	−0.005	0.104	1								
Expected Default Frequency (%)	0.374	0.117	−0.015	0.073	0.048	1							
Coupon (%)	0.320	0.089	0.004	0.086	0.108	0.130	1						
Amount outstanding (mln. euros)	−0.201	0.084	−0.008	0.068	−0.032	−0.088	0.078	1					
Amount issued (mln. euros)	−0.176	0.114	−0.009	0.076	−0.050	−0.083	0.132	0.937	1				
Term to maturity (yrs.)	0.106	−0.111	0.000	−0.052	0.044	−0.038	0.167	0.106	0.052	1			
Age (yrs.)	−0.134	−0.001	0.013	−0.046	0.030	−0.023	0.356	0.117	0.155	−0.131	1		
Maturity at issue (yrs.)	0.030	−0.103	0.007	−0.072	0.056	−0.047	0.338	0.159	0.128	0.861	0.392	1	
Duration (yrs.)	0.081	−0.107	0.001	−0.029	0.049	−0.057	0.038	0.083	0.022	0.963	−0.214	0.784	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).

spreads. We shall examine these two 'hard euro' countries separately from the 'soft euro' countries (Italy, Portugal and Spain).

Table 3 presents the cross-correlations across all sampled countries. We can note that the corporate bond spread is positively correlated with the following variables: the government bond spread relative to Germany, the average German comparable corporate bond spread and the expected default frequency, which is in line with our hypothesis that corporate default risk is positively associated with government default risk.

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 and a set of baseline explanatory variables to allow for liquidity and tax premiums, captured in V_{itk}, as per King and Khang (2005), Gilchrist and Zakrajšek (2012), and Bleaney, Mizen, and Veleanu (2016). We also include the government bond spread relative to Germany, $GOVTSPRD_{it}$, which reflects both currency risk and sovereign default risk. The model is as follows:

$$\ln(1 + S_{itk}) = a + b * \ln(1 + GOVTSPRD_{it}) + c * \ln(V_{itk}) + e_{itk} \quad (1)$$

The government spread, $GOVTSPRD_{it}$, is defined as the difference between the 10-year country-specific government bond yield and the 10-year German government bond yield. This variable will capture both sovereign default and currency redenomination risk and other risk premium associated with maturity and liquidity. 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 government bond spreads and corporate bond spreads, as in emerging markets and as documented by the literature so far (c.f. Durbin and Ng 2005; Borensztein, Cowan, and Valenzuela 2013; Bedendo and Colla 2015; Augustin et al. 2018).

The vector of bond-specific characteristics, V_{itk}, includes[5]: Expected Default Frequency (EDF), Macaulay duration, the amount outstanding, the fixed coupon rate, the age of the bond issue, and the bid-ask spread. The EDF 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 and the bond spread as a higher default risk probability will attract a higher spread in compensation for the increased risk of default.

The Macaulay duration 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 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 coefficient. We consider only bonds with a fixed coupon schedule. The amount of debt outstanding 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 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 bid-ask spread is included as a measure of liquidity in the bond market to mitigate endogeneity concerns that higher credit risk may be driven by a shortage of liquidity in the market and vice versa.[6]

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

$$\ln(1 + S_{itk}) = a + b * \ln(1 + GOVTSPRD_{it}) + c * \ln(V_{itk}) + d * \ln(Z_{it}) + e_{1itk} \quad (2)$$

The vector, Z_{it}, includes two additional variables. First, the *EUR_USD DE Govt yld sprd* which is defined as the difference between Euro-denominated and USD-denominated German government bonds and it reflects the perceived risk of denomination in hard euros relative to the dollar. According to interest parity, this variable should mostly capture an interest rate differential, and is included in levels. Furthermore, 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, the currency risk between the two countries could go in either direction. Second, the *Average of DE Corp bond sprd* is defined as the average of all German corporate bond spreads from Bloomberg and is constructed similarly to the corporate bond spread. This variable captures the average default risk in German non-financial corporates, and we expect a positive coefficient. These controls are added sequentially to our baseline model.

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

5. Results

5.1. Main results

We estimate the model of corporate bond spreads for two separate groups of countries – the countries where there is little perceived sovereign default and currency risk as per Figure 2 (France and the Netherlands), and the 'soft' euro countries comprising Italy, Portugal and Spain. The results are presented in Table 4 for bonds of all credit quality grades. Models 1–3 are alternative specifications for France; Models 4–6 are the same specifications applied to the Netherlands, and Models 7–9 are again the same specifications for the three 'soft' euro countries (which are pooled together because the sample for individual countries is relatively small). We separate the Netherlands from France despite its relatively small sample (1233 compared with 11,233, respectively), because the results are rather different.

Models 1, 4 and 7 of Table 4 contain all the bond-specific variables plus the government spread relative to Germany. In Model 1 (France), the government spread is highly significant ($p < 0.001$) and indicates an elasticity of corporate spreads of 0.737. For the Netherlands the corresponding estimate (Model 4) is 1.256; this is still significant at the 5% level, but the confidence interval is very wide since the standard error is 0.474. For Italy, Portugal and Spain the estimated coefficient in Model 7 is 0.557 and again has a p-value of less than 0.001. In terms of explanatory variables, the EDF, duration, coupon and the bid-ask spread are statistically significant and of the expected positive signs.

It is possible that the effects of the sovereign spread in Models 1, 4 and 7 are in fact partly related to euro-wide corporate credit default risk, with which sovereign spreads happen to be correlated because both spike during the sovereign debt crisis period. Accordingly, in Models 2, 5 and 8 we include the average corporate bond spread in Germany, as a measure of euro-wide corporate credit default risk. For France the coefficient is positive and highly significant, and its inclusion greatly reduces the government spread coefficient to an insignificant 0.149 (Model 2). For the Netherlands (Model 5), German corporate bond spreads have the expected positive coefficient, but it is not statistically significant. Nevertheless, the inclusion of this variable again reduces the government yield spread, from 1.149 to 0.838, which is now insignificant since its standard error is now as high as 0.684. For Portugal, Italy and Spain (Model 8), German corporate bond spreads have a coefficient that is highly significant, and inclusion of this variable also reduces the government yield spread coefficient somewhat (albeit not as significantly as for France) to 0.428 in Model 8 compared with 0.557 in Model 7.

Models 3, 6 and 9 add the yield differential between German euro- and US dollar-denominated government bonds, but this variable does not enter significantly, and its inclusion does not materially impact the government yield spread coefficient, so we do not discuss these models any further.

Table 4. Explaining the corporate bond spread ('hard' versus 'soft' euro area countries) – all grades.

	All grades								
	France			Netherlands			IT, PT and SP		
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Ln[1 + Govt yld sprd to DE]	0.737***	0.149	0.175	1.256**	0.838	0.842	0.557***	0.428***	0.427***
	(0.137)	(0.163)	(0.161)	(0.474)	(0.684)	(0.684)	(0.017)	(0.024)	(0.019)
Ln(1 + EDF)	0.695***	0.686***	0.824***	0.175**	0.179**	0.188**	0.250***	0.253***	0.258***
	(0.219)	(0.200)	(0.179)	(0.050)	(0.052)	(0.065)	(0.012)	(0.014)	(0.017)
Ln(1 + Coupon)	0.0817***	0.0665***	0.0705***	0.170*	0.161*	0.159*	0.0281	0.0117	0.0142
	(0.021)	(0.024)	(0.024)	(0.079)	(0.079)	(0.079)	(0.031)	(0.027)	(0.028)
[Ln(Amount outst.)]/1000	−0.252	−0.366*	−0.360**	−1.954	−1.895	−1.889	0.332	0.219	0.212
	(0.213)	(0.187)	(0.178)	(1.746)	(1.734)	(1.694)	(0.417)	(0.396)	(0.404)
[Ln(Duration)]/1000	4.860***	4.811***	4.771***	5.630**	5.511***	5.499***	4.292***	4.152***	4.142***
	(0.506)	(0.492)	(0.495)	(1.426)	(1.363)	(1.337)	(0.390)	(0.405)	(0.416)
[Ln(Age)]/1000	−0.286	−0.132	−0.17	−1.441*	−1.410*	−1.38	−0.251	−0.284	−0.3
	(0.203)	(0.203)	(0.196)	(0.643)	(0.694)	(0.705)	(0.185)	(0.189)	(0.192)
$Ln(1 + \text{Bid-Ask Spread})_{t-1}$	0.160*	0.149*	0.148*	−0.0142**	−0.0134**	−0.0135**	0.327*	0.303**	0.303**
	(0.087)	(0.082)	(0.083)	(0.004)	(0.004)	(0.004)	(0.096)	(0.062)	(0.054)
Ln(1 + Average of DE Corp yld sprd)		0.681***	0.618***		0.238	0.187		0.643**	0.616**
		(0.138)	(0.133)		(0.210)	(0.210)		(0.105)	(0.081)
EUR_USD DE Govt yld sprd			−0.000078			0.0011			−0.0001747
			(0.002)			(0.003)			(0.002)
Observations	11,223	11,215	10,458	1,233	1,233	1,149	4,349	4,344	4,036
R-squared	0.711	0.731	0.735	0.541	0.545	0.538	0.838	0.855	0.856
Firm FE	Y	y	Y	y	y	y	y	y	y

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 sprd to DE is the difference between the country-specific 10-year government bond yield and the 10-year Germany government bond yield, and is denominated in EUR. The EUR_USD DE Govt yld sprd 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. The Bid-Ask Spread is defined as (Ask Price – Bid Price)/Last Price, and we include the first lag of this variable's natural logarithm to mitigate any endogeneity concerns between credit risk and liquidity. The Average of DE Corp yld sprd represents a time-series average of all corporate bond spreads in Germany (calculated in the same way as the dependent variable). The variables amount outstanding, duration, and age have been rescaled by dividing by 1000 due to small magnitudes of coefficients and standard errors. All models are estimated by OLS regression with a constant which is not reported, firm fixed effects and cluster robust standard errors in parentheses clustered at firm (models 1–6) or country (models 7–9) and time dimensions. Sample countries include FR, NL, IT, SP and PT. Sample period: 2002M1–2015M12. $***p < 0.01, **p < 0.05, *p < 0.1$.

In Table 5 we restrict our sample to corporate bonds of investment grade quality only, to account for the possibility that our results may be unduly distorted by high-risk bonds, even though in this case they represent less than 10% of the sample. We present results only for France, and for Italy, Portugal and Spain, as there are no sub-investment grade bonds in our sample for the Netherlands. For France the sample is less than five percent smaller than in Table 4, but for Italy, Portugal and Spain this is reduced by about twenty percent. The coefficients are in line and follow the same pattern to those in Table 4.

Overall, our results suggest that corporate bond spreads in the Eurozone outside Germany are significantly correlated with government bond spreads, after controlling for other macroeconomic risks and bond- and firm-specific factors. The effect is less pronounced for the 'hard' Euro countries (where it enters significantly in one out of three specifications) compared to the 'soft' Euro countries.

5.2. Decomposition results

In this section, we disentangle sovereign default risk (DR, henceforth) and redenomination risk (RR, henceforth) within the government yield spread and shed light on an issue not previously known from other studies using corporate bond spreads, as to what extent these components have a statistically significant influence on the corporate bond spread. We measure redenomination risk based on the CDS quanto-yield spread (defined as the difference between USD- and EUR- denominated sovereign CDS spreads for each country) to Germany as per De Santis (2019). The residual obtained as the difference between the original government bond yield spread and this redenomination risk component is used as a proxy for sovereign default risk (and other risks such as term structure effects or liquidity risks associated with government bonds).[7] Krishnamurthy, Nigel, and Vissing-Jorgensen (2018) distinguish between DR (as measured by USD-denominated sovereign bond yields) and RR (as measured by the difference between corporate bond yields and CDS rates) in an event-study approach to analyse the effects of ECB policies on government bond yields. Our paper is, to our knowledge, the only paper that identifies the default and redenomination risk components separately to estimate their impact on non-financial corporate bond spreads in the Euro-area.

Thus, we regress the 10-year country-specific government spread to Germany on a measure of redenomination risk based on the observed sovereign quanto-CDS spread:[8]

$$\ln(1 + GOVT\ SPRD_{it}) = \alpha_i + \beta_i * \ln(1 + Quanto\ CDS\ spread_{it}) + \varepsilon_{it} \tag{3}$$

We estimate the above using OLS with firm FE with the standard errors double clustered at the firm and time dimensions, so that they are robust to both cross-sectional dependence and serial correlation to obtain the predicted spread, i.e. the redenomination risk component. The residual component (proxying default risk and other risks) is obtained from the linear decomposition for each bond k issued by firm j in country i at time t:

$$DR_{it} = GOVT\ SPRD_{it} - RR_{it} \tag{4}$$

We then break down this result into default risk and redenomination risk components of the government yield spread to explore which of these components has a statistically significant influence on the corporate bond spread.

We thus re-estimate our baseline specification augmented by controls to explain the corporate bond spread as follows. To mitigate generated regressor bias, we use bootstrapped standard errors in these estimations with fifty iterations:

$$\ln(1 + S_{itk}) = a_2 + b_2 * \ln(1 + DR_{it}) + c_2 * \ln(1 + RR_{it}) + d_2 * \ln(V_{itk}) + e_{2itk} \tag{5}$$

Table 6 presents the results of estimating Equation (5) for all grades of bonds. We concentrate on Models 2, 5 and 8 since German corporate bond spreads, which are highly significant for all countries, are not included in Models 1, 4 and 7, and in Models 3, 6 and 9 the spread between German euro-denominated and US$-denominated bonds is mostly statistically insignificant. In Model 2 of Table 6 (France), default risk is significant at the 1% level, with a coefficient of 0.680, but redenomination risk is not significant, with a coefficient of 0.054.

Table 5. Explaining the corporate bond spread ('hard' versus 'soft' euro area countries) – investment grade only.

	Investment Grade only								
	France			Netherlands			IT, PT and SP		
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Ln[1 + Govt yld sprd to DE]	0.715***	0.112	0.12	1.256**	0.838	0.842	0.514***	0.391***	0.396***
	(0.125)	(0.152)	(0.145)	(0.474)	(0.684)	(0.684)	(0.017)	(0.021)	(0.022)
Ln(1 + EDF)	0.578*	0.544**	0.788**	0.175**	0.179**	0.188**	0.306***	0.334***	0.322***
	(0.312)	(0.266)	(0.317)	(0.050)	(0.052)	(0.065)	(0.028)	(0.026)	(0.028)
Ln(1 + Coupon)	0.0930***	0.0785***	0.0795***	0.170*	0.161*	0.159*	0.103*	0.0876**	0.0857*
	(0.021)	(0.023)	(0.023)	(0.079)	(0.079)	(0.079)	(0.024)	(0.018)	(0.020)
[Ln(Amount outst.)]/1000	−0.229	−0.335*	−0.358*	−1.954	−1.895	−1.889	0.0437	−0.0642	−0.078
	(0.209)	(0.186)	(0.182)	(1.746)	(1.734)	(1.694)	(0.469)	(0.443)	(0.455)
[Ln(Duration)]/1000	4.846***	4.823***	4.724***	5.630**	5.511***	5.499***	3.653**	3.519**	3.505**
	(0.516)	(0.506)	(0.502)	(1.426)	(1.363)	(1.337)	(0.716)	(0.748)	(0.744)
[Ln(Age)]/1000	−0.455***	−0.315**	−0.322**	−1.441*	−1.410*	−1.38	−0.504	−0.541	−0.531
	(0.148)	(0.133)	(0.136)	(0.643)	(0.694)	(0.705)	(0.365)	(0.369)	(0.356)
$Ln(1 + \text{Bid-Ask Spread})_{t-1}$	0.119*	0.105*	0.107*	−0.0142**	−0.0134**	−0.0135**	0.325*	0.305**	0.302**
	(0.065)	(0.059)	(0.061)	(0.004)	(0.004)	(0.004)	(0.096)	(0.059)	(0.053)
Ln(1 + Average of DE Corp yld sprd)		0.699***	0.629***		0.238	0.187		0.620**	0.585**
		(0.141)	(0.132)		(0.210)	(0.210)		(0.133)	(0.103)
EUR_USD DE Govt yld sprd			−0.000407			0.0011			−0.000411
			(0.002)			(0.003)			(0.002)
Observations	10,530	10,522	9,805	1,233	1,233	1,149	3,386	3,383	3,151
R-squared	0.704	0.728	0.732	0.541	0.545	0.538	0.826	0.845	0.846
Firm FE	Y	y	y	y	y	Y	y	y	y

See Notes to Table 4.

Table 6. Explaining the corporate bond spread – default risk and redenomination risk, all grades.

	All Grades								
	France			Netherlands			IT, PT and SP		
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Ln[1 + DR]	1.235***	0.680***	0.719***	0.655***	−0.175	−0.225**	0.437***	0.375***	0.372***
	(0.070)	(0.055)	(0.070)	(0.067)	(0.111)	(0.112)	(0.013)	(0.015)	(0.010)
Ln[1 + RR]	0.459***	0.0537	0.0885*	5.432***	2.166***	2.040***	0.559***	0.447***	0.451***
	(0.049)	(0.043)	(0.050)	(0.543)	(0.559)	(0.627)	(0.013)	(0.019)	(0.016)
Ln(1 + EDF)	0.911***	0.884***	0.884***	0.232***	0.224***	0.238***	0.274***	0.274***	0.265***
	(0.038)	(0.034)	(0.039)	(0.021)	(0.026)	(0.027)	(0.020)	(0.016)	(0.027)
Ln(1 + Coupon)	0.100***	0.0761***	0.0772***	0.104***	0.0795***	0.0793***	0.0312***	0.0127	0.0126
	(0.005)	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.009)	(0.008)	(0.008)
[Ln(Amount outst.)]/1000	−0.163**	−0.326***	−0.320***	−1.847***	−1.766***	−1.780***	0.243*	0.178	0.153
	(0.082)	(0.077)	(0.097)	(0.255)	(0.204)	(0.207)	(0.125)	(0.161)	(0.129)
[Ln(Duration)]/1000	5.251***	5.057***	5.054***	5.376***	5.211***	5.194***	4.401***	4.144***	4.119***
	(0.263)	(0.251)	(0.248)	(0.281)	(0.253)	(0.269)	(0.205)	(0.189)	(0.230)
[Ln(Age)]/1000	−0.639***	−0.378***	−0.386***	−0.559***	−0.265*	−0.266*	−0.421***	−0.354***	−0.331***
	(0.091)	(0.077)	(0.073)	(0.128)	(0.136)	(0.139)	(0.103)	(0.103)	(0.096)
$\text{Ln}(1 + \text{Bid-Ask Spread})_{t-1}$	0.138	0.132*	0.132	−0.0114***	−0.00955***	−0.00941***	0.353***	0.325***	0.324***
	(0.093)	(0.078)	(0.084)	(0.002)	(0.002)	(0.001)	(0.029)	(0.029)	(0.028)
Ln(1 + Average of DE Corp yld sprd)		0.568***	0.525***		0.570***	0.573***		0.574***	0.552***
		(0.038)	(0.039)		(0.062)	(0.053)		(0.053)	(0.041)
EUR_USD DE Govt yld sprd			0.000852			−0.00189**			−0.00055
			(0.001)			(0.001)			(0.001)
Observations	10,588	10,588	9,864	1,103	1,103	1,036	4,042	4,042	3,773
R-squared	0.745	0.756	0.755	0.729	0.758	0.754	0.842	0.853	0.854
Firm FE	y	Y	y	y	y	y	y	y	y

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. DR and RR represent the default risk and redenomination risk (as measured by the CDS quanto spread) components within the country-specific 10-year government bond yield spread to Germany. The EUR_USD DE Govt yld sprd 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. The Bid-Ask Spread is defined as (Ask Price – Bid Price)/Last Price, and we include the first lag of this variable's natural logarithm to mitigate any endogeneity concerns between credit risk and liquidity. The Average of DE Corp yld sprd represents a time-series average of all corporate bond spreads in Germany (calculated in the same way as the dependent variable). The variables amount outstanding, duration, and age have been rescaled by dividing by 1000 due to small magnitudes of coefficients and standard errors. All models are estimated by OLS regression with a constant which is not reported, firm fixed effects and bootstrapped standard errors in parentheses. Sample countries include FR, NL, IT, SP and PT. Sample period: 2002M1–2015M12. $***p < 0.01, **p < 0.05, *p < 0.1$.

Table 7. Explaining the corporate bond spread – default risk and redenomination risk, investment grade only.

	Investment grade only								
	France			Netherlands			IT, PT and SP		
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Ln[1 + DR]	1.129***	0.594***	0.618***	0.655***	−0.175	−0.225**	0.352***	0.291***	0.292***
	(0.058)	(0.057)	(0.059)	(0.073)	(0.109)	(0.106)	(0.016)	(0.016)	(0.016)
Ln[1 + RR]	0.387***	0.00486	0.0336	5.432***	2.166***	2.040***	0.559***	0.452***	0.458***
	(0.036)	(0.039)	(0.055)	(0.484)	(0.652)	(0.691)	(0.017)	(0.015)	(0.021)
Ln(1 + EDF)	1.017***	0.928***	0.936***	0.232***	0.224***	0.238***	0.308***	0.326***	0.313***
	(0.050)	(0.045)	(0.045)	(0.029)	(0.027)	(0.029)	(0.033)	(0.024)	(0.026)
Ln(1 + Coupon)	0.107***	0.0849***	0.0863***	0.104***	0.0795***	0.0793***	0.0937***	0.0766***	0.0726***
	(0.005)	(0.005)	(0.006)	(0.007)	(0.008)	(0.009)	(0.011)	(0.010)	(0.009)
[Ln(Amount outst.)]/1000	−0.181***	−0.322***	−0.317***	−1.847***	−1.766***	−1.780***	−0.194	−0.231**	−0.251**
	(0.068)	(0.073)	(0.091)	(0.240)	(0.265)	(0.263)	(0.136)	(0.103)	(0.106)
[Ln(Duration)]/1000	5.172***	5.021***	5.011***	5.376***	5.211***	5.194***	3.424***	3.250***	3.232***
	(0.216)	(0.225)	(0.189)	(0.256)	(0.347)	(0.213)	(0.203)	(0.187)	(0.162)
[Ln(Age)]/1000	−0.739***	−0.502***	−0.518***	−0.559***	−0.265**	−0.266**	−0.677***	−0.604***	−0.567***
	(0.058)	(0.053)	(0.058)	(0.124)	(0.133)	(0.112)	(0.102)	(0.097)	(0.113)
$Ln(1 + \text{Bid-Ask Spread})_{t-1}$	0.102	0.095	0.0953	−0.0114***	−0.00955***	−0.00941***	0.366***	0.342***	0.341***
	(0.069)	(0.066)	(0.073)	(0.002)	(0.001)	(0.002)	(0.039)	(0.042)	(0.034)
Ln(1 + Average of DE Corp yld sprd)		0.552***	0.511***		0.570***	0.573***		0.546***	0.507***
		(0.029)	(0.037)		(0.061)	(0.069)		(0.050)	(0.058)
EUR_USD DE Govt yld sprd			0.000341			−0.00189**			−0.00086
			(0.000)			(0.001)			(0.001)
Observations	9,912	9,912	9,228	1,103	1,103	1,036	3,172	3,172	2,963
R-squared	0.741	0.753	0.752	0.729	0.758	0.754	0.832	0.845	0.846
Firm FE	y	y	y	y	y	y	y	y	y

See Notes to Table 6.

Table 8. Explaining the corporate bond spread – default risk and redenomination risk, all grades – standard deviations.

Country	Variable	Coefficient	S.D. of Variable	Coefficient∗S.D.
France	Ln[1 + DR]	0.680	0.00116	0.00079
France	Ln[1 + RR]	0.0537	0.00247	0.00013
Netherlands	Ln[1 + DR]	−0.175	0.00118	−0.00021
Netherlands	Ln[1 + RR]	2.166	0.00020	0.00044
Italy	Ln[1 + DR]	0.375	0.00617	0.00232
Italy	Ln[1 + RR]	0.447	0.00781	0.00349
Portugal	Ln[1 + DR]	0.375	0.00805	0.00302
Portugal	Ln[1 + RR]	0.447	0.00393	0.00175
Spain	Ln[1 + DR]	0.375	0.00576	0.00216
Spain	Ln[1 + RR]	0.447	0.01105	0.00494

Notes: This table is based on Table 6 Models 2, 5, and 8 estimated coefficients and the standard deviations of the respective variables in the country shown.

In Model 3 of Table 6, however, the redenomination risk component enters significantly at the 10% level and a slightly higher magnitude on the coefficient of 0.089. In the Netherlands (Model 5), the default risk coefficient is slightly negative (−0.175) although not significant, while the redenomination risk coefficient is large (2.17), and significant at the 1% level. In the 'soft' euro countries (Model 8), both coefficients are significant and similar in magnitude, 0.375 for default risk and 0.447 for redenomination risk. Table 7 repeats the exercise excluding non-investment grade bonds, with similar results. In both Tables 6 and 7, the coefficients of the other explanatory variables remain consistent with those in Tables 4 and 5.

Whether redenomination risk or default risk is more important in terms of its estimated impact on corporate bond spreads depends not just on the coefficients but also on how much variation there is in each independent variable. In Table 8, we show, by country, the estimated effect of an increase of one standard deviation in default and redenomination risks in that country on the corporate spread (the dependent variable) by multiplying each variable's standard deviation (in the relevant country) by the relevant coefficient shown in Table 6 Models 2, 5 or 8. The first point to note is that, as the last column of Table 8 shows, the numbers are much smaller for France and the Netherlands, even in the cases (RR for the Netherlands and DR for France) where the coefficient is larger than for the other three countries. This is because these risks are always much smaller in France and the Netherlands, as indicated by their relatively low government bond spreads in Figure 2. Secondly, we can note that the estimated effect of RR is larger than that of DR for Italy and particularly for Spain, but the opposite is true of Portugal, where the estimated RR effect is substantially smaller.

Overall, our results show that the redenomination risk component within the government bond yield spread, as measured by the sovereign CDS quanto-spread to Germany, is an important driver for the spillover of sovereign risk to nonfinancial corporate bonds in 'soft' euro countries which have experienced the euro sovereign debt crisis, but default and other risks have also made a significant contribution.

5.3. Robustness

To demonstrate that there is no reverse causality from corporate default risk to sovereign risk we redo the analysis in Tables 4–7 by including all the explanatory variables in their first lag. The results which are presented in Appendix 1, are highly consistent and do not change materially, confirming the fact that (Almeida et al. 2017; Augustin et al. 2018).

6. Conclusions

In this paper we investigate the determinants of corporate bond spreads over a safe euro swap interest rate issued by firms in two 'hard' euro area countries (France and the Netherlands) and three 'soft' euro area countries (Italy, Portugal and Spain). In addition to bond- and firm-specific factors, previously documented by the literature on corporate bond determinants, our paper shows that there is a statistically significant risk transfer of sovereign

risk (as measured by government bond yield spreads relative to German government bonds of similar maturity) to the nonfinancial corporate sector for bonds of all credit quality ratings, including investment grade only bonds, and particularly in 'soft' euro area countries. Corporate bond spreads are also strongly correlated with macroeconomic risk in the Eurozone as proxied by the average nonfinancial corporate bond spreads in Germany. Finally, we show that, after disentangling redenomination risk and default risk within the government yield spread, the relative importance of these varies across 'soft' euro area countries, with redenomination risk being particularly important in Spain and, to a lesser extent, Italy, but default risk being more important in Portugal.

Notes

1. See Panizza, Sturzenegger, and Zettelmeyer (2009) for a survey of the literature on sovereign debt.
2. Other euro-area countries such as Greece and Ireland were not included due to very limited corporate bond spread data availability.
3. 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 compiled using Moody's default database and leverages market data, industry, volatility, financial statement data, and historical default information in a proprietary financial model.
4. 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, and Consumer cyclical. Greece and Ireland drop out due to data availability.
5. We apply a natural logarithmic transformation to all variables 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, and it is acceptable to interpret the estimates as if we used the logarithm of the variable (Wooldridge 2006, chapter 6.2, p. 185).
6. On the one hand, bonds with greater default risk will experience significant deterioration in liquidity (Edwards, Harris, and Piwowar 2007; Bao, Pan, and Wang 2011). On the other hand, a deterioration in market liquidity, by affecting firms' refinancing operations negatively, can incentivise equity holders to default (He and Xiong 2012; He and Milbradt 2014).
7. These risks are, however, negligible given our sample and that the European sovereign debt crisis was a solvency rather than a liquidity crisis (Jeanneret 2015). We therefore refer to it as mainly default risk.
8. We use the most recent credit restructuring type, CR14, for the 5-year maturity CDS rates for the respective euro-area sovereigns from Bloomberg.

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Appendix 1

Table A1. Explaining the corporate bond spread ('hard' versus 'soft' euro area countries) – all grades.

	All grades								
	France			Netherlands			IT, PT and SP		
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
$Ln[1 + Govt\ yld\ sprd\ to\ DE]_{t-1}$	0.663***	0.103	0.129	1.032*	0.811	0.855	0.532***	0.402***	0.397***
	(0.136)	(0.164)	(0.162)	(0.457)	(0.650)	(0.652)	(0.024)	(0.025)	(0.022)
$Ln(1 + EDF)_{t-1}$	0.627***	0.615***	0.774***	0.157**	0.159**	0.172**	0.234***	0.237***	0.249***
	(0.235)	(0.214)	(0.193)	(0.048)	(0.048)	(0.060)	(0.011)	(0.014)	(0.017)
$Ln(1 + Coupon)_{t-1}$	0.0849***	0.0712***	0.0762***	0.173*	0.168	0.169	0.0281	0.0124	0.0155
	(0.023)	(0.025)	(0.025)	(0.083)	(0.084)	(0.084)	(0.034)	(0.030)	(0.031)
$[Ln(Amount\ outst.)]/1000_{t-1}$	−0.208	−0.307	−0.277	−1.953	−1.92	−1.883	0.448	0.344	0.349
	(0.230)	(0.205)	(0.204)	(1.712)	(1.702)	(1.670)	(0.408)	(0.408)	(0.430)
$[Ln(Duration)]/1000_{t-1}$	5.197***	5.184***	5.154***	5.740**	5.682***	5.599***	4.705***	4.587***	4.581***
	(0.459)	(0.437)	(0.445)	(1.434)	(1.408)	(1.370)	(0.363)	(0.391)	(0.418)
$[Ln(Age)]/1000_{t-1}$	−0.299	−0.167	−0.217	−1.557*	−1.541	−1.578	−0.194	−0.237	−0.275
	(0.204)	(0.202)	(0.196)	(0.758)	(0.792)	(0.787)	(0.177)	(0.177)	(0.183)
$Ln(1 + Bid\text{-}Ask\ Spread)_{t-2}$	0.142*	0.130*	0.126*	−0.0147**	−0.0143**	−0.0151**	0.323	0.295*	0.293*
	(0.075)	(0.070)	(0.070)	(0.004)	(0.004)	(0.005)	(0.116)	(0.083)	(0.076)
$Ln(1 + Average\ of\ DE\ Corp\ yld\ sprd)_{t-1}$		0.655***	0.607***		0.127	0.095		0.660**	0.646**
		(0.128)	(0.128)		(0.211)	(0.212)		(0.086)	(0.073)
$EUR\_USD\ DE\ Govt\ yld\ spread_{t-1}$			0.00246			0.00415			−0.00097
			(0.002)			(0.003)			(0.002)
Observations	10,926	10,918	10,163	1,211	1,211	1,127	4,227	4,222	3,914
R-squared	0.684	0.703	0.708	0.534	0.535	0.533	0.805	0.823	0.822
Firm FE	Y	y	y	y	y	y	y	y	y

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 sprd to DE is the difference between the country-specific 10-year government bond yield and the 10-year Germany government bond yield, and is denominated in EUR. The EUR_USD DE Govt yld sprd 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. The Bid-Ask Spread is defined as (Ask Price – Bid Price)/Last Price, and we include the first lag of this variable's natural logarithm to mitigate any endogeneity concerns between credit risk and liquidity. The Average of DE Corp yld sprd represents a time-series average of all corporate bond spreads in Germany (calculated in the same way as the dependent variable). The variables amount outstanding, duration, and age have been rescaled by dividing by 1000 due to small magnitudes of coefficients and standard errors. All explanatory variables are included in the first lag. All models are estimated by OLS regression with a constant which is not reported, firm fixed effects and cluster robust standard errors in parentheses clustered at firm (models 1–6) or country (models 7–9) and time dimensions. Sample countries include FR, NL, IT, SP and PT. Sample period: 2002M1–2015M12. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$.

Table A2. Explaining the corporate bond spread ('hard' versus 'soft' euro area countries) – investment grade only.

	Investment Grade only								
	France			Netherlands			IT, PT and SP		
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
$Ln[1 + Govt\ yld\ sprd\ to\ DE]_{t-1}$	0.642***	0.0707	0.0824	1.032*	0.811	0.855	0.490***	0.364***	0.365***
	(0.124)	(0.156)	(0.149)	(0.457)	(0.650)	(0.652)	(0.020)	(0.021)	(0.022)
$Ln(1 + EDF)_{t-1}$	0.514	0.481*	0.741**	0.157**	0.159**	0.172**	0.262**	0.293***	0.280**
	(0.317)	(0.272)	(0.323)	(0.048)	(0.048)	(0.060)	(0.028)	(0.027)	(0.029)
$Ln(1 + Coupon)_{t-1}$	0.0970***	0.0841***	0.0862***	0.173*	0.168	0.169	0.107*	0.0934*	0.0936*
	(0.022)	(0.024)	(0.024)	(0.083)	(0.084)	(0.084)	(0.026)	(0.022)	(0.024)
$[Ln(Amount\ outst.)]/1000_{t-1}$	−0.18	−0.271	−0.269	−1.953	−1.92	−1.883	0.102	−0.00177	−0.00595
	(0.226)	(0.204)	(0.206)	(1.712)	(1.702)	(1.670)	(0.457)	(0.455)	(0.482)
$[Ln(Duration)]/1000_{t-1}$	5.174***	5.186***	5.099***	5.740**	5.682***	5.599***	3.898**	3.774**	3.778**
	(0.477)	(0.458)	(0.454)	(1.434)	(1.408)	(1.370)	(0.705)	(0.759)	(0.780)
$[Ln(Age)]/1000_{t-1}$	−0.479***	−0.363***	−0.383***	−1.557*	−1.541	−1.578	−0.498	−0.553	−0.564
	(0.154)	(0.133)	(0.135)	(0.758)	(0.792)	(0.787)	(0.366)	(0.367)	(0.362)
$Ln(1 + Bid\text{-}Ask\ Spread)_{t-2}$	0.105*	0.0912*	0.0900*	−0.0147**	−0.0143**	−0.0151*	0.337	0.312*	0.304*
	(0.056)	(0.050)	(0.050)	(0.004)	(0.004)	(0.005)	(0.116)	(0.079)	(0.074)
$Ln(1 + Average\ of\ DE\ Corp\ yld\ sprd)_{t-1}$		0.669***	0.612***		0.127	0.095		0.644**	0.627**
		(0.131)	(0.127)		(0.211)	(0.212)		(0.108)	(0.092)
$EUR\_USD\ DE\ Govt\ yld\ spread_{t-1}$			0.00246			0.00415			−0.00047
			(0.002)			(0.003)			(0.002)
Observations	10,257	10,249	9,533	1,211	1,211	1,127	3,284	3,281	3,049
R-squared	0.68	0.703	0.707	0.534	0.535	0.533	0.791	0.812	0.81
Firm FE	Y	y	y	y	y	Y	y	y	y

See Notes to Table A1.

Table A3. Explaining the corporate bond spread – default risk and redenomination risk, all grades.

	All grades								
	France			Netherlands			IT, PT and SP		
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
$Ln[1 + DR]_{t-1}$	1.247***	0.764***	0.855***	0.673***	−0.174	−0.168	0.367***	0.313***	0.312***
	(0.063)	(0.060)	(0.060)	(0.074)	(0.122)	(0.117)	(0.012)	(0.022)	(0.028)
$Ln[1 + RR]_{t-1}$	0.347***	0.00313	0.0344	4.891***	1.499***	1.623***	0.550***	0.448***	0.443***
	(0.038)	(0.046)	(0.047)	(0.570)	(0.548)	(0.374)	(0.016)	(0.019)	(0.026)
$Ln(1 + EDF)_{t-1}$	0.878***	0.849***	0.855***	0.199***	0.191***	0.208***	0.258***	0.257***	0.255***
	(0.039)	(0.048)	(0.044)	(0.019)	(0.021)	(0.026)	(0.027)	(0.032)	(0.033)
$Ln(1 + Coupon)_{t-1}$	0.106***	0.0854***	0.0878***	0.110***	0.0858***	0.0872***	0.0259***	0.0101	0.0113
	(0.007)	(0.006)	(0.007)	(0.007)	(0.010)	(0.008)	(0.009)	(0.009)	(0.012)
$[Ln(Amount\ outst.)]/1000_{t-1}$	−0.112	−0.246**	−0.212**	−1.874***	−1.789***	−1.798***	0.287	0.24	0.238**
	(0.091)	(0.111)	(0.090)	(0.219)	(0.199)	(0.280)	(0.182)	(0.166)	(0.116)
$[Ln(Duration)]/1000_{t-1}$	5.650***	5.499***	5.518***	5.510***	5.377***	5.335***	4.714***	4.497***	4.491***
	(0.277)	(0.241)	(0.208)	(0.300)	(0.301)	(0.246)	(0.230)	(0.193)	(0.223)
$[Ln(Age)]/1000_{t-1}$	−0.668***	−0.455***	−0.479***	−0.621***	−0.317**	−0.351***	−0.373***	−0.319***	−0.313***
	(0.078)	(0.087)	(0.090)	(0.117)	(0.132)	(0.116)	(0.110)	(0.081)	(0.076)
$Ln(1 + Bid\text{-}Ask\ Spread)_{t-2}$	0.119	0.114	0.11	−0.0122***	−0.0102***	−0.0105***	0.365***	0.335***	0.333***
	(0.079)	(0.079)	(0.076)	(0.002)	(0.002)	(0.002)	(0.042)	(0.042)	(0.052)
$Ln(1 + Average\ of\ DE\ Corp\ yld\ sprd)_{t-1}$		0.491***	0.465***		0.592***	0.584***		0.531***	0.525***
		(0.036)	(0.040)		(0.066)	(0.059)		(0.053)	(0.050)
$EUR\_USD\ DE\ Govt\ yld\ spread_{t-1}$			0.00362***			0.000732			−0.00177
			(0.000)			(0.001)			(0.001)
Observations	10,300	10,300	9,578	1,082	1,082	1,015	3,921	3,921	3,652
R-squared	0.723	0.732	0.732	0.712	0.743	0.74	0.813	0.823	0.821
Firm FE	y	y	y	y	y	Y	y	y	y

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. DR and RR represent the default risk and redenomination risk (as measured by the CDS quanto spread) components within the country-specific 10-year government bond yield spread to Germany. The EUR_USD DE Govt yld sprd 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. The Bid-Ask Spread is defined as (Ask Price – Bid Price)/Last Price, and we include the first lag of this variable's natural logarithm to mitigate any endogeneity concerns between credit risk and liquidity. The Average of DE Corp yld sprd represents a time-series average of all corporate bond spreads in Germany (calculated in the same way as the dependent variable). The variables amount outstanding, duration, and age have been rescaled by dividing by 1000 due to small magnitudes of coefficients and standard errors. All explanatory variables are included in the first lag All models are estimated by OLS regression with a constant which is not reported, firm fixed effects and bootstrapped standard errors in parentheses. Sample countries include FR, NL, IT, SP and PT. Sample period: 2002M1–2015M12. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$.

Table A4. Explaining the corporate bond spread – default risk and redenomination risk, investment grade only.

	Investment grade only								
	France			Netherlands			IT, PT and SP		
Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
$Ln[1 + DR]_{t-1}$	1.104***	0.646***	0.728***	0.673***	−0.174	−0.168	0.288***	0.234***	0.237***
	(0.056)	(0.056)	(0.060)	(0.074)	(0.122)	(0.117)	(0.014)	(0.026)	(0.016)
$Ln[1 + RR]_{t-1}$	0.284***	−0.0346	−0.00698	4.891***	1.499***	1.623***	0.549***	0.448***	0.447***
	(0.036)	(0.042)	(0.041)	(0.570)	(0.548)	(0.374)	(0.018)	(0.024)	(0.014)
$Ln(1 + EDF)_{t-1}$	0.987***	0.905***	0.926***	0.199***	0.191***	0.208***	0.265***	0.283***	0.270***
	(0.056)	(0.050)	(0.060)	(0.019)	(0.021)	(0.026)	(0.025)	(0.035)	(0.027)
$Ln(1 + Coupon)_{t-1}$	0.113***	0.0950***	0.0976***	0.110***	0.0858***	0.0872***	0.0933***	0.0786***	0.0773***
	(0.007)	(0.006)	(0.007)	(0.007)	(0.010)	(0.008)	(0.013)	(0.010)	(0.012)
$[Ln(Amount outst.)]/1000_{t-1}$	−0.127	−0.240***	−0.208**	−1.874***	−1.789***	−1.798***	−0.206*	−0.229*	−0.229
	(0.086)	(0.078)	(0.092)	(0.219)	(0.199)	(0.280)	(0.112)	(0.129)	(0.203)
$[Ln(Duration)]/1000_{t-1}$	5.560***	5.446***	5.453***	5.510***	5.377***	5.335***	3.561***	3.409***	3.419***
	(0.218)	(0.175)	(0.185)	(0.300)	(0.301)	(0.246)	(0.185)	(0.182)	(0.264)
$[Ln(Age)]/1000_{t-1}$	−0.779***	−0.591***	−0.622***	−0.621***	−0.317**	−0.351***	−0.684***	−0.626***	−0.608***
	(0.080)	(0.054)	(0.078)	(0.117)	(0.132)	(0.116)	(0.118)	(0.082)	(0.126)
$Ln(1 + Bid\text{-}Ask\ Spread)_{t-2}$	0.0873	0.0809	0.0773	−0.0122***	−0.0102***	−0.0105***	0.391***	0.364***	0.359***
	(0.064)	(0.053)	(0.058)	(0.002)	(0.002)	(0.002)	(0.037)	(0.047)	(0.048)
$Ln(1 + Average\ of\ DE\ Corp\ yld\ sprd)_{t-1}$		0.469***	0.441***		0.592***	0.584***		0.524***	0.506***
		(0.039)	(0.033)		(0.066)	(0.059)		(0.051)	(0.049)
$EUR\_USD\ DE\ Govt\ yld\ spread_{t-1}$			0.00339***			0.000732			−0.00129
			(0.001)			(0.001)			(0.001)
Observations	9,646	9,646	8,963	1,082	1,082	1,015	3,071	3,071	2,862
R-squared	0.723	0.732	0.732	0.712	0.743	0.74	0.804	0.816	0.814
Firm FE	y	y	y	y	y	y	y	y	y

See Notes to Table A3.