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Sovereign yield spreads during the Euro-crisis – Fundamental factors versus redenomination risk*)

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Sovereign yield spreads during the Euro-crisis – Fundamental factors versus redenomination risk

Abstract: The intensity of the Euro-crisis was reflected by significant increases of sovereign bond yields in the troubled countries. This has launched a hot debate whether this increase can solely be attributed to fundamental factors like e.g. rescue programmes, rising budget deficits, deteriorating economic prospects or changes in the rating-status of the country, or whether a part of these growing yields is likely to represent a systemic risk, i.e. that one or more countries will drop out of the European Monetary Union and reintroduce their own national currencies. This empirical analysis explores whether such systemic risk is present in the yield spreads of nine Euro area countries by using a novel market based indicator from the virtual prediction market Intrade. Our empirical results suggest that beside fundamental factors a systemic risk component played a role in determination of sovereign yields. Our empirical measure of the systemic component in sovereign yields can be related to the expected change of the newly introduced national currency. Accordingly to that, Portugal, Ireland, Spain and Italy are expected to depreciate their currency while the others would appreciate after a withdrawal from the Euro area.

"Risk premia that are related to fears of the reversibility of the Euro are unacceptable, and they need to be addressed in a fundamental manner."(ECB-President Mario Draghi, August 2012)

"Es gibt fundamentale Zweifel der Märkte an der Sicherheit der Währungsunion." (Bundesbankpresident Jens Weidmann, July 2012)

1. Introduction

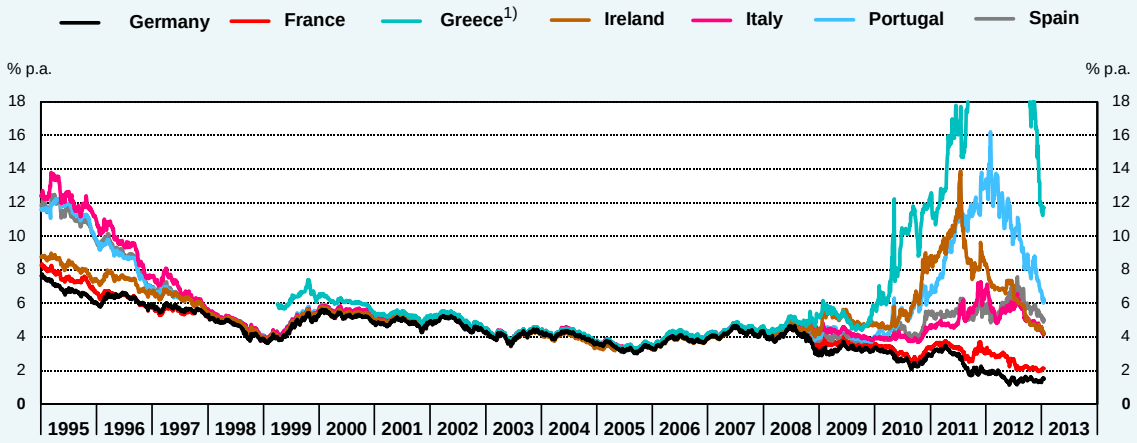
The European debt crisis that unfolded in 2010 has culminated in a deep crisis of confidence, raising fundamental doubts over the integrity of the Euro area: While the European treaties do not provide any explicit option to exit the European Monetary Union (EMU), evidence has been mounting that market participants nevertheless seem to expect that one or more members of the Euro area might exit. The redenomination risk – the risk that a country will unilaterally exit the EMU and redenominate its public and private liabilities– that was perceived by financial markets finally led *ECB-President Mario Draghi* to announce that the ECB "will do whatever it takes" to preserve the integrity of the Euro area in August 2012. Opinions regarding the existence of such redenomination risks are divided among economists, though. Therefore, we analyse empirically in this paper whether we find some evidence that such risk contribute(d) to the observed rising yield spreads across Euro area countries.

Becoming a member of the EMU meant to establish a life-long relationship that comes with costs and benefits. In retrospect, benefits inter alia arose with the introduction of the Euro when long-term interest rates for virtually all member countries converged to the level of Germany (Chart 1) initiating a strong credit demand in parts of the EMU: In Ireland and Spain borrowing was mostly done in the private sector (Lane, 2011; Bielsa and Duarte, 2011), in

Italy in the public sector and in the case of Greece (Lane, 2012) in both the private and public sector (Antzoulatos, 2011).

Chart 1

10 years government bond yields of selected countries in the Euro area



1) From 05.09.2011 to 12.10.2012 permanent over 18 % p.a.; figures in between not been given for enhanced legibility.

Source: Thomson Financial Datastream

With the outbreak of the crisis in the Euro area the potential costs of being a member of the EMU were revealed. Membership in the EMU implies that the countries are indebted in a currency which they cannot generate themselves and therefore troubled member countries cannot rely on monetary policy tools to either foster external devaluation to support the necessary real adjustments to regain price competitiveness or to finally rely on inflation to diminish the real value of nominal private and public debt. Instead, these countries have to sustain a long lasting and painful process of internal devaluation and if the fiscal position is not well balanced sustained fiscal austerity.

Given these disconcerting prospect of the road ahead, policy makers in the troubled countries might consider an exit from EMU to regain access to monetary policy tools. But also creditor countries might consider to exit from EMU, since in these countries political support for membership in the EMU is likely to dwindle with each additional rescue package potentially resulting in “rescue fatigue” putting pressure on domestic policy makers to leave the EMU. All these – yet hypothetical– considerations change the state of play in the currency union: If there was a fundamental change in expectations about the reversibility of the Euro, this would – at least to some degree – influence sovereign bond yields of EMU countries as they consequently include a risk premium for the expected exchange rate after the exit from the EMU.

In this paper we explore the association between market sentiments towards a (partial) disintegration of the Euro area and sovereign bond yields between September 2011 and August 2012. To proxy these market sentiments we use a novel indicator that is derived from the virtual trading platform INTRADE and is based on market expectations of the event that at least one country will leave the Euro area by the end of 2013. Using this indicator in an economet-

ric framework for estimating daily interest rate spreads shows that interest rates seem to correlate with expectations about countries leaving the EMU. Extending our regression analysis to a framework with time-varying coefficients reveals that this correlation is not constant over time: For most countries, the correlation between yield spreads and our proxy for the expectations about a break-up of the EMU is highest in times of market tension up to November 2011 and just before summer 2012.

We proceed as follows: In section 2 we present the theoretical framework and the related literature, followed by section 3 which provides an exposition of our econometric framework and the data used, while section 4 and 5 present the results emerging from the fixed- and variable-coefficient approaches. Section 6 delivers a range of robustness checks, before section 7 finally concludes.

2. Theoretical background and related literature

To develop our argument how the redenomination risk impacts sovereign yield spreads in a currency union, we follow and later extend the theoretical exposition of Bernoth, von Hagen and Schuknecht (2012): From a stylized portfolio model a reduced form equation can be derived that relates yield spreads between a risky (r_j) and a risk-free bond issuer (r^*) to a set of "fundamentals":

$$(1)\ r_j - r^* = p_{D,j}(F_j)HC_j + l_j + \Phi$$

with $p_{D,j}(F_j)HC_j$ representing the expected loss that may materialize in case of default with $p_{D,j}$ denoting the probability of default of sovereign j given fundamental factors F_j and HC_j denoting the expected haircut on the principle value. Accordingly, investors will demand higher yields if expected losses increase, demand a liquidity premium l compared to a risk free and fully liquid asset and demand a premium Φ depending on investors' degree of risk aversion.

An increasing global risk aversion may result in larger flows of capital to countries viewed as more solid, even though in such a "safe haven" the yields would probably be lower rendering the country specific impact on spreads ambiguous: Capital flows have recently concentrated on a few countries in the Euro area (e.g. Germany), while others suffered from a relatively low demand for their government bonds. But one could also observe a net outflow of liquidity from the Euro area during the debt crisis which signals global capital flows to be redirected to other parts of the world presumed to provide a safe haven.

Also the liquidity of the various government bonds will most likely influence the yield spread, with lower (higher) liquidity, leading to higher (lower) yield spreads. Liquidity is frequently measured by the bid-ask-spread of the underlying asset (Beber, Brandt, and Kavajecz 2009; Gerlach, Schulz, and Wolff 2010; Bernoth and Erdogan 2012), so a lower (higher) bid-ask-spread indicates a higher (lower) liquidity.

However, one of most important factors for interest rate spreads are fundamentals of the sovereign borrower and its national economy that directly influence the expected loss of investors like, e.g., a sovereign's debt level, its budget balance and expected GDP growth. Therefore, yield spreads are supposed to be higher for higher perceived risks of default of the bond issuer. A whole strand of the literature analyses these fundamental factors, e.g., budget deficits, GDP growth or debt levels, that may ultimately have a direct impact and confirms the importance of those factors for yields spreads (e.g. Bernoth, Von Hagen, and Schuknecht 2012; Aizenman, Hutchison, and Jinjarak 2011; Dötz and Fischer 2010; Haugh, Ollivaud, and Turner 2009).

Moreover, increasing spreads after the break-out of the financial crisis in 2008 have been subject to many studies so far (e.g. von Hagen, Schuknecht, and Wolswijk 2011; Dötz and Fischer 2010; Favero and Missale 2012). Several studies find that this increase in sovereign bond yields (relative to the German Bunds) cannot be sufficiently explained by fiscal or other fundamental factors (De Grauwe and Ji 2012; International Monetary Fund 2012). But as recently as 2012, Favero and Missale (2012), analysing data up to June 2011, conclude that the "non-default components [of spreads] are unlikely to reflect expectations of depreciation".

However, when yields of troubled countries skyrocketed in the second half of 2011 and again in spring 2012 this casts at least some doubts on whether this was purely driven by fundamentals that do exclude any expectations about a fundamental change in the institutional set-up of the monetary union, i.e. for some member countries there are doubts – well founded or not – about their commitment to the common currency eventually reintroducing a national currency and redenominating sovereign debt. In this case investors need to price in the probability of regime switch and the expected rate of devaluation $p_{Exit,j}\left(\frac{\Delta E}{E}\right)$vis-à-vis the common currency adds to the above-mentioned fundamental factors:

$$(2)\ r_j - r^* = p_{D,j}(F_j)HC_j + l_j + \Phi + p_{Exit,j}\frac{\Delta E}{E}$$

In a fully credible currency union the probability to exit the union is zero and investors do not care about redenomination risk.

Once the probability is non-zero, we are entering a regime with a fixed exchange rate that also entails the risk of exchange rate readjustments: Investors that invest in a foreign currency will consider potential changes of their asset value (including interest payments) that may result from exchange rate fluctuations. Most importantly, from the perspective of a single member country investor's expectations about the integrity of the currency union are crucial. If market expectations turn against a member country its yield spread may increase significantly and turn self-fulfilling because a member country itself cannot convince markets credibly to not exit the currency union. This is what many commentators of the Euro crisis coined the systemic risk or systemic element of the crisis (German Council of Economic Experts 2012). Among others, De Grauwe (2011) discusses these self-fulfilling speculations in the context of a currency union with sovereigns facing roll-over risk of existing debt. Additionally, the exit of one country will most likely lead to contagion effects potentially forcing other member countries to drop out of the monetary union which may eventually even lead to a complete

break-up of the Euro area. In any case, with a non-zero exit probability the expectation rate of appreciation (depreciation) may play an important role for the individual sovereign as it will decreases (increases) yield spreads today.

One of the first contributions that dealt implicitly with the perceived risk of one country withdrawing from the EMU is Eichler (2011). Using data from American depositary receipt (ADR) of underlying stocks from Spain, Italy, Greece, Ireland and Portugal for the period of January 2007 until March 2009, this study finds some evidence that even during that time which was long before the intense phase of the crisis, investors priced-in the risk of a withdrawal but concludes that the perceived risk over the given time period is rather small. To the best of our knowledge, so far only Di Cesare et al.(2012) using data up to spring 2012 have explicitly dealt with the issue of a systemic crisis, finding that this component plays a significant role in determining yield spreads. Unfortunately, this study takes only differences of German and Italian bond yields into account. They find that the risk of a Euro area break-up, approximated by the corresponding Google indicator for this phrase, indeed leads to an implied appreciation of the (hypothetically) newly introduced German and a depreciation of the Italian currency vis-à-vis the Euro.

3. Econometric framework

Our econometric approach resembles the reduced form equation (2). To proxy the impact of macroeconomic and fiscal fundamentals that influence the expected loss, entailing both the risk of default and the potential haircut on the principle and interest payments, we use the market price of credit default swaps (CDS) because CDS insure its holder against any financial losses resulting in an event of default of the issuer of the underlying asset. Consequently, CDS spreads should include all information available concerning an altered risk of default for each country, i.e. new information about rescue programmes, rising governmental deficits, revised GDP growth prospects (Aizenman, Hutchison, and Jinjarak 2011).In particular, by using CDS spreads we also capture the impact on bond markets of policy measures like the ECB's securities markets programme (SMP) or any rescue loan supplied to problem countries via the IMF, EFSF and ESM: These institutions implicitly demand seniority status increasing the expected loss of the remaining (then junior) debt.

Ultimately, for country j, the sovereign yield spread vis-a-vis the Euro will be determined by the four factors – fiscal and economic fundamentals, liquidity, expectations about a withdrawal from the Euro area and separately global as well as country specific risk aversion– simultaneously, as in equation (3) and (3a):

$$(3)\ r_{j,t} - r_t^{ECB} = \alpha_{1j}(BID - ASK)_{j,t-1} + \alpha_{2j}CDS_{j,t-1} + \alpha_{3j}Exit_{t-1} + \alpha_{4j}USBonds_{t-1} + \alpha_{5j}GARCH_{j,t} + \varepsilon_{j,t}$$

together with

$$\text{(3a) } GARCH_{j,t} = \beta_{0j} + \sum_{i=1}^{k} \beta_{i1j} \varepsilon_{j,t-i}^2 + \sum_{i=1}^{l} \beta_{i2j} \left(\varepsilon_{j,t-i}^2 \middle| \varepsilon_{j,t-i} < 0\right) + \sum_{i=1}^{m} \beta_{i3j} GARCH_{j,t-i}$$

The yield spread as the dependent variable is defined as the difference between the government bond yield of the respective Euro area country with a maturity of up to two years, and the risk-free rate which is the rate of the ECB deposit facility ($r_{j,t} - r_t^{ECB}$).[1] This rate can be considered as risk-free, because banks can deposit their excess funds at this rate overnight at the ECB. Additionally, there is virtually no liquidity risk for central bank assets allowing us to directly measure the liquidity premium for each country separately. This conditioning of the residual maturity to two years is done because of the exit probability which is bound to end with the year 2013. Although the maturity decreases in the sample this is the best approximation for most of the period under investigation. The liquidity premium and the default risk are modelled by the bid-ask-spread for government bonds ($(BID - ASK)_{j,t-1}$) and by the corresponding CDS premium for government bonds ($CDS_{j,t-1}$) respectively, both referring to a residual maturity of two years as well.

Our main focus is on the third term in (3) that should capture the risk premium stemming from the perceived risk of a country's withdrawal of the currency union ($Exit_{t-1}$). Unfortunately, no market based measure of exit probabilities for individual EMU is available. However, we use the probability that at least one member country will declare its exit from the monetary union by the end of 2013 (see Chart 2) which is derived from the internet platform INTRADE – a virtual prediction market that allows to predict real-world events by trading virtual securities whose predefined pay-off is conditioned on the particular real-world event to occur until maturity of the security. The procedure for trading these securities is as follows: If one or more member countries declare their exit before the end of 2013, the holders receive 10 US-Dollars, while the stock is worthless, if this is not the case. Therefore, the price of the stock (after re-scaling) can be interpreted as the subjective probability perceived by INTRADE participants of this underlying event. While this probability most likely reflects the probability of an exit of Greece,[2] our estimated coefficients for any other Euro area country have to be interpreted as the product of the conditional probability that this country will drop out of the monetary union because of the regime-shift introduced by the Greek exit and the expected rate of appreciation or devaluation of the newly introduced national currency. The estimated coefficients of the Exit variable can thus be interpreted as a proxy of the market's expectation of the probability weighted intensity of the appreciation (negative sign) or depreciation (positive sign) of a newly introduced national currency in comparison to the Euro today, when assuming that a Greek exit will lead to a complete break-up of the Euro-area. By assuming a conditional probability that country *j* will exit the currency union,

[1] Although the ECB deposit rate does have a lower maturity than the yield spreads, this is the best proxy we could think of as a risk-free rate because other rates other government yield are also possibly biased by their safe haven status.

[2] We cannot isolate if it is really Greek-exit that is reflected in the Exit indicator but in the European debt crisis Greece was mostly mentioned as a country possibly leaving the EMU. So we follow this argumentation.

$p_{exit,j|Greek-exit}$, after a Greek exit the exchange rate adjustment can be calculated as $\frac{\alpha_3}{p_{exit,j|Greek-exit}}$.

The fourth term is global risk aversion (*USBonds*) and is approximated by the US corporate BBB / government bond spreads as is frequently done in studies on bond yield estimations (Gerlach, Schulz, and Wolff 2010; von Hagen, Schuknecht, and Wolswijk 2011). Again the relevant assets have a maturity of up to two years. Summary statistics of all variables are provided in Table 1. To prevent reverse causality from biasing the results the right hand side variables are included with a one period lag.

Table 1

Summary statistics

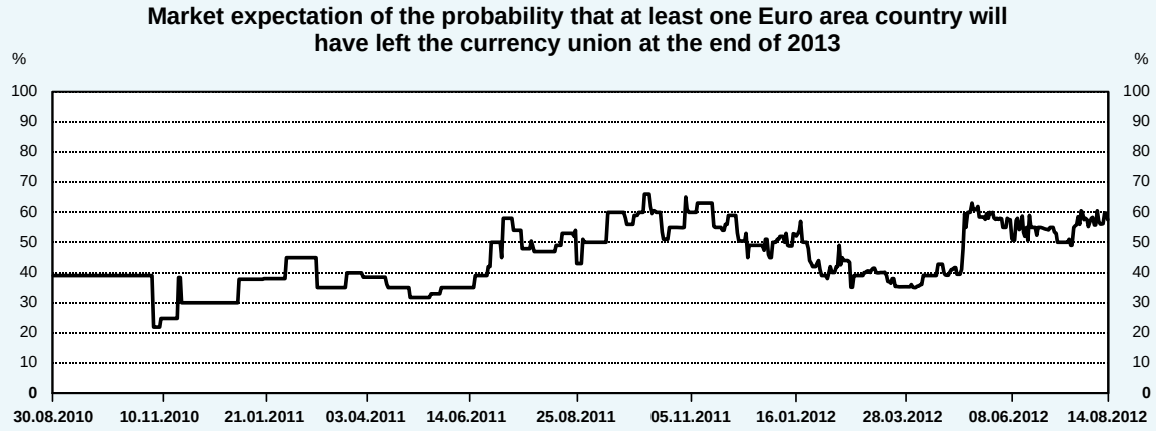
	Mean	Median	Maximum	Minimum	Standard Deviation
			Bond yield		
Austria	0,82	0,82	1,85	– 0,02	0,48
Belgium	1,53	1,65	4,61	0,18	0,67
France	0,77	0,72	1,77	– 0,04	0,44
Germany	0,41	0,06	1,70	– 0,34	0,58
Ireland	6,53	5,92	1,66	3,15	2,41
Italy	3,07	2,76	7,07	1,50	1,08
Netherlands	0,58	0,35	1,75	– 0,13	0,52
Portugal	1,01	1,02	2,12	2,83	4,79
Spain	3,14	2,99	6,77	1,75	0,90
			Bid-Ask-Spread		
Austria	0,26	0,24	1,02	0,09	0,11
Belgium	0,15	0,14	0,44	0,05	0,07
France	0,11	0,09	0,29	0,01	0,05
Germany	0,03	0,03	0,14	0,00	0,02
Ireland	1,59	1,53	3,92	0,00	0,72
Italy	0,04	0,04	0,13	– 0,39	0,04
Netherlands	0,04	0,04	0,11	0,00	0,02
Portugal	1,14	0,83	6,15	0,12	1,15
Spain	0,26	0,23	1,94	0,10	0,14
			Credit Default Swap		
Austria	0,53	0,48	1,28	0,08	0,28
Belgium	1,22	1,07	3,25	0,34	0,61
France	0,57	0,51	1,42	0,14	0,31
Germany	0,20	0,15	0,58	0,04	0,13
Ireland	6,73	6,03	1,44	2,91	2,16
Italy	2,38	2,55	5,42	0,28	1,47
Netherlands	0,36	0,53	0,82	0,03	0,20
Portugal	9,51	9,82	2,19	2,29	4,94
Spain	2,50	2,61	4,77	0,72	1,01
Euro-break up	0,44	0,42	0,66	0,22	0,10
Global risk premium	1,97	2,01	2,73	1,33	0,28

Finally, since equation (3) is estimated on a daily basis, a measure of the country specific volatility in yields spreads is introduced as well by adding the response to a GARCH-in-mean term (*GARCH*). This allows us to capture the impact of investors' country specific risk aversion on yields that results from changes in volatility of yields. In general, an increased volatility of the yield spread should increase the level of yield spreads because the predictability of

the bond value at a specific future point in time is lower resulting in a higher risk premium. The specific structure of the country specific volatility term (3a) follows the approach of Hallwood, MacDonald and Marsh (2000) and includes a constant, an ARCH-term, i.e. the lagged residual variance of the mean-equation given by (3), a threshold ARCH term, i.e. the lagged residual variance of the mean-equation given that the residuals are negative. This accounts for the fact that the reaction to positive and negative residuals may be asymmetric, i.e. that the volatility of rising spreads is larger than to falling spreads (Glosten, Jagannathan, and Runkle 1993). Finally the lagged GARCH term itself is introduced to the volatility equation to account for persistence in volatility. The individual lag structure of the ARCH, TARCH and GARCH term is optimized using the mode of the minimum of the Akaike-, Schwarz- and Hannan-Quinn-criterion (see Table 2). Moreover, the error term is not assumed to be normally distributed. Therefore, we introduce the General Normal Distribution (GED) which covers the Normal Distribution as a special case, if the GED-parameter is not statistically different from 2. However, with tail risks in European financial markets in the recent financial crisis on may expect a GED-parameter below 2.

The exit variable is available from August 2010 but it is obvious from Chart 2 that the market was rather illiquid up to September 2011. Therefore, the analysis is conducted from September 2011 onwards, as after this date the traded volumes in the market point to more liquidity. The end of the sample period is chosen to the 14th August 2012 due to data availability.

Chart 2



The member countries included in our analysis are: Austria, Belgium, Germany, France, Ireland, Italy, the Netherlands, Portugal and Spain. Estimations were also carried out for Greece but remained inconclusive, mainly due to the relatively large bond yields and CDS premia but also because of the debt haircut in March 2012.

Table 2

Information criteria for estimates of yield spreads for Euro area countries

Lags	Austria			Belgium			France			Germany			Ireland			Italy			Netherlands			Portugal			Spain		
	AIC	SW	HQ	AIC	SW	HQ	AIC	SW	HQ	AIC	SW	HQ	AIC	SW	HQ	AIC	SW	HQ	AIC	SW	HQ	AIC	SW	HQ	AIC	SW	HQ
ARCH																											
1	– 0,52	– 0,37	– 0,46	0,02	0,16	0,08	0,03	0,17	0,08	**– 1,63**	**– 1,49**	**– 1,58**	**1,19**	**1,33**	**1,25**	1,34	**1,48**	1,40	– 1,35	**– 1,21**	**– 1,29**	**5,08**	**5,22**	**5,14**	**1,20**	**1,34**	**1,26**
2	– 0,71	– 0,55	– 0,65	– 0,13	0,02	– 0,07	– 0,26	– 0,11	– 0,20	– 1,44	– 1,28	– 1,37	1,70	1,86	1,77	**1,33**	1,49	**1,39**	**– 1,35**	– 1,20	– 1,29	5,44	5,60	5,51	1,21	1,36	1,27
3	– 0,79	– 0,62	– 0,72	– 0,16	**0,01**	**– 0,09**	– 0,32	**– 0,15**	– 0,25	– 1,46	– 1,29	– 1,39	1,75	1,91	1,81	1,34	1,51	1,41	– 1,33	– 1,17	– 1,27	5,40	5,57	5,47	1,22	1,38	1,28
4	– 0,72	– 0,54	– 0,65	– 0,16	0,03	– 0,08	– 0,24	– 0,06	– 0,17	– 1,48	– 1,30	– 1,40	2,32	2,50	2,39	1,36	1,54	1,43	– 1,30	– 1,11	– 1,22	5,19	5,37	5,27	1,25	1,43	1,32
5	**– 0,82**	**– 0,63**	**– 0,74**	– 0,17	0,03	– 0,09	– 0,28	– 0,08	– 0,20	– 1,53	– 1,33	– 1,45	2,32	2,51	2,40	1,34	1,54	1,42	– 1,32	– 1,12	– 1,24	5,41	5,61	5,49	1,23	1,43	1,31
6	– 0,08	0,13	0,00	**– 0,17**	0,04	– 0,09	**– 0,34**	– 0,13	**– 0,26**	– 1,37	– 1,15	– 1,28	2,33	2,54	2,41	1,36	1,57	1,45	– 1,31	– 1,10	– 1,23	5,49	5,71	5,58	1,81	2,02	1,90
GARCH																											
1	**– 0,82**	**– 0,63**	**– 0,74**	**– 0,16**	**0,01**	**– 0,09**	**– 0,34**	**– 0,13**	**– 0,26**	**– 1,63**	**– 1,49**	**– 1,58**	**1,19**	**1,33**	**1,25**	**1,33**	**1,49**	**1,39**	– 1,35	**– 1,21**	**– 1,29**	**5,08**	**5,22**	**5,14**	1,20	1,34	1,26
2	– 0,24	– 0,03	– 0,15	– 0,13	0,06	– 0,05	– 0,22	0,01	– 0,13	– 1,54	– 1,38	– 1,48	1,28	1,44	1,35	1,35	1,52	1,42	– 1,33	– 1,17	– 1,26	5,09	5,25	5,15	1,18	1,34	1,24
3	0,06	0,29	0,16	0,03	0,22	0,11	– 0,16	0,08	– 0,06	– 1,37	– 1,20	– 1,30	1,65	1,82	1,72	1,35	1,53	1,42	– 1,32	– 1,15	– 1,25	5,10	5,27	5,17	1,24	1,41	1,31
4	– 0,25	– 0,01	– 0,15	– 0,14	0,07	– 0,05	0,03	0,29	0,14	– 1,36	– 1,18	– 1,29	2,40	2,59	2,48	1,36	1,56	1,44	**– 1,36**	– 1,18	– 1,29	5,14	5,32	5,21	**1,16**	**1,35**	**1,24**
TARCH																											
0	– 0,18	0,01	– 0,10	0,72	0,87	0,78	– 0,10	0,10	– 0,02	– 1,40	– 1,28	– 1,35	2,29	2,42	2,34	2,28	2,43	2,34	– 1,36	**– 1,23**	**– 1,30**	5,39	5,52	5,44	2,28	2,45	2,34
1	**– 0,82**	**– 0,63**	**– 0,74**	**– 0,16**	**0,01**	**– 0,09**	**– 0,34**	**– 0,13**	**– 0,26**	– 1,63	– 1,49	– 1,58	**1,19**	**1,33**	**1,25**	**1,33**	**1,49**	**1,39**	– 1,35	– 1,21	– 1,29	5,08	5,22	5,14	**1,16**	**1,35**	**1,24**
2	– 0,58	– 0,37	– 0,50	– 0,14	0,05	– 0,06	– 0,26	– 0,03	– 0,17	– 1,74	**– 1,58**	**– 1,68**	1,43	1,58	1,49	1,34	1,51	1,41	– 1,33	– 1,17	– 1,26	**5,07**	**5,23**	**5,14**	1,23	1,42	1,31
3	– 0,37	– 0,15	– 0,28	– 0,10	0,10	– 0,02	– 0,28	– 0,04	– 0,19	**– 1,74**	– 1,57	– 1,67	1,44	1,61	1,51	1,34	1,52	1,41	– 1,32	– 1,15	– 1,25	5,08	5,25	5,15	1,74	1,95	1,82
4	– 0,59	– 0,35	– 0,50	– 0,13	0,08	– 0,04	– 0,21	0,04	– 0,11	– 1,43	– 1,25	– 1,36	1,77	1,96	1,85	1,36	1,56	1,44	**– 1,37**	– 1,18	– 1,29	5,10	5,28	5,17	1,24	1,47	1,33

AIC: Akaike criterion, SW: Schwarz Criterion, HQ: Hannan-Quinn criterion; bold numbers signal minimum of criteria; optimal lag length chosen if two or more information criteria point to a minimum.

4. Estimation results

Equations (3) and (3a) are estimated simultaneously via Maximum-Likelihood. The estimation results are presented in Table 3. In line with our expectations, the bid-ask-spread – our proxy for market liquidity – is found to have a significantly positive impact on the yield spreads for six Euro area countries. Only with respect to Germany and Ireland the reverse seems to be true. For the global risk aversion, captured by the US Corporate/Government bond spread, all nine countries show the expected positive influence on government yield spreads. That is, global safe haven flows tend to go out of the Euro area and are thus not intra monetary union flows. With the exception of Portugal, also the volatility premium (GARCH) exhibits the expected positive influence on the bond yield spread. Quantitatively, the influence of the country specific volatility is most important in the case of Ireland, Italy and Spain, the three countries with the most pronounced swings in sovereign yields during the respective time period.

Concerning the influence of default risks within the EMU as reflected by the corresponding CDS premium, the results show a heterogeneous picture among Euro area countries. While the effects are the largest for Portugal and Spain, pointing to a high influence of any news on yield spreads, they are found to be lower for France and Italy. So the response of the government yield spreads on CDS premia is even stronger for those countries with the highest risk of default. In contrast, for Germany and the Netherlands which are the two countries in the sample with the lowest yield spreads, rising CDS premia even lead to lower yield spreads, although for the Netherlands the coefficient is insignificant. This puzzling result might be explained by the safe haven status of both countries. While the periods of rising default risk for these two countries correspond to an overall increase of the CDS premium for all Euro area countries, Germany and the Netherlands receive safe haven flows as the less default risky countries thereby lowering their bond yields. Therefore, safe haven flows might be seen either in the global risk aversion but also in the Euro area wide risk aversion which becomes evident in the CDS spreads.

The market based expectations with respect to an exchange rate adjustment in case of a Euro area break-up, measured by our Exit variable, clearly divide the Euro area into two groups. The first group comprises Portugal, Ireland, Spain and Italy which are all expected to depreciate their currency after a break-up. This depreciation would consequently lead to a lower repayment, once their debt matures, if it is redenominated into their new national currency. However, the size of the depreciation is rather limited with 0.68% for Italy, 3.04% for Spain and 5.09% for Ireland assuming that a Greek exit will lead to a Euro area break-up. But for Portugal the estimates imply that a break-up of the Euro area would lead to a depreciation of 10.74%, so bondholders would face an indirect haircut of more than 10%. The second group, France, the Netherlands, Germany, Austria and Belgium are expected to appreciate their currency after a Euro area break-up. This appreciation would be in the range of 2.45% to 0.01%, thus leading to higher repayments at maturity. Di Cesare et al. (2012) come up with similar results of their Euro area break-up variable based on the Google indicator when comparing Germany and Italy.

Table 3

Estimates of yield spreads for Euro area countries[1)]

	AT	BE	DE	FR	IE	IT	NL	PT	ES
Liquidity premium	0,63 ***	0,92 ***	– 2,28 ***	3,41 ***	– 0,07 **	8,81 ***	2,63 ***	0,70 ***	– 0,11
	(0,03)	(0,26)	(0,23)	(0,07)	(0,03)	(1,80)	(0,25)	(0,26)	(0,16)
Credit (default) risk	0,81 ***	1,25 ***	– 0,49 ***	0,39 ***	1,06 ***	0,65 ***	– 0,08	1,33 ***	1,56 ***
	(0,05)	(0,03)	(0,07)	(0,02)	(0,01)	(0,07)	(0,14)	(0,07)	(0,08)
Euro-break up	– 0,84 ***	– 0,01	– 1,15 ***	– 2,45 ***	5,09 ***	0,68	– 1,46 ***	10,74 ***	3,04 ***
	(0,12)	(0,22)	(0,10)	(0,00)	(0,29)	(0,49)	(0,09)	(2,48)	(0,50)
Global risk premium	0,67 ***	1,01 ***	0,57 ***	0,92 ***	1,99 ***	2,95 ***	0,46 ***	2,97 **	1,05 ***
	(0,04)	(0,07)	(0,04)	(0,01)	(0,15)	(0,14)	(0,04)	(1,19)	(0,19)
Volatility	0,24 ***	0,58 ***	0,14 ***	0,14 ***	2,69 ***	1,35 ***	0,01	– 0,73 ***	1,17 ***
	(0,02)	(0,05)	(0,02)	(0,00)	(0,03)	(0,10)	(0,01)	(0,24)	(0,09)
Volatility Equation									
C	0,00 ***	0,00 ***	0,00 ***	0,00 ***	0,04 ***	0,01 ***	0,00 ***	4,37 ***	0,01 ***
	(0,00)	(0,00)	(0,00)	(0,00)	(0,00)	(0,00)	(0,00)	(1,05)	(0,00)
ARCH (-1)	0,47 ***	0,44 ***	0,87 ***	1,09 ***	0,22 ***	0,34 ***	0,78 ***	1,05 ***	0,25 ***
	(0,07)	(0,08)	(0,18)	(0,07)	(0,03)	(0,06)	(0,12)	(0,25)	(0,05)
ARCH (-2)	– 0,03 ***	– 0,03 ***		0,36 ***		– 0,00			
	(0,00)	(0,01)		(0,00)		(0,00)			
ARCH (-3)	0,04 ***	0,03 ***		– 0,07 ***					
	(0,01)	(0,01)		(0,00)					
ARCH (-4)	– 0,01 ***			– 0,05 ***					
	(0,00)			(0,00)					
ARCH (-5)	– 0,01 **			– 0,08 ***					
	(0,00)			(0,00)					
ARCH (-6)				0,03 ***					
				(0,00)					
GARCH (-1)	0,83 ***	0,81 ***	0,73 ***	0,56 ***	0,90 ***	0,90 ***	0,17 **	– 0,53 ***	1,02 ***
	(0,01)	(0,02)	(0,02)	(0,01)	(0,01)	(0,01)	(0,07)	(0,13)	(0,04)
GARCH (-2)									– 0,17 ***
									(0,04)
GARCH (-3)									0,06 *
									(0,03)
GARCH (-4)									– 0,01
									(0,01)
TARCH (-1)	– 0,52 ***	– 0,52 ***	– 0,82 ***	– 0,10 ***	– 0,39 ***	– 0,45 ***		– 0,38	– 0,37 ***
	(0,07)	(0,09)	(0,16)	(0,08)	(0,03)	(0,07)		(0,26)	(0,05)
TARCH (-2)			0,01					0,18	
			(0,03)					(0,11)	
GED Parameter	0,77 ***	0,96 ***	1,14 ***	1,33 ***	0,69 ***	1,07 ***	3,54 ***	428,61	1,54 ***
	(0,08)	(0,13)	(0,15)	(0,16)	(0,07)	(0,14)	(0,08)	(5404,54)	(0,26)

1) Dependent variable: Sovereign yields minus ECB deposit rate. Estimation period 1/9/2011 to 14/08/2012; ***/**/* signal significance at the 99 % / 95 % / 90% level.

Our results for Ireland and Portugal have to be interpreted cautiously because during this time period both countries were already under an adjustment programme as they lost access to financial markets and relied mostly on EFSF/IMF funding. In both cases it is very likely that markets for sovereign bonds and CDS were highly dysfunctional with market prices reflecting not only fundamental factors but also the state of the markets.

5. Time-varying estimation results

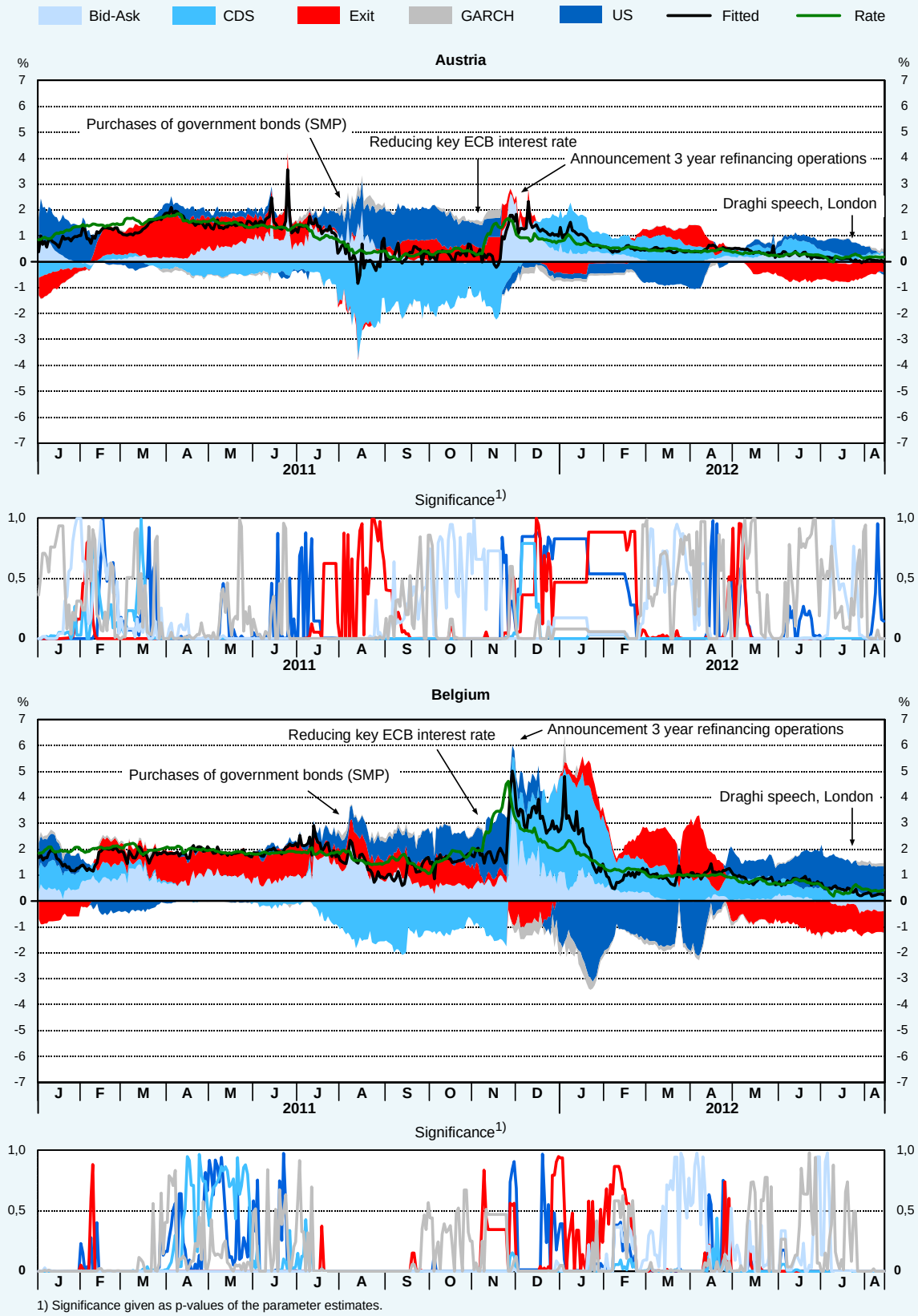
The influence of the four factors and the GARCH-term can be assumed to be rather time-dependent, so additionally their contribution to the yield spreads is estimated using rolling regressions for equations (3) and (3a). Recent contributions to the literature of the determinants of yield spreads during the crisis revealed potentially time-varying coefficients in estimations of yield spreads in Euro area (Aßmann and Boysen-Hogrefe 2011; Bernoth und Erdogan 2012). The window size is held constant with 100 observations each, so it is assumed that the current influence of the independent variables can be proxied by the average coefficients over this period. In addition the variables are smoothed as symmetric five day averages in order to avoid reversed daily swings in the bond yields and independent variables (Charts 3-7). The first estimation is thus made with a rolling window ending in January 1st 2011, due to data availability of the Exit variable, although the liquidity of this market is rather low until September 2011.Consequently up to this point the results for this variable should be interpreted cautiously. To determine the significance of the parameter estimates additional time series of the p-values are shown. Not surprisingly the parameters are mainly found to be insignificant if also the contribution to the yield spreads is low. However, for larger contributions the coefficients are in most cases found to be significantly different from zero. The results reveal similarities but also significant differences in the determinants of bond spreads across countries: In general the fit of the rolling regressions seems to be rather good as given by the comparison between the true bond-spread and its fitted values. This holds independently of the size of the bond-spread for all member states, so for either the countries currently under pressure due to high bond yields and those who are not.

The influence of the volatility premium modelled with a GARCH-specification is rather low for all Euro-area countries, although the fixed-period estimates point to significant contribution in almost all cases. The same holds to a lesser extent for the bid-ask spread which shows the influence of the liquidity component. Here especially for Belgium this variable is driving up yield spreads, but there is also a larger contribution of the bid-ask spread for Austria, the Netherlands, Italy and Spain all of them pointing to an increased effect.

The influence of global risk aversion as measured by the US corporate/government bond spreads is the most important factor for the two largest countries of the Euro area, Germany and France. While for these two the influence is mainly positive as expected there are several periods where there is also a negative contribution for several other countries. This is found especially for Spain from February 2012 onwards and may be explained by the rising importance of domestic and Euro area wide developments and less by the global component.

Chart 3

Contributions to yield spreads

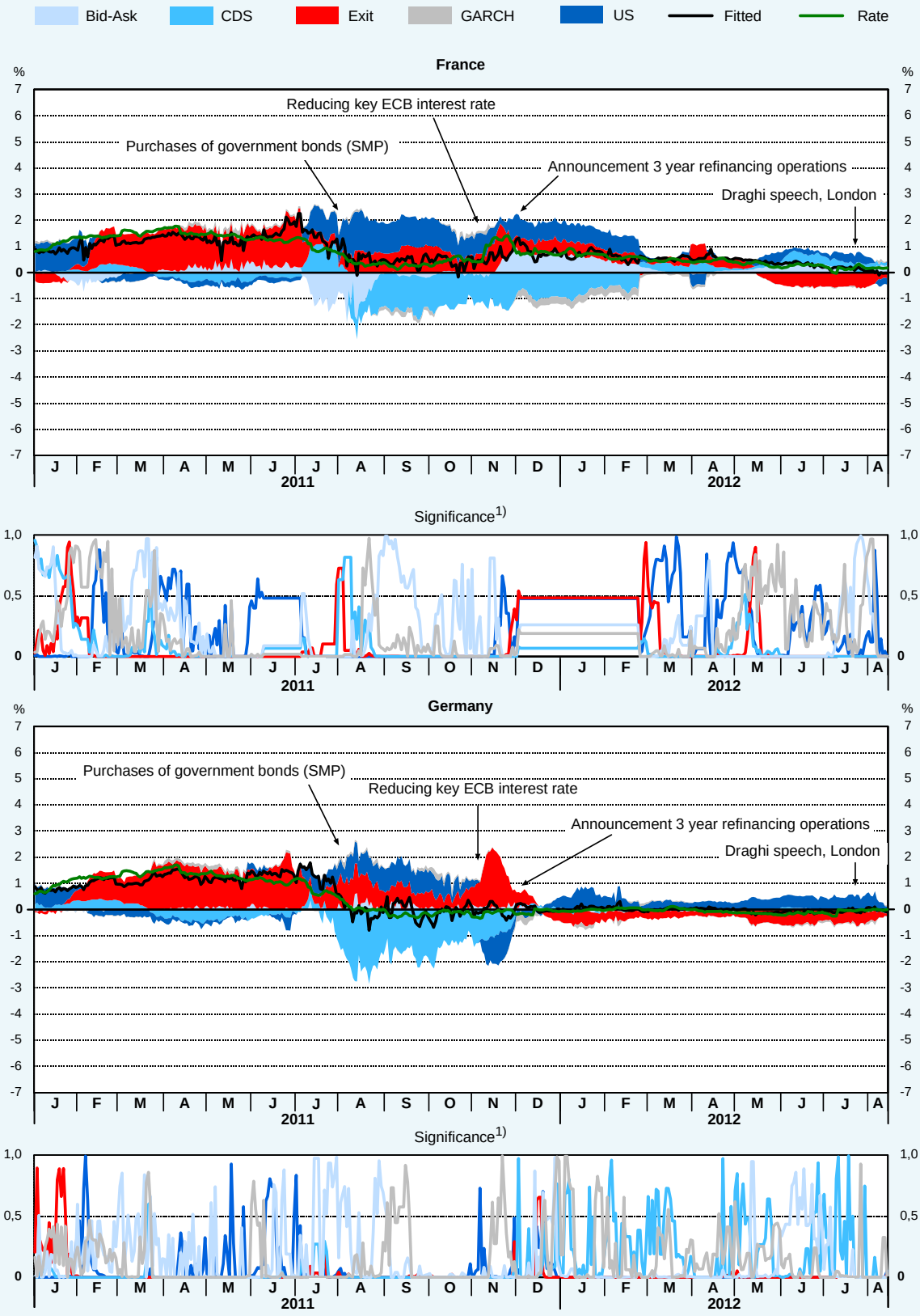


1) Significance given as p-values of the parameter estimates.

Source: Own calculations

Chart 4

Contributions to yield spreads

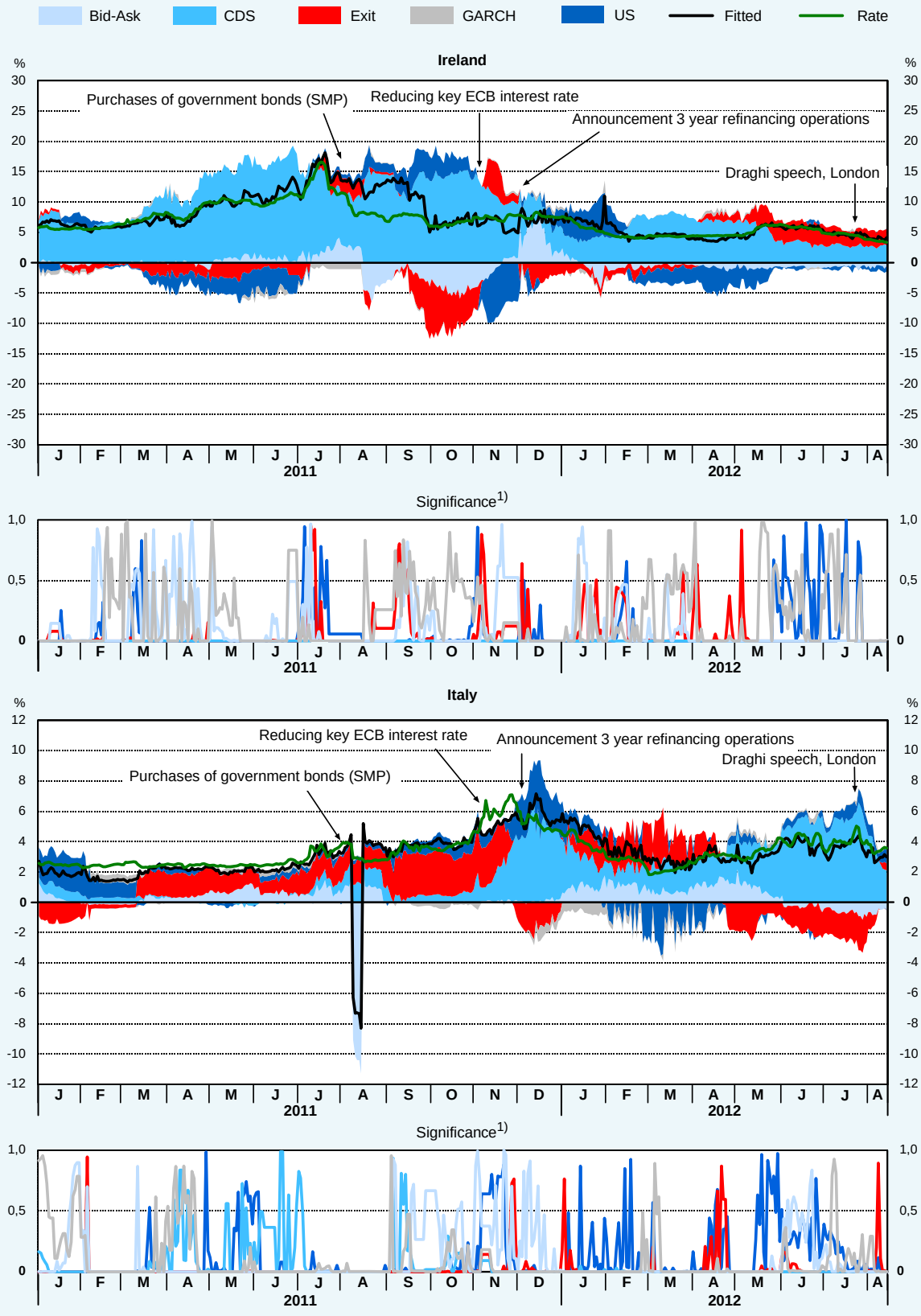


1) Significance given as p-values of the parameter estimates.

Source: Own calculations

Chart 5

Contributions to yield spreads

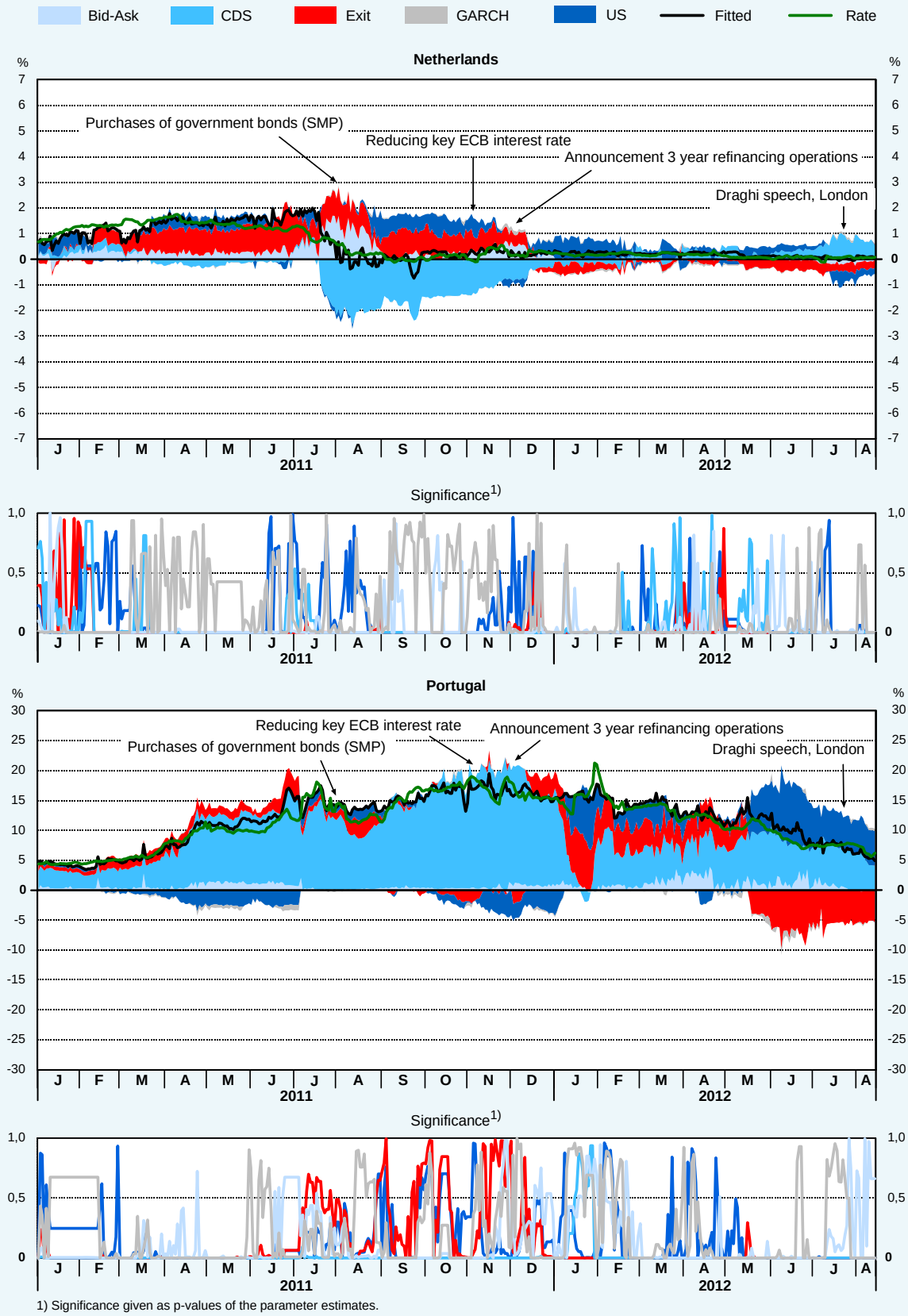


1) Significance given as p-values of the parameter estimates.

Source: Own calculations

Chart 6

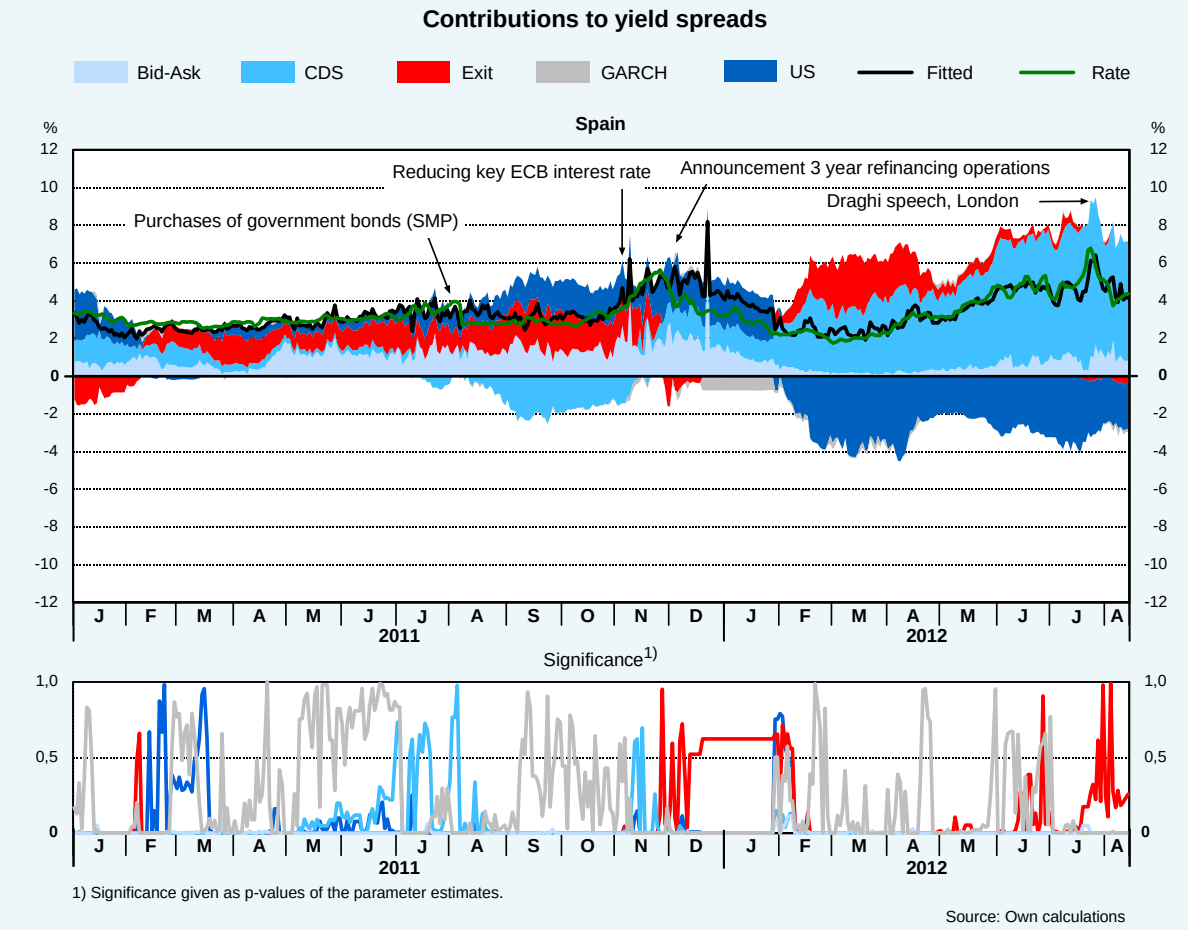
Contributions to yield spreads



1) Significance given as p-values of the parameter estimates.

Source: Own calculations

Chart 7



The importance of CDS spreads differs considerably across member countries. But also within several countries the influence of this variable is highly time-dependent. The first group consisting of Austria, Germany, France and the Netherlands exhibit a negative contribution of CDS to bond-spreads signalling their status as intra Eurosystem safe haven countries. These flows seem to be especially large in the period from April 2011 to November 2011 so exactly in the period of rising tensions in the Euro area, signalled by heightened yield spreads in crisis countries, which were temporarily relaxed by the ECB announcement to conduct two longer term refinancing operations with a maturity of three years executed in December 2011 and February 2012.

In contrast CDS spreads in Spain and Italy as the second group tended to have a rather low explanatory power for the yield spreads. However, in the course of 2012, this influence increased considerably being nowadays the most important factor in determining bond spreads in both countries. This result is in line with the rising doubt in the capital markets whether Italy or Spain would use the help of the Euro rescue funds EFSF or ESM, which may include a private sector involvement.

The third group of countries consists of Ireland and Portugal which used to have the largest average bond spreads over the sample period. For both of them the CDS premium is the main driving force leading to high yields in all periods. This is not a surprising result given that

both countries are as Greece in an EFSF program. However, with the declining bond rates after the introduction of the program also the default risk is lowered.

While it is certainly true that CDS premia explain most of the variation in the yield spread for the crisis countries Italy, Ireland, Portugal and Spain, thus the default risk while staying in the Euro area is the driving factor, also the contribution of the potential break-up of the Euro area plays a significant role. Especially before the ECB intervened with its two long term refinancing operations in all countries a significant part of the yield spreads could be accounted for by the exit variable. In this period, in almost all countries, the potential break-up would have led to a devaluation of the national currency. In contrast, after the two tenders with three year maturity conducted by the ECB this effect switches for Germany and the Netherlands leading to an appreciation of the currency, while the response of the other countries is rather mixed. The only country that is at the end of the sample expected to depreciate their national currency to the Euro is Ireland.

6. Robustness Check

There are several issues with CDS contracts in the event of a country's withdrawal from EMU. Currency redenomination will not in any case trigger a credit or restructuring event that eventually leads to a payment from the issuer of the contract to the holder, i.e. there are cases where CDS do not insure the holder against losses from redenomination of the principal and interest payment. According to the credit derivative definition of the International Swaps and Derivatives Association (ISDA) a permitted currency to which the currency of an underlying asset can be changed without triggering such a restructuring event is any legal tender of a G-7 country or of an OECD country with an S&P credit rating of AAA or more. The implied appreciation or depreciation of the newly introduced national currency after a potential break-up of the Euro area does only for countries fulfilling at least one of these requirements not lead to a credit default and thus only in these cases the exit variable can be interpreted as the change in the exchange rate times the probability of a Greek exit leading to an exit of the respective country. However, in the Euro area this holds only for the three G7-countries France, Germany and Italy and the Netherlands due to its AAA rating.[3] For the remaining five countries investigated in this study the introduction of a national currency would most likely trigger a credit default event, so CDS would become due independent of whether the country defaults within the Euro area or after a potential break-up which results in the introduction of a national currency. It is highly unlikely that one of the five countries would introduce another currency which is not their own by using a G7-currency to avoid the credit default event. Therefore, for the remaining five countries a robustness check is conducted (equation (4)) which accounts for the two different scenarios causing a credit default. The optimal lag structure is again found by using the mode of the minimum in the three information criteria introduced above (see Table 4). In line with the previous estimation, a default without leaving the EMU

[3]Austria lost its AAA-rating in January 2012 so also for this country an exit from the monetary union would most likely constitute a credit event.

is modelled by the CDS spread while the default occurring after a break-up of the Euro area is estimated as the product of the exit variable and the CDS spread.

$$(4)\ r_{j,t} - r_t^{ECB} = \alpha_{1j}(BID - ASK)_{j,t-1} + \alpha_{2j}CDS_{j,t-1} + \gamma_j Exit_{t-1}CDS_{j,t-1} +$$

$$\alpha_{4j}USBonds_{t-1} + \alpha_{5j}GARCH_{j,t} + \varepsilon_{j,t}$$

So the implied change in the exchange rate can be computed as γ_j/α_{2j} because the CDS becomes due independent of whether the default occurs remaing in or by dropping out of the monetary union. That is why in both cases the reaction of the CDS to the interest rate spread should be equal. This robustness check leads overall to the same results as the previous estimation did (Table 5). Coefficients on the liquidity premium (BID-ASK), the global risk aversion (USBonds), volatility premium (GARCH) and default risk (CDS) are generally found to exhibit the same tendency on the yield spreads. Even for the implied change in the exchange rate after a potential break-up of the Euro area, the same ordering of the countries appreciation and depreciation is found: While Portugal (1.33) and Ireland (0.17) depreciate if the Euro collapses, the Spanish rate is not altered (-0.00). Belgium (-0.49) and Austria (-1.16) would appreciate. Moreover, this robustness check tends to lower the estimated coefficients for all countries.

Table 4

Information criteria for estimates of yield spreads for Euro area countries – Accounting for default of an Euro area break-up

Lags	Austria			Belgium			Ireland			Portugal			Spain		
	AIC	SW	HQ	AIC	SW	HQ	AIC	SW	HQ	AIC	SW	HQ	AIC	SW	HQ
ARCH															
1	– 0,68	– 0,54	– 0,62	0,00	0,14	0,06	**1,45**	**1,60**	**1,51**	5,20	5,34	5,26	1,21	**1,35**	**1,27**
2	– 0,67	– 0,51	– 0,60	– 0,22	**– 0,07**	– 0,16	2,01	2,16	2,07	**5,17**	**5,33**	**5,23**	1,24	1,39	1,30
3	– 0,66	– 0,49	– 0,59	– 0,16	0,01	– 0,09	2,08	2,25	2,15	5,18	5,35	5,25	1,23	1,40	1,30
4	**– 0,86**	**– 0,68**	**– 0,79**	– 0,20	– 0,01	– 0,12	1,93	2,11	2,00	5,19	5,38	5,27	**1,21**	1,39	1,28
5	– 0,46	– 0,26	– 0,38	– 0,19	0,01	– 0,11	2,24	2,44	2,32	5,32	5,51	5,40	1,32	1,52	1,40
6	– 0,32	– 0,11	– 0,24	– 0,22	– 0,01	– 0,14	2,21	2,43	2,30	5,45	5,66	5,53	1,24	1,46	1,33
7	– 0,71	– 0,49	– 0,62	**– 0,25**	– 0,03	**– 0,16**	2,21	2,43	2,30	5,38	5,60	5,47	1,25	1,48	1,34
GARCH															
1	**– 0,86**	**– 0,68**	**– 0,79**	**– 0,25**	**– 0,03**	**– 0,16**	1,45	**1,60**	1,51	**5,17**	**5,33**	**5,23**	1,21	**1,35**	**1,27**
2	– 0,72	– 0,53	– 0,64	– 0,06	0,18	0,04	1,71	1,86	1,77	5,18	5,35	5,25	**1,21**	1,36	1,27
3	0,12	0,33	0,20	– 0,14	0,12	– 0,03	1,53	1,70	1,60	5,19	5,37	5,26	1,22	1,39	1,28
4	– 0,73	– 0,50	– 0,63	– 0,19	0,08	– 0,08	**1,44**	1,62	**1,51**	5,43	5,62	5,51	1,25	1,43	1,32
TARCH															
0	– 0,22	– 0,05	– 0,15	0,73	0,95	0,82	2,21	2,38	2,28	5,25	5,39	5,31	2,25	2,38	2,30
1	**– 0,86**	**– 0,68**	**– 0,79**	**– 0,25**	**– 0,03**	**– 0,16**	**1,44**	**1,62**	**1,51**	**5,17**	**5,33**	**5,23**	1,21	**1,35**	**1,27**
2	– 0,67	– 0,47	– 0,59	– 0,16	0,08	– 0,07	2,11	2,31	2,19	5,17	5,34	5,24	1,25	1,40	1,31
3	– 0,67	– 0,46	– 0,59	– 0,19	0,06	– 0,09	1,94	2,15	2,03	5,18	5,36	5,25	2,12	2,29	2,19
4	– 0,73	– 0,50	– 0,64	– 0,23	0,03	– 0,13	2,00	2,22	2,09	5,29	5,48	5,37	1,71	1,90	1,79
5	– 0,66	– 0,42	– 0,56	– 0,21	0,08	– 0,09	1,80	2,04	1,90	5,36	5,57	5,44	**1,21**	1,41	1,29

AIC: Akaike criterion, SW: Schwarz Criterion, HQ: Hannan-Quinn criterion; bold numbers signal minimum of criteria; optimal lag length chosen if two or more information criteria point to a minimum.

Table 5

Estimates of yield spreads for Euro area countries – Accounting for default of an Euro area break-up

	AT	BE	IE	PT	ES
Liquidity premium	0,60 ***	1,46 ***	– 0,23 ***	0,36	0,13
	(0,06)	(0,31)	(0,06)	(0,30)	(0,28)
Credit (default) risk	1,90 ***	1,71 ***	0,85 ***	1,31 ***	1,60 ***
	(0,11)	(0,09)	(0,06)	(0,08)	(0,20)
Credit (default) risk *					
Euro-break up	– 2,21 ***	– 0,83 ***	0,14 *	1,75 ***	– 0,00
	(0,19)	(0,16)	(0,08)	(0,05)	(0,29)
Global risk premium	0,46 ***	0,86 ***	3,50 ***	– 0,69	2,12 ***
	(0,04)	(0,04)	(0,23)	(0,51)	(0,24)
Volatility	0,23 ***	0,49 ***	1,49 ***	– 1,10 ***	1,87 ***
	(0,01)	(0,03)	(0,17)	(0,15)	(0,18)
Euro-break up implied	– 1,16 ***	– 0,49 ***	0,17 *	1,33 ***	– 0,00
	(0,05)	(0,07)	(0,10)	(0,09)	(0,18)
Volatility Equation					
C	0,00 ***	0,00 ***	0,02 ***	0,56 **	0,02 ***
	(0,00)	(0,00)	(0,00)	(0,26)	(0,00)
ARCH (-1)	0,78 ***	0,39 ***	0,40 ***	0,62 ***	0,23 ***
	(0,17)	(0,07)	(0,09)	(0,12)	(0,05)
ARCH (-2)	– 0,03 ***	– 0,02 ***		– 0,23 **	
	(0,01)	(0,00)		(0,11)	
ARCH (-3)	0,05 ***	0,04 ***			
	(0,01)	(0,01)			
ARCH (-4)	– 0,01	0,00			
	(0,01)	(0,01)			
ARCH (-5)		– 0,02 ***			
		(0,01)			
ARCH (-6)		– 0,02 ***			
		(0,01)			
ARCH (-7)		– 0,02 ***			
		(0,00)			
GARCH (-1)	0,77 ***	0,81 ***	1,00 ***	0,36 **	0,86 ***
	(0,02)	(0,02)	(0,08)	(0,15)	(0,03)
GARCH (-2)			– 0,14		
			(0,11)		
GARCH (-3)			– 0,08		
			(0,07)		
GARCH (-4)			0,05 *		
			(0,02)		
TARCH (-1)	– 0,82 ***	– 0,46 ***	– 0,46 ***	0,97 **	– 0,32 ***
	(0,18)	(0,07)	(0,10)	(0,42)	(0,05)
GED Parameter	0,88 ***	0,99 ***	1,13 ***	2,22 ***	1,64 ***
	(0,10)	(0,13)	(0,15)	(0,32)	(0,28)

1) Dependent variable: Sovereign yields minus ECB deposit rate. Estimation period 1/9/2011 to 14/08/2012; ***/**/* signal significance at the 99 % / 95 % / 90% level.

7.Conclusions

The European debt crisis has led to doubts about the irreversibility of the Euro as the common currency in all member countries. This risk is to a different degree reflected as a systemic component – redenomination risk – in the yield spreads of each country. We approximate the systemic component by using a novel market based index on whether any Euro area country will declare its exit from the monetary union before the end of 2013. While this indicator does not necessarily reflect a complete break-up of the EMU, it signals at least the market expectations of a regime shift in European monetary policy when it becomes possible to leave the monetary union. Therefore, the Euro area would change into a fixed-rate regime were it is possible for every member country to switch to flexible rates by introducing a national currency and thus leaving the Euro.

Our analysis provides descriptive evidence that redenomination risk had been present in sovereign yield spreads between September 2011 and August 2012 and is quantitatively important with those countries paying an redenomination premium (discount) that are expected to depreciate (appreciate) vis-à-vis the Euro after leaving the EMU. According to our results those countries that are nowadays in the centre of debt crisis (Portugal, Ireland, Spain and Italy) are expected to depreciate their currency once leaving the Euro area, France, the Netherlands, Germany, Austria and Belgium are expected to appreciate. Moreover, when allowing for time varying coefficients, our results indicate that the influence of expected reintroduction of national currencies is not time constant but varies considerably in its size depending on the level of stress in the markets, i.e. whether the ECB has announced new measures to ease those.

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