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Expected issuance fees and market liquidity[☆]

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ABSTRACT

We examine the interaction between the primary and secondary markets for euro area sovereign bonds. Primary dealers compete to be selected as lead manager in the primary market, and have an incentive to increase liquidity. For our 2008–2012 sample of sovereign bonds from 11 euro area countries, we find that expected issuance fees are positively and economically related to market liquidity. The fee-driven liquidity effect is especially strong for countries with high funding needs, in periods of high re-financing uncertainty, and for low-risk bonds.

1. Introduction

The turmoil surrounding the global financial crisis emphasizes the crucial role of market liquidity for an effective market functioning and global financial stability. In the aftermath of the bankruptcy of Lehman Brothers, the average bid-ask spread for listed stocks increased dramatically from 3% percent to 6% percent (Beber and Pagano, 2013). This dramatic drop in liquidity was associated with deteriorating asset prices and substantial decreases in security issuance, real investments, and market participation. This episode illustrates the importance and relevance of market liquidity, and how liquidity appears, intensifies, or disappears. Liquidity is especially an issue in the post-crisis bond markets, as there is evidence that volume has decreased substantially due to regulatory changes (Anderson and Stulz, 2017). In market liquidity studies, risk-related factors tend to take

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center stage (Pelizzon et al., 2016), such as the costs of holding risky assets (inventory carrying costs) (Amihud and Mendelson, 1980; Ho and Stoll, 1983; O'Hara and Oldfield, 1986), the costs of trading with better informed investors (adverse selection costs) (Kyle, 1985; Glosten and Milgrom, 1985; Admati and Pfleiderer, 1988; Easley and O'Hara, 1992), or the real costs of processing orders (order processing costs) (Chan et al., 1995).

In this paper, we extend the analysis of market liquidity determinants by considering an issuance fee-driven liquidity mechanism in the euro area sovereign bond market. This mechanism is driven by the dual role of investment banks as primary dealers in the secondary markets, as well as competitors for lead manager in the primary market. Sovereigns have the incentive to try to increase liquidity as this reduces their funding costs (Favero et al., 2010). Sovereigns select a lead manager from the pool of primary dealers based on their liquidity provision in the secondary market (AFME, 2015). As a result, market makers provide more liquidity than they are naturally inclined to do as they are competing for primary issuance fees. Hence, investment banks improve their chances of winning mandates in the primary market by increasing the liquidity in the secondary market through their market making role.

Interactions between the primary and secondary markets have been studied in the equity market. Ellis et al. (2000) show that lead underwriters of an IPO are always the dominant market maker after the IPO. Chowdhry and Nanda (1996) show that lead underwriters compensate uninformed investors for adverse selection costs by providing liquidity. Aggarwal (2000) corroborates previously documented results that a lead underwriter stabilizes prices by stimulating demand and restricting supply in the aftermarket. Furthermore, by studying the relation between stock market liquidity and the cost of issuing equity, Butler et al. (2005) find that liquidity is an important determinant of the cost of raising external capital.

To the best of our knowledge, we are the first to study the interactions between the primary and secondary markets in the euro area government bond market. The heterogeneity in the demand for capital makes the European bond market more interesting to study than, for example, the sovereign bond market in the United States, which accommodates but a single sovereign. This heterogeneity also creates differences in the incentives across sovereigns to engage in the issuance fee-driven liquidity mechanism.

We study the hypothesized issuance fee-driven mechanism by combining two data sets. First, we use high-frequency data from the Mercado Telematico dei Titoli di Stato (MTS) to measure market liquidity in bonds. On MTS, debt securities are quoted in an exchange-like fashion, allowing us to study market liquidity using techniques typical for exchange-traded products. In particular, we use high frequency order book data of all traded sovereign debt securities between 2008 and 2012 and create quote-based liquidity measures that capture variation in liquidity in time and across bonds. Second, we extract issuance fees from Dealogic to measure the timing and size of issuance fees. We use the new issuance fee data from Dealogic to construct an expected issuance fee measure. This results in a panel data set covering eleven countries in the euro area, with the high frequency order book data aggregated to daily observations for bonds, by country. We test whether the expected issuance fee measure is a determinant of euro area sovereign bond market liquidity, controlling for all factors known to influence market liquidity from the literature.

We find that the institutional setting matters for the liquidity of the European government bond market: the expected issuance fees are positively related to sovereign bond market liquidity. A one standard deviation increase in expected issuance fees leads to an economically significant increase of 7.0% in market liquidity in our most conservative specification. This result is robust to the commonly-known drivers of market liquidity at the country, time, and bond level, such as age, maturity, size, credit spread, traded volume, market volatility, and funding liquidity conditions. Including country, time, and bond fixed effects also leaves the results qualitatively similar.

Moreover, we find that the result is particularly strong for peripheral euro area countries.[1] This is explained by the fact that these countries are marginally more aided by additional market liquidity because of the increased refinancing risk, as opposed to core countries. This implies that the incentives to decrease the liquidity premium are strong, which is consistent with our hypotheses. From the perspective of the issuance fee-driven mechanism, our findings corroborate Beber et al. (2009)'s finding of a flight-to-liquidity versus flight-to-quality dynamic in the European sovereign bond markets. Furthermore, we find that the issuance fee-driven liquidity mechanism is especially strong in periods of high market uncertainty, as measured by equity market volatility and funding liquidity. By itself, we find that market volatility reduces market liquidity, as confirmed by the significant negative interaction between risk and liquidity documented also by Favero et al. (2010). Whilst volatile markets cause market makers to be less naturally inclined to provide liquidity, the existence of a fee-driven liquidity mechanism incentivizes dealers to provide marginally more liquidity. As such, the fee-driven mechanism dampens the effect of market volatility on market liquidity thereby reducing the risk of market illiquidity. Overall, these results indicate that the fee-driven liquidity mechanism is especially strong when the risk of refinancing from the issuer perspective is high.

We expect that the market makers weigh the risk of market making versus the potential gain of issuance fees. When interacting the expected issuance fee measure with bond characteristics, we find that the fee-driven liquidity mechanism is particularly strong for bonds with low risk or low costs for the market maker. Bonds that are hard to come by due to their small free float and old age are more aided by the fee-driven liquidity mechanism. Bonds with high credit risk and high yield shock sensitivity (as measured by their time to maturity) benefit less from the fee-driven liquidity model. Also, the fee mechanism is decreasing in traded volume because the additionally posted liquidity is a cost for the market maker. We find that the fee-driven liquidity

[1] During the European sovereign debt crisis, Greece, Ireland, Italy, Portugal and Spain were considered peripheral countries, whereas Austria, Germany, France, Finland, Belgium and the Netherlands were deemed core.

mechanism is weaker for bonds for which there is an active derivative market. This is explained by the fact that market making risk is mitigated by means of the derivatives market as it allows market makers to effectively hedge their inventory risk. Finally, we find that the fee-driven liquidity mechanism is increasing in the number of primary dealers. This is explained by the fact that more primary dealers in the market increases the competition for fees.

In a series of robustness tests, we show that the results are insensitive to the construction of the expected issuance fee measure. Both forward looking and backward looking fee expectation measures yield similar results. Alternatively constructed liquidity measures also give similar results. Our main liquidity measure is based on the slope of the order book, thereby capturing both price and volume effects. However, we also test for the effect of expected issuance fees on the bid-ask spread and the quoted volume alone. We find that the result is significant in both cases. Furthermore, excluding the countries that also use other mechanisms for placing their bonds does not alter the results. Estimating the model on the subset of days on which individual bonds are actively traded does not materially change the results. Finally, a full model including all interactions simultaneously leaves the results unchanged.

Our findings provide insight on market liquidity and provide an interesting compliment to previous work that has largely focused on the relation between price formation, market liquidity, and trading book imbalances (Menkveld et al., 2004; Caporale et al., 2012), the price discovery process on MTS (Dunne et al., 2007; Caporale and Girardi, 2013), the relation between cost of funds and liquidity (Biais et al., 2004), the overcrowding of liquidity (Coppola et al., 2013), and the impact of informational content of trading activity on bond prices (Alfonso Dufour, 2012). It also lends a different perspective to other studies that operate more from a macro perspective, focusing, for example, on the relation between credit risk and liquidity (Beber et al., 2009; Pelizzon et al., 2016), or volatility and liquidity (Favero et al., 2010) for determining bond yields. It complements our understanding of the fee dynamics of dealer markets under competition studied elsewhere (Ho and Stoll, 1983).

The fee-driven liquidity measure economically affects the liquidity of euro area sovereign bonds. For sovereigns, the lower financing costs compensate for the fees awarded in the primary market. Specifically, we know from Favero et al. (2010) that an increase in the liquidity of 1 bps leads to a decrease in the yield of 2 bps for euro area sovereign bonds. We find that a one standard deviation increase in expected issuance fees (0.00135) leads to a increase in the liquidity of (0.00135*52.1 =)7.0%. Hence, our analysis suggests that an investment of 13.5 basis points in additional issuance fees leads to a reduction in yields of (2*7.0 =)14.0% for the sovereign. With an average issuance size of 16.4 billion euro, this is an investment of 22.14 million euro that results in an extra capital of approximately 40.4 million euro.[2] Hence, the higher issuance fees are more than offset by the lower issuance costs for the sovereign. For investment banks, the cost of providing extra liquidity is compensated for by the issuance fees. Finally, the extra liquidity allows end-users to reduce their market impact.

The remainder of this paper is organized as follows. In Section 2, we further explain the institutional setting of the European sovereign bond market, leading up to our hypothesized fee-driven liquidity effect and other hypotheses. Section 3 contains the description of the MTS and Dealogic data sets, and the methodology employed to test our hypotheses. In Section 4, we present the results, and in Section 5 our robustness checks. We conclude in Section 6.

2. Institutional setting

The European sovereign bond market instantly became the second largest domestic bond market in the world when the euro was introduced on January 1, 1999, being outranked only by the U.S. Treasury market.[3] In contrast to the U.S., the European bond market has not one but 12 sovereign issuers, competing for the funds of euro-denominated investors. The yield that investors demand from the bonds they invest in can be decomposed into the market yield, the credit spread, and the liquidity spread. Not being in a position to influence the market yield nor the creditworthiness in the short run, debt management offices (DMOs) that act on behalf of sovereigns to obtain their funding focus on improving the liquidity of the bonds in their effort to lower refinancing costs. A lower liquidity premium reduces the issuer's future cost of debt, as outstanding bonds serve as a price reference for new bonds of the same sovereign. Indeed, in the academic literature liquidity is increasingly recognized as an important determinant of the yield that investors demand (Ericsson and Renault, 2006; Manganelli and Wolswijk, 2009; Favero et al., 2010; Gómez-Puig and Sosvilla-Rivero, 2013). The DMOs govern the liquidity of their sovereign's bonds primarily through the primary dealership arrangement. They appoint banks as primary dealers, who are given incentives to actively quote sovereign bonds in the secondary market.

The euro area government bond market is characterized by the primary dealership system. DMOs appoint a number of investment banks to act as primary dealers. Primary dealers have a secondary market-making obligation, which means that they are expected to quote the securities that fall under their primary dealership. Primary dealers could be awarded primary issuance mandates, which are perceived as being lucrative. Specifically, in the case of a new bond issue, DMOs select a small group of lead managers out of their pool of primary dealers. Lead managers assist in the distribution of newly issued government bonds and are remunerated through primary issuance fees. Typically, 80% of the issuance fees are awarded to the lead managers, whereas the remaining 20% goes to rest of the syndicate. Liquidity provision in the secondary market is one of the criteria by which banks could distinguish themselves in order to win the mandate. This competition by virtue of the institutional setting

[2] Assuming an average yield of 2.7% over our sample period, an average time to maturity of 7.6 years, and an average sized non-coupon paying bond.

[3] Bank of International Settlements securities data.

provides for an additional determinant of market liquidity: the issuance fee-driven liquidity mechanism, which we study in this paper.

AFME (2015) gives a detailed description of the primary dealership rules in each European country. All countries in our sample operate under different primary dealership systems. The main and common elements relevant for our purpose is that in the primary market, DMOs encourage their primary dealers to bid in auctions and participate in the syndication of new issues. Aside from some embedded optionality, auctions by themselves provide little compensation for the dealers. However, syndicated issues are accompanied by fees averaging 0.18% of the issued notional to be divided mostly by the lead managers. For this reason, we focus on syndicated issue fees when we analyze the fee-driven liquidity mechanism.

The secondary market for euro area government bonds is an over-the-counter (OTC) market, where trading is decentralized and takes place via voice broking or on various electronic platforms. In the electronification that the European government bond market experienced over the last three decades, however, the majority of interbank trading migrated to interdealer platforms.[4] Among the interdealer platforms, Mercato Telematico dei Titoli di Stato (MTS) was the first entrant in 1988. Interdealer platforms such as MTS allow the sovereigns' DMOs to monitor the primary dealers' activity. Coluzzi et al. (2008) also confirm that the MTS platform is used by dealers and issuers to monitor and bring transparency to the European sovereign bond market. Since primary dealers are the main market makers on MTS, the quoting that takes place here is particularly well-suited to study market liquidity provision in relation to issuance fees.

MTS is a quote-driven order book market for dealers in government bonds. The microstructure of the MTS market is described in Cheung et al. (2005), Caporale and Girardi (2013), and Darbha and Dufour (2013). Quotes are firm, immediately executable, and aggregated in an order book. All government securities issued by European countries are listed on their respective domestic MTS platform. Bonds with a minimal amount outstanding of five billion euro that satisfy certain listing requirements are also admitted to trade on EuroMTS. For benchmark bonds, dealers are allowed to post their quotes on both markets simultaneously. MTS operates a centralized order book for each platform. Dealers on MTS are either classified as market makers (primary dealers) or market takers (all other dealers). The latter cannot enter quotes into the system and are obliged to trade bonds on the bid-ask quotes placed by the primary dealers.[5]

MTS is the nexus between the primary and the secondary market for European government bonds. As the DMOs are able to monitor the activity of each primary dealer through MTS, they are able to rank them accordingly and give this feedback to the primary dealers.[6] This ranking is one of the main criteria for awarding the lead-management role for new issues.[7] As such, primary dealers have an incentive to quote competitively on MTS in order to be ranked favorably, leading to an increased probability of being granted the lead-manager role in the next syndicated issue.

By confronting high frequency order book data from MTS with the syndicated fees earned by banks from Dealogic, we are able to study the interaction between the primary market fees and the liquidity of the secondary market.

2.1. Hypotheses

We derive our hypotheses from the institutional setting described above. The objective of the DMOs is to reduce the risk of refinancing and to minimize the cost of debt. In addition, end-investors demand a yield that is dependent on the market rate, the credit risk, and the liquidity premium. The liquidity premium thus directly affects investors' appetite for primary issues. Therefore, a lower liquidity premium reduces both refinancing risk, as well as the cost of debt. Since the market interest rate and the sovereign's credit spread are exogenous to the DMO, we expect the DMO to minimize the liquidity premium on their bonds. By remunerating market makers by means of issuance fees based on their liquidity provision, a DMO has the option to influence liquidity via the primary dealers. If primary dealers recognize this potential, we expect the interaction between the primary market and the secondary market to emerge:

Hypothesis 1. Market liquidity for euro area sovereign bonds is positively related to expected issuance fees.

The sovereigns in our sample are a fairly heterogeneous group. DMOs face different constraints related to their sovereigns' financing needs, fiscal disciplines, macro-economic health, and the availability of assets correlated to their debt instruments. Given this heterogeneity, each DMO will remunerate banks according to the degree their financing needs stand to benefit from better liquidity. This leads to our second hypothesis:

Hypothesis 2. The relation between market liquidity and expected issuance fees is increasing in sovereign funding need.

Whereas Hypothesis 2 focuses on the cross-section of countries, by the same token we expect the fee-driven liquidity mechanism to be stronger in periods of high refinancing risk:

[4] See the BIS report from January 2016 entitled "Electronic trading in fixed income markets" and a BIS Quarterly Review article in March 2016 entitled "Hanging up the phone - electronic trading in fixed income markets and its implications."

[5] If an end-client wants to trade, she can indicate her interest on a dealer-to-customer platform. Quotes on dealer-to-customer platforms are typically just indicative from the dealer. If the end-client wants to trade on the indicated price, the dealer will subsequently turn to the inter-dealer platform to obtain or place the bonds at firm quotes. The MTS inter-dealer platform is therefore the ultimate source of liquidity; see Dunne et al. (2008).

[6] MTS is not the only platform where this liquidity provision and monitoring takes place, but among the inter-dealer platforms it is the only one that is used by all euro area countries.

[7] This is next to other benefits, such as the execution of liability-driven derivatives trades, arrangement of bond buy-back, and exchange programs, and exclusive access to non-competitive bids of auctions.

Hypothesis 3. The relation between market liquidity and expected issuance fees is increasing in market uncertainty.

Assuming that market makers are risk-averse, and that liquidity provision entails risks, we expect market makers to provide liquidity proportional to their risk-reward trade off. These risks include losses on price moves, not being able to borrow a short position, funding costs related to the funding of trading books, and being picked off via adverse selection. Since these risks are faced by the market makers collectively, we expect to observe the effects of these risks in the liquidity of the order book. Hence, endogenous bond characteristics affect the market makers' willingness to provide liquidity. These factors include the remaining time-to-maturity because of the yield sensitivity, the outstanding issue size, the seasonedness of the bond due to search costs, the trade volume, as well as the credit risk. Furthermore, the existence of an active derivatives market, futures in this case, might decrease the fee-driven liquidity mechanism. This is explained by the fact that market maker risk is mitigated by the derivative market, as it allows market makers to hedge their inventory and offload risk more easily. This leads to our fourth hypothesis:

Hypothesis 4. The relation between market liquidity and expected issuance fees is decreasing in bond risk.

The driving source behind our fee-driven liquidity mechanism is competition. This is because primary dealers are competing for issuance fees. Therefore, we expect the mechanism to become stronger when there is more competition for issuance fees. This leads to the fifth and final hypothesis:

Hypothesis 5. The relation between market liquidity and expected issuance fees is increasing in the number of active market makers.

3. Data and methods

In this section, we describe the MTS data and corresponding liquidity measures (Subsection 3.1), the Dealogic data and corresponding expected issuance fee measure (Subsection 3.2), as well as the empirical model we use to identify the issuance fee-driven liquidity mechanism (Subsection 3.3).

3.1. Measuring liquidity

We take data from the MTS interdealer platform, an exchange-like venue which functions as a purely quote-driven market. Dufour and Skinner (2004) provide a comprehensive description of the MTS data. The specific data set we use, contains the three best bid and ask prices as well as the executed trade prices and volumes. Our sample period ranges from February 2008 until December 2012, encompassing the depth of the global financial crisis of 2007–2009 and a significant part of the European sovereign debt crisis.

When creating our liquidity measures, we aggregate data to the daily level. A trading day on MTS spans from 08:00 until 17:30 CET, but preliminary analysis shows that the activity between 08:00 and 09:00 CET is very low. Also from 17:00 until 17:30 CET there is significantly less activity. Therefore, similarly to Pelizzon et al. (2016), we omit quotes outside the 09:00-17:00 CET interval. Whereas MTS hosts several non-euro denominated bonds and several sub-sovereign, supranational, and agency bonds on their platform, we only focus on euro-denominated sovereign bonds from 11 euro area countries.[8] We omit inflation-linked bonds and bonds with callable features. Finally, we omit trading days of bonds in which the order book is updated less than 50 times. Our final data set contains 307,510 observations, from 5 years, for 865 unique bonds covering eleven countries.

We follow Coluzzi et al. (2008) and Ejsing and Sihvonen (2009) in the construction of the liquidity measures from the MTS order book, and select the three most commonly used measures for our analysis. Ours include a measure of the tightness of liquidity based on the bid-ask spread, the depth of the liquidity based on the quoted volume, and the breadth of liquidity from a slope measure that is a combination of the two.

We define $p_{i,\tau,b} = p_{1,\tau,b}, \dots, p_{n,\tau,b}$ as the set of n bid prices at time τ. Where, by virtue of the structure of the order book, it holds that $p_{i,\tau,b} > p_{i+1,\tau,b} > \dots > p_{n,\tau,b}$. Conversely the set of ask prices $p_{i,\tau,a} = p_{1,\tau,a}, \dots, p_{n,\tau,a}$ is ordered such that $p_{i,\tau,a} < p_{i+1,\tau,a} < \dots < p_{n,\tau,a}$.

In the order book, every $p_{i,\tau,b}$ and $p_{i,\tau,a}$ is uniquely mapped to their quoted volumes $V_{i,\tau,b}$ and $V_{i,\tau,a}$ respectively via their rank i. Volumes have no restriction other than that both $V_{i,\tau,b}$ and $V_{i,\tau,a}$ are larger than the minimal order amount $V_{\min}$ determined by the exchange.

Price (e.g., bid-ask spreads) or volume (e.g., quoted volume) based liquidity measures focus on a single dimension of liquidity. While both are frequently used in the literature, they allow for the limit case of a very tight spread but virtually no tradeable volume. Conversely, the posted volume could be copious at an unreasonably large spread. In either limit case, such liquidity measures would contradict. For this reason, we utilize a liquidity measure that encompasses both price and volume information. Akin to Wuyts (2008), we define our main liquidity measure, the order book slope (*LOS*), by:

$$l_{\tau,LOS} = \frac{1}{n}\sum_{i=1}^{n}\frac{(p_{i,\tau,a} - \frac{1}{2}(p_{1,\tau,b} - p_{1,\tau,a}))}{\sum_{k=1}^{i} V_{k,\tau,a}} + \frac{1}{n}\sum_{i=1}^{n}\frac{(\frac{1}{2}(p_{1,\tau,b} - p_{1,\tau,a}) - p_{i,\tau,b})}{\sum_{k=1}^{i} V_{k,\tau,b}}. \quad (1)$$

[8] The set of countries includes Austria (AU), Belgium and Luxembourg (BE), Germany (DE), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Netherlands (NL), and Portugal (PT).

We take the average slope of the price increments from the midpoint over the cumulative limit order book volume posted. An appealing feature of this measure is that it can be interpreted as an elasticity of supply and demand. We aggregate the bid and ask-side slopes. In order to not penalize bonds that trade over par, we scale the slope measure by the mid-price. Note that a higher slope implies less liquidity.

We also create a price-based and a volume-based liquidity measure to verify the robustness of our results. Similar to the slope measure, we scale the price-based bid-ask measure by the mid-price:

$$l_{\tau,BA} = p_{1,\tau,a} - p_{1,\tau,b}, \tag{2}$$

and

$$l_{\tau,V} = \sum_{i=1}^{n} V_{i,\tau,b} + \sum_{i=1}^{n} V_{i,\tau,a}. \tag{3}$$

When dealing with high-frequency data, two issues need to be dealt with: irregular spacing and intraday seasonality. Since we aggregate our data to the daily level, we do not have to deal with intraday seasonality, although we corroborate the U-shaped intraday variety in liquidity as observed by Cheung et al. (2005) and Pelizzon et al. (2016). As for the irregular spacing, each of the $l_{t,\tau}$ measures currently is a snapshot in time. If we count the unique snapshots in an interval t, we have Υ_t snapshots (Υ_t can differ across intervals). If we define $\omega_{t,\tau}$ as the length of the period where the order book remains constant (and each of the $l_{t,\tau}$ measures unchanged), then we can create time-weighted measures in interval t by weighting Υ_t by the length $\omega_{t,\tau}$:

$$l_{t,x} = \frac{\sum_{\tau=1}^{\Upsilon_t} \omega_{t,\tau} l_{t,\tau,x}}{\sum_{\tau=1}^{\Upsilon_t} \omega_{t,\tau}}, \tag{4}$$

with $x \in \{LOS, BA, V\}$.

Applying the weighting method in equation (4) on equations (1)–(3), we create three time-weighted liquidity measures $l_{t,LOS}$, $l_{t,BA}$, and $l_{t,V}$ aggregated to the daily frequency. The former, $l_{t,LOS}$, is our main liquidity measure, as it combines price and volume aspects. We check the robustness of our results, however, using the other two measures. Table 1 presents the descriptive statistics of our liquidity measures organized by country and by year in Panels A and B, respectively.

All 11 countries are well represented in our data set, judging from the second and third columns in Table 1. Italy is the most prominent (with 19.8% of the observations) and Finland the least (with 3.2% of the observations). There are substantial differences between countries in terms of liquidity. The average slope measure ranges from 3.31E-07 for Italy to 1.55E-05 for Greece. In the bid-ask figures, there is a clear distinction between core and peripheral countries, with a bid-ask spread of over

Table 1
Descriptive statistics liquidity measures.

	Count	Percentage	Slope	Bid-ask	Volume
Panel A: by country					
AT	18,670	6.1%	2.60E-06	0.323	3.61E+07
BE	23,725	7.7%	1.21E-06	0.198	4.76E+07
DE	55,746	18.1%	2.93E-06	0.086	3.09E+07
ES	30,749	10.0%	3.18E-06	0.382	3.59E+07
FI	9934	3.2%	2.05E-06	0.120	4.38E+07
FR	44,734	14.5%	2.76E-06	0.139	4.20E+07
GR	16,020	5.2%	1.55E-05	1.203	1.82E+07
IE	10,617	3.5%	3.13E-06	1.358	2.10E+07
IT	60,747	19.8%	3.31E-07	0.240	4.59E+07
NL	19,733	6.4%	3.28E-06	0.101	4.39E+07
PT	16,835	5.5%	2.12E-06	2.261	3.46E+07
Panel B: by year					
2008	49,906	16.2%	7.91E-06	0.190	3.66E+07
2009	59,256	19.3%	1.90E-06	0.186	3.60E+07
2010	65,009	21.1%	2.94E-06	0.315	3.87E+07
2011	63,140	20.5%	2.17E-06	0.631	3.93E+07
2012	70,199	22.8%	6.77E-07	0.601	3.89E+07

Notes: This table shows descriptive statistics of the liquidity measures per country (Panel A) and per year (Panel B). Count represents the number of observations; Percentage the percentage of observations; Slope the slope-based liquidity measure given by equation (1); Bid-ask the bid-ask spread given by equation (2); Volume the quoted volume given by equation (3). All measures are time-weighted according to equation (4). The countries include Austria (AU), Belgium and Luxembourg (BE), Germany (DE), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Netherlands (NL), and Portugal (PT).

2.26 euro for Portugal and only 0.086 euro for Germany.

When looking at the time dimension, in Panel B of Table 1, the slope decreases, while the bid-ask spread increases substantially over the years in our sample. This might be caused by the increased sovereign risk over the crisis years.

For ease of interpretation of the regression results, we define our final liquidity measures as:

$$\begin{aligned} L_{t,LOS} &= -log(l_{t,LOS}), \\ L_{t,BA} &= -l_{t,BA}, \\ L_{t,V} &= log(l_{t,V}), \end{aligned} \tag{5}$$

such that all three liquidity measures have the property that a higher value of L coincides with the asset being more liquid. Logarithmic transformations are applied to mitigate the effect of extreme values.

Note that our liquidity measures are all ex-ante measures; we do not include ex-post measures of liquidity such as volume or turnover. This is because we are interested in the sensitivity of the quoting behavior of the primary dealers to expected issuance fees, rather than the trading behavior of all participants on the MTS platform.[9] It is conceivable, however, that the quoted liquidity is conditional on the ex-post liquidity in the previous period; in other words, ex-post liquidity might be a right-hand side variable in our analysis. We control for this possibility by including a set of control variables and fixed effects in the empirical model laid out in Subsection 3.3.

As a first preliminary test of Hypothesis 1, we run an event study in which we calculate the average liquidity of (existing) bonds from 100 days before until 100 days after a newly syndicated bond issue. Without the issuance fee mechanism, one would expect liquidity to increase after the issue, as the total supply of bonds is larger after the issue and fixed income investors will need to rebalance their portfolios in order to include the latest issue. Fig. 1 shows the results.

We observe that the liquidity in the sovereign bond markets increases substantially in the 40 days running up to a new issue. This effect appears to be stronger for peripheral countries than for core countries. This finding is consistent with Hypothesis 1 that primary dealers are increasing liquidity in anticipation of the issuance, arguably to increase the probability of being selected into the group of lead-managers.

3.2. Measuring expected issuance fees

We extract issuance fees from Dealogic for all bonds issued within our sample period, a comprehensive database that stores a broad set of issuance information from the international primary bond markets. Given that in the European sovereign bond market fees are only paid for syndicated bonds and not for auctioned bonds, we restrict our sample to syndicated bonds. We find 181 syndicated issues within our sample.[10]

In order to link the liquidity measures to the issuance fees of their respective countries, we need to manipulate the issuance fees. First of all, the measure should reflect expected issuance fees. Second, it would not suffice to link issuance fees to single bonds in the cross-sample, since issuance mandates are awarded by DMOs who oversee the complete outstanding debt portfolio of a sovereign. For these reasons, we opt to create country-specific time series of expected issuance fees, reflecting the countries' incentives awarded to the market makers, as follows:

$$I_{t,k} = \sum_{i=1}^{I} P_i e^{-\lambda(t-x_i)} D_{t>x_i}, \tag{6}$$

for each bond $B_i = B_1 \ldots B_I$ issued within our sample period whose issuance is announced at time x_i. P_i are the issuance mandate proceeds as a percentage of the total issue size for bond i that is issued at time x_i discounted by a decay factor λ. To ensure the issuance measure is backward looking, we exclude cases where $t > x$ by multiplying by the indicator variable $D_{t>x_i}$ which takes the value of 1 if $t > x$ and 0 otherwise. In essence, for each point in time for each country, we discount the issuance proceeds of the past. In using this measure, we assume that market makers have realistic expectations of the issuance revenues based on the past, but that they account for the fact that revenues materialized further in the past by discounting these proceeds. Thus they are increasingly more motivated to provide liquidity when the announcement of an issuance approaches. As a benchmark, we take $\lambda = 0.01$ per day. The backward-looking nature of equation (6) is realistic as it assures that all information is available to all market participants. We observe that the fee is rather stable per country, increasing the validity of a backward looking measure. Furthermore, the backward-looking nature helps reduce the possible endogeneity issue in our empirical tests. In this paper, we explore the effect of expected issuance fees on market liquidity. It might also be the case, however, that market liquidity affects fees. When DMOs experience relatively low market liquidity and therefore have difficulties re-financing their debt, they might increase fees to attract more liquidity. This mechanism, however, implies a negative relation between market liquidity and expected issuance fees. Hence, this alternative mechanism would work against our results as we expect a positive

[9] Primary dealers are the only parties allowed to enter quotes into the MTS system.

[10] The fact that we have 865 unique bonds in total is because many issues are taps on existing bonds.

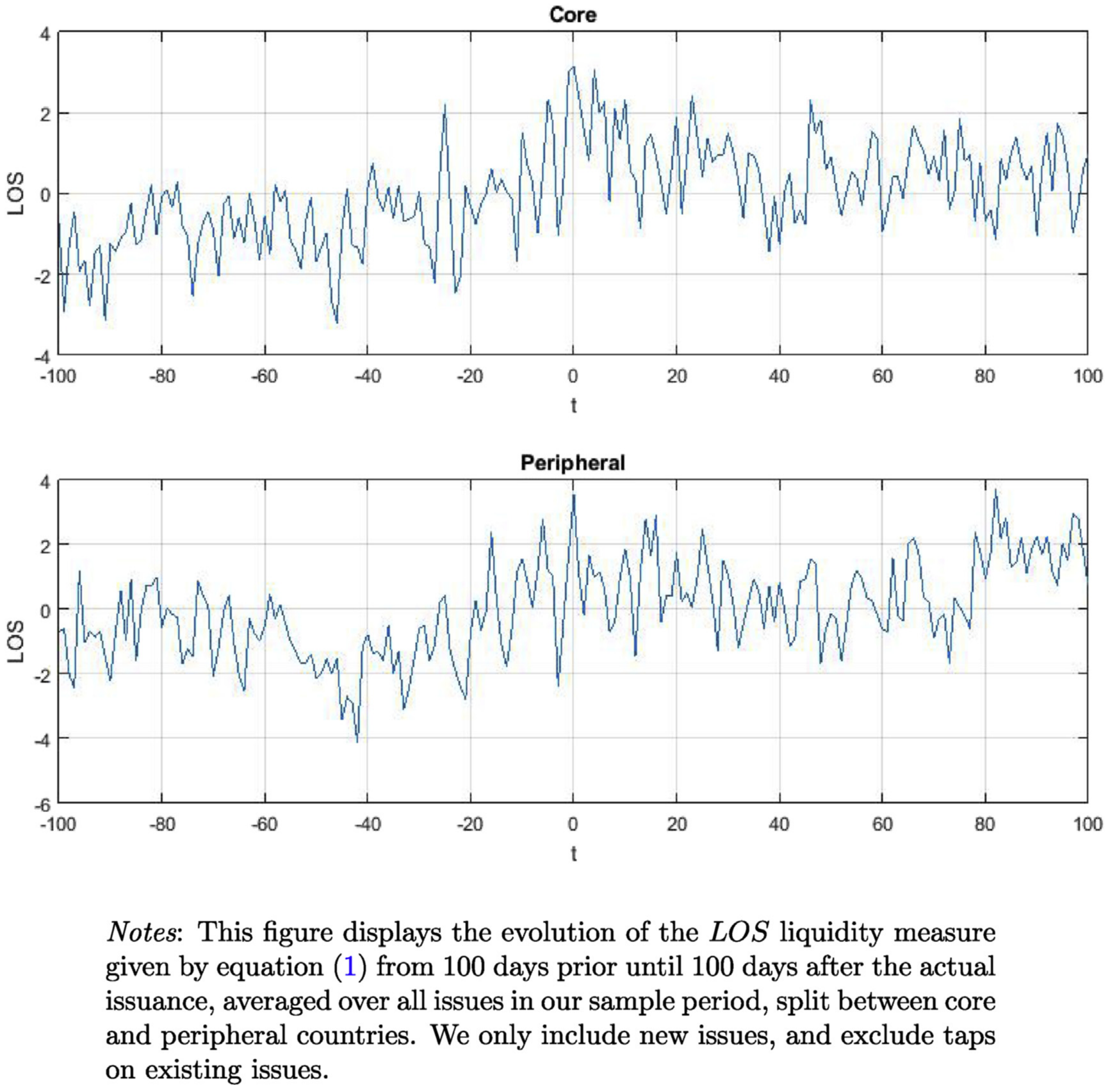


Fig. 1. Liquidity around issuance. *Notes*: This figure displays the evolution of the *LOS* liquidity measure given by equation (1) from 100 days prior until 100 days after the actual issuance, averaged over all issues in our sample period, split between core and peripheral countries. We only include new issues, and exclude taps on existing issues.

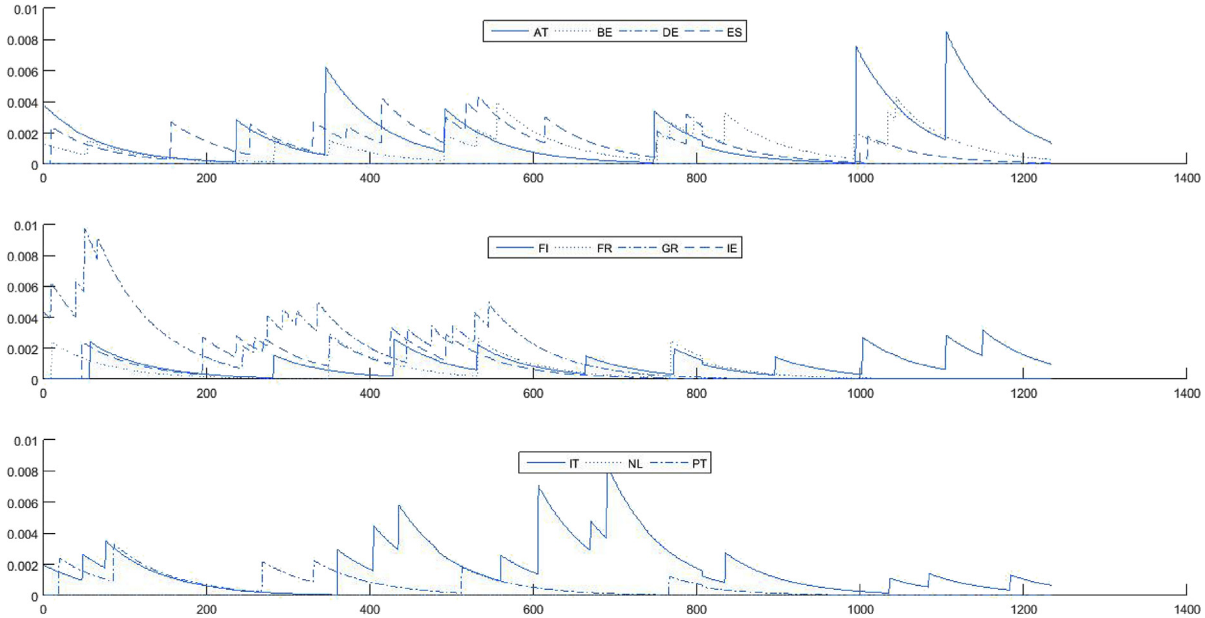
relation. Hence, the significance of the results are not an issue, but the effect size is potentially biased when not taking the reverse causality issue into account.[11]

Fig. 2 displays the evolution of the expected issuance fee measure over time for the 11 countries in our sample, as well as the descriptive statistics of the issuance fees paid.

We observe a number of patterns in Fig. 2. First, there are countries that do not, or hardly ever, utilize the syndicated bond market, such as Germany and the Netherlands.[12] Other countries, such as Spain and Italy, make frequent use of the syndicated bond market. This heterogeneity helps us identify the issuance fee mechanism. These observations are consistent with Dunne et al. (2006), whose view is that countries that rely more on syndicate issuance and the placing of secondary market obligations on primary dealers have higher turnover on MTS. In the time-dimension, we observe that the majority of countries increase fees in 2009, corresponding to the aftermath of the global financial crisis. From 2011, during the European sovereign debt crisis, fees are back at their prior levels. These findings are confirmed in Table 2, which presents the descriptive statistics of the issuance fee data.

[11] We test the sensitivity of our results to this choice in Section 5.

[12] In Subsection 5.3, we test the robustness of our results excluding Germany and the Netherlands.



Notes: This figure displays the evolution of the backward-looking expected issuance fee measure over time, for all 11 countries in our sample, as measured by equation (6) using a decay rate λ of 0.01.

Fig. 2. Expected issuance fee measure. *Notes*: This figure displays the evolution of the backward-looking expected issuance fee measure over time, for all 11 countries in our sample, as measured by equation (6) using a decay rate λ of 0.01.

3.3. Empirical model

Our main objective is to estimate the effect of expected issuance fees on market liquidity. As such, in our empirical model we regress market liquidity on the expected fee measure, controlling for a set of known determinants of liquidity. Given that we have a daily measure of liquidity spanning over five years and 11 countries, we estimate our model in panel format. Since bonds are issued and mature at different points in time, we have an unbalanced panel. Specifically:

$$L_{t,i} = \alpha + \beta I_{t,k} + \gamma X_{t,i,k} + \mu_t + \eta_k + \varepsilon_{t,i}, \tag{7}$$

in which $L_{t,i}$ is the liquidity measure at time t for bond i, $I_{t,k}$ the expected issuance fee measure at time t for country k, and $X_{t,i,k}$ a vector of control variables at the time, bond, and country levels. We estimate α, β, and γ by means of OLS; μ_t and η_k represent time and country fixed effects, respectively.

The set of control variables in $X_{t,i,k}$ consists of the bond-level variables, seasonedness, maturity, issue size, traded volume, and credit spread; the time-dependent variable funding liquidity, and the country-level variable volatility. Those variables are empirically shown to have a significant effect on liquidity by other authors, including by those that have studied liquidity in the euro area government bond market with MTS data. Ejsing and Sihvonen (2009) establish that seasonedness and time-to-maturity have a negative effect on liquidity in the German government bond market. Issue size is expected to have a positive effect on liquidity, and this is indeed established by Pelizzon et al. (2013) for the Italian treasury market. A negative effect of market volatility on liquidity is established by Caporale and Girardi (2013). Beber et al. (2009) and Pelizzon et al. (2016) confirm that credit risk is the main driver of liquidity in the European government bond market. Pelizzon et al. (2013), Pelizzon et al. (2014), Pelizzon et al. (2016), and Lillo et al. (2016) also highlight the importance of funding liquidity measures as determinants of market liquidity.[13]

We measure seasonedness as the bond age in years, maturity as the remaining time to maturity in years, and issue size as the log nominal amount for which the bond is issued in euros. These control variables are constructed by using the bond descriptions in Bloomberg. Traded volume is the logarithm of the sum of all trades on day $t-1$, obtained from MTS. The credit spread is proxied via the z-spread for each specific bond, also obtained from Bloomberg. To account for time and country variation in the macro-economic sentiment, we measure volatility by means of conditional volatilities estimated on the basis of a GARCH(1,1)-

[13] The effect of the on-the-run status of a bond is found to be insignificant by Coluzzi et al. (2008) and Ejsing and Sihvonen (2009). The insignificance of the on-the-run status on liquidity is corroborated by our own unpublished results, and explains why we have not included the on-the-run status as a control variable.

Table 2
Issuance fee measure and actual fees paid.

	AT	BE	DE	ES	FI	FR	GR	IE	IT	NL	PT
Panel A: Percentage of issued amount											
2008	2.07E-06	1.40E-06	0	1.49E-06	1.11E-06	6.14E-07	3.09E-06	8.06E-07	2.08E-06	0	7.01E-07
2009	2.16E-06	1.46E-06	0	1.56E-06	1.16E-06	6.41E-07	3.22E-06	8.41E-07	2.17E-06	0	7.32E-07
2010	2.52E-06	1.70E-06	0	1.81E-06	1.35E-06	7.46E-07	3.75E-06	9.79E-07	2.53E-06	0	8.52E-07
2011	1.33E-06	8.98E-07	0	9.58E-07	7.16E-07	3.94E-07	1.98E-06	5.17E-07	1.34E-06	0	4.50E-07
2012	1.04E-06	7.02E-07	0	7.49E-07	5.59E-07	3.08E-07	1.55E-06	4.04E-07	1.04E-06	0	3.52E-07
Panel B: Absolute amounts											
2008	19.21	10.56		19.45	9.73	7.29	51.71	26.74	19.09		14.59(2)
	(2)	(2)		(2)	(1)	(1)	(6)	(2)	(3)		
2009	21.20	12.46		43.06	16.05	17.51	80.35	41.20	43.76		12.36(2)
	(4)	(3)		(4)	(2)	(1)	(8)	(4)	(3)		
2010	11.39	22.93		30.09	11.42	12.16	27.72	8.51	70.04		5.04(1)
	(2)	(3)		(4)	(2)	(1)	(3)	(1)	(6)		
2011	13.29	21.37		17.99	10.25	7.29			5.76		4.11(1)
	(2)	(4)		(2)	(2)	(1)			(1)		
2012	73.08	22.17		6.72	17.30				26.04		
	(8)	(3)		(1)	(3)				(3)		
2013	42.04	25.26		40.27	11.42	10.94		11.32	66.42		7.75(2)
	(6)	(4)		(4)	(2)	(1)		(2)	(5)		
2014	18.20	20.67		49.10	11.42	8.51	3.47	21.18	43.80		15.58(3)
	(4)	(2)		(5)	(2)	(1)	(2)	(3)	(4)		
2015	12.92	24.94	5.88	44.05	10.58			9.73	51.76		33.88(5)
	(2)	(3)	(1)	(4)	(2)			(1)	(4)		

Notes: This table presents the descriptive statistics of the expected issuance fee measures per country-year, in percentages of the issued amount (Panel A) and in millions of euros per year (Panel B). In parentheses the number of syndicated issues per country per year. Due to the forward-looking nature of the issuance measure we take into account issues beyond our 2008–2012 sample. The expected issuance fee is calculated by equation (6). The countries include Austria (AU), Belgium and Luxembourg (BE), Germany (DE), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Netherlands (NL), and Portugal (PT).

Table 3
Descriptive statistics control variables.

	Maturity	Seasonedness	Credit spread	Issue size	Volatility	Funding liquidity	Traded volume	# Dealers
Mean	7.640	4.149	73.517	1.64E+10	0.026	0.505	6.547	22.117
St.Dev.	8.011	3.160	487.395	7.53E+09	0.026	0.333	8.158	6.692
Min.	0.006	0.000	−1659.3	1.00E+09	0.003	0.106	0.000	8.000
Max.	50.085	19.123	19,274.3	4.09E+10	0.383	1.955	20.865	39.000

Notes: This table shows descriptive statistics of the control variables. Maturity is the time to maturity (in years); Seasonedness the age (in years); Credit spread represents the z-spread retrieved from Bloomberg; Issue Size is the initial size of the bond issue (in euros); Volatility is the conditional volatility as implied by a GARCH(1,1)-specification for each of the countries major equity index. Funding liquidity is given by the 3-month EURIBOR - EONIA spread.

specification of their respective equity indices. We measure funding liquidity as the 3-month EURIBOR - EONIA spread. This variable captures funding uncertainty, similar to the TED and CP spreads that are used in liquidity studies of the U.S. markets (Hameed et al., 2010; Fontaine and Garcia, 2012; Bouwman et al., 2015). Table 3 presents the descriptive statistics of our control variables.

4. Results

In this section, we discuss the results. In Subsection 4.1 we present the main estimation results. Then, we run several additional tests to assess the strength of the fee-driven liquidity mechanism for specific countries, periods, and bonds. Other papers have looked into the time-varying relation between risk and liquidity. Favero et al. (2010) finds that the interaction between liquidity and risk is significantly negative. Beber et al. (2009), Bao et al. (2011), and Darbha and Dufour (2013) find that the relation between liquidity and credit risk changes during sudden volatility shocks. As such, in Subsection 4.2 we study for which countries and periods the fee-driven liquidity mechanism is stronger, and in Subsection 4.3 for which bonds the mechanism is stronger. In Subsection 4.4, we further study the effect of competition on the issuance fee mechanism, and in Subsection 4.5 we include all interactions in the empirical model simultaneously.

4.1. Issuance fee-driven liquidity

Table 4 presents the estimation results of equation (7). Model 1 gives the univariate relation between liquidity and expected issuance fees; in Model 2 we add a number of control variables; Model 3 includes country fixed-effects to control for possi-

Table 4
Main estimation results.

	1	2	3	4	5
Issuance	43.522***	43.843***	20.749***	77.702***	52.100***
	(1.333)	(1.243)	(1.429)	(1.048)	(1.173)
Seasonedness		−0.005***	−0.001***	−0.012***	−0.007***
		(0.001)	(0.001)	(0.000)	(0.000)
Issuesize		1.256***	0.650***	1.179***	0.584***
		(0.008)	(0.012)	(0.006)	(0.009)
V olatility		−3.471***	−2.824***	−4.863***	−2.490***
		(0.080)	(0.078)	(0.106)	(0.106)
FundingLiq		−0.615***	−0.658***		
		(0.006)	(0.006)		
Maturity		−0.017***	−0.016***	−0.017***	−0.016***
		(0.000)	(0.000)	(0.000)	(0.000)
CreditSpr		−0.616***	−0.244***	−0.912***	−0.476***
		(0.025)	(0.024)	(0.020)	(0.019)
Tradedvolume		0.008***	0.002***	0.010***	0.004***
		(0.000)	(0.000)	(0.000)	(0.000)
Country FE	No	No	Yes	No	Yes
Time FE	No	No	No	Yes	Yes
Adj. R^2	0.003	0.185	0.282	0.492	0.582

Notes: This table presents the estimation results from the regression $L_{t,i} = \alpha + \beta I_{t,k} + \gamma X_{t,i,k} + \mu_t + \eta_k + \varepsilon_{t,i}$, in which $L_{t,i}$ is the LOS-liquidity measure at time t for bond i, which is created by aggregating high frequency order book data to the daily level from February 2008 until December 2012. $I_{t,k}$ represents the expected issuance fee measure at time t for country k, and $X_{t,i,k}$ a vector of control variables at the time, bond, and country level. We estimate α, β, and γ by means of OLS; μ_t and η_k represent time and country fixed-effects, respectively. Standard errors in parentheses; *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

ble country-specific effects in bond liquidity; Model 4 includes time-fixed effects to control for possible omitted time-specific factors; and Model 5 combines all of the above.

First and foremost, Table 4 shows that there is a positive and significant relation between expected issuance fees and market liquidity. This relation is robust to the inclusion of a number of control variables, as well as country and time fixed effects.

Specifically, for Model 1 we find a positive coefficient on the expected issuance fee of 43.522, which is significant at the 1% level ($P < 0.000$). A one standard deviation increase in expected issuance fees results in a 5.9% increase in liquidity. Hence, this effect is economically significant. As can be seen in Model 2, this result is robust to the inclusion of control variables; the coefficient for the expected issuance fee remains of the same order of magnitude and of similar significance.

The control variables carry the expected signs. *Seasonedness* is negative and significant, implying that older bonds are less liquid. This is explained by the fact that these bonds are traded relatively infrequently, as they tend to be held in buy-and-hold portfolios, as Fontaine and Garcia (2012) also find. *Maturity* is also negatively related to liquidity. This implies that shorter issues are more liquid (as expected, given their reduced sensitivity to the yield curve). Our result confirms that the negative effect of *Seasonedness* and *Maturity* on liquidity, as found for German sovereign bonds by Ejsing and Sihvonen (2009), holds on average for all eleven euro area sovereign bond markets. Bao et al. (2011) find the same relations for the corporate bond market. *IssueSize* is positively related to liquidity, reflecting the reduced search costs due to the higher free-float. Our result generalizes the positive effect of issue size on liquidity for Italian bonds found by Pelizzon et al. (2013) to the total euro area sovereign bond market. This result is also consistent with Bao et al. (2011) and is comparable with the low liquidity of small-cap stocks in equity markets (Pastor and Stambaugh, 2003). *V olatility* is negatively related to liquidity, consistent with Caporale and Girardi (2013) for the European sovereign bond market and Chordia et al. (2003) for the U.S. stock and bond markets. *FundingLiquidity* is negatively related to market liquidity, which is also consistent with liquidity spirals as described by Brunnermeier and Pedersen (2009). *TradedV olume* is positively related to our LOS measure, as both are measures of liquidity. *CreditSpread*, finally, is negatively related with liquidity, as shown by Beber et al. (2009) and Pelizzon et al. (2016) for sovereign bonds and by Bao et al. (2011) for corporate bonds.

The inclusion of country fixed effects (Model 3), time fixed effects (Model 4), or both (Model 5) does not affect the significance of our results qualitatively. The inclusion of country fixed effects, however, decreases the effect size by half. This is not surprising given the strong country effects in both the liquidity measure and the expected issuance fee measure, as we observed in Tables 1 and 2 After including both country and time fixed effects, however, the coefficient increases to 52.1 and remains economically significant: in the most conservative configuration (Model 5), a one standard deviation increase in expected issuance fees results in a 7.0% increase in market liquidity.

Overall, we conclude that there is a positive and significant relation between the expected issuance fee and market liquidity in the euro area government bond market. This finding is robust to the inclusion of both control variables and country and time fixed effects. These results corroborate Hypothesis 1.

Table 5
Issuer interactions.

	1	2	3	4
Issuance	−26.592***	46.807***	41.663***	53.919***
	(2.588)	(2.080)	(1.562)	(1.2800)
FundingLiq	−0.739***			
	(0.007)			
*Issuance**FundingLiq*	110.60***			
	(5.041)			
V olatility		−1.943***		
		(0.093)		
*Issuance**V olatility*		1256.1***		
		(72.865)		
LTRO			0.233***	
			(0.004)	
*Issuance**LTRO*			−4.669	
			(3.332)	
Peripheral				−0.103***
				(0.003)
*Issuance**Peripheral*				2.537
				(1.947)
Controls	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Time FE	No	No	No	Yes
Adj.R^2	0.283	0.282	0.291	0.583

Notes: This table presents the estimation results from the regression $L_{t,i} = \alpha + \beta_1 I_{t,k} + \beta_2 I_{t,k} Uncertainty_{t,k} + \gamma X_{t,i,k} + \mu_t + \eta_k + \varepsilon_{t,i}$, in which $L_{t,i}$ is the LOS-liquidity measure at time t for bond i, which is created by aggregating high frequency order book data to the daily level from February 2008 until December 2012. $I_{t,k}$ represents the expected issuance fee measure at time t for country k, and $Uncertainty_{t,k}$ represents funding liquidity, volatility, a LTRO dummy, and a peripheral dummy respectively. For reasons of conciseness, we only present the estimates for β_1 and β_2 of equation (8). The remaining coefficients are qualitatively similar to those in Table 4 and available on request. Standard errors in parentheses; *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

4.2. Issuer interactions

The sovereign has more incentive to rely on the fee-driven liquidity mechanism at times of uncertainty. After all, in these periods the liquidity risk is highest, and with that the risk of high funding costs. We proxy for different market circumstances by funding liquidity, market volatility, and the LTRO period.[14] LTRO represents a measure of stability because this ECB program provided increased liquidity for euro area banks.

For countries that face the threat of being unable to refinance their debt, the incentive for the DMO is stronger to monitor and evaluate dealer market making. As such, we expect the fee-driven liquidity mechanism to be stronger in these countries. We proxy high refinancing risk by means of a periphery dummy.[15]

We expect the fee-driven liquidity effect to be increasing in volatility, decreasing in funding liquidity, decreasing during the LTRO period, and increasing in the subset of peripheral countries. The model we estimate is given by:

$$L_{t,i} = \alpha + \beta_1 I_{t,k} + \beta_2 I_{t,k} Uncertainty_t + \beta_3 Uncertainty_t + \gamma X_{t,i,k} + \eta_k + \varepsilon_{t,i}, \tag{8}$$

in which $Uncertainty_t$ is the set of indicators consisting of *Fundingliquidity*, *V olatility*, *LTRO*, and *Peripheral*. Table 5 presents the estimation results.[16]

Model 1 presents the interaction between the expected issuance fee measure and funding liquidity. We find that the direct effect of funding liquidity on market liquidity is negative and significant, as in Table 4. The direct effect of the expected issuance fee measure is negative and significant. However, this is offset by the strong interaction effect between expected issuance fees and funding liquidity. In other words, the importance of the fee-driven liquidity effect is increasing in market stress as measured by the funding liquidity.[17] The total effect of the issuance fee on market liquidity becomes positive when funding liquidity exceeds 24.0 bps.

Model 2 presents the estimation results for the model with an interaction between expected issuance fees and market volatility. The direct effect of expected issuance fees is in this case positive and significant. The direct effect of *V olatility* on market

[14] LTRO is an acronym that stands for "long-term refinancing operations," which are used by the European Central Bank (ECB) to lend money at very low interest rates. As such, this dummy proxies for a reduction in uncertainty.

[15] The periphery countries include Ireland, Italy, Spain, Portugal, and Greece.

[16] Note that due to the time-series character of some of these interactions, we cannot include time fixed-effects. We do not expect that this affects the results substantially, though, because of the limited effect of the time fixed effects on the direct effect of the issuance fee measure in Model 4 in Table 4.

[17] Note that the measure is a negative measure of funding liquidity.

liquidity is negative and highly significant, as observed in Table 4. The interaction between expected issuance fees and market volatility, however, is positive and highly significant. Hence, the issuance fee-driven liquidity mechanism is stronger in periods of high volatility. Our result confirms the negative interaction between risk and liquidity that Favero et al. (2010) establish from their investor-driven CAPM model.

Model 3 displays the interaction between the expected issuance fees and the LTRO dummy. The direct effect of the expected issuance fee is again positive and highly significant. The direct effect of the ECB's LTRO policy is also positive, reflecting the perceived decrease in risk because of the cheap refinancing possibilities at the ECB. The interaction effect between the expected issuance fee measure and the LTRO dummy is negative but marginally insignificant. This implies that the fee-driven liquidity mechanism is marginally weaker during the LTRO period. This result is consistent with the results from Pelizzon et al. (2013) and Pelizzon et al. (2016). These finding suggests that the LTRO program substantially decreases the uncertainty in the market during the aftermath of the global financial crisis.

Model 4 shows the interaction of the fee-driven liquidity mechanism with a peripheral dummy. We find that the direct effect of the expected issuance fee remains positive and significant. The direct effect of the peripheral dummy is negative and significant, suggesting that countries in the periphery have a lower overall bond market liquidity.[18] The interaction effect between the expected issuance fee measure and the periphery dummy is positive but marginally insignificant, implying that the fee-driven liquidity mechanism is marginally stronger for peripheral countries. Specifically, whereas the effect is equal to 53.919 for core countries, it is equal to 56.456 for peripheral countries.

Combined, the results from Table 5 partly confirm Hypothesis 2 and fully confirm Hypothesis 3: Countries with more stressing funding needs show a marginally higher sensitivity of liquidity to expected issuance fees. In addition, during market turmoil, countries have a stronger incentive to attempt to increase market liquidity because the cost of capital and the risk of refinancing is higher during these periods. As such, the fee-driven liquidity mechanism is stronger in times of market stress and when there are few alternatives available. An important implication of this finding is that the fee-driven liquidity mechanism mitigates the risk of market illiquidity during crisis periods.

4.3. Market maker interactions

The primary dealer weighs up the cost of providing extra market liquidity with a (potential) fee revenue in the primary market. The question that naturally arises from this cost-benefit analysis, is which types of bonds the primary dealer will select to increase liquidity for. We hypothesize that the primary dealer will especially increase the liquidity of those bonds for which the expected cost for the extra liquidity is lowest (i.e., the bonds that are safest). We use the following bond characteristics to measure risk for the market maker: maturity, age, issue size, traded volume, and credit spread.

Furthermore, for some of the countries in our sample, there is an active market for derivatives that have the sovereign bonds as underlying, notably futures. This holds for Germany, Italy, and France for part of the sample period. An active futures market could affect the strength of the fee-driven liquidity mechanism, since an active futures market reduces the risk of market making. Indeed, Ejsing and Sihvonen (2009) find that the highly liquid German bond futures market leads to significant liquidity spillovers for bonds that are deliverable into the futures contracts. Pelizzon et al. (2014) also confirm a liquidity effect between the bond and the futures market in the case of Italy. As the existence of a derivative market makes liquidity providing less costly, we expect these bonds to be more liquid and relatively unmoved by the fee measure. We create a dummy variable that is equal to one for bonds that are eligible for delivery in a futures contract at that point in time.[19] The model we estimate is given by:

$$L_{t,i} = \alpha + \beta_1 I_{t,k} + \beta_2 I_{t,k} Bond_{t,i} + \beta_3 Bond_{t,i} + \gamma X_{t,i,k} + \mu_t + \eta_k + \varepsilon_{t,i}, \quad (9)$$

in which *Bond* is the set of bond characteristics consisting of *Derivatives*, *Maturity*, *Seasonedness*, *Issuesize*, *Tradedvolume*, and *Creditspread*. The estimation results are presented in Table 6.

Model 1 in Table 6 reveals that the direct effect of the expected issuance fees remains positive and significant after inclusion of the maturity interaction. The direct effect of *Maturity* is negative and significant. The interaction effect between *Issuance* and *Maturity* is negative and significant. This implies that the fee-driven liquidity mechanism is weaker (stronger) for bonds with longer (shorter) time to maturity.

In Model 2, the direct effect of *Issuance* also remains positive and significant. The direct effect of *Seasonedness* is negative and significant, and the interaction effect *Issuance***Seasonedness* is positive and significant. This implies that the fee-driven liquidity mechanism becomes stronger as bonds become older.

Model 3 shows the results of the model with an interaction between *Issuance* and *Issuesize*. The direct effect of the expected issuance fees again remains positive and significant. As before, the direct effect of *Issuesize* is also positive. The interaction between the two is negative and highly significant. This implies that bonds from smaller issues benefit more from the fee-driven liquidity mechanism. We can conclude from Models 1, 2, and 3 that the issuance fees have a particularly strong effect on the liquidity of bonds that are relatively illiquid due to increased search costs, and therefore safer for the market maker to post more liquidity for. Model 4 in Table 6, finally, displays the interaction between the expected issuance fee and the traded volume. The direct effect of the expected issuance fee again remains positive and significant. The direct effect of volume, as we

[18] Note that this is *after* controlling for the credit spread, which is one of the control variables in our empirical model.

[19] These are the bonds that satisfy the maturity conditions dictated by Eurex for the Schatze, Bobl, Bund, Buxl, OAT, and BTP futures.

Table 6
Market maker interactions.

	1	2	3	4	5	6
Issuance	78.619***	40.306***	2356.6***	68.277***	65.555***	63.120***
	(1.458)	(1.702)	(47.270)	(1.498)	(1.226)	(1.193)
Maturity	−0.013***					
	(0.000)					
*Iss.**Mat.*	−3.018***					
	(0.112)					
Seasonedness		−0.010***				
		(0.001)				
*Iss.**Sea.*		3.360***				
		(0.284)				
Issuesize			0.782***			
			(0.010)			
*Iss.**size*			−227.31***			
			(4.667)			
Tradevolume				0.006***		
				(0.000)		
*Iss.**volume*				−1.537***		
				(0.109)		
CreditSpr					−0.284***	
					(0.020)	
*Iss.**Credit*					−1176.9***	
					(42.066)	
Derivatives						0.104***
						(0.005)
*Iss.**Deriv.*						−94.073***
						(2.964)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Coun∗∗∗try FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
	***					
Adj. R^2	0.582	0.582	0.585	0.582	0.583	0.583

Notes: This table presents the estimation results from the regression $L_{t,i} = \alpha + \beta_1 I_{t,k} + \beta_2 I_{t,k} Bond_{t,i} + \gamma X_{t,i,k} + \mu_t + \eta_k + \varepsilon_{t,i}$, in which $L_{t,i}$ is the LOS-liquidity measure at time t for bond i, which is created by aggregating high frequency order book data to the daily level from February 2008 until December 2012. $I_{t,k}$ represents the expected issuance fee measure at time t for country k, and $Bond_{t,i}$ represents a set of bond-level variables including a derivative dummy, time to maturity (in years), seasonedness, (log) issue size, and credit spread, respectively. $X_{t,i,k}$ is a vector of control variables at the time, bond, and country level. We estimate α, β, and γ by means of OLS; μ_t and η_k represent time and country fixed-effects, respectively. For reasons of conciseness, we only present the estimates for β_1 and β_2 of equation (9). The remaining coefficients are qualitatively similar to those in Table 4 and available on request. Standard errors in parentheses; *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

already observed in Table 4, is positive and significant. The interaction between the expected issuance fee measure and traded volume is negative and significant. This implies that the fee-driven liquidity mechanism is weaker for bonds that are traded more frequently.

Model 5 in Table 6 displays the coefficients for the model with an interaction between the expected issuance fee and the credit spread. The direct effect of the expected issuance fee again remains positive and significant. The direct effect of the credit spread, as observed in Table 4, is negative and significant. The interaction between the expected issuance fee measure and credit spread is negative and significant. This implies that the fee-driven liquidity mechanism is weaker for bonds with a higher credit spread. The results from Models 4 and 5 are explained by the fact that the credit spread and volume are measures of adverse selection costs for the market maker.

Model 6, gives the interaction between the derivatives dummy and the expected issuance fee measure. The direct effect of the expected issuance fee measure remains positive and significant. The direct effect of the derivatives dummy is also positive and significant, corroborating the results of Ejsing and Sihvonen (2009). The interaction effect between the expected issuance fee and the derivatives dummy is negative. Hence, the existence of a sovereign bond futures market crowds out the effect of the fee-driven liquidity mechanism. In fact, the total effect for countries/periods with a futures market is negative and significant ($63.120 - 94.073 = -30.953$). This suggests that issuance fees do not improve the liquidity of the bonds for which there is an active futures market.

Overall, we can distinguish illiquidity due to real economic risk (credit risk and yield curve sensitivity) and search cost-induced illiquidity (limited free float and age). The fee liquidity mechanism is strongest in mitigating the latter form of illiquidity, and counter-effective otherwise. These findings are consistent with Hypothesis 4.

4.4. Number of primary dealers

In order to add further evidence on the fee-driven liquidity channel we study, we introduce an additional analysis that incorporates an essential element in the mechanism but is exogenous to the liquidity process: competition between primary

Table 7
Number of dealers interaction.

Issuance	−36.531***
	(8.815)
#Dealers	0.004***
	(0.001)
*Issuance**#Dealers*	4.312***
	(0.426)
Seasonedness	−0.007***
	(0.000)
Issuesize	0.583***
	(0.009)
Maturity	−0.016***
	(0.000)
Creditspread	−0.471***
	(0.019)
Tradedvolume	0.004***
	(0.000)
V olatility	−2.305***
	(0.107)
Country FE	Yes
Time FE	Yes
Adj.R^2	0.582

Notes: This table presents the estimation results from the regression $L_{t,i} = \alpha + \beta_1 I_{t,k} + \beta_2 I_{t,k}\#Dealers_{t,k} + \beta_3\#Dealers_{t,k} + \gamma X_{t,i,k} + \mu_t + \eta_k + \varepsilon_{t,i}$, in which $L_{t,i}$ is the LOS-liquidity measure at time t for bond i, which is created by aggregating high frequency order book data to the daily level from February 2008 until December 2012. $I_{t,k}$ represents the expected issuance fee measure at time t for country k, and $\#Dealer_{t,k}$ represents the number of primary dealer active in period t for country k. $X_{t,i,k}$ is a vector of control variables at the time, bond, and country level. We estimate α, β, and γ by means of OLS; μ_t and η_k represent time and country fixed-effects, respectively. Standard errors in parentheses; *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

dealers.[20] Primary dealers compete in the secondary market to be selected as lead manager for primary issues. Therefore, we expect that an increase in the number of primary dealers strengthens the fee-driven mechanism. We obtain data about the number of primary dealers from the AFME website; see Table 3 for the descriptive statistics. The estimation results are presented in Table 7.

The estimation results in Table 7 reveal that the direct effect of the expected issuance fee measure remains positive and highly significant after introducing the number of primary dealers as a control variable and an interaction variable. The direct effect of the number of dealers is positive and significant, which is explained by the fact that more dealers will lead to intensified quoting and therefore a higher liquidity, ceteris paribus. The interaction of the number of dealers with the issuance fee measure is also positive and significant. Hence, a higher number of dealers leads to a stronger issuance fee mechanism, which is consistent with the notion that more dealers increases competition for issuance fees. This finding supports Hypothesis 5.

4.5. Full model

We next examine whether all interactions remain significant when included simultaneously. In Tables 5–7, one-by-one we included a set of interactions first from the issuer perspective and then from the market maker perspective. It might be, though, that there is correlation between the confounders. For example, it is conceivable that there is a relation between volatility and credit risk. In this analysis, we include all interactions simultaneously to examine the ultimate drivers of the mechanism. The results are presented in Table 8.

The estimation results in Table 8 reveal that including all interactions at the same time does not materially affect the conclusions. There are some interesting changes to be noted, though. First, in Table 5 the interaction between the issuance measure and LTRO and the interaction between the issuance measure and the peripheral dummy were both marginally insignificant. In the full model, however, both turn up highly significant and with the expected sign. Because this model is effectively more com-

[20] The set of primary dealers is managed by the national ministries of finance.

Table 8
Full model.

Issuance	1559.1***
	(52.975)
Seasonedness	−0.012***
	(0.001)
Issuesize	0.802***
	(0.010)
Maturity	−0.014***
	(0.000)
Creditspread	−0.212***
	(0.020)
Tradedvolume	0.004***
	(0.000)
V olatility	−1.092***
	(0.117)
LTRO	0.258***
	(0.038)
Derivative	0.063***
	(0.005)
Peripheral	−0.104***
	(0.003)
Fundingliquidity	−0.826***
	(0.047)
#Dealers	0.007***
	(0.001)
*Iss.*Peripheral*	4.349***
	(1.954)
*Iss.*Creditspread*	−621.68***
	(42.608)
*Iss.*Derivatives*	−52.625***
	(3.059)
*Iss.*Fundingliqiquidity*	219.62***
	(4.795)
*Iss.*V olatility*	−675.56***
	(66.753)
*Iss.*LTRO*	−64.935***
	(2.878)
*Iss.*Maturity*	−2.233***
	(0.113)
*Iss.*Seasonedness*	2.788***
	(0.2912)
*Iss.*Issuesize*	−159.15***
	(5.115)
*Iss.*Tradedvolume*	0.025
	(0.114)
Iss.#Dealers*	2.447***
	(0.445)
Country FE	Yes
Time FE	No
Adj.R^2	0.593

Notes: This table presents the estimation results from the regression $L_{t,i} = \alpha + \beta_1 I_{t,k} + \beta_2 I_{t,k}\#Dealers_{t,k} + \beta_3 \#Dealers_{t,k} + \gamma X_{t,i,k} + \mu_t + \eta_k + \varepsilon_{t,i}$, in which $L_{t,i}$ is the LOS-liquidity measure at time t for bond i, which is created by aggregating high frequency order book data to the daily level from February 2008 until December 2012. $I_{t,k}$ represents the expected issuance fee measure at time t for country k, and $Dealer_{t,k}$ represents the number of primary dealers active in period t for country k. $X_{t,i,k}$ is a vector of control variables at the time, bond, and country level. We estimate α, β, and γ by means of OLS; μ_t and η_k represent time and country fixed-effects, respectively. Standard errors in parentheses; *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

plete than the one estimated in Table 5, we can now fully confirm Hypothesis 2 as well. The interaction between the issuance measure and traded volume loses its significance.

Table 9
Estimation results for alternative liquidity measures.

	Log volume					Bid-ask spread				
	1	2	3	4	5	1	2	3	4	5
Issuance	62.486***	80.040***	128.60***	89.249***	127.31***	52.589***	61.467***	101.11***	40.746***	74.582***
	(1.331)	(1.128)	(1.183)	(1.155)	(1.212)	(1.332)	(1.260)	(1.444)	(1.299)	(1.494)
Seasonedness		−0.024***	−0.034***	−0.025***	−0.033***		−0.007***	−0.002***	−0.002***	−0.007***
		(0.001)	(0.000)	(0.001)	(0.000)		(0.001)	(0.001)	(0.001)	(0.001)
Issuesize		1.350***	1.420***	1.312***	1.448***		0.985***	0.120***	1.031***	0.160***
		(0.007)	(0.010)	(0.007)	(0.009)		(0.008)	(0.012)	(0.008)	(0.012)
V olatility		−4.290***	−1.754***	−8.906***	−2.703***		−0.587***	−0.134***	−2.254***	−1.425***
		(0.073)	(0.065)	(0.110)	(0.103)		(0.082)	(0.079)	(0.119)	(0.123)
FundingLiq		−0.197***	−0.284***				−0.063***	−0.051***		
		(0.006)	(0.005)				(0.007)	(0.006)		
Maturity		−0.052***	−0.053***	−0.051***	−0.053***		−0.014***	−0.013***	−0.014***	−0.013***
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
CreditSpr		−2.575***	−1.665***	−2.500***	−1.614***		−4.383***	−3.464***	−4.013***	−3.050***
		(0.023)	(0.020)	(0.022)	(0.020)		(0.025)	(0.025)	(0.025)	(0.024)
Tradedvolume		0.007***	0.003***	0.007***	0.002***		0.007***	0.008***	0.007***	0.008***
		(0.000)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Country FE	No	no	Yes	No	Yes	No	no	Yes	No	Yes
Time FE	No	no	No	Yes	Yes	No	no	No	Yes	Yes
Adj. R^2	0.007	0.330	0.507	0.377	0.551	0.005	0.162	0.267	0.207	0.316

Notes: This table presents the estimation results using alternative liquidity measures, using the regression $L_{t,i} = \alpha + \beta I_{t,k} + \gamma X_{t,i,k} + \mu_t + \eta_k + \varepsilon_{t,i}$. For the five leftmost output columns $L_{t,i}$ represents the volume-liquidity measure (logarithmic order book volume), whereas in the five subsequent columns $L_{t,i}$ is measured by the $-(bid - askspread)$. The measures are created by aggregating high frequency order book data to the daily level from February 2008 until December 2012. $I_{t,k}$ represents the expected issuance fee measure at time t for country k, and $X_{t,i,k}$ a vector of control variables at the time, bond, and country level. We estimate α, β, and γ by means of OLS; μ_t and η_k represent time and country fixed-effects, respectively. Standard errors in parentheses; *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

5. Robustness tests

The main purpose of this section is to study the sensitivity of our results to the (empirical) choices we make. We explore the effect of using alternative liquidity measures in Subsection 5.1, alternative expected issuance fee measures in Subsection 5.2, and the sensitivity to some other empirical choices such as the set of countries, positive trading volume, and bond fixed effects in Subsection 5.3.

5.1. Alternative liquidity measures

In Subsection 3.1 we argued that the *LOS* liquidity measure is our preferred liquidity measure, as it incorporates both price (bid-ask) and volume dimensions of quoted liquidity. In this subsection we test the robustness of the results to this choice, by re-estimating the main results from Table 4 using the two components of the *LOS* liquidity measure: bid-ask spread and volume. The results give an indication whether the primary dealers primarily compete on price or volume in reaction to expected issuance fees. Table 9 presents the results.

The first five models in Table 9 show the results for the volume measure. As for the *LOS* liquidity measure in Table 4, we find that the expected issuance fee measure is positively and significantly associated with the volume-based liquidity measure. The result is robust to the inclusion of control variables, country fixed effects, as well as time fixed effects. Whereas the effect size decreases by half after including country fixed effects for the *LOS* measure, the effect size actually increases after inclusion of the controls and fixed effects for the volume-based liquidity measure. The right-hand side of Table 9 presents the estimation results using the bid-ask spread as the liquidity measure. Also in this case, the results are highly similar to those of the benchmark results. Again, we find that the reduction in the effect size after including country fixed effects is rather limited.

In unreported results we also study the issuer and market maker interactions for the alternative liquidity measures, as we did in Tables 5 and 6 for the *LOS* measure. The results are consistent in that the expected issuance fee remains positively associated with both the volume measure and the bid-ask liquidity measure.

5.2. Alternative expected issuance fee measures

The expected issuance fee measure introduced in Subsection 3.2 builds on the assumption that primary dealers are backward-looking with a certain decay factor λ. In this subsection, we will evaluate the robustness of the results to the exact specification of equation (6). Specifically, we vary the decay parameter λ between 0.005 and 0.10. Furthermore, we use a forward-looking expectation measure. Additionally, we proxy the issuance measure with a simple backward-looking dummy that takes the value of 1 if there was a fee-paying primary issue for that country within the previous 20 business days and zero

Table 10
Estimation results with alternative expected fee measures.

	Backward 0.005	Backward 0.02	Backward 0.1	Forward 0.01	Backward dummy	Backward fee sum
Issuance	41.931***	49.542***	36.277***	34.679***	0.0299***	21.254***
	(0.875)	(1.629)	(3.691)	(1.222)	(0.004)	(2.042)
Seasonedness	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Issuesize	0.583***	0.584***	0.585***	0.584***	0.585***	0.585***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Maturity	−0.016***	−0.016***	−0.016***	−0.016***	−0.016***	−0.016***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CreditSpr	−0.447***	−0.518***	−0.554***	−0.517***	−0.553***	−0.551***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Tradedvolume	0.004***	0.004***	0.004***	0.0041***	0.004***	0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
V olatility	−2.412***	−2.757***	−2.958***	−2.880***	−2.978***	−2.965***
	(0.106)	(0.106)	(0.106)	(0.106)	(0.106)	(0.106)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.583	0.581	0.580	0.581	0.580	0.580

Notes: This table presents the estimation results using alternative expected issuance fee measures, using the regression $L_{t,i} = \alpha + \beta I_{t,k} + \gamma X_{t,i,k} + \mu_t + \eta_k + \varepsilon_{t,i}$. Columns two to four represents the results using a decay rate λ in equation (6) of 0.005, 0.02, and 0.1, respectively. Column five represents a forward looking measure, with decay rate λ equal to 0.01. Column 6 represents the results using an issuance measure constructed as a dummy variable that takes the value of 1 if that country has a syndicated issue in any of the previous 20 business days. Column 7 represents the results using an issuance measure constructed as the sum of the syndicated issuance fees paid out over the previous 20 business days. $I_{t,k}$ represents the expected issuance fee measure at time t for country k, and $X_{t,i,k}$ a vector of control variables at the time, bond, and country level. We estimate α, β, and γ by means of OLS; μ_t and η_k represent time and country fixed-effects, respectively. Standard errors in parentheses; *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

otherwise.[21] Finally, in the last robustness check we construct the issuance measure as the sum of primary issue fees paid over the previous 20 business days per country. Table 10 presents the results.

The estimation results in Table 10 first and foremost indicate that our results are virtually insensitive to the exact specification of the expected issuance fee measure. Models 1, 2, and 3 present estimation results with varying decay factors of 0.005, 0.02, and 0.1. We observe that the estimated coefficient remains unchanged. Although the estimate remains significant, the standard error increases with the decay factor. This is an indication that the actual amount of historical information used by the primary dealers to form expectations about the future fee is relatively large (i.e., the decay factor low).

The forward-looking model also gives significant results. However, the effect size and significance are somewhat lower in Model 4 than in the previous three models. Our results continue to hold when using simplified issuance measures based on a 20-day backward-looking window in Models 5 and 6. The coefficient in Model 5 is of a different order of magnitude, but this is explained by the fact that the issuance measure is a monetary amount in that case and therefore not directly comparable to the other measures.

5.3. Additional tests

The descriptive statistics in Table 2 reveal that the issuance fees for Germany and the Netherlands are virtually equal to zero. During our sample period, Germany had one issue for which it paid out a certain fee whereas the Netherlands had none. This is explained by the fact that these two countries are the most creditworthy sovereigns in our sample, with corresponding high unconditional liquidity in the secondary market of their sovereign bonds. As such, these countries have little refinancing uncertainty. In addition, Germany and the Netherlands also use other channels than the syndicated loan market to place bonds, such as direct auctions (AFME, 2015). Therefore, we do a robustness test by re-estimating equation (7) excluding Germany and the Netherlands. Table 11 presents the results.

Overall, the estimation results in the first column of Table 11 are highly comparable to those in Table 4. Both the effect of the expected issuance fee as well as the control variables are only marginally different. Therefore, we conclude that our results are not impacted by the relatively special cases of Germany and the Netherlands.

Another observation from the descriptive statistics in Table 3, is that the traded volume can be zero. In fact, traded volume is zero in roughly 50% of the bond-day combinations. Therefore, we run a robustness test by excluding all days in which there is no trade. The results are presented in the second column of Table 11. The coefficient on the issuance measure decreases somewhat in magnitude, but remains highly positive and significant. Hence, whereas the effect size decreases, the results remain qualitatively similar.

[21] Typically the details of a new issue are published roughly 20 days before the actual issue.

Table 11
Additional tests.

	Excl DE/NL	Positive volume	Bond FE
Issuance	53.941***	37.989***	58.249***
	(1.157)	(1.676)	(1.162)
Seasonedness	−0.004***	−0.001***	−0.007***
	(0.000)	(0.001)	(0.000)
Issuesize	0.654***	0.425***	0.572***
	(0.010)	(0.014)	(0.009)
Maturity	−0.018***	−0.018***	−0.016***
	(0.000)	(0.000)	(0.000)
CreditSpr	−0.427***	−0.389***	
	(0.018)	(0.030)	
Tradedvolume	0.005***	0.034***	0.004***
	(0.000)	(0.002)	(0.000)
V olatility	−2.967***	−4.739***	
	(0.107)	(0.184)	
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Adj.R^2	0.619	0.609	0.583

Notes: This table presents the estimation results of various version of the regression $L_{t,i} = \alpha + \beta I_{t,k} + \gamma X_{t,i,k} + \mu_t + \eta_k + \theta_i + \varepsilon_{t,i}$, in which $L_{t,i}$ is the LOS-liquidity measure at time t for bond i, which is created by aggregating high frequency order book data to the daily level from February 2008 until December 2012. $I_{t,k}$ represents the expected issuance fee measure at time t for country k, and $X_{t,i,k}$ a vector of control variables at the time, bond, and country level. We estimate α, β, and γ by means of OLS; μ_t, η_t, and η_k represent time, bond, and country fixed-effects, respectively. The first column gives results excluding German and Dutch bonds from the sample; the second column gives results excluding bond-day combinations in which there is no trade; and column 3 gives results including bond fixed effects. Standard errors in parentheses; *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

In column (3) of Table 11, we present the results of the model in which we include bond fixed effects to assure ourselves that we have controlled for all remaining unobserved bond-specific heterogeneity. The credit spread variable drops out because this is specific to bonds, and constant over time. The results are highly comparable to those in Table 4. This confirms that the initial set of control variables and fixed effects was sufficient.

6. Conclusion

In this paper, we examine the issuance fee-driven liquidity mechanism for our 2008–2012 sample of sovereign bonds from 11 euro area countries, using high-frequency orderbook data from MTS matched with issuance fee data from Dealogic. We find that the expected issuance fee is significantly related to government bond market liquidity, controlling for risk-related factors. Therefore, liquidity does not only depend on the common factors such as inventory risk and adverse selection, but also on the extent to which the sovereign is willing to compensate the primary dealer for their services.

The sovereign will make a cost-benefit analysis: does the fee compensate for the lower funding cost resulting from the higher liquidity? Likewise, the primary dealer will make a cost-benefit analysis: the costs incurred on the extra quoted liquidity on the secondary market compensate for the additional fee revenue? Our results indicate that as a result of both these cost-benefit analyses, the issuance fee-driven liquidity mechanism is especially strong for countries with relatively high funding needs, in periods of high market uncertainty, and for safe bonds.

We find that the institutional setting matters for the liquidity of the European government bond market. The rules of engagement give rise to an issuance fee-driven liquidity mechanism that is welfare-increasing. This could imply that markets are more liquid than expected leading up to new bond issues, or that liquidity studies need to take the fee-driven liquidity mechanism explicitly into account. We feel that further investigation of these issues is warranted.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.finmar.2019.100514.

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