Web Appendix to Euro area sovereign bond risk premia before and during the Covid-19 pandemic*

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A Identification summary tables

This section discusses two summary tables that compare KNV's identification approach to our approach. Table A.1 reproduces KNV's baseline approach for Italian data (their Table 2B, page 15). The table relates four observed time series (presented in rows) to four sovereign bond risk premia to be identified (in columns). To explain Table A.1's third and fourth row, ENI is an Italian multinational oil and gas company whose bond yield was assumed to be independent of Italian sovereign default risk.

Table A.1: KNV (2018)'s baseline implementation for Italy

	default risk premium	corporate default risk premium	redenomination risk premium	segmentation risk premium
≈5y IT EUR bond yield - EUR 5y OIS rate	1	0	1	1
≈5y IT USD bond yield - USD 5y OIS rate	1	0	0	0
≈5y ENI EUR bond yield - USD 5y OIS rate	0	1	1	0
5y ENI USD CDS CT2003 spread	0	1	0	0

Table A.2: Our implementation for Germany, France, Italy, and Spain

	expected short-rate & term premium	default risk premium	redenomination risk premium	"aid" component	liquidity risk premium	segmentation risk premium
5y bond yield, BBG	1	β_D	β_R	0	β_L	1
5y bond yield, Reuters	1	β_D	β_R	0	β_L	1
5y OIS EUR rate	1	0	0	0	0	0
5y CDS EUR CT2003	0	1	0	0	0	0
5y CDS USD CT2014	0	0	1	1	0	0
5y CDS USD CT2003	0	0	0	1	0	0
5y liquidity risk factor	0	0	0	0	1	0

Table A.2 corresponds to our approach as explained in Section 2.2. It relates seven observed time series (presented in rows) to five sovereign bond risk premia to be identified (in columns). The "aid component" (fifth column of Table A.2) corresponds to the five-year CDS USD CT2003 time series adjusted for measurement error. (The sixth row of Table A.2 is the fourth row of an I_6 identity matrix, selecting this time series.) This specification identifies redenomination risk as the difference between the 5y CDS USD CT2014 and the 5y CDS USD CT2003 time series when both CDS spreads are subject to measurement error (see fifth row of Table A.2).

B Measuring default risk: USD bond spread vs. ISDA 2003 CDS spread

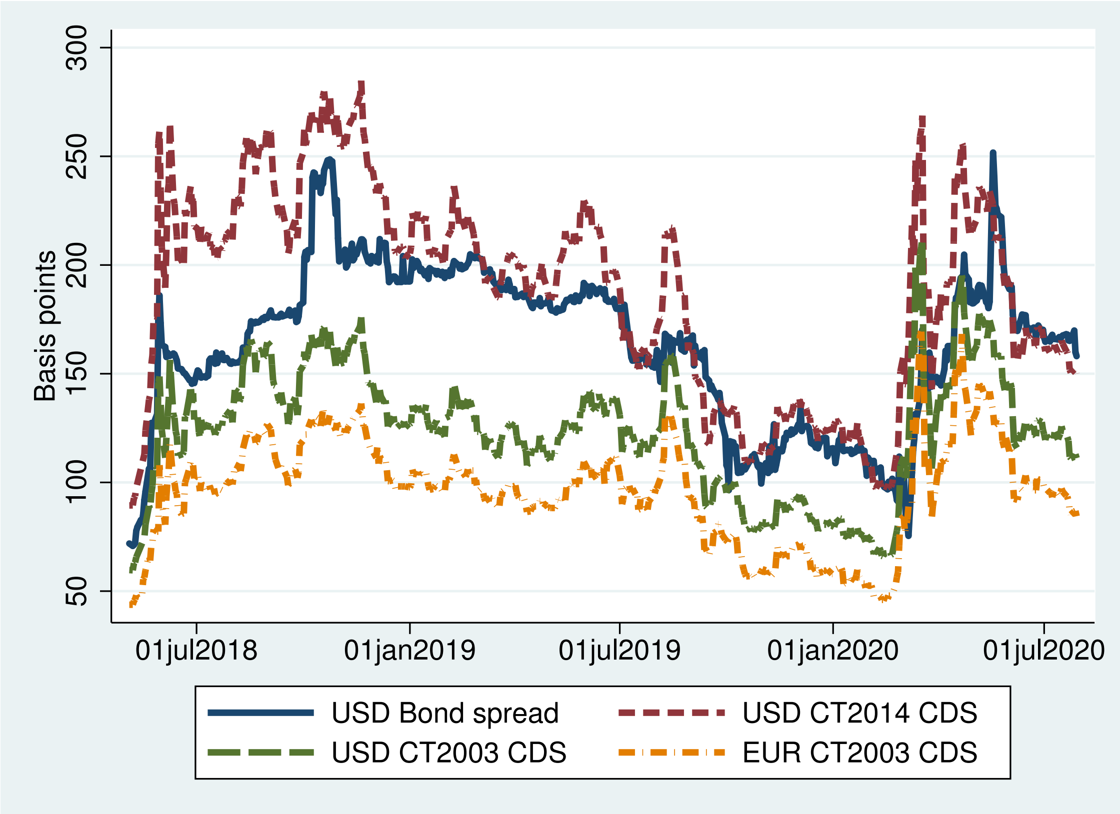
This section compares two alternative measures of the default risk premium: a risk spread taken from U.S. dollar (USD)-denominated bonds issued by a euro area sovereign on the one hand, and the euro (EUR)-denominated ISDA 2003 CDS spread on the other hand. KNV infer the default risk premium from the spread between the yield of a USD-denominated foreign-law sovereign bond and the corresponding USD OIS rate. By contrast, we rely on the EUR CT2003 CDS spread.

For this comparison we need to rely exclusively on Italian data, for the simple reason that, to our knowledge, France, Germany, and Spain do not have outstanding USD-denominated sovereign bonds, rendering the KNV approach infeasible for these three countries. And even for Italy, we need to make do with only two USD-denominated sovereign bonds. We obtain bid, ask, and mid prices, as well as implied yields for these two bonds. The data are at a daily frequency, ranging from 1 May 2018 until 9 October 2020. CDS spreads are obtained from Credit Market Analysis (CMA) DataVision, also ranging from 1 May 2018 until 9 October 2020. CMA reports bid, ask, and mid quotes, allowing us to compare bid-ask spreads below.

The first Italian bond matures in 2023 (Republic of Italy 4.75 8/1/2023 Govt), implying a residual maturity of about five years in mid-2018. The residual maturity of this bond thus approximately matches the maturity of a five-year CDS contract. The second bond matures in 2033 (Republic of Italy 6 5/1/2033 Govt). We obtain KNV's USD bond-based yield spread as follows. First, we linearly interpolate the two Italian bond yields to obtain the yield of a hypothetical five-year constant-maturity bond. We then subtract the five-year USD OIS rate.

Figure B.1 plots the USD-denominated bond spread. The bond spread (blue continuous line) can now be compared to the five-year USD CT2003 CDS spread (green long-dashed line), the USD CT2014 CDS spread (red dashed line), and the EUR CT2003 CDS spread (yellow long-dashed line). The USD CT2003 CDS spread and the USD bond spread co-move most closely, with a correlation coefficient of approximately 83%. The USD-denominated bond spread is larger on average than the USD CT2003 CDS spread. This is intuitive. As discussed in KNV, the USD-denominated bond spread can embed other premia. For example, *i*) USD-denominated bonds are potentially much less liquid than euro-denominated bonds, *ii*) they might be taxed differently than euro-denominated bonds, and *iii*) may be held by a different investor type. All of these frictions can affect their

Figure B.1: Alternative default risk premium measures for Italy
KNV's USD bond-based risk spread (blue continuous line), the five-year USD CT2003 CDS spread (green long-dashed line), the five-year USD CT2014 CDS spread (red dashed line), and the five-year EUR CT2003 CDS spread (yellow long-dashed line).



yields. To account for these frictions, KNV at times extend their statistical framework to try and estimate a foreign segmentation component.

The five-year EUR CT2003 CDS spread strongly co-moves with its USD CT2003 CDS spread counterpart. The correlation coefficient is approximately 98%. The EUR CT2003 CDS spread is lower than the USD CT2003 CDS spread throughout the sample. This is intuitive, as only the latter provides additional protection against a depreciation of the euro against the U.S. dollar should a sovereign credit event occur; see e.g. Monfort, Pegoraro, Renne, and Roussellet (2021).

The five-year USD CT2014 CDS spread and the USD bond spread also co-move, but do so less closely. The correlation coefficient is approximately 75%. The USD CT2014 CDS spread provides protection against both default and redenomination risk (as well as against a depreciation of the euro against the U.S. dollar should a sovereign credit event occur). As a result, it should provide an upper bound to any proxy for the default risk premium.

Finally, we compare the market liquidity of the five-year EUR CT2003 CDS contract with that of the two U.S. dollar-denominated Italian sovereign bonds. We focus on the bid-ask spread for this purpose. The EUR CT2003 CDS contract is more liquid on average (bid-ask spread of approximately 7.6 bps) than the two U.S. dollar-denominated sovereign bonds (bid-ask spreads of 10.9 bps and 11.6 bps, respectively). We conclude that, for our sample, CDS spreads are the most available, direct, and liquid measure of a sovereign's default risk.

C ISDA 2014 and 2003 CDS terms

C.1 Credit event definitions: redenomination risk

The International Swaps and Derivatives Association (ISDA) is a trade organization of participants in the market for over-the-counter derivatives. As one of its main functions, it sets rules and definitions for the CDS market. The ISDA's standardized definitions have changed occasionally in response to new developments. The most recent update was implemented in September 2014. Before that, the most recent update was released in 2003.

Under the 2003 definition, a sovereign could redenominate an obligation into a number of "permitted currencies" without triggering a default. Specifically,

> "Permitted Currency" means (1) the legal tender of any Group of 7 country (or any country that becomes a member of the Group of 7 if such Group of 7 expands its membership) or (2) the legal tender of any country which, as of the date of such change, is a member of the Organisation for Economic Cooperation and Development and has a local currency long-term debt rating of either AAA or higher assigned to it by Standard & Poor's, a division of The McGraw-Hill Companies, Inc. or any successor to the rating business thereof, Aaa or higher assigned to it by Moody's Investors Service, Inc. or any successor to the rating business thereof or AAA or higher assigned to it by Fitch Ratings or any successor to the rating business thereof."

France, Germany, and Italy are part of the G7 countries. (In addition, Germany is an OECD member country with a sufficiently high rating. Spain is an OECD country and was rated AAA by S&P between December 2004 and January 2009.) As a result, under the ISDA 2003 rules, France, Germany, and Italy could each issue a new currency, and then redenominate the existing debt into a new currency, without triggering the existent CT2003 CDS contracts. For these countries, CT2003 CDS contracts do not provide adequate protection against a redenomination event. This was widely understood and discussed in the financial press at the time; see e.g. Kaminska (2010).

In our sample, Spain is not a G7 member country. It is an OECD country, but has not been AAA-rated since 2009. As a result, the above "G7 loophole" does not apply. Still, two additional issues arise in the case of Spain. First, since the euro area sovereign debt crisis there has been a discussion of the case of a country exiting the euro and redenominating its debt into a new shared currency (e.g., a "southern states euro"), while another country participating in the new shared currency is a G7 country (e.g., Italy). It is then unclear whether this new shared currency is a "permitted currency," and whether the Spanish CDS would trigger as a result.[1] Second, the ISDA Credit Derivatives Determinations Committee would have been ultimately responsible for assessing whether the "redenomination" event directly or indirectly arises from a deterioration in the creditworthiness or financial condition of the sovereign at the time. Such a deterioration could be difficult, and time-consuming, to prove following a "redenomination." With these two justifications in mind we also use the ISDA basis to inform the redenomination risk premium estimate for Spain. Alternatively, the reader is free to refer to the sum of the Spanish redenomination risk premium and default risk premium collectively as Spanish "credit-related premia."

In response to the euro area sovereign debt crisis, and growing concerns about the possibility of a redenomination of some euro area government debt, the ISDA amended Section 4.7 in its 2014 terms. Now, the only permitted currencies are enumerated explicitly as

> ... the lawful currency of Canada, Japan, Switzerland, the United Kingdom, the U.S., and the euro and any successor currency to any of the aforementioned currencies (which in the case of the euro, shall mean the currency which succeeds to and replaces the euro in whole.)"

As a result, the new ISDA 2014 wording effectively addresses and removes the "G7-loophole" in its 2003 terms. Under the ISDA 2014 definitions, a redenomination of debt into a new French, German, Italian, or Spanish currency would trigger a sovereign CT2014 CDS contract (provided the redenomination is detrimental to bondholders, see the next paragraph).

Finally, the ISDA 2014 terms also replaced the requirement that a restructuring credit event would be triggered only in the case of a deterioration in the creditworthiness or financial condition of the sovereign that exits the euro. Because it would be difficult to judge whether or not such a deterioration has taken place, the 2014 ISDA definitions switched off this requirement. Instead, it introduced a more "rule-based" requirement, stating that the restructuring credit event is triggered by *any* redenomination into a new currency, as long as an implied haircut or market loss occurs to existing bondholders.

[1] See https://www.isda.org/a/sFiDE/icm-21318534-v8-memo-to-kirsty-taylor.pdf.

C.2 Asset package delivery

The changes discussed is Section C.1 are not the only ones distinguishing the ISDA 2003 and 2014 terms. This could matter for our use of the ISDA basis as a measure of redenomination risk. This section discusses another change in terms, commonly referred to as the "asset package delivery" (APD) clause. The new clause clarifies which assets are taken into account when calculating a bond's recovery value at default, and was a direct response to the Greek debt restructuring of 2012.

In principle, pricing differences between the ISDA 2003 and 2014 sovereign CDS contracts could also depend on the additional APD clause. We argue, however, that the addition of the APD clause is unlikely to lead to an economically significant pricing differential between CT2003 and CT2014 contracts in our sample because the magnitude of the recovery value matters most when countries are close to default. This is not the case in our sample.[2] The ISDA basis for non-G7 euro area countries (such as e.g. Portugal or Ireland) can be positive if market participants perceive that a country's exit from the euro could be correlated with an Italian exit (to form a new "southern states euro"). Given that this new currency would then also be legal tender in Italy, a G7 country, the CT2003 CDS referencing the non-G7 euro area country would not necessarily be triggered in this case. ISDA bases for non-euro area countries (such as Japan or the U.K.) tend to be tiny (single digit basis points), see e.g. Kremens (2021, Figure 1b), and are not too dissimilar from a pure noise component as included as the last term in Equation (1) of the main paper.

We acknowledge that, if the APD clause led to a constant level shift in the spread between 2003 and 2014 contracts, our redenomination risk premium estimates would be too high, and our segmentation premium estimates would be too low/negative. Our event study results in Section 4.4 would remain unaffected.

[2]For example, Pan and Singleton (2008) argue that they cannot reliably identify CDS recovery values from a term structure of CDS spreads at low default risk premia, and apply their method to emerging markets (Mexico, Turkey, and Korea) for this reason. In our euro area sample, the maximally observed CDS spread is approximately 180 bps (for Italy, in Spring 2020).

D Additional data plots

D.1 Selected input data

This section presents time series plots of selected input data. Figure D.1 plots default risk premia as inferred from five-year EUR CT2003 CDS swap spreads. The top panel of Figure D.2 plots TradeWeb's liquidity measure, which we use as one input into our country-specific liquidity factor. The liquidity measure is computed by TradeWeb from transaction prices vs. price quotes for sovereign bonds within a 2-year to 5.5-year maturity bracket. The bottom panel of Figure D.2 plots the ISDA bases of France, Germany, Italy, and Spain.

Figure D.1: CT2003 CDS spreads

CT2003 EUR CDS spreads in basis points for Germany, France, Italy, and Spain.

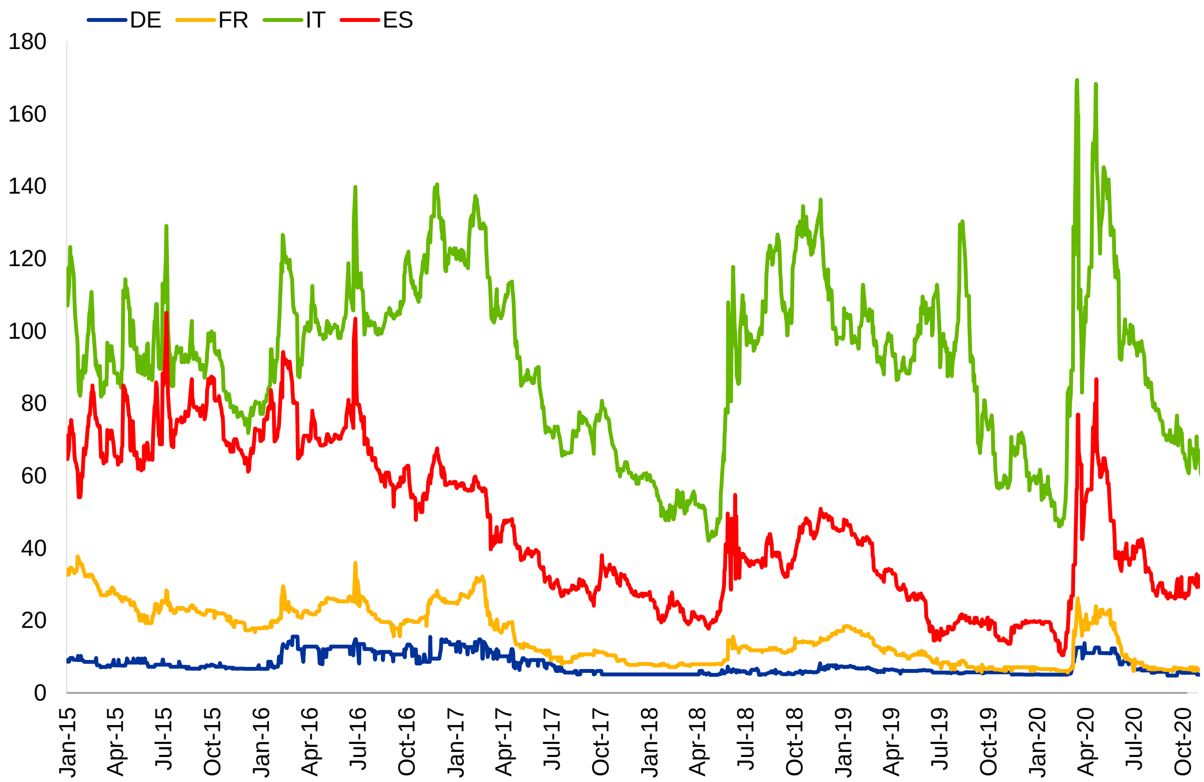
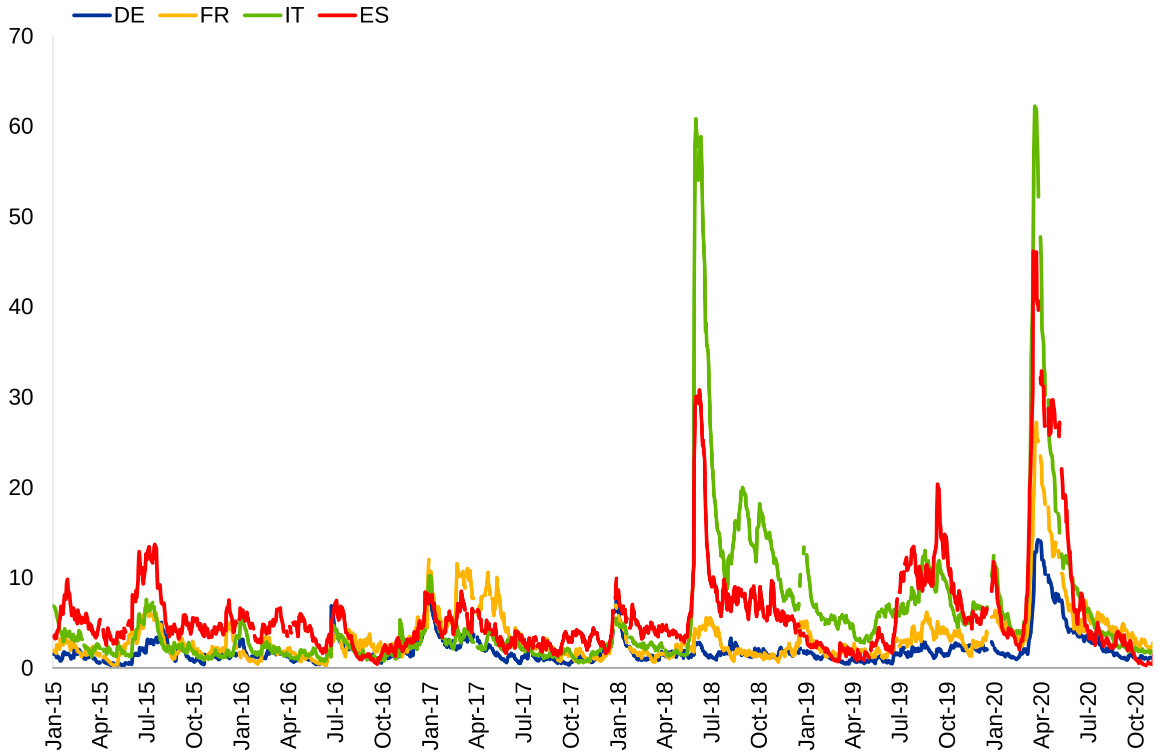
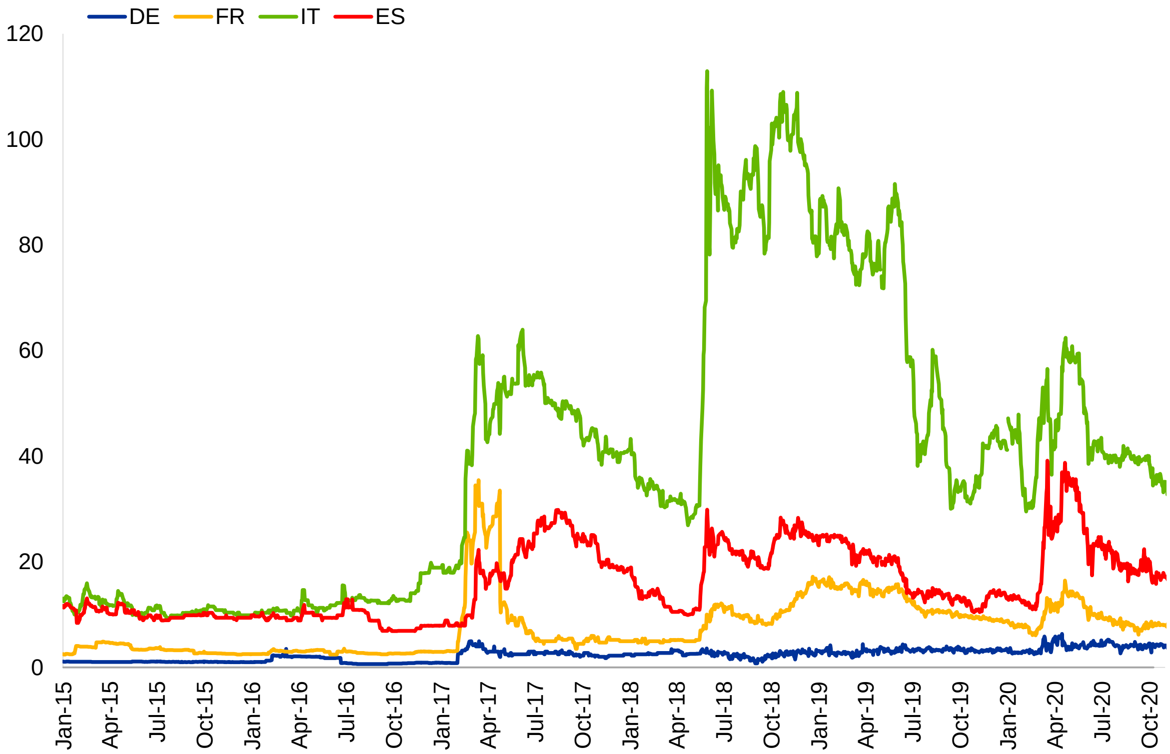


Figure D.2: Tradeweb's liquidity measure (top) and ISDA bases (bottom)

Top: TradeWeb's (il)liquidity measure for sovereign bonds for Germany, France, Italy, and Spain. Bottom: The ISDA bases for the same countries, calculated as the spread between USD CT2014 and USD CT2003 CDS spreads. The vertical axes are in basis points.





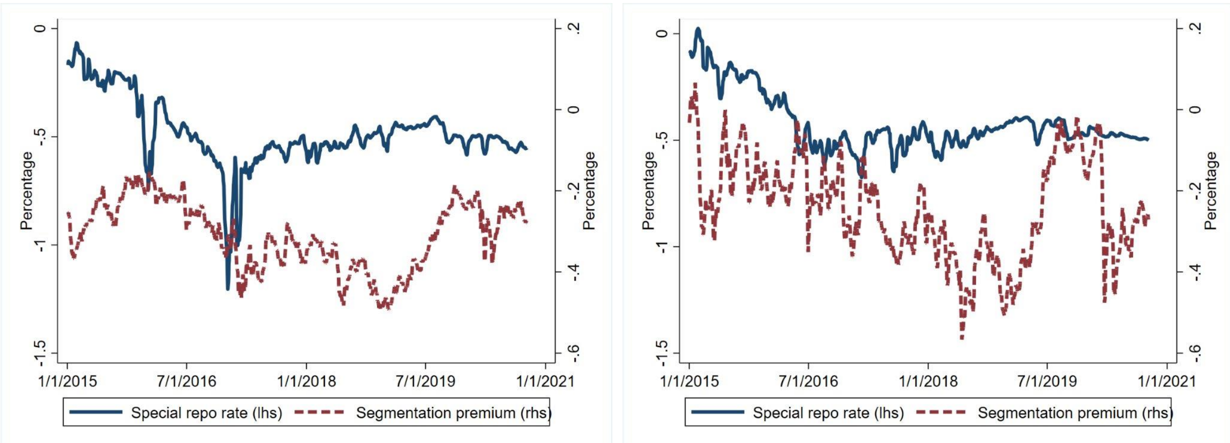
D.2 FR and ES special repo rates

This section presents time series plots of special repo rates and segmentation premium estimates for French (left) and Spanish (right) five-year benchmark bonds. Figure D.3 thus complements Figure 4 in the main text.

Figures 4 and D.3 use data on special repo contracts traded on the BrokerTec and MTS platforms. Each platform covers a significant percentage of European market transactions. Most transactions are settled using a central clearing counterparty.

Figure D.3: **FR and ES special repo rates and segmentation premium**

Special repo rate and segmentation premium for French (left) and Spanish (right) five-year sovereign benchmark bonds. Data are daily between 2 January 2015 and 9 October 2020. Special repo rates are reported as a 20-day moving average.



E A regression-based decomposition approach

This section develops a regression-based decomposition approach which does not rely on state space methods but leads to comparable sovereign yield decomposition results.

In the regression-based approach, we first estimate the loading parameters β by a (restricted) least squares regression of sovereign yields on the other financial instruments' rates. We run this regression in first differences. All data are stacked vertically to obtain common parameter estimates across countries. The remaining estimates in ψ can subsequently be obtained conditional on β, if desired, as follows. First, the scaled regressors are subtracted from the (average of the two observed) five-year benchmark bond yields to obtain a regression-based segmentation premium. Any measurement error/noise in bond yields is attributed to the segmentation premium. Second, all scaled yield components can be stacked into α_t^*. The volatility and correlation coefficients δ and ρ can now be obtained from the covariance matrix of $\eta_t = \Delta\alpha_t^*$. Measurement error variances γ are implicitly set to zero.

Figures E.1 and E.2 compare the outcomes of the two estimation approaches for Italy, Spain, France, and Germany. The decomposition results are visibly similar for all four countries. The estimate of $\beta_L^{\mathrm{OLS}} = 0.22$ is similar to $\beta_L^{\mathrm{ML}} = 0.25$; see Section 4.1.

Figure E.1: Comparison of filtering- and OLS-based decompositions: IT and ES

Filtering- and OLS-based risk premium estimates for IT (top) and ES (bottom). Six panels each refer to i) the five-year yield that is decomposed into ii) expected future risk-free short-term rates and a term premium, iii) a default risk premium, iv) redenomination risk premium, v) liquidity risk premium, and vi) segmentation premium. The restriction $\beta_D = \beta_R = 1$ was imposed for in either case.

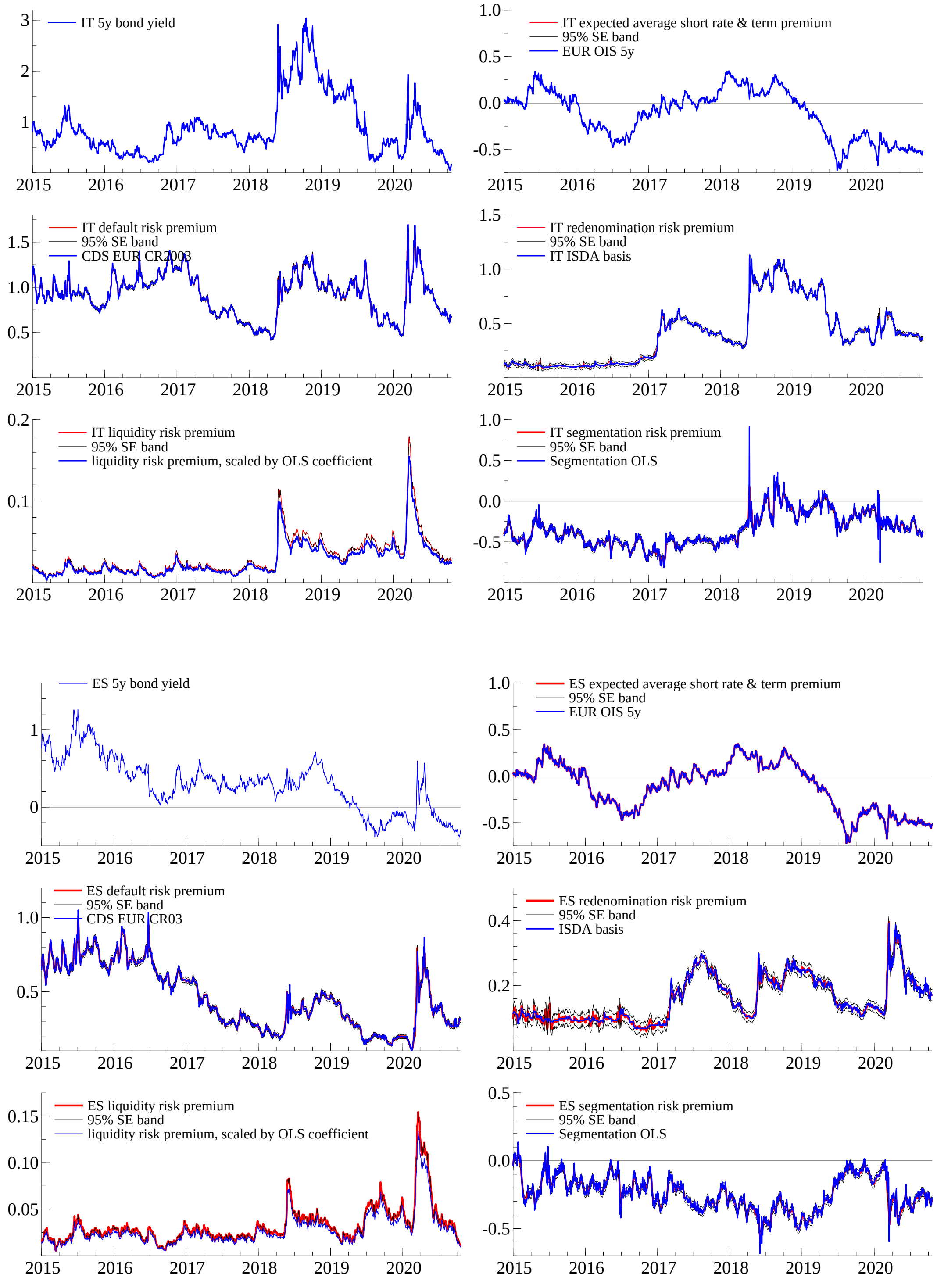
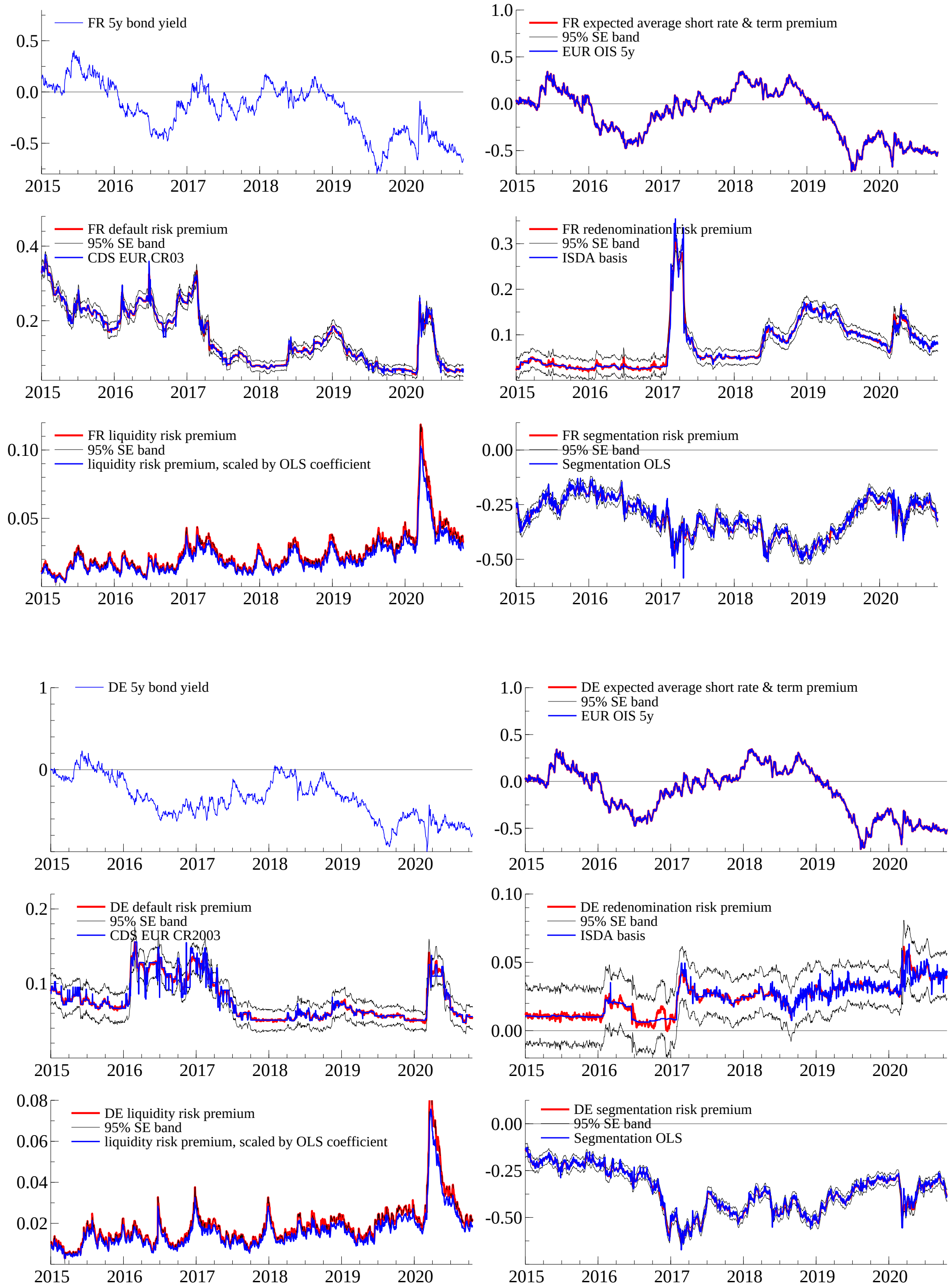


Figure E.2: Comparison of filtering- and OLS-based decompositions: FR and DE

Filtering- and OLS-based risk premium estimates for FR (top) and DE (bottom). Six panels each refer to i) the five-year yield that is decomposed into ii) expected future risk-free short-term rates and a term premium, iii) a default risk premium, iv) redenomination risk premium, v) liquidity risk premium, and vi) segmentation premium. The restriction $\beta_D = \beta_R = 1$ was imposed for in either case.



F Descriptive statistics and diagnostic checks

F.1 Unit root and cointegration testing

This section presents the outcome of unit root and cointegration tests applied to our raw data as used for the empirical analysis in Section 4.

Table F.1 presents the outcomes of Augmented Dickey Fuller unit root tests. The table suggests that most of our input data is non-stationary. For example, the null hypothesis of a unit root is not rejected for most sovereign yields and CDS spreads.

Table F.2 presents the outcomes of Johansen VAR-based cointegration tests. The table indicates that certain linear combinations of non-stationary input data could be stationary, and that the number of appropriate cointegration relationships is probably country-specific.

Finally, Table F.3 presents the outcomes of Augmented Dickey Fuller unit root tests applied to our full-sample convenience yield estimates. The test's critical values assume that the cointegration vector is known (potentially implying too much cointegration). The table suggests that three out of four convenience yield estimates are probably not stationary. This is in line with our discussion in Section 4.1, where we specify each risk premium unobserved component to follow a driftless random walk.

Table F.1: ADF unit root tests

T-statics and p-values of Augmented Dickey Fuller (ADF) tests performed on each series. The test regression includes an intercept (left) or alternatively an intercept and linear trend (right). Lag length selection is based on minimal BIC, with the maximum number of lags set to ten. MacKinnon (1996) one-sided p-values are reported. The test outcomes associated with the 5y OIS EUR rate and then 10y KfW-Bund spread are common to all countries, and therefore only reported once. The ADF null hypothesis states that the respective time series has a unit root.

	Intercept No trend			Intercept Trend		
	lags	t-statistic	p-value	lags	t-statistic	p-value
Italy						
5y benchmark bond yield, Bloomberg	2	-2.366	0.152	2	-2.327	0.419
5y benchmark bond yield, Reuters	0	-2.575	0.098*	0	-2.531	0.313
5y OIS EUR rate	0	-2.859	0.052*	0	-3.381	0.056*
5y CDS EUR ISDA CT2003	8	-3.025	0.033**	8	-3.067	0.115
5y CDS USD ISDA CT2014	1	-2.915	0.044**	1	-3.071	0.114
5y CDS USD ISDA CT2003	1	-3.705	0.004***	1	-3.702	0.022**
5y Tradeweb liquidity indicator	3	-5.046	0.000***	3	-5.549	0.000***
10y KfW-Bund spread	1	-1.473	0.547	1	-3.927	0.011**
Spain						
5y benchmark bond yield, Bloomberg	0	-2.037	0.271	0	-3.584	0.031**
5y benchmark bond yield, Reuters	0	-2.215	0.201	0	-3.986	0.009***
5y CDS EUR ISDA CT2003	8	-1.947	0.311	8	-2.890	0.166
5y CDS USD ISDA CT2014	1	-3.121	0.025**	1	-3.758	0.019**
5y CDS USD ISDA CT2003	0	-2.420	0.136	0	-3.391	0.053*
5y Tradeweb liquidity indicator	1	-2.592	0.095*	1	-2.697	0.238
France						
5y benchmark bond yield, Bloomberg	0	-2.034	0.272	0	-3.043	0.121
5y benchmark bond yield, Reuters	0	-1.815	0.373	0	-2.591	0.285
5y CDS EUR ISDA CT2003	4	-2.629	0.087*	4	-3.320	0.063*
5y CDS USD ISDA CT2014	1	-2.759	0.065*	1	-3.052	0.119
5y CDS USD ISDA CT2003	0	-2.175	0.216	0	-2.792	0.200
5y Tradeweb liquidity indicator	4	-2.291	0.175	4	-2.632	0.266
Germany						
5y benchmark bond yield, Bloomberg	0	-2.079	0.254	0	-2.757	0.214
5y benchmark bond yield, Reuters	0	-2.050	0.266	0	-2.830	0.187
5y CDS EUR ISDA CT2003	3	-2.976	0.037**	3	-3.291	0.068*
5y CDS USD ISDA CT2014	0	-2.223	0.198	0	-2.445	0.356
5y CDS USD ISDA CT2003	0	-1.951	0.309	0	-2.459	0.349
5y Tradeweb liquidity indicator	0	-3.748	0.004***	0	-3.822	0.016**

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table F.2: Johansen VAR-based cointegration tests

Johansen's Trace and a Max-Eigenvalues cointegration (CI) test outcomes. Two model specifications are considered: the CI relationships have a non-zero intercept but no trend (left), and a non-zero intercept and a linear trend (right). Lag length selection minimized the BIC. The number of CI relationships is detected by sequential testing at a 5% significance level. Critical values based on MacKinnon-Haug-Michelis (1999).

	Intercept No Trend	Intercept Trend
Italy		
Trace	2	2
Max-Eig	2	2
Spain		
Trace	3	3
Max-Eig	1	2
France		
Trace	1	2
Max-Eig	1	1
Germany		
Trace	3	3
Max-Eig	3	3

Table F.3: ADF test on convenience yield

T-statics and p-values of Augmented Dickey Fuller (ADF) tests performed on convenience yield estimates for each country. The test regression includes an intercept. Lag length selection is based on minimal BIC, with the maximum number of lags set to ten. MacKinnon (1996) one-sided p-values are reported, assuming that the CI vector is known. The ADF null hypothesis states that the respective time series has a unit root.

	lags	t-statistic	p-value
Segmentation premium, Italy	2	-2.889	0.047**
Segmentation premium, Spain	1	-4.112	0.001***
Segmentation premium, France	1	-2.779	0.062*
Segmentation premium, Germany	3	-2.474	0.122

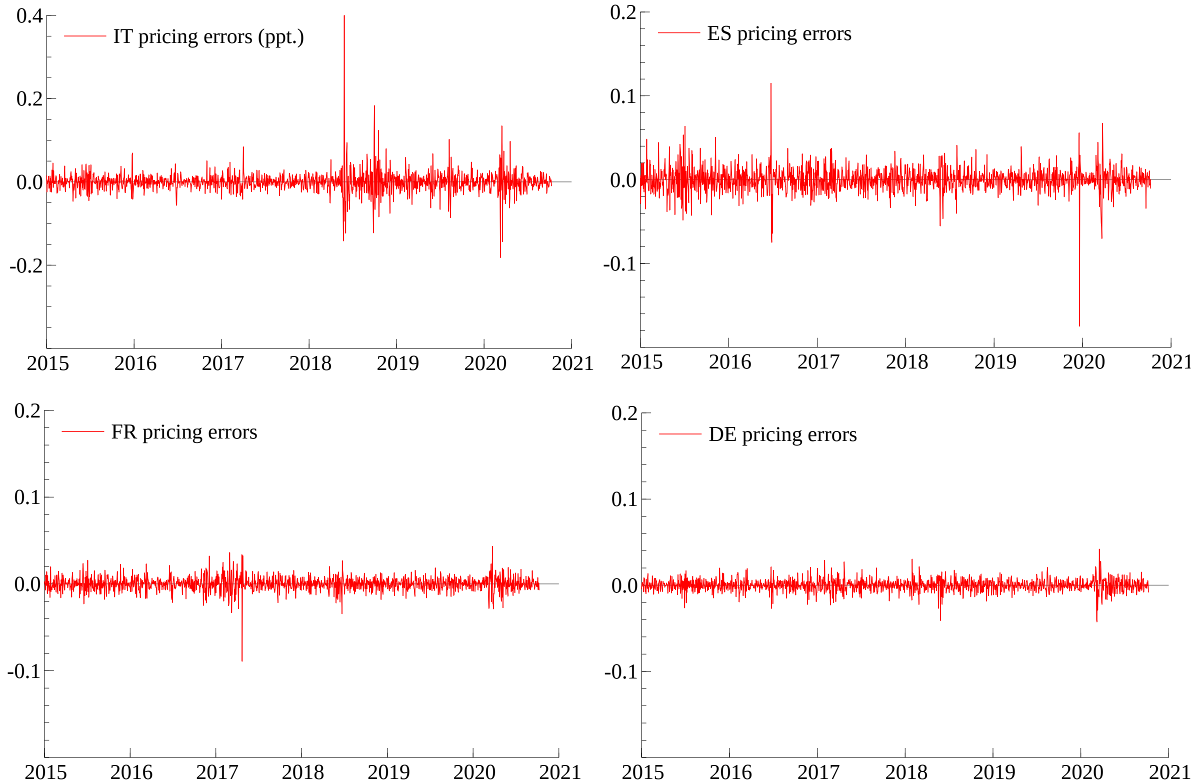
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

F.2 Bond pricing errors

This section discusses the sovereign bond pricing errors associated with our statistical model. Figure F.1 plots the bond pricing errors $v_t = \frac{1}{2}(\epsilon_{1t} + \epsilon_{2t})$, in percentage points, where ϵ_t is defined in Equation (2). The pricing errors are zero on average and visibly close to white noise processes. In particular, the pricing errors are serially uncorrelated and only subject to minor volatility clustering (serial correlation in the second moment). The mean absolute pricing error is 1.5 bps, 1.0 bps, 0.6 bps, and 0.5 bps for IT, ES, FR, and DE bonds, respectively.

Figure F.1: Pricing errors

Pricing errors from the empirical model fitted to IT, ES, FR, and DE five-year sovereign yields. The vertical axes are in percentage points.



G Additional event study results

G.1 Changes in ECB collateral rules

The ECB eased its collateral policies twice in April 2020: on 7 and 22 April. On 7 April, the ECB decided to reduce its collateral haircuts by 20 percent, thereby increasing the liquidity banks can mobilise for any given amount of collateral. On 22 April 2020, the ECB decided to accept downgraded bonds in its eligible collateral pool, effectively lowering the credit rating threshold for asset eligibility in credit operations by two notches from BBB- to B-.

Table G.1 presents the associated impact estimates. We do not find any easing effect on sovereign yields from the 7 April announcement. A potential explanation is that the collateral easing measure had already been anticipated by the market. Alternatively, the effect could be swamped by other events happening at around the same time.

The middle panel in Table G.1 suggests that the 22 April announcement had a statistically and economically significant easing effect only on Italian yields. The model attributes the decrease in Italian yields mainly to a lower default risk premium (by 13 bps), redenomination risk premium (by 3 bps) and segmentation premium (by 2 bps). A strong effect on Italian yields is intuitive: Italian bonds were at risk of being downgraded to junk-status at the time, and the new collateral rules meant that Italian banks would not be cut off from accessing Eurosystem credit operations if a downgrade were to materialise. On the other hand, the impact of the 22 April announcement could also be in part influenced by the EU's fiscal policy announcement on the following day (see Table 3). When considering the 21 and 22 April as the relevant event window, there is no stabilising effect on Italian yields. The impact of both collateral easing announcements is therefore more uncertain.

Table G.1: ECB collateral rules: Event study parameter estimates

Parameter estimates associated to the event study regression (4). The additional event dates are 7 April and 22 April 2020. The bottom panel (21 April 2020) refers to a robustness check. We consider two-day event windows. P-values are based on Newey and West (1987) HAC standard errors with a one lag bandwidth.

	(1) 5Y Bond Yield	(2) Short Rate & Term Premium	(3) Default Risk Premium	(4) Redenomination Risk Premium	(5) Liquidity Risk Premium	(6) Segmentation Premium
7 April 2020						
Italy	19.04***	4.38*	5.58**	1.75*	-0.72	2.65*
	(4.87)	(2.45)	(2.17)	(0.93)	(0.54)	(1.42)
Spain	8.12***	4.38*	1.42	0.33	-1.01***	1.84***
	(2.38)	(2.45)	(1.65)	(0.85)	(0.39)	(0.60)
France	8.07**	4.38*	-0.24	0.03	-0.37**	2.21***
	(3.38)	(2.45)	(0.52)	(0.26)	(0.17)	(0.62)
Germany	7.31**	4.38*	-0.01	0.22	-0.30	1.65***
	(3.20)	(2.45)	(0.34)	(0.27)	(0.28)	(0.58)
22 Apr 2020						
Italy	-25.72***	1.38	-12.71***	-3.31***	-0.48**	-2.11***
	(3.35)	(1.75)	(1.64)	(0.36)	(0.22)	(0.16)
Spain	3.77	1.38	-2.64	0.04	-0.69***	2.40**
	(7.45)	(1.75)	(2.91)	(0.72)	(0.26)	(1.04)
France	-2.10	1.38	-1.25	-0.75***	-0.65***	-1.10**
	(5.00)	(1.75)	(0.83)	(0.28)	(0.13)	(0.49)
Germany	3.70	1.38	0.03**	-0.32***	-0.53***	1.12***
	(2.75)	(1.75)	(0.01)	(0.10)	(0.10)	(0.11)
21 Apr 2020						
Italy	11.53	3.58***	1.19	2.13	-0.25	3.20
	(21.90)	(0.66)	(5.31)	(2.36)	(0.34)	(2.55)
Spain	17.33***	3.58***	4.93***	3.06***	0.47	2.07*
	(0.71)	(0.66)	(0.87)	(0.79)	(0.83)	(1.21)
France	4.11**	3.58***	2.24**	0.72	-0.33	-1.30**
	(1.91)	(0.66)	(0.91)	(0.46)	(0.29)	(0.59)
Germany	2.20	3.58***	0.48**	-0.34***	-0.33*	-0.23
	(3.51)	(0.66)	(0.23)	(0.09)	(0.20)	(0.78)

G.2 PSPP-related events

The ECB modified its Asset Purchase Programme (APP) several times; see e.g. Koijen, Koulischer, Nguyen, and Yogo (2021). This subsection focuses on key dates when the ECB modified the amount of purchases per month.

On 10 March 2016, monthly purchases under the APP were expanded to €80 billion, starting on 1 April 2016. On the same date, the ECB announced a decrease of the deposit facility rate to -0.4%, as of 16 March 2016, and the launch of the Corporate Sector Purchase Programme (CSPP).

On 8 December 2016, the ECB announced that purchases of €80 billion per month would decrease to €60 billion, as of April 2017. In addition, the ECB modified the eligibility criteria for purchases in two ways. First, the minimum maturity threshold for eligibility was decreased from two years to one year. Second, purchases under the PSPP of securities with a yield below the deposit facility rate were now permitted. In addition, the ECB announced an easing of security lending terms: Eurosystem members would have made securities lending available also against cash collateral, as of 15 December 2016.

On 26 October 2017, the ECB announced that the net asset purchases were intended to continue at a monthly pace of €30 billion, from January 2018 to September 2018.

Finally, on 14 June 2018, the ECB announced that the pace of monthly purchases would be reduced to €15 billion, from January 2018 until the end of December 2018.

Table G.2 presents the associated impact estimates. The impact estimates are generally in the single digit basis points, and not always statistically significant. In particular, the impact estimates tend to be smaller than those relating to the ECB's PEPP announcements on 18 March and 4 June 2020; see Table 2.

Table G.2: PSPP: Event study parameter estimates

Parameter estimates associated to the event study regression (4). The additional event dates are 10 March 2016, 8 December 2016, 26 October 2017 and 14 June 2018. We consider two-day event windows. P-values are based on Newey and West (1987) HAC standard errors with a one lag bandwidth.

	(1) 5Y Bond Yield	(2) Short Rate & Term Premium	(3) Default Risk Premium	(4) Redenomination Risk Premium	(5) Liquidity Risk Premium	(6) Segmentation Premium
Italy						
10-March-2016	-4.79	4.05	-10.27***	-2.20***	0.05	0.42***
	(4.37)	(3.29)	(0.33)	(0.17)	(0.10)	(0.15)
8-Dec-2016	2.37	-2.23***	1.54	1.76***	0.23	-1.86***
	(2.96)	(0.66)	(0.94)	(0.16)	(0.20)	(0.16)
26-Oct-2017	-6.80*	-4.98***	-0.55*	-0.35**	0.12**	-0.91***
	(3.88)	(1.58)	(0.33)	(0.16)	(0.05)	(0.27)
14-June-2018	-32.33***	-8.14***	-8.63***	-5.10***	-0.82***	-7.53***
	(4.57)	(0.71)	(1.45)	(0.59)	(0.07)	(0.48)
Spain						
10-March-2016	-5.65	4.05	-9.86***	-2.30***	-0.02	-0.05
	(4.41)	(3.29)	(0.71)	(0.38)	(0.35)	(0.37)
8-Dec-2016	-2.94	-2.23***	1.54***	0.68***	0.24**	-4.10***
	(3.36)	(0.66)	(0.45)	(0.12)	(0.10)	(0.48)
26-Oct-2017	-2.89	-4.98***	0.74	-0.13	0.36	-0.11
	(6.14)	(1.58)	(0.99)	(0.28)	(0.22)	(0.97)
14-June-2018	-9.90***	-8.14***	-2.55	0.02	-0.34***	0.39*
	(1.14)	(0.71)	(1.78)	(0.12)	(0.08)	(0.21)
France						
10-March-2016	4.26	4.05	-0.97***	-0.41**	-0.39***	0.62
	(7.38)	(3.29)	(0.22)	(0.19)	(0.11)	(0.45)
8-Dec-2016	-5.00***	-2.23***	0.06	0.03	0.25	-1.81***
	(0.66)	(0.66)	(0.29)	(0.05)	(0.23)	(0.64)
26-Oct-2017	-10.11***	-4.98***	-0.25***	-0.27***	0.06***	-2.06***
	(0.20)	(1.58)	(0.03)	(0.06)	(0.02)	(0.25)
14-June-2018	-8.65***	-8.14***	-0.35***	0.26***	0.08**	-0.62
	(3.08)	(0.71)	(0.13)	(0.02)	(0.04)	(0.52)
Germany						
10-March-2016	6.61	4.05	-1.18***	0.06	-0.03	1.88***
	(6.65)	(3.29)	(0.45)	(0.27)	(0.27)	(0.11)
8-Dec-2016	-7.66***	-2.23***	-0.05	-0.52***	0.12	-3.26***
	(0.14)	(0.66)	(0.22)	(0.13)	(0.26)	(0.52)
26-Oct-2017	-10.26***	-4.98***	-0.22***	-0.21	0.21	-2.21***
	(0.74)	(1.58)	(0.08)	(0.15)	(0.16)	(0.14)
14-June-2018	-7.71***	-8.14***	0.23	0.23	-0.20***	0.57***
	(1.96)	(0.71)	(0.36)	(0.15)	(0.01)	(0.16)

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