FLIGHT)TO)LIQUIDITY FLOWS IN THE EURO AREA SOVEREIGN DEBT CRISIS

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FLIGHT-TO-LIQUIDITY FLOWS IN THE EURO AREA SOVEREIGN DEBT CRISIS [(*)]

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Abstract

In periods of market stress, portfolio reallocations in bond markets reflect both safety and liquidity concerns. Using sovereign and national agency bonds, we construct indicators of liquidity premia in major euro area bond markets; we document the weakening of the correlation between core and periphery market liquidity during the euro area sovereign bond crisis; and we identify several episodes of significant flight-to-liquidity (FTL) flows above and beyond flight-to-safety (FTS) spells in the period 2009-13. We show that FTL flows led to significant inverse moves in sovereign bond yields in euro area core and periphery markets. Moreover, FTL flows triggered declines in core and periphery stock markets and are associated with lower macroeconomic confidence in the euro area as a whole, which underscores the importance of FTL episodes for investors and policymakers alike.

Keywords: liquidity premia, flight to liquidity, flight to safety, sovereign debt crisis.

JEL Classification: G01, G12, H63.

Resumen

En períodos de tensión en los mercados financieros, recomposiciones en las carteras de renta fija pueden generarse por la preocupación no solo por el riesgo de crédito, sino también por el riesgo de liquidez. Usando información de bonos emitidos por Gobiernos y agencias públicas, construimos indicadores de las primas de liquidez en los principales mercados de bonos de la zona del euro, mostrando el debilitamiento de la correlación en la liquidez de los mercados de los países del núcleo y de la periferia durante la crisis de la deuda soberana europea, e identificando varios episodios de significativos flujos de huida a la liquidez *(flight-to-liquidity,* FTL), además de los flujos de huida a la seguridad *(flight-to-safety,* FTS), durante el período 2009-2013. El análisis demuestra que los flujos FTL provocaron movimientos significativos en direcciones opuestas en los rendimientos de los bonos soberanos entre los mercados de los países centrales y de la periferia de la zona del euro. Por otra parte, los flujos de FTL produjeron descensos en todos los mercados de valores de la zona del euro y están asociados, a escala macroeconómica, con una menor confianza económica en el conjunto de la zona del euro, lo que pone de relieve la importancia de los episodios FTL tanto para los inversores como para la toma de decisiones de política económica.

Palabras clave: prima de liquidez, huida a la liquidez, huida a la seguridad, crisis de deuda soberana.

Códigos JEL: G01, G12, H63.

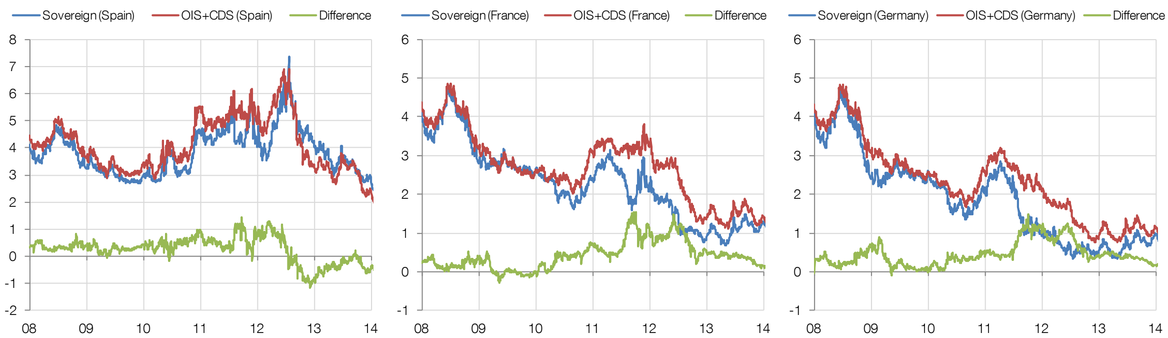
1 Introduction

In periods of market stress, extreme and inverse market movements in the bond and equity markets are often referred to as “flights to safety” or “flights to quality”. Such episodes were relatively frequent during the sovereign debt crisis in the euro area. The decrease in value of periphery sovereign debt was undoubtedly related to changes in perceived default probabilities and thereby in the increase in the required premium for bearing that credit risk. Under those circumstances, some market participants were willing to decrease their portfolio exposure to securities bearing the perceived higher credit risk triggering sudden swings in bond prices. In an influential paper, Baele et al. (2013) document flight-to-safety episodes in more than 20 bond markets and show that such episodes are important to understand developments in major bond markets.

Flights to safety episodes may be however related not only to flights to quality but also about *flights to liquidity*. In periods of market turbulence, the liquidity of the bonds, i.e. the capacity to undo positions at reasonable costs, is also an important concern for bond market investors. Abrupt changes in bond prices may therefore be the result of flight to liquidity episodes when market participants suddenly prefer to hold highly liquid securities rather than less liquid ones, thereby requesting a higher premium for holding the less liquid bonds, in addition to or even regardless their credit risk.

Developments in euro area bond markets in the period 2009-13 are an important example of the relevance of flight to safety and flight to liquidity episodes. As an illustration, Figures 1 depict a simple decomposition of sovereign bond yields in three major euro area countries (Germany, Spain and France) using OIS rates as proxy for risk-free interest rates and CDS premia as proxy for credit risk compensation.

Figure 1: Five-year sovereign bond yields compared to the sum of OIS rates and CDS premia



Note: 5-year spot yield of the sovereign (blue line) and the sum of the 5-year Overnight Interest Rate Swap (OIS) rate and the 5-year CDS (percentage points, red line), as well as the difference between both series (green line). Left chart represent data for Spain, centre chart for France, and right one for Germany.

While the combined effect of monetary policy expectations and credit risk compensation help mimic quite well developments in observed sovereign yields in those markets, it is also evident that both effects are insufficient to fully explain the observed bond yields, leaving more than 100 basis points unaccounted for at times and stressing the role of flight to liquidity flows.

Against this background, the goal of this paper is to investigate the dynamics of liquidity premium in euro area bond markets during the financial and sovereign debt crisis. In particular, we show that flight to liquidity flows were an important dimension of the turbulences experienced in bond markets during the global financial crisis and in particular in the euro area bond markets, beyond and above flight to safety episodes.

A major challenge to analyse the impact of liquidity considerations in sovereign bond yields is that the liquidity premium is unobservable, so its identification relies on the use of some proxies that imperfectly capture some aspects of liquidity (e.g.: traded volumes, bid-ask spreads). Unfortunately, such measures are not always available or their reliability differs across bond markets, which makes it difficult drawing sound conclusions for multi-country analysis.

In this paper, we take a more direct approach by looking at more direct proxies of liquidity premium. To measure changes in liquidity premium in individual bond markets, we calculate yield spreads between sovereign bonds and equivalent bonds issued by government sponsored agencies of Germany (*Kreditanstalt fur Wiederaufbau, KfW*), France (*Caisse d'Amortissement de la Dette Sociale, CADES*) and Spain (*Instituto de Crédito Oficial, ICO*). Specifically, we estimate both sovereign and agency zero-coupon term structures of bond yields and calculate the spreads at the five year maturity for three of the largest bond markets in the euro area: Germany, France and Spain. The rationale is that, being fully guaranteed by the governments, the bonds issued by such agencies have the same credit risk as the bonds issued by the respective treasuries, and yield spreads, therefore, provide evidence of the liquidity premium in each bond market. Longstaff (2004) indeed showed that agency spreads capture a substantial part of the flight to safety episodes in the US bond market using yield spreads between US Treasuries and bonds issued by the Resolution Funding Corporation (Refcorp).

We analyse the time-varying co-movement of liquidity premium across those three euro area bond markets in recent years and document significant swings in liquidity premium in euro area bond markets between 2008 and 2013. Following the collapse of Lehman Brothers, liquidity premium rose across all bond markets as a result of strong flight-to safety flows. Later on, however, the unfolding of the sovereign debt crisis in some euro area countries led to a gradual increase in the market discrimination across sovereign issuers with strong episodes of flight-to-liquidity since late 2009 between Spanish and AAA-rated sovereign bonds (French and German ones) and from 2011 even between AAA-rated bonds.

To isolate pure flight to liquidity effects from those associated with more general flight to safety episodes in sovereign bond markets, we estimate a dynamic two-factor model using the liquidity spreads for Germany, France and Spain. Since one of the factors is strongly related to stock market volatility and therefore helps account for the influence to flight to safety flows, the second factor allows us to identify liquidity effects more directly linked to flight to liquidity flows.

We show that flight to liquidity was an important element of the financial turbulences during the euro area debt crisis. The reaction in euro area sovereign bond markets was clearly asymmetric: while sovereign yields from "stressed" countries (Spain, Italy, Greece, Portugal and Ireland) increased as a result of flight to liquidity flows, yields of "core" countries (Germany, France, Austria, Belgium, Finland and The Netherlands) decreased significantly. Moreover the yield impact of flight to liquidity flows was sizeable: our estimates suggest a variation in Spanish five-year sovereign bond yield of around 80 basis points during the crisis solely as a result of flight to liquidity pressure.

The importance of flight to liquidity flows is further underscored by the fact that their effects extended well beyond sovereign bond markets. We show that euro area stock markets were negatively affected by flight to liquidity flows. In stark contrast to bond markets, stock markets in *both* core and stressed countries exhibited significant declines in returns during flight to liquidity episodes, even after controlling for a potential simultaneous flight to safety effects. Furthermore, we also find evidence of deterioration in economic confidence associated to flight to liquidity episodes, which suggest that such episodes were perceived not only by financial market investors but by economic agents in general as an important element of the euro area crisis that should be taken into account.

Our results provide strong evidence in support of market liquidity playing an important role to understand movements in sovereign yield spreads in the euro area in recent years. Beber et al. (2009) already showed that even before the financial and debt crisis in times of market stress, investors in the Euro-area sovereign bond market demand liquidity rather than credit quality in their portfolios. Our evidence based on the available agency spreads for three different countries suggests that such practices are likely to have intensified in recent years as a result of the financial and sovereign debt crisis. Schwarz (2010) also uses KfW spreads as proxies for liquidity in euro area bond markets. There is also an ample theoretical literature arguing in favour of the presence of significant effects of liquidity in asset pricing (e.g.: Vayanos, 2004; Caballero and Krishnamurthy, 2008; Brunnermeier and Pedersen, 2009, among others).

The rest of the paper is organised as follows. Section 2 introduces the computation of the liquidity spreads for Germany France and Spain. In Section 3 we describe our identification strategy for flight to liquidity flows and their characteristics during the euro area debt crisis. We then investigate the quantitative impact of flight to liquidity flows in all euro area sovereign bond and stock markets, as well as on economic confidence in Section 4. Finally, Section 5 concludes.

2 Measuring liquidity premia in euro area bond markets

From a practical point of view, the yield of a given bond ($i_t(s)$) can be decomposed into risk-free interest rates (r_t), credit risk compensation ($c_t(s)$) and liquidity risk compensation ($l_t(s)$):

$$i_t(s) = r_t + c_t(s) + l_t(s) \quad (1)$$

For this reason, when considering a sovereign spread (the difference between the yields of two sovereign bonds issued, for instance, by Spain and Germany), their spread will include the difference in the credit risk premia as well as differences in the liquidity premia.

$$[i_t(s_1) - i_t(s_2)] = [c_t(s_1) - c_t(s_2)] + [l_t(s_1) - l_t(s_2)] \quad (2)$$

By contrast, an agency bond spread (the yield spread between a bond issued by an agency owned by the government and the corresponding sovereign bond) will allow cancelling out the credit risk and therefore isolating the liquidity premia (Longstaff, 2004):[1]

$$X_t^{s_1} = [i_t(s_1) - i_t(a_1)] = [l_t(s_1) - l_t(a_1)] \quad (3)$$

Clean measures of liquidity premium in each bond market can therefore be obtained by computing the yield spread between standard sovereign and agency bonds. We would however need bonds with exactly the same maturity and structure of payments (frequency and size of coupons, as well as principal) or the spreads would be affected by differences in term premia and changes in the benchmarks.

We therefore compute yield spreads on daily zero-coupon term structures estimated using a Nelson Siegel parametric specification (Nelson and Siegel, 1987) for Spanish, French and German government bonds, as well as for their respective agency bonds (ICO, CADES and KfW), between January 2008 and December 2013. Our choice of the Nelson Siegel specification is motivated by the limited number of agency bonds in some markets. Despite its simplicity, the Nelson Siegel specification is widely used among central banks (see, BIS 2005). To ensure the stability of the estimated parameters we employed the genetic algorithm introduced in Gimeno and Nave (2009).[2]

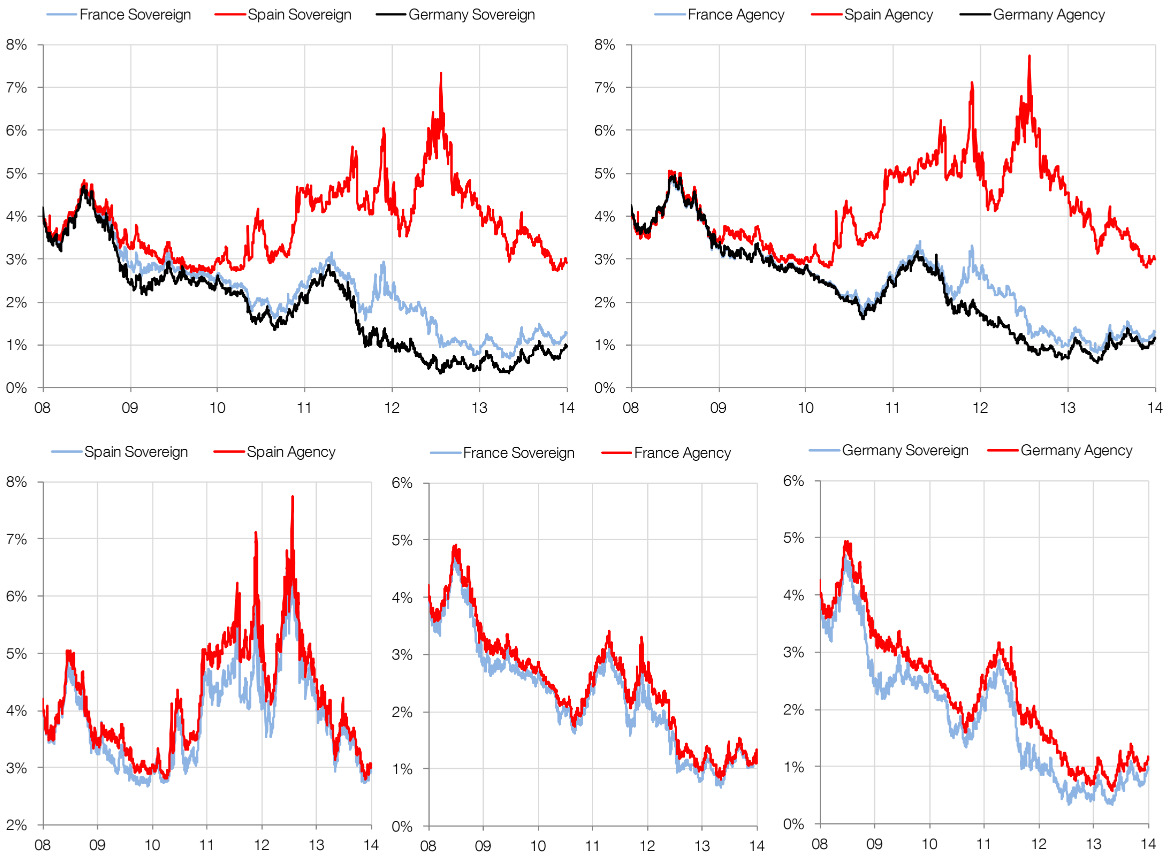
Within the estimated term structures, in the light of the available agency market structures, we focus on five year spreads as benchmark maturity (see Figure 2). Moving beyond the five-year maturity reduces the number of available bonds and lowers the reliability of the zero-coupon term structures (see Figure A1 in the Appendix).[3] We will nonetheless show that our main findings hold for two and ten-year maturities, too.

1. The analyses in Schwarz (2010) and Ejsing et al. (2012) are also based on the assumption that KfW and CADES bond yields have the same level of credit risk as their government counterparts.

2. The procedure involves a heuristic search of the optimum that mimics the process of natural evolution and explores the whole parameter universe, and including random perturbations around solutions to avoid local minima.

3. The Appendix also includes a list and the main characteristics of the bonds used in our estimation.

Figure 2: 5-year zero-coupon bond yields

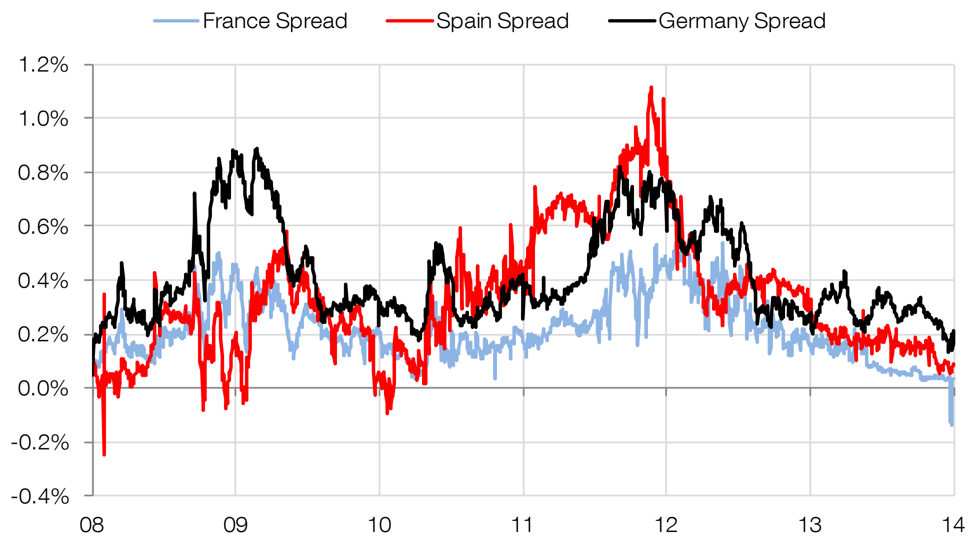


Note: Yields are computed from a Nelson-Siegel yield curve estimated daily with Gimeno and Nave (2009) algorithm. The left hand side chart represents the 5-year rate for the Spanish (red), German (black), and French (blue) Sovereign (Government) bonds. The right hand side chart represents the 5-year rate for the ICO (Spanish, red), KfW (German, black), and CADES (French, blue) Agency bonds. Below are the same series but represented by country (Spain, left; France, centre; and Germany, right), with agency rates in red and sovereign rates in blue.

Figure 2 shows that in some periods (e.g. late 2008-early 2009) there is a higher variation in government bonds than in agency bonds. Once we recover the corresponding agency spreads (agency rate minus the sovereign bond yield, see Figure 3), it is apparent that liquidity premia dynamics played an important role in the widening of the intra-euro area sovereign yield spreads.

Table 1 provides descriptives statistics for both our sovereign and agency yields as well as country- specific agency spreads, both for levels and first differencies. As yields and agency spreads are highly persistent, we below specify our models in terms of first differences to work with stationary time series. We can also observe that, as a consequence of the crisis, Spanish yields, both sovereign and agency, have extreme values, as the kurtosis coefficients highlights (this also produce some correlation with the first lag).

Figure 3: Agency Spreads for five-year maturity bond yields



Note: Computed as the difference of the 5-year spot yield of the agency minus the 5-year spot yield of the corresponding sovereign (percentage points). For France (blue line), the agency is CADES; for Spain (red line), the agency is ICO; and for Germany (black line), the agency is KfW.

Table 1: Descriptive statistics for the involved variables

	ean	STDev.	Skewness	Kurtosis	Corr(1)	Corr(2)	Corr(3)
Level							
ICO (Spain)	4.17	0.96	0.63	2.79	.994	.986	.978
KfW (Germany)	2.29	1.12	0.35	2.19	.998	.996	.994
CADES (France)	2.48	0.99	0.24	2.39	.997	.995	.992
ES sovereign	3.84	0.83	0.73	3.37	.992	.981	.971
DE sovereign	1.87	1.11	0.48	2.33	.997	.994	.992
FR sovereign	2.27	0.96	0.38	2.53	.997	.994	.991
ES agency spread	0.33	0.23	0.86	3.41	.982	.974	.966
DE agency spread	0.41	0.18	0.93	2.71	.990	.981	.973
FR agency spread	0.22	0.12	0.61	2.82	.972	.948	.926
	Mean	STDev.	Skewness	Kurtosis	Corr(1)	Corr(2)	Corr(3)
First Difference							
ICO (Spain)	-.001	.097	-1.34	17.46	.212	.015	-.079
KfW (Germany)	-.002	.044	0.20	7.34	.034	-.006	-.019
CADES (France)	-.002	.048	0.15	7.32	.062	.043	-.055
ES sovereign	-.001	.100	-1.29	16.23	.183	-.004	-.087
DE sovereign	-.002	.055	0.05	5.22	.004	-.035	-.021
FR sovereign	-.002	.054	0.22	6.74	.030	-.010	-.021
ES agency spread	.000	.043	1.32	35.12	-.263	-.017	-.062
DE agency spread	.000	.024	-0.26	13.11	-.086	-.045	.018
FR agency spread	-.000	.027	-0.18	11.55	-.086	-.040	-.048

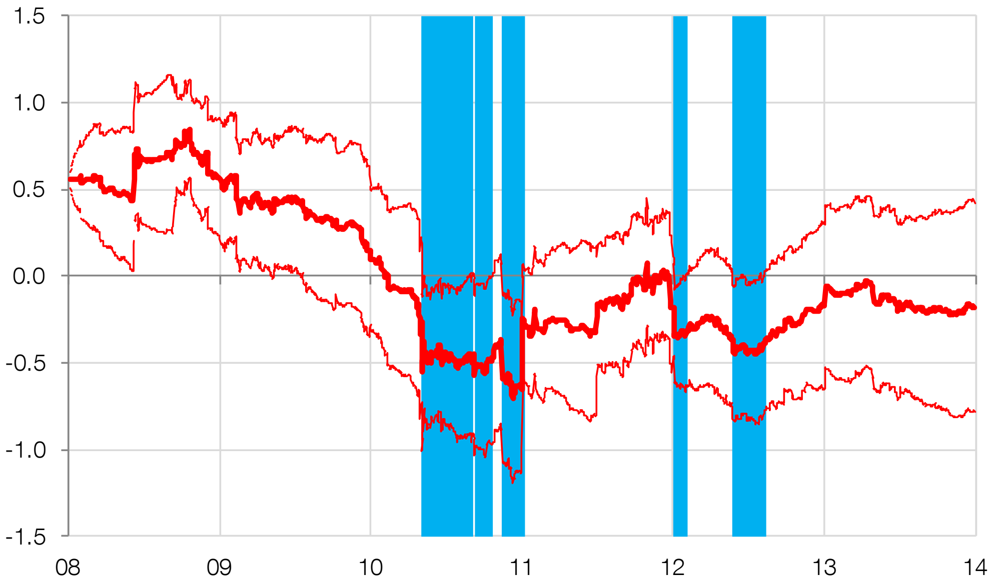
Note: Yields for each issuer are 5-year zero-coupon rates obtained by daily estimating Nelson-Siegel yield curves using Gimeno and Nave (2009) algorithm. Sample: from January 4th 2008 to December 31st 2013.

3 Identifying flight to liquidity episodes

In the case of the European debt crisis, episodes of flight to liquidity have been often proxied in the literature as a widening in the KfW yield spread over the German bund (e.g. Schwartz, 2010). While such a yield spread is easy to compute, its simplicity may unfortunately come at a cost in terms of economic interpretation of such episodes.[4]

This paper argues that a major shortcoming of focusing exclusively on the German bond market to identify FTL episodes over the last few years is that the nature of those FTS/FTL flows may have varied substantially as the sovereign debt crisis unfolded in euro area bond markets. Specifically, while in the early stages of the crisis FTS episodes involved a portfolio relocation between the then-considered riskier assets (equity, corporate bonds) and sovereign bonds, a crucial characteristic of the sovereign debt crisis in the euro area is that it also involved important portfolio reallocations within the euro area sovereign bond asset class.

Figure 4: Comovement between Spanish and German liquidity spreads during the crisis



Shadows represent periods of statistically significant negative correlation based on a time-varying coefficient in a regression of changes in Spanish liquidity spread on changes in German ones. The solid line represents the estimated parameter, and the dotted lines the 95% confidence intervals. Kalman filter parameters estimated: $\hat{\alpha} = -0.015$; $\hat{\sigma}_v = 18.958$; $\hat{\sigma}_w = 0.00058$; $\hat{\beta}_0 = 0.556$.

As an illustration, Figure 4 depicts the bivariate correlation between the agency spreads of Germany (as market destination of flight to liquidity flows) and Spain (as example of a country negatively affected by the sovereign debt crisis) since the beginning of the financial turbulences. We model such a comovement using a regression of the changes in sovereign liquidity spreads of one country as a function of the changes in the liquidity spread of a second country.

4. As an illustration in the Appendix, Figures A3 and A4 depict the identification of FTL episodes based on relatively unusual daily widening of the KfW spread alone, and instances of joint KfW spread widening together with a decline in German bund yields. In both cases the result is a relatively large number of short-lived episodes since the beginning of the financial turbulences.

$$\Delta X_t^{S_1} = \alpha + \beta_t \Delta X_t^{S_2} + v_t \qquad v_t \sim N[0, \sigma_v] \qquad (4)$$

where the relationship between both spreads (β_t) is time varying, with the coefficients behaving as a random walk,

$$\beta_t = \beta_{t-1} + w_t \qquad w_t \sim N[0, \sigma_w] \qquad (5)$$

The resulting system is estimated by using standard Kalman filtering techniques.

Although the correlation started declining since late 2008, it remained significantly positive until late 2009. The intensification of the sovereign debt crisis in the euro area however pushed it into negative territory in early 2010 and a negative co-movement between German and Spanish agency spreads has remained broadly negative since then. Indeed, in statistical terms, this analysis suggests three protracted episodes of significant negative co-movement in liquidity premium in German and Spanish bond markets between 2010 and 2013, only attenuated by the introduction of the Eurosystem long-term refinancing operations in late 2011 and thereafter by President Draghi's "whatever it takes to save the euro" pledge in the summer of 2012 (Draghi, 2012).

Those episodes of negative co-movement between German and Spanish agency spreads do suggest significant liquidity flows between both bond markets. Yet, it has to be taken into account that there was also a strong deterioration in Spanish public finances with the financial and economic crisis following the collapse of Lehman Brothers, and a FTS portfolio relocation from Spanish into German bonds would be observationally equivalent to a flight-to-liquidity episode.

The evolution of the co-movement between French and German agency spreads is also very telling about the deepening of the euro area debt crisis (see Figure A2). Indeed, although French sovereign bonds were not affected by the crisis to the same extend as the Spanish bonds in the early stages of the crisis, there was a protracted decline in the strength of the correlation between German and French agency spreads since early 2009, to the extent that by the Spring of 2012 it become significantly negative and only recovered after President Draghi's "whatever it takes" policy statement.

3.1 Identifying flight to liquidity using a multivariate model

Models where one of the agency spreads is a function of other of the agency spreads are necessarily descriptive and suffer from endogeneity problems, especially during the crisis, since both agency spreads are affected by what is happening to the other. Here we propose a more structural analysis where the three agency spreads are determined by a set of latent factors.

To better identify FTL episodes in euro area sovereign bond markets, we first look at the statistical properties of the three agency spreads available for the euro area. A principal component analysis suggests that two factors are enough to explain more than 95% of the variation in those three agency spreads (see Table 2). The principal-component analysis indicates that only one of the components has an eigenvalue greater than one. However, the second component retains a high level of explanatory power. Therefore, we have opted for a model with two latent factors that have the potential of explaining up to a 95% of the variability of the series.

Table 2: Principal Component Eigenvalues and explained Variance of Spanish, German and French agency spreads

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	2.157	1.451	0.719	0.719
Comp2	0.706	0.568	0.235	0.954
Comp3	0.138		0.046	1.000

Table 2b: Eigenvectors for the Principal Component analysis

Variable	Comp1	Comp2	Comp3	Unexplained
ES	0.462	0.872	0.164	0
DE	0.609	-0.446	0.656	0
FR	0.645	-0.203	-0.737	0

Note: Variables used in the Principal Component Analysis are daily time series (from January 4th 2008 to December 31st 2013) of the ICO Spread (ES, the difference between the 5-year zero-coupon rate of ICO and the equivalent Spanish Sovereign), KfW Spread (DE, the difference between the 5-year zero-coupon rate of KfW and the equivalent German Sovereign) and CADES Spread (the difference between the 5-year zero-coupon rate of CADES and the equivalent French Sovereign).

The eigenvectors of the principal components (Table 2b) suggests an important characteristic of the two components. The first one has similar loadings for all agency spreads and can be considered as the level factor, while the second one accounts for the heterogeneity among them. Therefore, we propose a two latent factors model, where the measurement equation is equal to:

$$\begin{pmatrix} X_t^{ES} \\ X_t^{DE} \\ X_t^{FR} \end{pmatrix} = \begin{pmatrix} \mu_{ES} \\ \mu_{DE} \\ \mu_{FR} \end{pmatrix} + \begin{pmatrix} \gamma_1^{ES} & \gamma_2^{ES} \\ \gamma_1^{DE} & \gamma_2^{DE} \\ \gamma_1^{FR} & \gamma_2^{FR} \end{pmatrix} \begin{pmatrix} L_{1t} \\ L_{2t} \end{pmatrix} + \begin{pmatrix} \sigma_m & 0 & 0 \\ 0 & \sigma_m & 0 \\ 0 & 0 & \sigma_m \end{pmatrix} \begin{pmatrix} u_t^{ES} \\ u_t^{DE} \\ u_t^{FR} \end{pmatrix} \quad (6)$$

In this model, there are two latent factors. We have imposed the error terms u_t^j to be uncorrelated, so shocks affecting more than one market would come from movements on the latent factors, while differences in agency spreads variability would rise from different sensibility to movements in the latent factors. In order to identify factors we have chosen that the coefficients for the German spread to be equal to 1 ($\gamma_1^{DE} = \gamma_2^{DE} = 1$), so the magnitude for both factors can be interpreted as the basis point impact of each factor into the German agency spread. If coefficients for the same factor are all positive (as we will show is the case for the first one, L_{1t}), the factor can be interpreted as a common liquidity component, governing their joint behaviour, and therefore as a general preference for sovereign versus agency bonds. If the coefficients have values both positive and negatives, (as is the case of the second component, L_{2t}), the corresponding factor would reflect the transfer of liquidity between sovereigns (liquidity premium changes that affects asymmetrically the different markets). Lastly, we let noise components (u_t^j) to be uncorrelated, so common shocks to agency spreads will come through the noise components of the state equation.

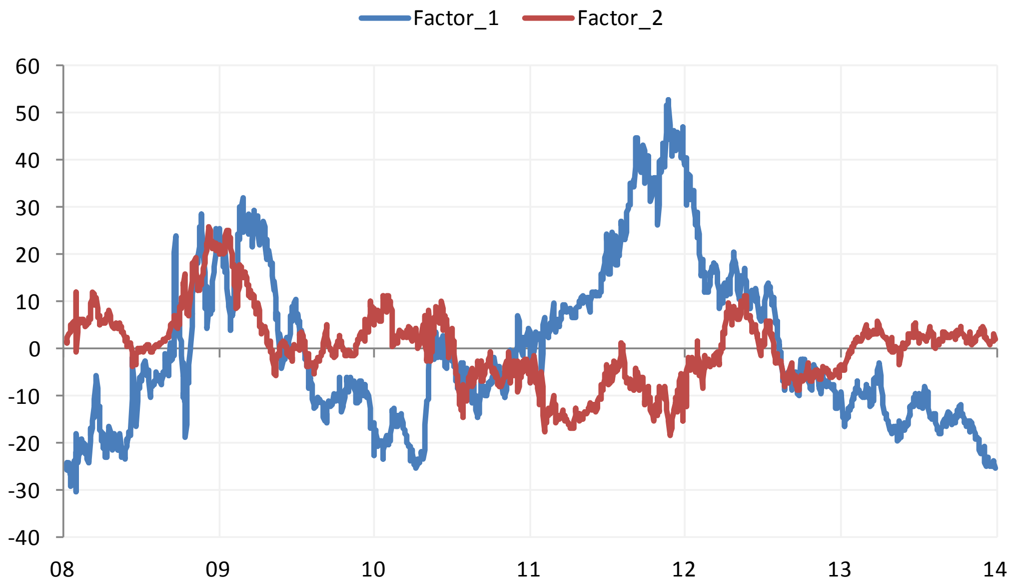
We set the state equation for the latent factors to be equal to:

$$\begin{pmatrix} L_{1t} \\ L_{2t} \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} L_{1t-1} \\ L_{2t-1} \end{pmatrix} + \begin{pmatrix} \sigma_{l_1} & 0 \\ 0 & \sigma_{l_2} \end{pmatrix} \begin{pmatrix} v_{l_1 t} \\ v_{l_2 t} \end{pmatrix} \quad (7)$$

The model can therefore be considered as a filtering tool to isolate movements in agency spreads not (or at least less) related to market fears or sovereign credit risk that should be strongly associated to FTS flows captured by the first factor. The second factor would more directly capture the effects of FTL episodes. Specifically, as this factor moves German and Spanish liquidity spreads in opposite directions, its negative realisations capture a simultaneous widening of German spreads and a narrowing of Spanish spreads, consistent with the common understanding of a FTL away from Spanish sovereigns and into German bunds. Interestingly, the loadings of the second factor suggest that FTL episodes away from the Spanish bond market also took place in the early stages of the financial crisis, following the collapse of Bear Stearns in early 2008 and following Lehman collapse into the first months of 2009, well ahead of the intensification of the sovereign debt crisis in the euro area in 2010 and the downgrading of Spanish sovereign debt.

We set the matrix of coefficients in (7) to be diagonal. This is equivalent to rotate the factors to make them orthogonal. As can be seen in Figure 5, agency spreads move in line and divergences among them seem to revert in time. Thus, we have opted to set both factors to be a random walk, so shocks are considered to be permanent. Alternative specifications where we let coefficients in equation (7) to be different from one produce values close to the unity. Using a standard Kalman Filter approach to estimate the latent factors, the results are shown in Table 3.

Figure 5: Latent factors of the liquidity model



Note: Latent factors obtained from a Kalman Filter estimate of the Dynamic Factor Model proposed in equations 6-7. Observed variables are French, Spanish and German agency spreads from January 2008, to December 2013.

Similarly to the results obtained for the principal components analysis, we get a first factor with similar coefficients for the three agency spreads, whereas the second factor has an opposite sign for Spain versus Germany and France. In figure 5, we can observe the estimated evolution of each factor.

The first factor strongly increases both around the Lehman Brothers crisis (2008Q4-2009Q1), and also around the euro area sovereign debt crisis (being at is maximum in the second half of 2011, just before the beginning of the VLTROs-Very Long Term Refinancing Operations-). In fact, this factor has a very similar evolution to measures of market risk or fear, as for example the VSTOXX volatility index for the EUROSTOXX 50 index, the equivalent to the VIX index for the US market (see Figure 6). This evidence lends support to our interpretation of the first factor as capturing FTS flows.

Table 3: Dynamic latent factor model estimation.

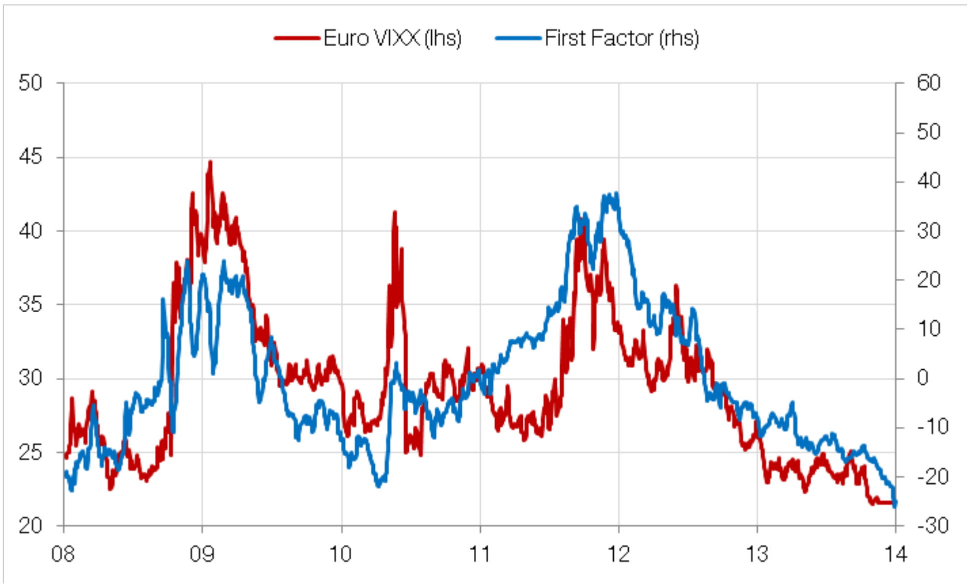
	Measurement equation		
	ES	*DE*	*FR*
μ	33.60	41.18	21.54
γ_1	0.90	1.00	0.60
γ_2	-1.84	1.00	0.28
σ	2.30	0.65	6.07

	State Equation	
	F_1	F_2
φ	1	1
σ_f	1.91	1.22

Note: Dynamic latent factor model proposed in equation 6 (Measurement equation) and 7 (State equation). Variables used are daily time series (from January 4th 2008 to December 31st 2013) of the ICO Spread (ES, the difference between the 5-year zero-coupon rate of ICO and the equivalent Spanish Sovereign), KfW Spread (DE, the difference between the 5-year zero-coupon rate of KfW and the equivalent German Sovereign) and CADES Spread (the difference between the 5-year zero-coupon rate of CADES and the equivalent French Sovereign).

By contrast, the second factor provides signals of liquidity differentiation between countries both in the aftermath of the Lehman Brothers collapse and also in mid-2012, when a financial support programme for the Spanish economy was in consideration given the significant deterioration of bond market conditions. We therefore interpret this factor as providing evidence on the impact of more genuine FTL flows beyond and above liquidity effects stemming from FTL flows. Therefore, this second factor underpins our identification of FTL episodes and is the starting point for our investigation of the quantitative effects of those episodes on several financial and macroeconomic variables. It is important to note, however, that by controlling by the liquidity effects of FTS flows by mean of the first latent factor, our investigation is likely to provide a lower bound on the liquidity premium in those financial instruments.

Figure 6: Risk aversion (First latent) factor and ITRAXX index.



Blue line (right-hand-side) represents the first latent factors obtained from the Kalman Filter estimate of the Dynamic Factor Model proposed in equations 6-7 (French, Spanish and German 5-year agency spreads as observed variables). Red line represents the VIXX volatility index for the EuroStoxx for the larger maturity available (24 months) for a better match with the maturity of the agency spreads.

4 FTL and the economic and financial environment

This section documents the impact of FTL flows on different financial and economic indicators. The purpose is to characterise FTL episodes identified using the factor model introduced in the previous section rather than to look for causality. In particular, an important aspect of our analysis here is to analyse the behaviour of those variables across most euro area bond markets and not only in the three major ones for which agency spreads are available.

We first focus in detail on euro area sovereign bond markets. We will report our regression results for the three countries for which we have computed the agency spreads, namely Spain, Germany and France, and also Italy, the other large bond market in the euro area,. Our tables will also provide summary statistics (average, standard deviation and max/min values) of the impact of FTL flows for two euro area country groups: (i) “core” countries (Austria, Belgium, Finland, France, Germany and Netherlands) and (ii) “stressed” countries (Greece, Ireland, Italy, Portugal and Spain), whose sovereign debt was more seriously affected by the market turbulences and that eventually was subject to the Eurosystem Securities Market Programme (SMP).

4.1 Sovereign bond markets during FTL episodes

Table 4 provides evidence of the effects of FTL episodes on euro area sovereign bond markets. Before discussing our results some considerations are worth bearing in mind. We will report results for the zero-coupon yields at the 2, 5 and 10-year maturities. While zero-coupon term structures are necessary to compute the liquidity spreads for Spain, Germany and France, it is worth noting that the estimation of those zero-coupon term structures imply some fitting errors that may convey important information on liquidity. Recent literature has shown that such fitting errors contain information about the liquidity premia in the underlying bonds used in the estimation (see Hu et al., 2013, Berenguer et al., 2013). To the extent that fitted yields are likely to be partially deprived from liquidity premia content, our quantitative findings are likely to be biased downwards.

As a robustness exercise, we also consider the yields of benchmark sovereign bonds (by Bloomberg) for each maturity. Although on-the-run premia effects seem to be weaker in the euro area than in the US market, those bonds are likely to remain somewhat more liquid than the off-the-run ones, so if anything, their use in our analysis should also tend to bias the analysis against a significant liquidity deterioration and, therefore, our empirical findings should be interpreted as a low estimate of such a deterioration*.*

Finally, our purpose is to analyse the impact of FTL flows in all euro area bond markets. Since sovereign bond yields of some euro area countries were particularly volatile and exhibited signals of (local) non-stationarity in our sample, we report results for regressions both in levels and first differences.

The regressions results reported in Table 4 Panel A point to significant increases in the levels of Spanish bond yields, and decreases in German and French sovereign bond yields, which corresponds to the basic intuition between FTL flows among those bond markets. Importantly, these qualitative findings hold not only for the three countries for which we can compute the agency spreads but also for the country blocks they represent. Indeed, our regression results suggest significant changes in sovereign yields in opposite directions reflecting strong portfolio relocation flows from stressed to core bond markets within the euro area. For example, our results also suggest significant increases in the other large sovereign bond markets under stress during the crisis, Italy, with the impact being somewhat stronger at longer maturities. Average results and standard deviations of the impact estimates for all stressed countries are significantly higher than those reported for Italy and Spain, which suggest that FTL flows were particularly adverse for smaller and more seriously stressed bond markets.

Table 4: Impact of flight to liquidity on sovereign bond markets: yields and trading activity

					CORE (DE, FR, AT, BE, NL, FI)					STRESSED (ES, IT IE PT GR)				
	ES	DE	FR	IT	MEAN	STD	MIN	MAX	SIG.	MEAN	STD	MIN	MAX	SIG.
Impact on yields														
Panel A: levels														
Zero-coupons														
2-year	-1.517***	3.099***	2.958***	-0.552**	3,415	1,070	1,617	5,044	6	-31,610	49,171	-129,282	-0,552	5
5-year	-2.367***	2.692***	2.466***	-0.868***	2,625	0,747	1,076	3,301	6	-16,250	17,408	-49,103	-0,868	5
10-year	-3.476***	2.399***	1.881***	-1.439***	2,232	0,756	0,726	2,973	6	-10,161	7,520	-22,477	-1,439	5
Benchmark bonds														
2-year	-1.934***	2.887***	2.976***	-0.746***	2,634	0,948	0,750	3,504	6	-35,449	51,366	-136,944	-0,746	5
5-year	-2.812***	2.538***	2.490***	-1.106***	2,686	0,854	1,034	3,651	6	-18,108	19,120	-54,050	-1,106	5
10-year	-3.488***	2.074***	1.907***	-1.374***	2,233	0,813	0,674	2,976	6	-13,685	12,430	-36,407	-1,374	5
Panel B: First differences														
Zero-coupons														
2-year	0.966***	-0.141	0.036	0.986***	0,006	0,137	-0,141	0,283	0	1,163	0,447	0,853	2,053	3
5-year	1.053***	-0.223*	0.080	1.010***	0,033	0,195	-0,223	0,395	1	2,263	2,203	1,010	6,650	3
10-year	0.789***	-0.299**	0.022	0.807***	-0,020	0,198	-0,299	0,341	2	0,382	1,665	-2,860	1,805	3
Benchmark bonds														
2-year	1.616***	0.111	0.026	0.993***	0,183	0,180	0,026	0,568	1	11,076	17,244	0,993	45,484	5
5-year	1.264***	0.068	0.262**	0.987***	0,289	0,175	0,068	0,536	3	3,527	3,145	0,987	9,497	5
10-year	0.669***	-0.070	0.211*	0.609***	0,184	0,167	-0,070	0,468	2	2,220	1,915	0,609	5,789	5
Impact on trading activity														
Order-flow (buys-sells)	-146.842***	72.352**	-167.054**	58.356	20,869	128,024	-167,054	254,873	3	-14,111	71,138	-146,842	58,356	1

Note: Each row in the table represents the linear regression estimates where the regressed variable is reported in the first column. In all cases, the regressors are the two factors of the Dynamic Factor Model (equations 6-7), although only the coefficient of the second one (Flight to Liquidity factor) is reported. We perform separate estimations for each country. Columns 2-5 report the estimations for the top 4 bond markets in the euro area. Columns 6-10 report mean, minimum, maximum as well as standard deviations of the coefficients estimated for those countries labelled *core* (Germany, France, Austria, Belgium, The Netherlands, and Finland), where the last column (10^{th}) is the number of regressions where this coefficient is statistically significant at a 5% level. Columns 11-15 report mean, minimum, maximum as well as standard deviations of the coefficients estimated for those countries labelled *stressed* (Spain, Italy, Ireland, Portugal, Greece), where the last column (15^{th}) is the number of regressions where this coefficient is statistically significant at a 5% level. . Robust standard errors are used for the computation of the statistical tests.

By contrast, the level of sovereign bond yields of all core euro area countries did exhibit significant decreases during FTL episodes, in line with the results for Germany and France. The average impact for all core markets as a whole is somewhat lower than for Germany, but smaller bond markets also benefited from those inflows and the standard deviation of the estimated effects suggests less heterogeneity than for the stressed countries. Those qualitative findings seem to be quite robust across yield measures. On average, the sign and magnitude of the estimated coefficients using yield levels for benchmark bonds are broadly in line with those for the zero-coupon yields, as discussed above if anything somewhat higher as should be expected.

Table 4 Panel B results on first differences also suggest strong significant increases in sovereign bond yields for stressed countries, in theory those whose behaviour tends to exhibit a stronger upward trend and more symptoms of non-stationarity. The influence of FTL flows during the financial crisis in the euro area is also quantitatively important: for Spain it suggests a variation in 5-year sovereign yields of almost 80 basis points and around 60 basis points for Italian bond yields. In contrast, overall, the significance of the estimates drops for daily changes in the more stable bond yields of the core countries.

4.1.1 TRADING ACTIVITY IN BOND MARKETS.

Finally, we investigate the extent to which our FTL episodes also have an impact in bond trading activity that justifies those effects in sovereign bond yields. Unfortunately global trading activity in euro area bond markets is not available at daily frequency. We therefore employ order-flow (buy minus sell volumes) of transactions within the MTS interdealer market, by far the largest electronic trading system for the euro area bond market and has been already employed in several studies of the euro area bond market (e.g. Beber et al., 2009). 5 Bond trading through the MTS system can take place on two different platforms, the pan-European EuroMTS and the domestic (national) ones. In its early years, the EuroMTS was the reference electronic market for euro benchmark bonds and those with a minimum outstanding value of EUR5bn, while the domestic (national) MTS platforms allowed for trading of all remaining sovereign bonds of euro area countries, but MTS gradually evolved to a symmetric dual-platform trading system from 2006. Our empirical work is based on trading statistics consolidated across platforms. Despite those considerations, it has to be borne in mind that MTS market share differs across euro area countries, ranging even within the largest ones from being very high for Italy but much lower for Germany for instance, which may influence our results.

We find that trading activity is also significantly affected by FTL episodes, as reflected in order-flow activity in bond markets. FTL episodes are associated to negative changes in order-flow for stressed bond markets, for example Spain, suggesting an asymmetry in trading activity towards sell orders in those markets which is consistent with the upward pressure on bond yields we reported above. Furthermore, we also find a negative impact of FTL on order-flow in all stressed countries. In this regard, the significance and magnitude of the coefficient for Italy is particularly important, for, as discussed above, the MTS share of overall trading activity in Italian bonds is particularly high. In contrast, the FTL impact on order-flow in core bond markets is, on average, positive although results do reflect some heterogeneity probably related to the differences in MTS share across countries that may explain the low significance of the estimated impacts.

4.2 Stock market performance during FTL episodes

To assess the behaviour of stock markets during FTL episodes, we regress daily returns of the overall market and 10 different industry-specific portfolios (using the Datastream industry classification) on the two factors in our model, the FTS factor and our FTL factor. In addition, as stressed in Baele et al. (2013) it is important to note that the coefficient on FTL must be interpreted as an abnormal return during FTL episodes, but it does not indicate which portfolios perform best or worst during FTL episodes spells, as portfolios with positive (negative) FTL betas may have also high (low) market betas.

5. MTS-system market share among the electronic trading systems in Europe was already 74% of daily average turnover in 2003, and has been further developed since them.

Table 5: Impact of flight to liquidity and flight to safety on stock markets

					CORE (DE, FR, AT, BE, NL, FI)					CORE (ES, IT IE PT GR)				
	ES	DE	FR	IT	MEAN	STD	MIN	MAX	SIG.	MEAN	STD	MIN	MAX	SIG.
Panel A: impact of flight-to-safety factor														
Stocks (all sectors)	0.010	0.003	-0.007	-0.010	-0,019	0,021	-0,061	0,003	0	-0,021	0,021	-0,051	0,010	0
Individual sectors														
Oil	-0.004	-0.035	0.002	0.027	-0,041	0,031	-0,094	0,002	1	-0,041	0,051	-0,123	0,027	0
Basic	-0.047*	0.018	-0.005	0.018	-0,020	0,026	-0,065	0,018	0	-0,011	0,037	-0,057	0,040	0
Industrial	-0.025	-0.015	-0.021	-0.042*	-0,038	0,015	-0,055	-0,015	0	-0,032	0,009	-0,044	-0,021	0
Consumer goods	-0.012	0.022	0.004	-0.038	-0,001	0,025	-0,042	0,034	0	-0,014	0,025	-0,038	0,032	0
Health	-0.001	-0.011	0.008	-0.033	-0,007	0,013	-0,030	0,008	0	-0,047	0,065	-0,146	0,037	1
Consumer services	0.008	-0.031	-0.014	-0.036	-0,025	0,013	-0,043	-0,004	0	-0,022	0,018	-0,044	0,008	0
Telecom	0.033	0.009	0.038	-0.013	0,012	0,028	-0,047	0,038	0	0,024	0,038	-0,013	0,094	0
Utilities	0.015	0.007	0.009	-0.009	-0,003	0,010	-0,017	0,009	0	-0,004	0,020	-0,034	0,015	0
Financials	0.018	-0.015	-0.030	-0.012	-0,041	0,022	-0,071	-0,015	0	-0,017	0,027	-0,057	0,018	0
Technology	0.027	0.030	-0.048*	-0.090*	-0,017	0,026	-0,048	0,030	0	-0,032	0,043	-0,090	0,027	1
Panel B: impact of flight-to-liquidity factor														
Stocks (all sectors)	-0.125***	-0.043	-0.085**	-0.099**	-0,074	0,029	-0,133	-0,043	2	-0,096	0,021	-0,125	-0,059	4
Individual sectors														
Oil	-0.067	-0.141***	-0.087**	-0.082*	-0,104	0,046	-0,188	-0,059	3	-0,117	0,044	-0,193	-0,067	3
Basic	-0.105***	-0.056	-0.065*	-0.079	-0,082	0,031	-0,147	-0,056	1	-0,136	0,062	-0,255	-0,079	4
Industrial	-0.093**	-0.055	-0.065*	-0.076**	-0,078	0,025	-0,113	-0,044	3	-0,085	0,021	-0,123	-0,061	3
Consumer goods	-0.059***	-0.017	-0.065*	-0.080**	-0,051	0,018	-0,070	-0,017	1	-0,038	0,046	-0,080	0,038	3
Health	-0.109***	-0.033	-0.051	-0.082***	-0,067	0,032	-0,130	-0,033	1	-0,090	0,108	-0,263	0,077	3
Consumer services	-0.103**	-0.084***	-0.079**	-0.093***	-0,062	0,023	-0,084	-0,021	4	-0,082	0,045	-0,120	0,007	4
Telecom	-0.071	-0.006	-0.025	-0.064	-0,042	0,037	-0,110	-0,006	1	-0,012	0,179	-0,161	0,339	2
Utilities	-0.115***	-0.045	-0.114***	-0.068**	-0,071	0,028	-0,114	-0,036	2	-0,080	0,029	-0,115	-0,038	2
Financials	-0.186***	-0.070*	-0.134**	-0.158***	-0,105	0,031	-0,153	-0,070	4	-0,171	0,034	-0,223	-0,120	4
Technology	-0.033	-0.035	-0.086**	-0.162***	-0,069	0,018	-0,086	-0,035	3	-0,049	0,057	-0,162	-0,009	1

Note: Each row in the table represents the linear regression estimates where the regressed variable is reported in the first column. In all cases, the regressors are the two factors of the Dynamic Factor Model (equations 6-7). Panel A shows the estimated coefficient of the first factor (flight-to-liquidity factor), and Panel B shows the estimated coefficient of the second one (Flight to Liquidity factor). We perform separate estimations for each country. Columns 2-5 report the estimations for the top 4 bond markets in the euro area. Columns 6-10 report mean, minimum, maximum as well as standard deviations of the coefficients estimated for those countries labelled *core* (Germany, France, Austria, Belgium, The Netherlands, and Finland), where the last column (10^{th}) is the number of regressions where this coefficient is statistically significant at a 5% level. Columns 11-15 report mean, minimum, maximum as well as standard deviations of the coefficients estimated for those countries labelled *stressed* (Spain, Italy, Ireland, Portugal, Greece), where the last column (15^{th}) is the number of regressions where this coefficient is statistically significant at a 5% level. . Robust standard errors are used for the computation of the statistical tests.

Table 5 results indicate that FTL episodes during the euro area financial and debt crisis had a negative impact on stock markets, as stocks were indeed perceived as riskier assets during those episodes. Furthermore, in contrast to bond markets, the fact that both core and stressed countries' stock markets display significantly negative daily returns on those days highlights the importance of accounting for such episodes to understand developments in euro area financial markets as a whole.

At sector level, we find that the performance of most if not all sectors are significantly and adversely affected by FTL flows. Moreover, qualitative results hold for most if not all countries, and our results do not suggest any specific defensive sector in the event of such episodes. The standard deviation of the estimated impact coefficients across countries displays some strong variation across sectors but this may be related to the different weight of specific sectors across countries and the size of the stock markets.

4.3 Economic confidence and FTL episodes

The FTL episodes we identified in our analysis also coincide with a deepening of the economic crisis in many euro area countries. Although we identified FTL episodes using bond market data only, the results in the previous section showed that the impact of FTL episodes was also significant on stock markets. This section explores the extent to which those episodes also affected confidence in the euro area economies and not only in financial markets.

To investigate the contemporaneous relationship between the financial and the real economy dimensions of the crisis, in Table 6 we report results of regressions of changes in monthly indicators of consumer and economic confidence on the average of our FTL factor in the previous month to their release. We find strong evidence that the financial market turbulence associated to the FTL episodes were an important determinant of the deterioration in economic confidence. Importantly, as for the stock market, FTL episodes led to lower confidence in all euro area countries, both core and stressed, and not only in those whose bond markets were adversely affected by the liquidity outflows. Moreover, Table 6 shows that the associated confidence deterioration among euro area consumers is robust to the use of alternative indicators, which suggests that FTL episodes were interpreted as a signal of a deepening of the economic crisis in the euro area as a whole. We also report results for the FTS factor as such episodes are often link to negative returns in the stock market corroborating the findings in Baele et al. (2013), which stress the importance of accounting for the effects of these turbulences in financial markets on the real economy.

Table 6: Impact of flight to liquidity and flight to safety factors on economic and consumer confidence

					CORE (DE, FR, AT, BE, NL, FI)					CORE (ES, IT IE PT GR)				
	ES	DE	FR	IT	MEAN	STD	MIN	MAX	SIG.	MEAN	STD	MIN	MAX	SIG.
Panel A: impact of flight-to-safety factor														
OECD Economic Sentiment	-14.791***	-15.054***	-16.511***	-18.322***	-19,287	3,630	-24,821	-15,054	6	-22,787	6,385	-29,908	-14,791	4
EC Consumer Confidence	-0.953*	-1.306	-1.589***	-2.709***	-2,307	1,438	-5,360	-1,113	6	-9,409	14,529	-38,440	-0,953	3
Panel B: impact of flight-to-liquidity factor														
OECD Economic Sentiment	-44.837***	-98.461***	-66.846***	-42.558***	-75,310	12,134	-98,461	-65,963	6	-20,543	24,801	-44,837	15,124	3
EC Consumer Confidence	-7.746***	-12.832***	-2.581***	0.386	-7,041	3,686	-12,832	-2,581	6	20,078	39,905	-7,746	99,383	3

Note: Each row in the table represents the linear regression estimates where the regressed variable is reported in the first column. In all cases, the regressors are the two factors of the Dynamic Factor Model (equations 6-7), although only the coefficient of the second one (Flight to Liquidity factor) is reported. We perform separate estimations for each country. Columns 2-5 report the estimations for the top 4 bond markets in the euro area. Columns 6-10 report mean, minimum, maximum as well as standard deviations of the coefficients estimated for those countries labelled *core* (Germany, France, Austria, Belgium, The Netherlands, and Finland), where the last column (10^{th}) is the number of regressions where this coefficient is statistically significant at a 5% level. Columns 11-15 report mean, minimum, maximum as well as standard deviations of the coefficients estimated for those countries labelled *stressed* (Spain, Italy, Ireland, Portugal, Greece), where the last column (15^{th}) is the number of regressions where this coefficient is statistically significant at a 5% level. Robust standard errors are used for the computation of the statistical tests.

Table 7: Impact of flight to liquidity and flight to safety factors on asset swap spreads

	flight-to-safety factor	flight-to-liquidity factor
BofA Merrill Lynch Asset Swap Spread Index		
Euro Area Non-Financial	0.054	0.097*
Euro Area Financial	0.113***	0.162***
Euro Area Government	-0.026	1.222***
Periphery Non-Financial	0.066**	0.185***
Periphery Financial	0.106***	0.196***
Periphery Government	0.276	1.032***
Non-Periphery Non-Financial	0.044	0.089*
Non-Periphery Financial	0.114***	0.158***
Non_Periphery Government	-0.631	0.010

Note: Each row in the table represents the linear regression estimates where the regressed variable is reported in the first column. In all cases, the regressors are the two factors of the Dynamic Factor Model (equations 6-7). Regressions are estimated in differences for both the Asset Swap Spreads and the factors, and robust standard errors are used for the computation of the statistical tests.

5 Concluding remarks

By comparing sovereign and agency bonds (bonds with identical level of credit risk but different levels of liquidity), this paper analysed liquidity premia in three major euro area sovereign bond markets (Spain, Germany and France) between 2008 and 2013. We showed that such liquidity spreads reached more than 100 basis points during the euro area debt crisis, and identified flight to liquidity episodes above and beyond “flight to quality” or “flight to safety” spells.

We then showed that accounting for flight to liquidity episodes is an essential element for a thorough understanding of developments in euro area bond markets in recent years. First, flight to liquidity flows contributed to explain the significant widening of intra-euro area sovereign spreads by increasing the yields of the bonds from stressed countries while at the same time lowering those from core countries. In addition, we showed that flight to liquidity episodes were associated with stock market declines and confidence deterioration in the euro area as a whole, that is, not only in stressed but also in core countries, and thereby aggravating the financial and economic crisis.

The strong effects of flight to liquidity flows that we find in this paper suggest at least two areas for further research. First, a more thorough understanding of their effects in other market segments, like for example corporate bond markets, and the macroeconomy, for example on growth expectations, is important and such extensions of our analysis are already in our agenda.

Our results also show that the effects of flight to liquidity episodes on bond and other financial markets are important for policy makers. Indeed, the timing and goals of some of the policy measures taken during the euro area debt crisis could be better understood by the intensity of flight to liquidity episodes. Assessing the impact of such measures, for example the sovereign bond purchases under the Securities Market Programme of the Eurosystem, on attenuating flight to liquidity episodes is another important avenue to explore. In this field, the original analyses of Eser and Schwaab (2013) and Ghysels et al. (2013) are seminal and the factors proposed in our paper could be added to their methodology to assess the improvements in liquidity of the SMP programme.

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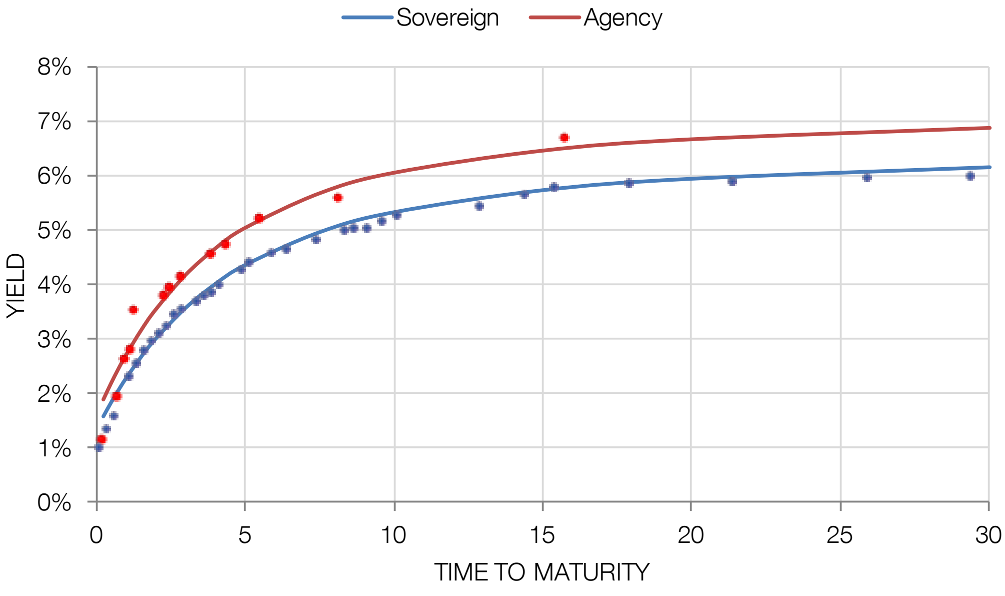
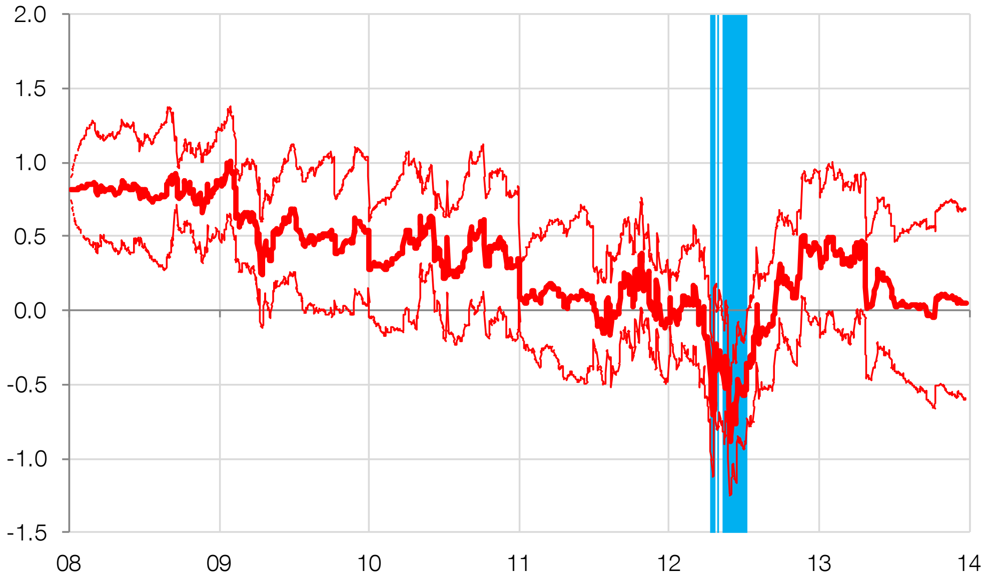
APPENDIX

Figure A1: Yield curve of ICO and Spanish Sovereign bonds



Note: Red dots represent yield and time to maturity of Spanish sovereign bonds; Blue dots represent yields and time to maturity of ICO bonds, while continuous lines represent the zero-coupon Nelson-Siegel yield curves. All data corresponds to the 01/04/2011.

Figure A2: Time variant coefficient in the regression between daily changes in French and German liquidity spreads



Shadows represent periods of statistically significant negative correlation. The solid line represents the estimated parameter, and the dotted lines the 95% confidence intervals. Kalman filter parameters estimated: $\hat{\alpha} = -0.019$; $\hat{\sigma}_v = 6.366$; $\hat{\sigma}_w = 0.0006$; $\hat{\beta}_0 = 0.820$.

Table A.1: ICO Bonds used for the estimation of the yield curve

ISIN	Maturity	Issuance	Coupon
XS0268276473	15/09/2008	15/09/2006	3.600
ES0200130435	18/12/2008	26/03/1998	5.000
XS0088241772	18/12/2008	24/06/1998	5.000
XS0169577714	22/12/2008	05/06/2003	3.000
XS0236867247	16/03/2009	05/12/2005	2.875
XS0297220641	15/09/2009	25/04/2007	4.125
XS0285098710	01/02/2010	01/02/2007	4.000
XS0366354875	27/05/2011	27/05/2008	4.375
XS0436694607	30/06/2011	30/06/2009	2.121
XS0441517660	27/07/2011	27/07/2009	1.920
XS0403519068	09/12/2011	09/12/2008	3.375
XS0417901641	16/03/2012	17/03/2009	2.875
XS0502287203	15/04/2012	15/04/2010	1.480
XS0301818166	23/05/2012	23/05/2007	4.375
XS0437697740	02/07/2012	02/07/2009	2.500
XS0633097299	16/05/2013	02/06/2011	3.875
XS0525700778	15/07/2013	15/07/2010	3.750
XS0386473267	10/09/2013	10/09/2008	4.500
XS0452822520	18/09/2013	18/09/2009	2.500
XS0408637022	20/01/2014	20/01/2009	3.500
XS0485309313	10/02/2015	10/02/2010	3.250
XS0485309313	10/02/2015	10/02/2010	3.250
XS0513825280	30/04/2015	02/06/2010	2.900
XS0528912214	28/07/2015	28/07/2010	3.750
XS0455534692	16/09/2016	02/10/2009	1.200
XS0428962921	20/05/2019	20/05/2009	4.375
ES0200130369	28/12/2026	24/07/1997	6.750

Table A.2: KfW Bonds used for the estimation of the yield curve

ISIN	Maturity	Issuance	Coupon
DE0002760998	15/02/2008	15/02/2006	3.000
DE0002760907	25/04/2008	20/02/2003	3.250
DE0002760972	17/11/2008	05/10/2005	2.500
DE0002760782	04/01/2009	01/04/1998	5.000
DE000A0E83R2	19/01/2009	19/01/2007	3.875
DE0002760923	17/04/2009	12/02/2004	3.500
DE000A0E83S0	30/06/2009	04/07/2007	4.375
DE0002760832	04/01/2010	08/09/1999	5.250
DE000A0E83C4	05/02/2010	05/02/2008	3.750
DE000A0NKXX4	09/04/2010	27/03/2007	3.875
DE000A0E83D2	02/08/2010	31/07/2008	4.875
DE0002760964	11/10/2010	16/06/2005	2.500
DE000A0E83E0	22/10/2010	22/10/2008	3.875
DE000A0XXM20	31/01/2011	29/01/2009	2.250
DE000A0E9C91	08/04/2011	22/04/2008	4.000
DE0002760840	04/07/2011	29/03/2001	5.000
DE000A0KPWU7	14/10/2011	20/09/2006	3.750
DE000A0Z1V18	05/12/2011	05/06/2009	1.875
DE000A0XXM04	16/01/2012	26/11/2008	3.375
DE000A1DAMF4	23/03/2012	23/03/2010	1.125
DE000A0XXM87	21/05/2012	20/05/2009	2.250
DE0002760873	04/07/2012	13/03/2002	5.250
DE000A0S8KS8	12/10/2012	17/07/2007	4.625
DE000A1DAMK4	17/06/2013	15/06/2010	1.250
DE0002760915	04/07/2013	03/07/2003	3.875
DE000A0E9DM0	11/10/2013	17/09/2008	4.375
DE000A1K0UE1	15/11/2013	15/11/2011	0.875
DE000A0XXM38	25/02/2014	25/02/2009	3.125
DE0002760931	04/07/2014	29/04/2004	4.250
DE000A1DAMJ6	10/04/2015	28/04/2010	2.250
DE0002760956	04/07/2015	26/01/2005	3.500
DE000A1EWEB2	16/11/2015	16/11/2010	1.875
DE000A1H36V3	08/04/2016	19/04/2011	3.125
DE000A0Z2KS2	04/07/2016	02/12/2009	3.125
DE000A1K0UB7	07/09/2016	07/09/2011	2.000
DE000A1DAME7	22/03/2017	22/03/2010	2.875
DE000A0MFJX5	04/07/2017	30/01/2007	4.125
DE000A1H36X9	15/06/2018	15/06/2011	3.125
DE000A0SLD89	04/07/2018	16/01/2008	4.375
DE000A0L1CY5	21/01/2019	20/01/2009	3.875
DE000A1CR4S5	20/01/2020	19/01/2010	3.625
DE000A1EWEJ5	18/01/2021	18/01/2011	3.375
DE0002760980	04/07/2021	17/01/2006	3.500
DE000A0PM5F0	04/01/2023	16/10/2007	4.625

Table A.3: CADES Bonds used for the estimation of the yield curve

ISIN	Maturity	Issuance	Coupon
FR0000571259	25/10/2008	02/02/1998	5.125
FR0010295949	23/02/2009	23/02/2006	3.125
FR0010093377	12/07/2009	23/06/2004	3.750
FR0010173773	12/07/2010	22/03/2005	3.125
FR0010718338	25/04/2012	29/01/2009	2.625
FR0000571366	25/10/2012	27/03/1998	5.250
FR0010249763	25/04/2013	04/11/2005	3.250
FR0010660100	04/09/2013	04/09/2008	4.500
FR0011147701	18/11/2013	18/11/2011	1.750
FR0010120410	25/10/2014	11/10/2004	4.000
FR0010831669	15/01/2015	08/12/2009	2.625
FR0011185032	16/02/2015	24/01/2012	1.875
FR0010163329	25/04/2015	09/02/2005	3.625
FR0011008366	25/02/2016	16/02/2011	3.000
FR0010301747	25/04/2016	08/03/2006	3.625
FR0010456434	25/04/2017	12/04/2007	4.125
FR0010143743	25/10/2019	21/12/2004	4.000
FR0010767566	25/04/2020	10/06/2009	4.250
FR0010198036	25/10/2020	27/05/2005	3.750
FR0010915660	25/04/2021	29/06/2010	3.375
FR0010347989	25/10/2021	25/07/2006	4.375
FR0011037001	25/04/2023	18/04/2011	4.125
FR0011192392	15/12/2025	01/02/2012	4.000

Table A.4: Spanish Government Bonds used for the estimation of the yield curve

ISIN	Maturity	Issuance	Coupon
ES0000011652	31/01/2008	15/07/1997	6.000
ES00000120H2	31/10/2008	17/01/2006	2.900
ES0000012882	31/01/2009	19/01/2004	3.600
ES0000012064	30/07/2009	10/07/1998	5.150
ES0000012239	31/01/2010	11/05/1999	4.000
ES00000120E9	30/07/2010	12/04/2005	3.250
ES00000120Z4	30/04/2011	15/01/2008	4.100
ES0000012387	30/07/2011	19/09/2000	5.400
ES0000012452	31/10/2011	12/06/2001	5.350
ES00000121I8	30/04/2012	13/01/2009	2.750
ES0000012791	30/07/2012	14/05/2002	5.000
ES00000120L4	31/10/2012	16/01/2007	3.900
ES0000011660	31/01/2013	15/07/1997	6.150
EH988544	30/04/2013	06/10/2009	2.300
ES0000012866	30/07/2013	15/04/2003	4.200
EI263529	31/10/2013	15/06/2010	2.500
ES00000121H0	31/01/2014	07/10/2008	4.250
ES00000123D5	30/04/2014	12/04/2011	3.400
ES0000012098	30/07/2014	07/12/1998	4.750
EH885945	31/10/2014	07/07/2009	3.300
ES0000012916	31/01/2015	28/06/2004	4.400
EI169668	30/04/2015	09/03/2010	3.000
ES00000123L8	30/07/2015	17/01/2012	4.000
ES00000120G4	31/01/2016	20/09/2005	3.150
ES00000122X5	30/04/2016	09/11/2010	3.250
ES00000123J2	31/10/2016	06/09/2011	4.250
ES00000120J8	31/01/2017	18/10/2006	3.800
ES0000012783	30/07/2017	11/03/2002	5.500
ES00000121A5	30/07/2018	19/02/2008	4.100
ES00000121L2	30/07/2019	10/02/2009	4.600
ES00000121O6	31/10/2019	02/06/2009	4.300
EI109866	30/04/2020	20/01/2010	4.000
ES00000122T3	31/10/2020	13/07/2010	4.850
ES00000123B9	30/04/2021	24/01/2011	5.500
ES00000123K0	31/01/2022	22/11/2011	5.850
ES00000121G2	31/01/2024	16/09/2008	4.800
EI153632	30/07/2025	24/02/2010	4.650
ES00000123C7	30/07/2026	15/03/2011	5.900
ES0000011868	31/01/2029	15/01/1998	6.000
ES0000012411	30/07/2032	23/01/2001	5.750
ES0000012932	31/01/2037	17/01/2005	4.200
ES00000120N0	03/07/2040	20/06/2007	4.900
EH984269	30/07/2041	28/09/2009	4.700

Table A.5: German Government Bonds used for the estimation of the yield curve

ISIN	Maturity	Issuance	Coupon
DE0001137131	14/03/2008	10/03/2006	3.000
DE0001141422	11/04/2008	16/05/2003	3.000
DE0001137149	13/06/2008	23/06/2006	3.250
DE0001135077	04/07/2008	10/07/1998	4.750
DE0001135093	04/07/2008	30/10/1998	4.125
DE0001137156	12/09/2008	15/09/2006	3.500
DE0001141430	10/10/2008	10/10/2003	3.500
DE0001137164	12/12/2008	15/12/2006	3.750
DE0001135101	04/01/2009	08/01/1999	3.750
DE0001137172	13/03/2009	16/03/2007	3.750
DE0001141448	17/04/2009	13/02/2004	3.250
DE0001137180	12/06/2009	15/06/2007	4.500
DE0001137198	11/09/2009	14/09/2007	4.000
DE0001141455	09/10/2009	27/08/2004	3.500
DE0001137206	11/12/2009	14/12/2007	4.000
DE0001135135	04/01/2010	22/10/1999	5.375
DE0001137214	12/03/2010	14/03/2008	3.000
DE0001141463	09/04/2010	01/04/2005	3.250
DE0001137222	11/06/2010	13/06/2008	4.750
DE0001135150	04/07/2010	05/05/2000	5.250
DE0001137230	10/09/2010	12/09/2008	4.000
DE0001141471	08/10/2010	23/09/2005	2.500
DE0001137248	10/12/2010	12/12/2008	2.250
DE0001135168	04/01/2011	20/10/2000	5.250
DE0001137255	11/03/2011	13/03/2009	1.250
DE0001141489	08/04/2011	24/03/2006	3.500
DE0001137263	10/06/2011	29/05/2009	1.500
DE0001135184	04/07/2011	25/05/2001	5.000
DE0001137271	16/09/2011	11/09/2009	1.250
DE0001141497	14/10/2011	29/09/2006	3.500
DE0001137289	16/12/2011	20/11/2009	1.250
DE0001135192	04/01/2012	04/01/2002	5.000
DE0001137297	16/03/2012	19/02/2010	1.000
DE0001141505	13/04/2012	30/03/2007	4.000
DE0001137305	15/06/2012	14/05/2010	0.500
DE0001135200	04/07/2012	05/07/2002	5.000
DE0001137313	14/09/2012	13/08/2010	0.750
DE0001141513	12/10/2012	28/09/2007	4.250
DE0001137321	14/12/2012	12/11/2010	1.000
DE0001135218	04/01/2013	10/01/2003	4.500
DE0001137339	15/03/2013	25/02/2011	1.500
DE0001141521	12/04/2013	28/03/2008	3.500
DE0001137347	14/06/2013	13/05/2011	1.750
DE0001137354	13/09/2013	19/08/2011	0.750
DE0001141539	11/10/2013	26/09/2008	4.000
DE0001137362	13/12/2013	18/11/2011	0.250
DE0001135242	04/01/2014	31/10/2003	4.250
DE0001137370	14/03/2014	24/02/2012	0.250
DE0001141547	11/04/2014	27/03/2009	2.250
DE0001135259	04/07/2014	28/05/2004	4.250
DE0001141554	10/10/2014	25/09/2009	2.500
DE0001135267	04/01/2015	26/11/2004	3.750
DE0001141562	27/02/2015	15/01/2010	2.500
DE0001141570	10/04/2015	16/04/2010	2.250
DE0001135283	04/07/2015	20/05/2005	3.250
DE0001141588	09/10/2015	24/09/2010	1.750
DE0001135291	04/01/2016	25/11/2005	3.500
DE0001141596	26/02/2016	14/01/2011	2.000
DE0001141604	08/04/2016	26/04/2011	2.750
DE0001135309	04/07/2016	19/05/2006	4.000
DE0001141612	14/10/2016	30/09/2011	1.250
DE0001135317	04/01/2017	17/11/2006	3.750
DE0001141620	24/02/2017	13/01/2012	0.750
DE0001135333	04/07/2017	25/05/2007	4.250

ISIN	Maturity	Issuance	Coupon
DE0001135341	04/01/2018	16/11/2007	4.000
DE0001135358	04/07/2018	30/05/2008	4.250
DE0001135374	04/01/2019	14/11/2008	3.750
DE0001135382	04/07/2019	22/05/2009	3.500
DE0001135390	04/01/2020	13/11/2009	3.250
DE0001135408	04/07/2020	30/04/2010	3.000
DE0001135416	04/09/2020	20/08/2010	2.250
DE0001135424	04/01/2021	26/11/2010	2.500
DE0001135440	04/07/2021	29/04/2011	3.250
DE0001135457	04/09/2021	26/08/2011	2.250
DE0001135465	04/01/2022	25/11/2011	2.000
DE0001135473	04/07/2022	13/04/2012	1.75
DE0001134922	04/01/2024	04/01/1994	6.250
DE0001135044	04/07/2027	04/07/1997	6.500
DE0001135069	04/01/2028	23/01/1998	5.625
DE0001135143	04/01/2030	21/01/2000	6.250
DE0001135176	04/01/2031	27/10/2000	5.500
DE0001135226	04/07/2034	31/01/2003	4.750
DE0001135275	04/01/2037	28/01/2005	4.000
DE0001135325	04/07/2039	26/01/2007	4.250
DE0001135366	04/07/2040	25/07/2008	4.750
DE0001135432	04/07/2042	23/07/2010	3.25

Table A.6: French Government Bonds used for the estimation of the yield curve

ISIN	Maturity	Issuance	Coupon
FR0105427795	12/01/2008	28/01/2003	3.500
FR0108197569	12/03/2008	22/11/2005	2.750
FR0000570632	25/04/2008	15/01/1998	5.250
FR0105760112	12/07/2008	24/06/2003	3.000
FR0109136137	12/09/2008	25/07/2006	3.500
FR0000570665	25/10/2008	25/06/1992	8.500
FR0106589437	12/01/2009	22/01/2004	3.500
FR0000571432	25/04/2009	08/10/1998	4.000
FR0106841887	12/07/2009	22/06/2004	3.500
FR0110979178	12/09/2009	24/04/2007	4.000
FR0000186199	25/10/2009	12/05/1999	4.000
FR0107369672	12/01/2010	23/11/2004	3.000
FR0000186603	25/04/2010	08/02/2000	5.500
FR0107674006	12/07/2010	21/06/2005	2.500
FR0113872776	12/09/2010	20/05/2008	3.750
FR0000187023	25/10/2010	12/09/2000	5.500
FR0108354806	12/01/2011	24/01/2006	3.000
FR0000570731	25/04/2011	26/02/1996	6.500
FR0108847049	12/07/2011	20/06/2006	3.500
FR0116843519	12/09/2011	26/05/2009	1.500
FR0000187874	25/10/2011	11/09/2001	5.000
FR0109970386	12/01/2012	23/01/2007	3.750
FR0000188328	25/04/2012	12/03/2002	5.000
FR0110979186	12/07/2012	26/06/2007	4.500
FR0000188690	25/10/2012	10/09/2002	4.750
FR0000570780	26/12/2012	25/02/1987	8.500
FR0113087466	12/01/2013	22/01/2008	3.750
FR0000188989	25/04/2013	11/03/2003	4.000
FR0114683842	12/07/2013	22/07/2008	4.500
FR0010011130	25/10/2013	09/09/2003	4.000
FR0010061242	25/04/2014	09/03/2004	4.000
FR0010112052	25/10/2014	07/09/2004	4.000
FR0117836652	15/01/2015	26/01/2010	2.500
FR0010163543	25/04/2015	08/02/2005	3.500
FR0118462128	12/07/2015	22/06/2010	2.000
FR0010216481	25/10/2015	12/07/2005	3.000
FR0119105809	25/02/2016	25/01/2011	2.250
FR0010288357	25/04/2016	07/02/2006	3.250
FR0119580050	25/07/2016	21/06/2011	2.500
FR0000187361	25/10/2016	06/02/2001	5.000
FR0120473253	25/02/2017	21/02/2012	1.750
FR0010415331	25/04/2017	09/01/2007	3.750
FR0010517417	25/10/2017	11/09/2007	4.250
FR0010604983	25/04/2018	08/04/2008	4.000
FR0010670737	25/10/2018	07/10/2008	4.250
FR0000189151	25/04/2019	10/06/2003	4.250
FR0000570921	25/10/2019	25/01/1989	8.500
FR0010776161	25/10/2019	07/07/2009	3.750
FR0010854182	25/04/2020	09/02/2010	3.500
FR0010949651	25/10/2020	12/10/2010	2.500
FR0010192997	25/04/2021	10/05/2005	3.750
FR0011059088	25/10/2021	07/06/2011	3.250
FR0011196856	25/04/2022	07/02/2012	3.000
FR0000571085	25/04/2023	27/01/1992	8.500
FR0010466938	25/10/2023	09/05/2007	4.250
FR0000571150	25/10/2025	25/02/1994	6.000
FR0010916924	25/04/2026	06/07/2010	3.500
FR0000571218	25/04/2029	12/03/1998	5.500
FR0000187635	25/10/2032	12/06/2001	5.750
FR0010070060	25/04/2035	06/04/2004	4.750
FR0010371401	25/10/2038	12/09/2006	4.000
FR0010773192	25/04/2041	30/06/2009	4.500
FR0010171975	25/04/2055	28/02/2005	4.000

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