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Working Paper

Institutional presence in secondary bank bond markets: How does it affect liquidity and volatility?

ECB Working Paper, No. 2276

Provided in Cooperation with:

European Central Bank (ECB)

Suggested Citation: Oprică, Silviu; Weistroffer, Christian P. (2019) : Institutional presence in secondary bank bond markets: How does it affect liquidity and volatility?, ECB Working Paper, No. 2276, ISBN 978-92-899-3538-8, European Central Bank (ECB), Frankfurt a. M., <https://doi.org/10.2866/46155>

This Version is available at:

<https://hdl.handle.net/10419/208310>

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EUROPEAN CENTRAL BANK

EUROSYSTEM

Working Paper Series

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Institutional presence in
secondary bank bond markets:
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No 2276 / May 2019

Abstract

Using newly available information on euro area sectoral holdings of securities, this paper investigates to what extent the presence of institutional investors affects volatility and liquidity in secondary bank bond markets. We find that non-bank financial intermediaries, in particular money market funds (MMFs), have a positive impact on secondary bank bond markets' liquidity conditions, at the cost of significantly increasing volatility of daily returns. The effect translates to more than a 19% improvement in liquidity conditions and up to 57% increase in daily-return volatility, assuming MMFs hold about 10% of the notional amount in the secondary market of a representative euro area bank bond. The effect is relative to the impact the non-financial private sector has on markets. Investment funds, insurance corporations and pension funds are found to similarly affect market conditions, though to a lesser magnitude. We find a trade-off between volatility and liquidity, where the stronger presence of institutional investors at the same time improves liquidity and increases volatility. The results suggest that possible structural shifts in investor composition matter for market conditions and should be monitored by financial stability authorities.

Keywords: *Financial Markets, Institutional Ownership, Bond Liquidity, Securities Holdings, Generalized Method of Moments*

JEL Classifications: G10, G15, G23

Non-technical summary

Views diverge to what extent the presence of institutional investors, such as insurance corporations, pension funds, money market funds and investment funds does affect conditions in the markets in which these institutions are investing. Financial market supervisors and risk overseers are in particular concerned about how the presence of certain types of investors affects market liquidity and volatility conditions from a financial stability perspective. Some investor types, such as banks and securities dealer providing services as market makers, are expected to affect market conditions positively. Other types, such as pension funds and insurance companies, are presumed to have a benign effect on market conditions, as they are believed to provide stable investment flows. Still others, such as open-end investment funds, are expected to adversely affect liquidity and volatility conditions due to their procyclical trading behaviour.

One can think of a number of factors, such as investment horizon, liquidity or leverage constraints, affecting institutions' trading behaviour in a potentially beneficial or detrimental manner for conditions in the underlying markets. But it remains an empirical question whether the presence of institutional investors does affect market conditions and in which direction the effect would manifest. The analysis presented in this paper tries to assess this question employing a rigorous econometric strategy. The non-financial private sector serves hereby as a benchmark against which to assess whether the presence of institutional investors affects volatility and liquidity conditions in bank bonds markets. The results thus help evaluate whether additional risks to financial stability can arise through institutionally intermediated, rather than direct investments by the non-financial private sector. Moreover, the paper identifies sectors that have a larger and more significant effect on market conditions, possibly requiring closer monitoring of their activities.

The focus on secondary bank bond markets allows us to gain insights from a segment where the link between banks and market-based finance is particularly close and potentially relevant from a systemic risk perspective. Conditions in secondary bank bond markets will determine the premia demanded by agents in primary markets, thereby affecting future bank funding conditions. Conversely, stress in the banking sector will affect the bank bond market with possible repercussions for the wider financial system.

By limiting the dataset to unsecured bank bonds, which are not eligible under the ECB's asset purchase programme, a direct effect by the central bank's purchases on liquidity and volatility measures at ISIN-level can be avoided. While we cannot exclude that market conditions are indirectly affected by the ECB's purchases through spillovers or a rebalancing effect, we do control for asset purchases in the regression specifications to the extent that they homogeneously affect each ISIN at the country and quarterly level.

Drawing mainly from cross-sectional variation in the holdings of individual bank bond issuances, the paper finds that institutionally intermediated investments do significantly affect volatility and liquidity conditions in secondary markets. This effect is particularly pronounced for the presence of money market funds (MMF), but also significant for insurance corporations and pension funds, as well as investment funds, suggesting that structural shifts towards higher intermediated investments can alter liquidity and volatility conditions in bank bond markets. The observed effects resulting from higher presence of institutional investors are however not necessarily detrimental for market liquidity. On average, larger holdings of a given issuance by MMF result in improved liquidity conditions as measured by the bid-ask and effective spreads. At the same time, price volatility tends to be higher in issuances where there is a stronger presence of the latter. Overall the results suggest that a trade-off exists between volatility and liquidity in the presence of institutional investors. The stronger presence of institutional investors at the same time improves liquidity and increases volatility. The results may be explainable by typical trading patterns, where institutional investors are expected to trade at higher frequencies resulting in lower transaction costs for the securities they trade.

From a policy perspective, it is not clear how the benefits of higher liquidity should be weighed against the cost of higher volatility. The higher volatility may just be a side-effect of more frequent trading due to the improved price discovery offered by a liquid market, which in turn can lead to quicker and possibly stronger price adjustments reflected by higher price volatility. What can be concluded, however, is the non-negligible impact of institutional investors on market conditions. The results presented for the MMF sector provide a case in point. The presence of these highly competitive, well-informed investors that specialise in the short-end of the bank bond market improves liquidity conditions. If these investors were to limit their trading in certain securities, liquidity can be expected to be lower with a possible negative impact on bank funding costs and ease of rolling-over debt. Should this scenario persist or become recurrent, rational agents may demand higher premiums from primary

bond issuances in order to compensate for the lack of liquidity in secondary markets and the likelihood that the assets may be harder to sell during downturns. This in turn could constrain the funding opportunities for credit institutions, leading to spillovers from the market side. Authorities responsible for monitoring financial stability must therefore be concerned not only with cyclical developments affecting liquidity, but also with possible structural shifts in the investor composition, in particular the withdrawal of investors known to be actively trading and contributing to higher liquidity.

1. Introduction

How do institutional investments affect conditions in secondary bond markets? This question has become ever more pertinent as the assets managed by institutional investors, such as investment funds, insurers and pension funds have been growing strongly, while market liquidity conditions seem to have deteriorated compared to the levels prior to the global financial crisis. The rising share of institutional investments is also relevant from a financial stability perspective. As some of the global risk overseers have noted, the locus of financial stability risks seems to have shifted from banks to non-bank financial institutions and from solvency to market liquidity risks (IMF, GFSR, April 2015).

The common view held by financial market supervisors and risk regulators stipulates the presence of some types of institutional investors affecting the underlying market conditions. Market makers for instance have a clear objective of influencing market conditions and are thus expected to have a beneficial effect on the market. Other types of financial institutions are seen as having a more benign effect on market conditions, such as pension funds and insurance companies, as these investors are expected to provide stable investment flows. Still others, such as open-end investment funds, are believed to adversely affect liquidity and volatility conditions if they trade in a procyclical manner. For instance, Feroli et al. (2014) argue that investment fund flows can drive up asset prices as a by-product of the performance race, while return chasing can reverse sharply and affect price volatility, such as during the 2013 'taper tantrum' episode.

While traditional asset pricing models assume that prices are determined by news rather than order flows, recent contributions to theoretical and empirical modelling account for concentration in ownership and the presence of certain types of investors (e.g. Koijen and Yogo, 2015; Ben-David et al., 2015). For our purpose, cross-sectoral heterogeneity in the updating of beliefs and the magnitude of trades in response to new information shall be sufficient to explain why some economic sectors are affecting liquidity and volatility more than others. Such heterogeneity is well documented in the literature, which finds significant links between institutional ownership and stock pricing (e.g. Zhiguo, Kelly, and Manel, 2017; Adrian, Etula and Muir, 2011). Another strand of the literature explores how ownership constraints affect stock liquidity (e.g. Dang et al., 2018; Kini and Mian, 1995; Szewczyk, Tsetsekos and Varma, 1992).

We expect intermediated investments to affect conditions in secondary bond markets (i) if new information is not processed and reacted upon uniformly across the holding sectors and (ii) if some sectors are more important than others in transmitting news to the market. Our analysis thus presumes that certain factors might rationally restrict investors' reactions to news and hence their trading behaviour, which in turn, affects liquidity and volatility in the securities held or traded. Such restrictions can result from informational advantages, sector-specific regulatory constraints, but also from investment horizons and risk aversion (Agarwal, 2007) or frequency of trading.

Previous studies show that institutional participation in the U.S. stock market helps explain cross-sectional variation in stock market liquidity, with the number of institutions that own and trade a stock relating positively to the stock's liquidity (Blume and Keim, 2012). The focus of our analysis is on the presence of various types of institutional investors in bank bond markets and their possible impact on volatility and liquidity conditions in the underlying markets. Our approach draws inference from a large and recent dataset containing institutional and non-institutional holdings of bank debt securities. It does not seek to verify specific trading patterns, but more generally investigates the effect of certain types of institutional investors being present, i.e. holding and possibly trading securities in the secondary market for bank-issued bonds. The paper thus contributes to the newly emerging literature which makes use of granular statistics on securities holdings aggregated at sector level (e.g. Timmer, 2016; Steins Bisschop et al., 2016).

Using information on euro area sectoral holdings of securities (SHSS), our dataset allows us to distinguish between different types of institutional investors in order to test whether their presence has a significant effect on the underlying market conditions. In particular, we look at mutual funds, money market funds, as well as insurance corporations and pension funds' contribution to volatility and liquidity of the securities they hold. Information at the securities' level (ISIN) allows us to distinguish between security-specific factors affecting liquidity and volatility as well as market-wide factors. Using quarterly observations, we analyse the period from Q4 2013 to Q1 2016.

We restrict our sample to the market for non-secured bonds issued by banking institutions. This market is sizable and constitutes a potential channel for contagion, as witnessed for instance during the US financial crisis when banks were not able to roll-over their debt due to perceptions regarding the secondary market turmoil. Debt instruments are a key source of

funding also for the euro area banking sector and a smooth functioning of secondary markets for bank-issued bonds is vital for the funding of euro area banks. A better understanding of the factors affecting liquidity and volatility in these markets is thus paramount for the monitoring of risk at the interplay between institutional investing and bank funding. Moreover, restricting our sample to non-secured bank bonds avoids a blind spot in the dataset, where we cannot identify central bank purchases of securities eligible under the ECB's extended asset purchase programme (EAPP). This ensures that market conditions for securities in the sample cannot be directly affected by central bank purchases, even though indirect effects may still play a role.

From a financial stability perspective, it will be important to account for volatility and liquidity, separately as they can evolve in different directions. Volatility of an asset may be low simply because it is not frequently traded and hence not liquid. Vice versa, highly liquid assets may experience higher volatility in an environment of volatile news flow and with price discovery taking place through trading of the liquid asset. However, volatility and liquidity – our main variables of interest – are also simultaneously determined in the market. When investors respond to the news flow, this will likely affect prices, hence volatility, but it also affects liquidity measures which poses a challenge to our empirical strategy.

A second challenge relates to the possibility that causality can also run in the opposite direction. A sector may choose to invest in securities which display more or less volatility or have certain liquidity levels, in line with their risk averseness and potential regulatory constraints, rather than the presence of institutional investors affecting conditions in the underlying markets. Not least, the presence of simultaneity as well as reverse causality calls for an adequate identification strategy.

To address the endogeneity problem we employ an instrumental variables (IV) approach implemented through an iterative GMM model. In the case of volatility, two types of excess volatility measures are used as an instrument to capture both the cross-sectional and time-series dynamics of excess volatility. Liquidity is instrumented using residual maturity for each security and an off-the-run binary variable constructed using the entire SHSS universe. Because the volatility and liquidity instruments are most likely important determinants for their endogenous variables, these are also used in the cross equations whenever they are not instruments. Finally, the sectoral holdings are instrumented using their first lag to address

the potential reverse causality, as these holdings on average display little changes from one quarter to the next⁴, which should serve towards the relevance criterion of the instruments.

Overall, we find that institutional investments do significantly affect volatility and liquidity conditions in secondary bank bond markets. This effect is particularly pronounced for the presence of money market funds (MMFs), but it is also significant – although to a lesser extent – for other types of investment funds, insurance corporations and pension funds. Our results suggest that a trade-off exists between volatility and liquidity in secondary bank bond markets linked to the presence of institutional investors. Larger holdings by the institutional investors result in lower transaction costs as measured by the bid-ask and effective spreads. At the same time, price volatility tends to be higher in issuances where there is a stronger presence of institutional investors. The stronger presence of institutional investors thus, at the same time, improves liquidity and increases volatility. The results may be explained by typical trading patterns, where certain types of institutions are expected to trade at higher frequencies resulting in tighter spreads and thus lower transaction costs for the securities they trade. Likewise, the higher volatility can be explained by more frequent updating of portfolio choices by these investors resulting in more frequent price changes. The presence of institutional investors seems desirable from a market micro-perspective, as it shall benefit liquidity and price discovery. But the associated higher volatility can also have a negative bearing on financial stability.

The remainder of the paper is organised as follows. Section 2 describes the dataset and the construction of some key variables used to measure volatility and liquidity in the paper. Section 3 presents our empirical strategy in light of the research questions – the main findings from our empirical analysis are discussed and some robustness checks are provided. Section 4 concludes.

2. Data

Our dataset spans the period from Q4-2013 to Q1-2016 and merges several data sources in order to augment bond holding information with issuance-specific market data and ISIN

⁴ See Appendix C for results regarding persistency.

characteristics, such as coupon size, yield-to-maturity, maturity of the issuance, seniority, ratings, etc. The main variable of interest to our analysis describes the patterns of sectoral holdings and is calculated as the amounts held by a particular sector relative to the issuance volume of a specific security. To derive such information for a number of relevant sectors and securities we make use of the bank bond data contained in the SHSS. This dataset offers a bird's eye view on the amounts held of all such outstanding bonds for which at least one sector from an euro area country has some holdings. The SHSS is a proprietary database⁵ of the Eurosystem, which collects on a quarterly basis ISIN-level information regarding sectoral holdings of debt and equity securities in the euro area. The statistics contain information on net holdings calculated as gross acquisitions minus disposals during each quarter's accounting period.⁶ This highly granular dataset is further enhanced using the ECB's Centralized Securities Database (CSDB) with issuance-specific characteristics at ISIN-level.

While we can distinguish between holding patterns of individual ISINs, information regarding the agents holding the securities is aggregated at the sector-country level. For example, for some given bond, one can see how much of the issuance is held by the investment fund sector in Germany, or by the household sector in Italy, and track these holdings throughout the life of the security. The main sectors included in our analysis comprise credit institutions (CI), governments including social security funds (Gov), investment funds excluding money market funds (IVF), money market funds (MMF), insurance corporations and pension funds (ICPF), other financial institutions⁷ (OFI), the non-financial private sector⁸ (NFPS), and a residual comprising all holdings outside the euro area (U) for which no sectoral breakdowns are available. Our dataset contains both euro area and non-euro area issuances, though we are able to differentiate between the countries of the issuers allowing us to construct different sub-samples and control for regional differences.

The dataset allows us to observe *inter*-sectoral re-allocations but does not show *intra*-sectoral shifts in the securities held.⁹ Accordingly, our analysis aims to identify the sectors

⁵ See *Who holds what? New information on securities holdings*, ECB Economic Bulletin, Issue 2/2015.

⁶ Netting over the accounting period implies that short-selling of securities will reduce the net amounts held, potentially creating a negative net position.

⁷ Other financial institutions refer to financial vehicle corporations (FVCs), and other financial institutions that are not contained in the previous breakdowns.

⁸ The non-financial private sector (NFPS) comprises households, non-financial corporations and institutions, as well as non-profit organisations.

⁹ An intra-sectoral re-allocation would maintain the same presence of the sectors in an ISIN's market, albeit within each sector the composition of holdings may vary across entities.

that drive market conditions not the individual institutions themselves. To further focus the analysis on sectoral patterns, and to allow for a sample as broad as possible, we aggregate the country holdings at the euro area level and exploit the variation in the holdings between sectors.

We retrieve the holdings data in euro denominated nominal amounts in order to ensure comparable features and to avoid valuation and foreign exchange effects over the studied period. We then convert the holding figures to ratios in percentage points of the total amount outstanding at the date of issuance in order to avoid any scaling effects across ISINs. Partial bond buybacks or early redemptions amounting to a fraction of some given issuance cannot be identified in our sample since time series data on outstanding amounts is not available. This should not pose a problem for the identification of euro area sectors' impact because the relative figures are constructed using a denominator which is fixed in time to the date of issuance. Any early partial redemption will therefore be interpreted in the model as a reduction of relative holdings of the sectors which exercised their redemption rights. This goes along simultaneous with an increase in the amounts held by the extra-euro area sectors, which are accounted for as a residual and are used primarily for control purposes in the analysis.

For the second pillar of our dataset, we source ISIN-specific information from commercial market data vendors. Specifically, we collect daily clean price¹⁰ information for every ISIN using Thomson Reuters Datastream and subject to availability. For volatility, we construct the quarterly average of monthly standard deviations in the daily log-returns of bond prices. For liquidity, we construct two common measures based on quotes and observed transaction prices. As a first liquidity measure, we use quarterly average of the bid-ask spread standardized by the prevailing daily mid-price. This measure is used as a proxy for the transaction cost dimension of liquidity. Lower liquidity is typically associated with a higher bid-ask spread and therefore higher round-trip transaction costs. The second measure, quarterly average of effective spreads¹¹, is often used in practice as a reflection of the depth and breadth dimension of market liquidity. A less liquid market is typically associated with a shallower order book allowing the transaction price to move farther away from the mid-price. The two measures thus capture some key dimensions of market liquidity. A lack of turnover

¹⁰ Effective spreads are computed as: $Effective\ Spreads_t = 2 \cdot |Price_t - Mid\ price_t|$, where every period t represents a business day.

¹¹ Effective spreads are computed as: $Effective\ Spreads_t = 2 \cdot |Price_t - Mid\ price_t|$, where every period t represents a business day.

data in European bank bond markets prevents us from expanding the list of measures to this further dimension of market liquidity.

Some attention has been given to controlling the quality of the dataset and to removing outliers. Observations for which euro area holdings totalled above 100% or below 0% of the amount outstanding have been dropped. These cases could in principle be due to lending/borrowing or repos/reverse repos with sectors outside the euro area, considering the SHSS data reflects net acquisitions over the accounting period without distinguishing between securities sold from own inventories or borrowed in the market. But since we cannot reliably confirm that these extreme observations are not in fact the result of reporting issues, we remove them from the sample. Similarly, if aggregate euro area holdings of an ISIN double from one quarter to the next then rebound in the following quarter, we suspect the observation to be a reporting error and exclude it from the sample.

On the market data side, we drop daily price observations that are below 10 pp of the notional amount (i.e. trading at an unreasonable value below par) or above 300 pp (i.e. trading at an unreasonable value above par) as we deem these values implausible. We further remove observations for which the price does not vary for three business days in a row, or changes from a day to the next by more than 50 pp, to ensure our data reflects to the best extent possible real market conditions. In constructing the volatility and liquidity indicators at the quarterly level we are mindful not to induce a small sample bias. It is important to note that some of these bank bonds may not trade every day. But since we cannot distinguish whether the lack of trades for some ISINs are due to reduced market activity or poor data coverage of the issuance, and in order to have accurate estimates of liquidity and volatility at the quarterly level, we drop quarterly observations for which these measures are constructed with less than 20 business days' worth of price data. This procedure results in a sample that includes the most frequently traded issuances. In the interest of ensuring that our findings remain robust in light of the data cleaning procedures, the main model specification is in addition tested using an alternative dataset, which relaxes several of the above restrictions imposed on the market data (see Appendix C).

Finally, we remove from our sample all bank covered bonds (CB) and asset-backed securities (ABS), since the volatility and liquidity conditions for them may have been directly affected to an unknown extent by purchases under the ECB's Covered Bond Purchase Program 3 (CBPP3), and the Asset-Backed Securities Purchase Program (ABSPP),

respectively. The remaining bank debt types are not included in any of the ECB's asset purchase programs. An analysis of the sectors driving their liquidity and volatility conditions is feasible, provided any potential spillovers from outstanding non-standard policy programs are controlled for using time and regional fixed effects.

After mapping the sectoral holdings with market data, performing quality checks on the matched observations and removing CB and ABS, the estimation sample comprises a total of 93,894 ISIN-quarter observations. Further breakdowns of the coverage by period are provided in Table 9, which shows a significant decrease from the total observations available in the SHSS universe. This is primarily due to the lack of pricing data for smaller issuances, which may not be traded on a frequent basis. While in terms of unique worldwide issued ISINs this means we cover about 9% of the SHSS database, in terms of amounts outstanding our estimation sample covers about 51.57% of the total sample. After our data quality checks have been applied, the results should be representative of bonds which are traded frequently in secondary markets. Table 10 shows the quarter-by-quarter coverage in terms of ISINs and amounts outstanding for each of the sub-samples analysed. As expected, our analysis indeed covers the larger and more widely traded issuances. Additional tables and summary statistics for our sample variables can be found in Appendix B.

3. Empirical strategy and main findings

From a financial stability perspective, both liquidity and volatility conditions are of interest as they interact with each other and jointly determine market conditions, including fire-sale properties of any traded asset. Nevertheless, it will be important to account for them separately in the empirical framework as volatility and liquidity can evolve in different directions. Volatility of an asset may be low simply because it is not frequently traded and hence not liquid. Vice versa, highly liquid assets may experience higher volatility in an environment of volatile news flow and with price discovery taking place through trading of the liquid asset. Our empirical strategy should thus account for the impact low market liquidity could have on price returns, as well as the effect volatility can have on order book quotes which are the basis for certain liquidity measures. To this end, we pursue two main equations: in the first, we model volatility as a function of liquidity, sectoral holdings and

controls, as seen in equation (1). In the second we switch the roles of liquidity and volatility to dependent variable and regressor respectively, as in equation (2).

$$Volatility_{it} = \beta_0 + \beta_1 \cdot Liquidity_{it} + Holdings'_{it} \Psi + Z'_{it} \Lambda + \varepsilon_{it}^{vola} \quad (1)$$

$$Liquidity_{it} = \gamma_0 + \gamma_1 \cdot Volatility_{it} + Holdings'_{it} \Phi + Z'_{it} \Delta + \varepsilon_{it}^{liq} \quad (2)$$

Where: *Holdings* is a 7x1 vector containing the relative sectoral holdings of each ISIN *i* at quarter *t* for the CI, Gov, IVF, MMF, ICPF, OFI and U sectors. Ψ , Φ , Λ and Δ are equation specific column vectors of parameters, and *Z* is a vector of controls.

Note that due to the fact the relative holdings sum up to 100% of the amount outstanding each period, one sector must be excluded from every equation in order to avoid a perfect multicollinearity problem in the estimation. We have chosen to exclude the non-financial private sector (NFPS), thereby making this our baseline against which to assess all other sectors. Our analysis should then be interpreted as the impact the other sectors have on market conditions, compared with the NFPS. The choice of the NFPS as a baseline is motivated by our interest in the marginal effect of institutional investments on volatility and liquidity compared to non-intermediated investments. Direct investments by the NFPS are potentially less distortive to market conditions due to a reduced propensity to trade, risk-management and other considerations that might affect the behaviour of institutional investors more strongly. Indeed, financial motive driven transactions of the non-financial private sector may be delegated to specialized intermediaries, such as credit institutions, investment funds and money market funds, and therefore should be captured by the latter sectors instead.

We control through the vector *Z* for ISIN-specific characteristics, including seniority, bond rating, price at issuance, yield to maturity, whether the bond is issued in a currency other than the Euro, whether the bond is a hybrid, its last coupon rate, the coupon type, the issuance maturity expressed in years, amounts outstanding in Euros, and the euro area sectoral concentration of holdings using a Herfindahl index. Macro aggregate and news driven shocks are accounted for through time-fixed effects and any time-constant unobservables are dealt with through fixed effects at the regional level.

Regarding the latter, we differentiate between securities issued by banks located in non-EU countries, EU countries excluding the euro area, and three groups of euro area countries¹² classified depending on whether they experienced significant credit rating downgrades post-2008. Group A is used as a baseline in our estimation and comprises countries that have not experienced significant sovereign rating downgrades: Austria, Belgium, France, Luxembourg, Estonia, Malta, Lithuania, Latvia and Slovakia. Group B includes countries which have experienced significant rating downgrades post-2008: Cyprus, Greece, Ireland, Italy, Portugal, Slovenia and Spain. Finally, Group C includes countries which have not experienced significant downgrades, similar to Group A, but additionally have accumulated positive TARGET2 balances since the European debt crisis: Germany, Finland and the Netherlands.

3.1 Estimation strategy

Our estimation strategy aims to overcome potential endogeneity issues one would face in using standard panel methods on (1) and (2). On the one hand, volatility and liquidity are simultaneously determined by market participants. When investors update their beliefs and preferences this usually affects prices, hence volatility, but it also affects the order book and thus our quote-based measures of liquidity. In addition, holdings of securities and volatility/liquidity conditions in their markets are likely affected by reverse causality. In other words, while the distribution of holdings across sectors may determine market conditions, economic agents will choose their portfolio allocations every period based on a number of factors, which may include volatility and liquidity of the invested securities according to investor preferences or external constraints on risk-taking. The issue may be further exacerbated by the fact that we observe the data at quarterly frequency which allows sufficient time for the causal relationship to manifest in both directions.

To address the endogeneity problem, we employ an instrumental variables (IV) approach implemented through an iterative GMM model. Alternative designs such as difference-in-difference or regression discontinuity would be suboptimal as they do not allow us to analyse the impact of all sectors on market conditions at the same time. Instead they would restrict

¹² Adapted from the ECB's Financial Integration Report (April 2016).

the analysis to one or several sectors at a time, depending on the exogenous event or constraint considered. The former would also impose a parallel trend assumption, namely that the treated and non-treated groups would follow the same pattern *caeteris paribus* – an assumption that may be problematic for a pooled euro area analysis where long-run trends in core country sectors may not match the ones in the periphery.

The model's set-up leads to eight potentially endogenous¹³ variables per equation that need to be instrumented, i.e. the 7 sectors and one liquidity or volatility measure for equation (1) or (2), respectively. Aside from the baseline, we consider seven holding sectors in order to allow the interpretation of the results to be relative to the NFPS only¹⁴. In addition, we consider both liquidity in equation (1), and volatility in equation (2), with the view to properly disentangle the effect of the holdings from other market forces.

In order to ensure the reliability of our model-based conclusions we pursue a conservative approach to IV estimation and inference. The standard approach to IV estimation is the two-stage least squares model (2SLS), which is a special case of GMM estimation where the weight matrix, $(Z'Z)^{-1}$, is constructed using the vector of exogenous variables Z . In light of the above, our main specification is an equation-by-equation iterative GMM model (iGMM). Contrary to 2SLS, the iGMM will update its weight matrix, $(Z'\widehat{u}_k\widehat{u}_k'Z)^{-1}$, at each iteration $k+1$ using the previous iteration's residuals, \widehat{u}_k , until two consecutive matrices converge. This should ensure the moment conditions underlying the estimation are not arbitrarily set, and limit any potential bias of our conclusions. Furthermore, for the same conservative rationale, our main model uses standard errors clustered at the issuer level in order to assess the significance of parameter estimates.

The following provides the rationale of our instrument choices considering the relevance and exogeneity criteria. In the case of volatility and liquidity, we use two instruments for either variable, ensuring overidentification.

In the case of volatility, the first instrument uses for each ISIN the number of days within a quarter that exhibited volatility above that of the euro area iBoxx sovereigns index, expressed in percentage of total trading days per quarter. The second instrument is computed in a similar manner using the number of days a bond exhibited volatility above the ISIN's entire

¹³ The 7 sectors and one liquidity or volatility measure for equation (1) or (2), respectively.

¹⁴ The outside euro area sector (U), and to some extent the other financial institutions (OFI) have limited interpretability since both are constructed as residual holdings.

sample average. These IVs should capture the cross sectional and time series dynamics of excess volatility for each bank bond we analyse. Such features should be highly representative of each bond's volatility, while the way they are constructed should avoid the simultaneity shared with the liquidity measures because changes in the number of days a bond exhibits excess volatility are orthogonal to price levels and, therefore, to quote based liquidity proxies employed. In other words, when price quotes move and affect the spread measures, we have no reason to expect the excess volatility of a bond will respond in any particular direction or that it is simultaneously determined. This is because the underlying benchmark of each excess measure can itself change and can lead to any type of dynamics for the resulting excess volatility IVs.

In the case of liquidity, we instrument using residual maturity and an off-the-run binary variable constructed using the entire SHSS universe. The latter takes value one whenever there exists a bond with a more recent issue date and the same tenor, from the same issuer. Residual maturity and off-the-run status are well known factors that affect liquidity in bond markets (see Pasquariello and Vega, 2008) and both are independent of the simultaneous changes in volatility conditions due to their deterministic nature. The underlying reasoning is that liquidity is expected to decrease in time, as the residual maturity approaches zero, due to newer issuances being available in the market from which market participants can extract higher returns in exchange for maturity risk. A level shift in liquidity conditions is also expected once a newer debt instrument from the same issuer is available to investors.

Because the volatility and liquidity instruments are likely important determinants for their endogenous variables, we will use them in the cross equations whenever they are not instruments. Specifically, the excess volatility measures, which are instruments for the volatility regressor in the liquidity equation (2), will be used as regressors in the volatility equation (1). Similarly, the residual maturity and the off-the-run dummy, which instrument liquidity in the volatility equation (1), will be determinants of the left-hand side liquidity variable in the equation (2).

Finally, for the holdings of the included sectors we instrument using their first lag to address the potential reverse causality. We observe that sectoral holdings do not on average change dramatically from one quarter to the next, and this persistence should serve towards the relevance criterion of the instruments. With respect to the exogeneity criterion, we note that contemporaneous decisions regarding holdings may be affected by current market dynamics,

while past holdings cannot be reverse caused by realizations of volatility and liquidity from the future. Market participants could of course forecast conditions and form expectations, but they will not know for a fact these features until the uncertainty is resolved one quarter ahead. This should ensure that our instruments for holdings are both relevant and exogenous and can thus lead to consistent parameter estimates.

To support our premise regarding the relevance criteria, Appendix C provides throughout Tables 14-25 the first-stage regression results for the main specifications of our model (i.e. the iterative GMM estimates) for each of the available issuance samples: worldwide, European Union and euro area, respectively. We can note that the instruments indeed exhibit high statistical significance in the reduced-form equations, with magnitudes comparable across samples. A further discussion of the results can be found in Appendix C.

3.2 Main findings

Institutional investments do significantly affect volatility and liquidity conditions in secondary markets. We find that in terms of impact on market liquidity conditions several sectors play a key role regardless of the sample considered, as can be seen in Tables 3, 5 and 7 in Appendix A. In particular, the Gov, ICPF, IVF and MMF sectors are all highly significant and seem to positively affect market liquidity conditions, in the sense of narrowing spreads (i.e. their coefficients are negative) if they are prevalent in the market of a particular bond. At the same time, price volatility tends to be higher in issuances where there is a stronger presence of institutional investors.

Our model specifications benefit from a large cross section from which we draw our inference, after controlling for heterogeneity in bond characteristics. Overall, the results suggest that a trade-off exists between volatility and liquidity in the presence of institutional investors, for both samples considered. We perform our analysis on sub-samples with different geographic coverage, including the overall sample of worldwide issuances for which the euro area has holdings, as well as on the EU-only issuances and the euro area-only issuances subsamples. We observe some differences in the magnitude of the results which we report below, although the main findings remains robust across sub-samples.

The stronger presence of institutional investors therefore improves liquidity and increases volatility at the same time.

MMFs are consistently the strongest contributors to liquidity compared to other sectors and in the markets where they are active. Relative to the non-financial private sector, MMF narrow on average the standardized bid-ask spreads by approximately 0.03 (0.05) for every 10 pp. share they own in the market of a bond, for the worldwide (euro area issuance) sample. Effective spreads would similarly be improved by approximately 0.03 and 0.04 for the worldwide and EA samples, respectively. These effects may seem small, but they are economically significant taking into account that they refer to daily conditions, which are usually not prone to ample swings from one day to the next. For example, on the worldwide sample the bid-ask spreads (effective spreads) have a median of 0.2079 (0.2143), while on the EA sample the bid-ask (effective spreads) have a median of 0.2271 (0.2226). To put this result into perspective, it implies that should the MMF presence stand at 10% of total amount outstanding in the market of a representative bond with liquidity characteristics similar to the worldwide sample median, this would lead to an increase in the worldwide daily relative liquidity conditions for such a bond (in the sense of narrowing spreads) by 15.58% for bid-ask spreads, and by 12.97% for effective spreads.

Other sectors play a similar role for bid-ask (effective spreads). In particular, governments including social security funds amplify liquidity in relative terms by 7.98% (8.72%), ICPF by 4.44% (6.3%), and IVF by 4.69% (4.66%). A broader overview of the relative impact on liquidity and volatility conditions for a representative bond with market features similar to the worldwide sample is depicted in Table 1. Here we can further observe that the OFI sector, as well as the residual comprising all sectors outside the euro area (U) may play a role towards liquidity as well. Nevertheless, these findings are weaker as they are not confirmed for both liquidity dimensions.

Table 1: Relative impact on worldwide daily liquidity/volatility conditions, for the case of a 10 pp. presence in the market of a representative bond with features similar to the median of the worldwide sample				
	Bid-Ask/Mid	Effective spreads	Volatility, Bid-Ask/Mid controlled for	Volatility, Effective Spreads controlled for
CI	<i>not significant</i>	<i>not significant</i>	<i>not significant</i>	<i>not significant</i>
Gov	-7.98%	-8.72%	<i>not significant</i>	8.90%
IVF	-4.69%	-4.66%	5.30%	5.80%
MMF	-15.58%	-12.97%	15.12%	15.02%
ICPF	-4.44%	-6.30%	3.92%	6.92%
OFI	<i>not significant</i>	-7.51%	<i>not significant</i>	9.44%
U	<i>not significant</i>	-5.82%	4.73%	7.79%

Where: CI = Credit institutions, Gov = Governments including social security funds, IVF = Investment Funds excl. Money Market Funds, MMF = Money Market Funds, ICPF = Insurance Corporations and Pension Funds, OFI = Other Financial Institutions, U = all other non-EA sectors. The effects are relative to the impact of the Non-financial Private Sector baseline.

For the euro area sample (EA), the relative impact of MMF on daily conditions for a representative bond with characteristics akin to the median is significantly amplified. This is to be expected, as the euro area sectors are more likely to hold and transact bank bonds issued by euro area entities than other worldwide issued securities. We can see in Table 2 that within the Eurozone, daily bid-ask spreads (effective spreads) driven by this sector narrow by as much as 20.82% (19.41%), while the other sectors maintain magnitudes roughly on par with the previous worldwide issuance sample, with the exception of Governments which shrink in importance. As before, credit institutions, OFI, and extra euro area sectors are found to have no consistent impact on liquidity when cross checking both liquidity measures. This lack of significance for the extra-EA residual does not imply external sectors have no effect on market conditions. Instead, it is likely that the effect of more prominent sectors is averaged out in the presence of less significant ones, since all non-EA sectors are bundled together and cannot be disentangled in this analysis.

Our results thus underpin the important role of euro area MMF in the market for short-term debt financing of euro area banks and, in particular, the role MMF play in enhancing market liquidity conditions in bank bond markets. While the non-financial private sector may be less rationally restricted, e.g. due to regulatory or other balance sheet constraints, it may face informational disadvantages compared to institutional investors and higher trading costs resulting in less trading, which in turn results in lower liquidity and volatility in the securities

held by the non-financial private sector. The institutional sectors which are more actively trading may, on the other hand, contribute positively to liquidity.

	Bid-Ask/Mid	Effective spreads	Volatility, Bid-Ask/Mid controlled for	Volatility, Effective Spreads controlled for
CI	<i>not significant</i>	-2.20%	<i>not significant</i>	<i>not significant</i>
Gov	-5.15%	-6.83%	<i>not significant</i>	19.94%
IVF	-4.93%	-3.27%	10.34%	9.42%
MMF	-20.82%	-19.41%	36.45%	57.15%
ICPF	-4.13%	-4.67%	6.85%	13.72%
OFI	<i>not significant</i>	-9.66%	<i>not significant</i>	28.45%
U	<i>not significant</i>	-5.35%	<i>not significant</i>	16.38%

Where: CI = Credit institutions, Gov = Governments including social security funds, IVF = Investment Funds excl. Money Market Funds, MMF = Money Market Funds, ICPF = Insurance Corporations and Pension Funds, OFI = Other Financial Institutions, U = all other non-EA sectors. The effects are relative to the impact of the Non-financial Private Sector (NFPS) baseline.

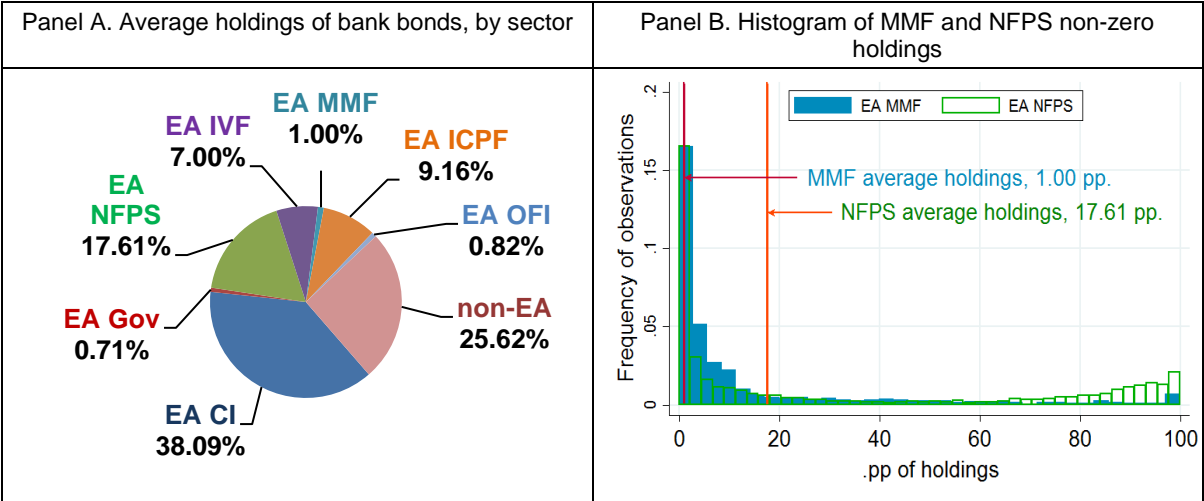
Improving transaction cost and depth/breadth of the market conditions most likely requires intensive trading on a certain market. For this reason, transaction prices, and their returns might in turn become more volatile in the short run contrary to expectations that more liquid markets are also less volatile. While MMFs primarily act as liquidity enhancers if they are prevalent in bank bond markets, Tables 1 and 2 suggest also that they are the main volatility amplifiers relative to the NFPS. The IVF and ICPF sectors again play a similar but less prominent role, while the OFI and U sectors are either not mutually confirmed by the two liquidity controls or, in the case of the U sector on the worldwide sample, have limited interpretability in light of the residual nature.

A possible explanation for this finding is that higher volatility may just be the result of more frequent trading by MMF, which in turn can lead to quicker and more frequent price adjustments resulting in higher price volatility. Such responsiveness can be relevant in particular in the highly competitive markets in which MMF operate. Considering that MMF are allowed to only hold bonds with a short residual maturity, those intermediaries are likely to adjust portfolios whenever bonds mature or longer-dated bonds become eligible for purchase. Moreover, any redemptions from MMFs possibly translate into security purchases or sales, while other types of investors may adjust their main investment portfolio less frequently at the sector level.

The impact of the various financial sectors on volatility, with the exception of credit institutions, is sizable for all samples considered. For example, should MMFs maintain a presence in a market of 10% of the outstanding value, we find they can amplify daily volatility conditions by as much as 57.15% if the euro area sample is considered and effective spreads are controlled for. The effect is nevertheless dampened on the worldwide sample to about 15.02%, suggesting other foreign sectors have a more important role in their local markets and accounting for the fact euro area entities have a smaller presence internationally than locally.

It is worth noting that our findings regarding liquidity and volatility conditions suggest the average size of holdings of each sector is not the key determinant of its market footprint. In fact, as can be seen in Figure 1, Panel A, the largest holders of euro area issuances are on average the credit institutions themselves, the non-euro area sectors a whole, and the NFPS.

Figure 1: Distribution of euro area issuance holdings for all sample periods, by sector



Where: CI = Credit institutions, Gov = Governments including social security funds, IVF = Investment Funds excl. Money Market Funds, MMF = Money Market Funds, ICPF = Insurance Corporations and Pension Funds, OFI = Other Financial Institutions, U = all other non-EA sectors.

It may seem puzzling that sectors that hold a relatively small amount of securities can be such important drivers of market conditions. A more detailed look at the MMF sector and NFPS reveals a vast heterogeneity of holdings which can be hidden by a simple average. Indeed, our exemplified 10 pp. holdings at the expense of the baseline NFPS sector could easily be accommodated considering the distribution of holdings we observe on our sample (Figure 1, Panel B). The histogram shows that while in general MMFs hold small amounts

overall, whenever they are invested in a certain issuance their holdings can exceed 10% and in some cases go as high as 100% of outstanding amounts.

3.3 Robustness

For robustness considerations we cross-check our findings with a standard Two-Stage Least Squares (2SLS) model, as well as with a panel method counterpart which aims to strip out any relevant fixed effects at the ISIN level should they not be captured by the regional dummies. The latter takes the form of a Random Effects (RE) 2SLS model augmented with Mundlak correction terms¹⁵ which will take care of any unobserved fixed effects under the assumption of linear dependence to the model's regressors. The model is estimated using Baltagi's Error Components 2SLS (EC2SLS) model, which is an efficient Random Effects estimator for 2SLS, while the Mundlak correction (i.e. time averages of all exogenous regressors) will capture any ISIN fixed effects subject to the assumption of linearity imposed on these unobservables. A Mundlak corrected implementation is necessary in our case due to the fact a First Difference (FD) or a Fixed Effects Estimator (FE) approach would eliminate a large number of relevant time-constant regressors, due to the differencing or demeaning step respectively and would thus fail to account for relevant information in the conditional means. More precisely, seniority, the foreign currency dummy, the regional issuance dummies, the CoCo dummy and coupon types dummies would all be removed, and a bias may arise for the rating dummies which have the same rating¹⁶ throughout the life of an issuance. Failing to account for these factors would, for example, see the model treat in the same way the liquidity and volatility dynamics of a senior bond to a subordinated bond from the same issuer, which is likely not the way the market perceives or makes holding decisions of such issuances in practice. For this reason, RE and Mundlak are the next-best approach one could take to cross-check that any fixed effect components are indeed stripped out in the main iGMM model.

Regardless of the estimation approach, the results from the main model (iGMM) are confirmed for all sub-samples considered. Indeed, our main model is the most conservative

¹⁵ See Mundlak (1978), Baltagi (1981) and Baltagi et. al. (2006)

¹⁶ E.g. a higher rated bond that keeps the same rating throughout the life of the security will be treated in the same way by the FD or FE estimator as a bond that has kept the lowest rating from issuance to maturity.

of all three specifications, and our conclusions about individual sectors are drawn only if the significance is confirmed for both the liquidity measures tested¹⁷.

An alternative specification using system GMM or 3SLS estimation has also been considered. Nevertheless, in light of the fact such estimation would require a large set of exclusion restrictions to ensure the parameters are not reduced form estimates (i.e. each equation would need at least 8 exogenous variables unique to it) the approach has been deemed less feasible than single equation specifications. The trade-off for our chosen approach comes at the expense of standard errors, since equation-by-equation estimation is less efficient than its system counterparts, but this choice should again lead to more conservative inference results.

4. Conclusions

Drawing mainly from cross-sectional variation in the holdings of individual bank bond issuances, we find that institutionally intermediated investments do significantly affect volatility and liquidity conditions in secondary markets. This effect is particularly pronounced for the presence of money market funds, but also significant for insurance corporations and pension funds, as well as investment funds, suggesting that structural shifts towards higher intermediated investments can alter liquidity and volatility conditions in bank bond markets. The observed effects resulting from higher presence of institutional investors are, however, not necessarily detrimental for market liquidity. For example, larger holdings of a particular issuance by money market funds (MMF) result in lower transaction costs as measured by the bid-ask and effective spreads. At the same time, price volatility tends to be higher in issuances where there is a stronger presence of institutional investors. Again, MMF stand out in the results as their presence affects volatility more than any other sector. Overall the results suggest that a trade-off exists between volatility and liquidity in the presence of institutional investors. The stronger presence of institutional investors at the same time improves liquidity and increases volatility. The results may be explainable by typical trading

¹⁷ I.e. Bold figures in Tables 3-8 showcase this aspect.

patterns where institutional investors are expected to trade at higher frequencies resulting in lower transaction costs for the securities they trade.

From a policy perspective it is not clear how the benefits of higher liquidity should be weighed against the cost of higher volatility. Higher volatility in the presence of institutional investors might just be a side-effect of more frequent trading, which in turn can lead to quicker and more frequent price adjustments resulting in higher price volatility. Our analysis shows, in any case, a non-negligible impact of institutional investors on market conditions. For instance the presence of MMFs, which are highly competitive and well-informed investors specialised in the short-end of the bank bond market, seems to improve liquidity conditions. If these investors were to refrain from trading in certain securities, liquidity can be expected to be lower. Possible structural shifts in the investor composition, in particular the withdrawal of investors known to be actively trading and contributing to higher liquidity, thus matter for market conditions and should be monitored by financial stability authorities.

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Appendix A: Main regression results

Table 3: Regression of Liquidity measures on Volatility, Holdings and Controls Worldwide issuance sample					
	Main model Bid-Ask/Mid	Bid-Ask/Mid	Bid-Ask/Mid	Main Model Effective spreads	Effective spreads
Volatility	0.702 *** (0.0366)	0.735 *** (0.0231)	0.602 *** (0.0234)	0.794 *** (0.0342)	0.803 *** (0.0184)
CI	-0.000218 (0.000288)	-0.000178** (8.79e-05)	-0.000455*** (0.000147)	-0.000452 (0.000278)	-0.000442*** (7.98e-05)
Gov	-0.00166 ** (0.000702)	-0.00161 *** (0.000295)	-0.00206 *** (0.000493)	-0.00187 *** (0.000707)	-0.00185 *** (0.000236)
IVF	-0.000976 ** (0.000406)	-0.000964 *** (0.000192)	-0.00101 *** (0.000258)	-0.000999 *** (0.000353)	-0.000982 *** (0.000142)
MMF	-0.00324 *** (0.000422)	-0.00323 *** (0.000192)	-0.00263 *** (0.000228)	-0.00278 *** (0.000353)	-0.00278 *** (0.000140)
ICPF	-0.000923 *** (0.000326)	-0.000883 *** (0.000139)	-0.00121 *** (0.000220)	-0.00135 *** (0.000296)	-0.00135 *** (0.000119)
OFI	0.000152 (0.000961)	5.96e-05 (0.000535)	-0.00159*** (0.000474)	-0.00161*** (0.000550)	-0.00159*** (0.000270)
U	-0.000679 (0.000477)	-0.000686*** (0.000254)	-0.00110*** (0.000293)	-0.00121*** (0.000379)	-0.00122*** (0.000177)
Controls	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES	YES
ISIN-Quarter observations	53,457	53,457	53,457	51,542	51,542
ISINs	12,082	12,082	12,082	11,898	11,898
Hansen J statistic, chi(1)†	1.8722 (p = 17.12)	0.9623 (p = 32.66)	1.2071 (p = 27.19)	2.5702 (p = 10.89)	1.6294 (p = 20.18)
Estimation method	iGMM	2SLS	EC2SLS Mundlak	iGMM	2SLS
Standard Errors	Clustered (1303 bank IDs)	Robust	Robust	Clustered (1252 bank IDs)	Robust
				Robust	Robust
				EC2SLS	EC2SLS Mundlak

Standard errors in parentheses. *** ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Where: CI = Credit Institutions, Gov = Government, IVF = Investment Funds, MMF = Money Market Funds, ICPF = Insurance Corporations and Pension Funds, OFI = Other Financial Institutions, U = unidentified sectors outside the euro area. The effects are relative to the holdings of the Non-Financial Private Sector.

† for the case of the 2SLS models the Wooldridge Score test is automatically implemented for technical reasons. Its null hypothesis and asymptotic distribution are identical to the Hansen J test.

Table 4: Regression of Volatility on Liquidity, Holdings and Controls				
Worldwide issuance sample				
	Main model	Main model	Main model	Main model
	Volatility of daily returns	Volatility of daily returns	Volatility of daily returns	Volatility of daily returns
Bid-Ask/Mid	0.524*** (0.0689)	0.546*** (0.0361)	0.626*** (0.0330)	0.569*** (0.0650)
Effective spreads				0.574*** (0.0337)
CI	6.09e-05 (0.000154)	6.96e-05 (5.08e-05)	9.05e-05 (0.000106)	0.000230*** (5.03e-05)
Gov	0.000648 (0.000395)	0.000690*** (0.000178)	0.000966** (0.000397)	0.000893*** (0.000159)
IVF	0.000526** (0.000226)	0.000566*** (0.000114)	0.000687*** (0.000223)	0.000584*** (9.24e-05)
MMF	0.00150*** (0.000322)	0.00158*** (0.000168)	0.00143*** (0.000209)	0.00150*** (0.000135)
ICPF	0.000389** (0.000188)	0.000418*** (8.54e-05)	0.000542*** (0.000174)	0.000687*** (8.20e-05)
OFI	2.56e-05 (0.000499)	7.41e-05 (0.000298)	0.000144 (0.000568)	0.000951*** (0.000179)
U	0.000469* (0.000268)	0.000489*** (0.000147)	0.000457* (0.000275)	0.000777*** (0.000117)
Controls	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES
ISIN-Quarter observations	53,457	53,457	53,457	51,542
ISINs	12,082	12,082	12,082	11,898
Hansen J statistic, chi(1)†	1.0838 (p = 29.78)	0.3729 (p = 54.14)	0.8199 (p = 36.52)	0.7173 (p = 39.7)
Estimation method	iGMM	2SLS	EC2SLS Mundlak	2SLS
Standard Errors	Clustered (1303 bank IDs)	Robust	Robust	Robust
			Clustered (1252 bank IDs)	Robust
				EC2SLS Mundlak
				(p = 34.29)

Standard errors in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. here: CI = Credit Institutions, Gov = Government, IVF = Investment Funds, MMF = Money Market Funds, ICPF = Insurance Corporations and Pension Funds, OFI = Other Financial Institutions, U = unidentified sectors outside the euro area. The effects are relative to the holdings of the Non-financial Private Sector.

† for the case of the 2SLS models the Wooldridge Score test is automatically implemented for technical reasons. Its null hypothesis and asymptotic distribution are identical to the Hansen J test.

Table 5: Regression of Liquidity measures on Volatility, Holdings and Controls
EU issuance sample

	Main model Bid-Ask/Mid	Bid-Ask/Mid	Bid-Ask/Mid	Main model Effective spreads	Effective spreads	Effective spreads
Volatility	0.655*** (0.0422)	0.670*** (0.0280)	0.612*** (0.0295)	0.778*** (0.0397)	0.783*** (0.0225)	0.685*** (0.0271)
CI	-0.000182 (0.000293)	-0.000167* (8.85e-05)	-0.000176 (0.000168)	-0.000452 (0.000277)	-0.000448*** (7.91e-05)	-0.000438*** (0.000144)
Gov	-0.00125* (0.000666)	-0.00124*** (0.000295)	-0.00125** (0.000576)	-0.00154** (0.000694)	-0.00153*** (0.000239)	-0.00159*** (0.000469)
IVF	-0.00116*** (0.000384)	-0.00117*** (0.000194)	-0.00102*** (0.000368)	-0.00105*** (0.000335)	-0.00104*** (0.000145)	-0.00103*** (0.000262)
MMF	-0.00406*** (0.000443)	-0.00407*** (0.000221)	-0.00365*** (0.000339)	-0.00360*** (0.000394)	-0.00360*** (0.000165)	-0.00337*** (0.000254)
ICPF	-0.000960*** (0.000357)	-0.000944*** (0.000144)	-0.000952*** (0.000293)	-0.00120*** (0.000317)	-0.00119*** (0.000118)	-0.00108*** (0.000215)
OFI	1.76e-05 (0.00107)	-5.35e-05 (0.000577)	-0.000500 (0.000989)	-0.00184*** (0.000561)	-0.00183*** (0.000281)	-0.00174*** (0.000493)
U	-0.000295 (0.000530)	-0.000327 (0.000287)	-0.000206 (0.000507)	-0.000940** (0.000400)	-0.000947*** (0.000193)	-0.000910*** (0.000318)
Controls	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES	YES	YES
ISIN-Quarter observations	35,742	35,742	35,742	34,860	34,860	34,860
ISINs	8,123	8,123	8,123	8,060	8,060	8,060
Hansen J statistic, chi(1)†	1.6322 (p = 20.14)	0.3720 (p = 54.19)	0.5932 (p = 44.12)	1.8355 (p = 17.55)	1.5013 (p = 22.05)	1.6505 (p = 19.89)
Estimation method	iGMM	2SLS	EC2SLS Mundlak	iGMM	2SLS	EC2SLS Mundlak
Standard Errors	Clustered (563 bank IDs)	Robust	Robust	Clustered (551 bank IDs)	Robust	Robust

Standard errors in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Where: CI = Credit Institutions, Gov = Government, IVF = Investment Funds, MMF = Money Market Funds, ICPF = Insurance Corporations and Pension Funds, OFI = Other Financial Institutions, U = unidentified sectors outside the euro area. The effects are relative to the holdings of the Non-financial Private Sector.

† for the case of the 2SLS models the Wooldridge Score test is automatically implemented for technical reasons. Its null hypothesis and asymptotic distribution are identical to the Hansen J test.

Table 6: Regression of Volatility on Liquidity, Holdings and Controls EU issuance sample				
	Main model	Main model	Main model	Main model
	Volatility of daily returns	Volatility of daily returns	Volatility of daily returns	Volatility of daily returns
Bid-Ask/Mid	0.581 *** (0.123)	0.592 *** (0.0593)	0.592 *** (0.0496)	0.747 *** (0.136)
Effective spreads				0.770 *** (0.0763)
CI	5.99e-05 (0.000170)	6.31e-05 (5.59e-05)	6.88e-05 (0.000103)	0.000304 (0.000220)
Gov	0.000534 (0.000442)	0.000557*** (0.000196)	0.000706* (0.000389)	(7.16e-05) 0.00105***
IVF	0.000702 ** (0.000274)	0.000727 *** (0.000139)	0.000666 *** (0.000236)	0.000795 *** (0.000226)
MMF	0.00214 *** (0.000586)	0.00219 *** (0.000290)	0.00184 *** (0.000274)	0.000560 *** (0.000195)
ICPF	0.000481 ** (0.000239)	0.000500 *** (0.000103)	0.000621 *** (0.000178)	0.00257 *** (0.000137)
OFI	5.37e-05 (0.000616)	8.43e-05 (0.000347)	0.000325 (0.000583)	0.00266 *** (0.000323)
U	0.000339 (0.000325)	0.000343 * (0.000177)	0.000316 (0.000302)	0.000861 *** (0.000123)
Controls	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES
ISIN-Quarter observations	35,742	35,742	35,742	34,860
ISINs	8,123	8,123	8,123	8,060
Hansen J statistic, chi(1)†	0.8657 (p = 35.21)	0.2918 (p = 58.91)	0.6198 (p = 43.11)	0.6693 (p = 41.33)
Estimation method	iGMM	2SLS	EC2SLS Mundlak	2SLS
Standard Errors	Clustered (563 bank IDs)	Robust	Robust	Robust
				Clustered (551 bank IDs)
				EC2SLS Mundlak (p = 37.64)
				Robust

Standard errors in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Where: CI = Credit Institutions, Gov = Government, IVF = Investment Funds, MMF = Money Market Funds, ICPF = Insurance Corporations and Pension Funds, OFI = Other Financial Institutions, U = unidentified sectors outside the euro area. The effects are relative to the holdings of the Non-financial Private Sector.

† for the case of the 2SLS models the Wooldridge Score test is automatically implemented for technical reasons. Its null hypothesis and asymptotic distribution are identical to the Hansen J test.

Table 7: Regression of Liquidity measures on Volatility, Holdings and Controls

	Main model		Euro area issuance sample	
	Bid-Ask/Mid	Bid-Ask/Mid	Main model	Effective spreads
Volatility	0.688*** (0.0525)	0.700*** (0.0382)	0.861*** (0.0454)	0.866*** (0.0292)
CI	-0.000192 (0.000295)	-0.000184** (9.37e-05)	-0.000489* (0.000277)	-0.000486*** (8.27e-05)
Gov	-0.00117* (0.000670)	-0.00115*** (0.000303)	-0.00152** (0.000721)	-0.00151*** (0.000248)
IVF	-0.00112*** (0.000431)	-0.00114*** (0.000233)	-0.000729* (0.000375)	-0.000722*** (0.000174)
MMF	-0.00473*** (0.000484)	-0.00473*** (0.000272)	-0.00432*** (0.000443)	-0.00432*** (0.000207)
ICPF	-0.000939** (0.000395)	-0.000920*** (0.000164)	-0.00104*** (0.000341)	-0.00104*** (0.000133)
OFI	-0.000383 (0.00115)	-0.000461 (0.000639)	-0.00215*** (0.000536)	-0.00214*** (0.000281)
U	-0.000419 (0.000654)	-0.000445 (0.000356)	-0.00119** (0.000497)	-0.00120*** (0.000233)
Controls	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES
ISIN-Quarter observations	27,637	27,637	27,008	27,008
ISINs	6,210	6,210	6,173	6,173
Hansen J statistic, chi(1)†	1.7136 (p = 19.05)	0.6708 (p = 41.28)	2.0119 (p = 15.61)	1.5528 (p = 21.27)
Estimation method	iGMM	2SLS	iGMM	2SLS
Standard Errors	Clustered (394 bank IDs)	Robust	Clustered (391 bank IDs)	Robust
				EC2SLS Mundlak
				Robust

Standard errors in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Where: CI = Credit Institutions, Gov = Government, IVF = Investment Funds, MMF = Money Market Funds, ICPF = Insurance Corporations and Pension Funds, OFI = Other Financial Institutions, U = unidentified sectors outside the euro area. The effects are relative to the holdings of the Non-financial Private Sector.
 † for the case of the 2SLS models the Wooldridge Score test is automatically implemented for technical reasons.
 Its null hypothesis and asymptotic distribution are identical to the Hansen J test.

Table 8: Regression of Volatility on Liquidity, Holdings and Controls Euro area issuance sample					
	Main model Volatility of daily returns	Volatility of daily returns	Volatility of daily returns	Main model Volatility of daily returns	Volatility of daily returns
Bid-Ask/Mid	0.664*** (0.207)	0.658*** (0.0926)	0.469*** (0.0556)	1.053*** (0.275)	1.078*** (0.167)
Effective spreads					
CI	0.000100 (0.000195)	9.22e-05 (6.67e-05)	3.53e-05 (9.00e-05)	0.000500 (0.000328)	0.000514*** (0.000124)
Gov	0.000624 (0.000550)	0.000606*** (0.000232)	0.000664* (0.000362)	0.00157* (0.000908)	0.00161*** (0.000382)
IVF	0.000814** (0.000379)	0.000790*** (0.000188)	0.000549** (0.000249)	0.000742* (0.000429)	0.000772*** (0.000214)
MMF	0.00287*** (0.00107)	0.00285*** (0.000511)	0.00147*** (0.000324)	0.00450*** (0.00152)	0.00461*** (0.000826)
ICPF	0.000539* (0.000317)	0.000522*** (0.000131)	0.000588*** (0.000171)	0.00108** (0.000498)	0.00111*** (0.000214)
OFI	0.000295 (0.000823)	0.000267 (0.000434)	0.000362 (0.000518)	0.00224*** (0.000911)	0.00231*** (0.000472)
U	0.000351 (0.000456)	0.000368 (0.000242)	0.000297 (0.000307)	0.00129** (0.000584)	0.00130*** (0.000301)
Controls	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES	YES
iSIN-Quarter observations	27,637	27,637	27,637	27,008	27,008
iSINs	6,210	6,210	6,210	6,173	6,173
Hansen J statistic, chi(1)†	0.9326 (p = 33.42)	0.3011 (p = 58.32)	0.7553 (p = 38.48)	1.4049 (p = 23.59)	0.5201 (p = 47.08)
Estimation method	iGMM	2SLS	EC2SLS Mundlak	iGMM	2SLS
Standard Errors	Clustered (394 bank IDs)	Robust	Robust	Clustered (391 bank IDs)	Robust

Standard errors in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Where: CI = Credit Institutions, Gov = Government, IVF = Investment Funds, MMF = Money Market Funds, ICPF = Insurance Corporations and Pension Funds, OFI = Other Financial Institutions, U = unidentified sectors outside the euro area. The effects are relative to the holdings of the Non-financial Private Sector.
† for the case of the 2SLS models the Wooldridge Score test is automatically implemented for technical reasons.
Its null hypothesis and asymptotic distribution are identical to the Hansen J test.

Appendix B: Estimation sample coverage, summary statistics and data sources

Table 9: Distribution of SHSS ISIN-quarter data points

date	without market data or under ECB non-standard purchases	with market data (in the estimation sample)	Total
2013q4	94,181	10,846	105,027
2014q1	96,917	10,727	107,644
2014q2	98,963	10,613	109,576
2014q3	99,058	10,546	109,604
2014q4	96,435	10,497	106,932
2015q1	97,122	9,957	107,079
2015q2	97,257	9,873	107,130
2015q3	95,228	9,538	104,766
2015q4	82,241	2,169	84,410
2016q1	99,976	9,128	109,104
Total	957,378	93,894	1,051,272

Table 10: Estimation sample coverage

date	Coverage in terms of amount outstanding, pp.				Coverage in terms of number of ISINs, pp.			
	EA	EU	Rest of the world	All world	EA	EU	Rest of the world	All world
2013q4	34.63	42.36	76.84	50.29	7.16	8.16	41.93	10.33
2014q1	36.62	45.21	75.50	52.61	6.66	7.87	40.60	9.97
2014q2	36.91	44.83	76.09	52.80	6.29	7.50	41.28	9.69
2014q3	38.65	45.72	76.16	54.03	6.34	7.37	41.08	9.62
2014q4	39.53	45.91	77.27	55.04	6.38	7.43	41.31	9.82
2015q1	40.00	45.62	77.81	55.51	5.83	6.95	42.41	9.30
2015q2	41.00	44.69	75.89	54.28	5.58	6.73	43.13	9.22
2015q3	40.03	43.34	74.99	53.39	5.49	6.43	45.60	9.10
2015q4	13.52	16.89	62.27	31.77	0.59	0.99	33.78	2.57
2016q1	41.40	44.97	53.17	48.38	4.90	5.92	33.03	8.37
All periods	37.23	43.08	71.54	51.57	5.61	6.65	40.42	8.93

Table 11: Summary statistics. Worldwide issuance sample, Q4 2013 - Q1 2016 period

Variable	Observations	Mean	Median	S.D.	Min	Max	Q1	Q3
CI (pp)	93,894	22.80	0.67	36.90	0.00	100.00	0.00	29.22
Gov (pp)	93,894	0.47	0.00	4.26	0.00	100.00	0.00	0.00
NFPS (pp)	93,894	10.14	0.00	25.73	0.00	100.00	0.00	1.22
IVF (pp)	93,894	6.95	0.93	14.67	0.00	100.00	0.00	6.89
MMF (pp)	93,894	1.01	0.00	7.34	0.00	100.00	0.00	0.00
ICPF (pp)	93,894	7.21	0.00	20.71	0.00	100.00	0.00	0.90
OFI (pp)	93,894	0.73	0.00	5.52	0.00	100.00	0.00	0.01
U (pp)	93,894	0.01	0.00	0.14	0.00	10.43	0.00	0.00
Volatility (pp)	93,894	0.17	0.10	0.24	0.00	8.94	0.03	0.22
Bid Ask/Mid (pp)	87,954	0.39	0.21	0.62	0.00	22.40	0.10	0.47
Effective spread (pp)	85,366	0.34	0.21	0.38	0.00	3.00	0.10	0.44
Excess volatility relative to EA Sovereign benchmark (pp)	93,893	24.59	0.00	36.15	0.00	100.00	0.00	44.44
Excess volatility relative to own time mean (pp)	93,893	37.78	33.33	33.30	0.00	100.00	1.56	64.06
Herfindahl index	93,894	0.35	0.11	0.41	0.00	1.00	0.00	0.80
Amount outstanding (in EUR mn)	93,894	444.09	198.81	749.71	0.00	80633.53	34.50	623.81
Residual maturity (days)	93,894	3,124.58	941.00	12,804.76	0.00	perpetual	412.00	1,871.00
Issuance maturity (years)	93,894	54.24	6.51	351.17	0.25	perpetual	5.00	10.01
Issue price	93,894	99.10	100.00	4.58	65.73	102.04	99.71	100.00
Yield to maturity (pp)	82,859	1.87	0.96	3.26	-1.50	52.70	0.34	2.38
Last coupon rate (pp)	84,008	3.02	2.75	2.13	0.00	30.69	1.25	4.38
Issuance in non-Euro currency dummy	93,894	0.49	0	0.50	0	1	0	1
ECB rating 1 dummy	93,894	0.35	0	0.48	0	1	0	1
ECB rating 2 dummy	93,894	0.37	0	0.48	0	1	0	1
ECB rating 3 dummy	93,894	0.21	0	0.41	0	1	0	0
ECB rating 4 dummy	93,894	0.07	0	0.25	0	1	0	0
Unavailable seniority dummy	93,894	0.10	0	0.29	0	1	0	0
Secured debt dummy	93,894	0.10	0	0.30	0	1	0	0
Senior Unsecured debt dummy	93,894	0.69	1	0.46	0	1	0	1
Subordinated debt dummy	93,894	0.11	0	0.32	0	1	0	0
CoCo dummy	93,894	0.00	0	0.06	0	1	0	0
Fix coupon dummy	93,894	0.66	1	0.47	0	1	0	1
Floating coupon dummy	93,894	0.27	0	0.44	0	1	0	1
Indexed coupon dummy	93,894	0.00	0	0.07	0	1	0	0
Zero coupon dummy	93,894	0.05	0	0.22	0	1	0	0
EA country dummy	93,894	0.53	1	0.50	0	1	0	1
non-EA but EU country dummy	93,894	0.16	0	0.37	0	1	0	0
non EU dummy	93,894	0.47	0	0.50	0	1	0	1
Group A EA country dummy	93,894	0.10	0	0.30	0	1	0	0
Group B EA country dummy	93,894	0.06	0	0.24	0	1	0	0
Group C EA country dummy	93,894	0.37	0	0.48	0	1	0	1

*Note: perpetual bonds are assigned residual maturity value of 99,999 (days) in the sample.

Table 11 (cont'd)

Variable	Observations	Mean	Median	S.D.	Min	Max	Q1	Q3
Q4 2013 dummy	93,894	0.12	0	0.32	0	1	0	0
Q1 2014 dummy	93,894	0.11	0	0.32	0	1	0	0
Q2 2014 dummy	93,894	0.11	0	0.32	0	1	0	0
Q3 2014 dummy	93,894	0.11	0	0.32	0	1	0	0
Q4 2014 dummy	93,894	0.11	0	0.32	0	1	0	0
Q1 2015 dummy	93,894	0.11	0	0.31	0	1	0	0
Q2 2015 dummy	93,894	0.11	0	0.31	0	1	0	0
Q3 2015 dummy	93,894	0.10	0	0.30	0	1	0	0
Q4 2015 dummy	93,894	0.02	0	0.15	0	1	0	0
Q1 2016 dummy	93,894	0.10	0	0.30	0	1	0	0

Table 12: Summary statistics. EU issuance sample, Q4 2013 - Q1 2016 period

Variable	Observations	Mean	Median	S.D.	Min	Max	Q1	Q3
CI (pp)	65,184	31.52	5.41	40.69	0.00	100.00	0.00	75.00
Gov (pp)	65,184	0.63	0.00	5.07	0.00	100.00	0.00	0.00
NFPS (pp)	65,184	14.21	0.04	29.76	0.00	100.00	0.00	4.80
IVF (pp)	65,184	7.65	0.32	16.26	0.00	100.00	0.00	7.47
MMF (pp)	65,184	1.06	0.00	7.31	0.00	100.00	0.00	0.00
ICPF (pp)	65,184	8.72	0.00	22.55	0.00	100.00	0.00	2.27
OFI (pp)	65,184	0.79	0.00	6.02	0.00	100.00	0.00	0.01
U (pp)	65,184	0.01	0.00	0.14	0.00	10.43	0.00	0.00
Volatility (pp)	65,184	0.16	0.09	0.24	0.00	8.94	0.03	0.20
Bid Ask/Mid (pp)	61,569	0.40	0.23	0.64	0.00	22.40	0.11	0.48
Effective spread (pp)	60,308	0.35	0.22	0.38	0.00	3.00	0.11	0.46
Excess volatility relative to EA Sovereign benchmark (pp)	65,183	21.86	0.00	34.40	0.00	100.00	0.00	35.38
Excess volatility relative to own time mean (pp)	65,183	37.05	33.33	33.53	0.00	100.00	0.00	63.64
Herfindahl index	65,184	0.48	0.43	0.41	0.00	1.00	0.02	0.95
Amount outstanding (in EUR mn)	65,184	375.58	100.00	683.75	0.00	13410.00	20.00	490.98
Residual maturity (days)	65,184	3,188.42	888.00	13,237.70	0.00	perpetual	375.00	1,819.00
Issuance maturity (years)	65,184	57.70	7.01	363.28	0.25	perpetual	5.00	10.01
Issue price	65,184	98.92	100.00	5.03	65.73	102.04	99.73	100.00
Yield to maturity (pp)	55,330	1.70	0.75	3.59	-1.50	52.70	0.26	1.88
Last coupon rate (pp)	57,391	2.80	2.50	2.02	0.00	30.69	1.13	4.10
Issuance in non-Euro currency dummy	65,184	0.32	0	0.47	0	1	0	1
ECB rating 1 dummy	65,184	0.35	0	0.48	0	1	0	1
ECB rating 2 dummy	65,184	0.40	0	0.49	0	1	0	1
ECB rating 3 dummy	65,184	0.19	0	0.39	0	1	0	0
ECB rating 4 dummy	65,184	0.06	0	0.25	0	1	0	0

*Note: perpetual bonds are assigned residual maturity value of 99,999 (days) in the sample.

Table 12 (cont'd)

Variable	Observations	Mean	Median	S.D.	Min	Max	Q1	Q3
Unavailable seniority dummy	65,184	0.09	0	0.29	0	1	0	0
Secured debt dummy	65,184	0.11	0	0.32	0	1	0	0
Senior Unsecured debt dummy	65,184	0.70	1	0.46	0	1	0	1
Subordinated debt dummy	65,184	0.09	0	0.29	0	1	0	0
CoCo dummy	65,184	0.00	0	0.07	0	1	0	0
Fix coupon dummy	65,184	0.62	1	0.48	0	1	0	1
Floating coupon dummy	65,184	0.32	0	0.47	0	1	0	1
Indexed coupon dummy	65,184	0.01	0	0.08	0	1	0	0
Zero coupon dummy	65,184	0.04	0	0.20	0	1	0	0
EA country dummy	65,184	0.77	1	0.42	0	1	1	1
non-EA but EU country dummy	65,184	0.23	0	0.42	0	1	0	0
Group A EA country dummy	65,184	0.15	0	0.35	0	1	0	0
Group B EA country dummy	65,184	0.09	0	0.29	0	1	0	0
Group C EA country dummy	65,184	0.53	1	0.50	0	1	0	1
Q4 2013 dummy	65,184	0.12	0	0.33	0	1	0	0
Q1 2014 dummy	65,184	0.12	0	0.33	0	1	0	0
Q2 2014 dummy	65,184	0.12	0	0.32	0	1	0	0
Q3 2014 dummy	65,184	0.12	0	0.32	0	1	0	0
Q4 2014 dummy	65,184	0.11	0	0.32	0	1	0	0
Q1 2015 dummy	65,184	0.11	0	0.31	0	1	0	0
Q2 2015 dummy	65,184	0.10	0	0.30	0	1	0	0
Q3 2015 dummy	65,184	0.10	0	0.30	0	1	0	0
Q4 2015 dummy	65,184	0.01	0	0.11	0	1	0	0
Q1 2016 dummy	65,184	0.09	0	0.29	0	1	0	0

Table 13: Summary statistics. Euro area issuance sample, Q4 2013 - Q1 2016 period

Variable	Observations	Mean	Median	S.D.	Min	Max	Q1	Q3
CI (pp)	50,213	38.09	12.64	42.75	0.00	100.00	0.00	95.42
Gov (pp)	50,213	0.71	0.00	5.69	0.00	100.00	0.00	0.00
NFPS (pp)	50,213	17.61	0.08	32.55	0.00	100.00	0.00	12.54
IVF (pp)	50,213	7.00	0.00	16.10	0.00	100.00	0.00	6.00
MMF (pp)	50,213	1.00	0.00	7.11	0.00	100.00	0.00	0.00
ICPF (pp)	50,213	9.16	0.00	23.42	0.00	100.00	0.00	2.24
OFI (pp)	50,213	0.82	0.00	6.25	0.00	100.00	0.00	0.01
U (pp)	50,213	0.01	0.00	0.13	0.00	7.33	0.00	0.00
Volatility (pp)	50,213	0.15	0.08	0.22	0.00	8.94	0.03	0.18
Bid Ask/Mid (pp)	47,496	0.40	0.23	0.65	0.00	22.40	0.11	0.48
Effective spread (pp)	46,765	0.35	0.22	0.38	0.00	3.00	0.11	0.46
Excess volatility relative to EA Sovereign benchmark (pp)	50,212	20.19	0.00	33.44	0.00	100.00	0.00	31.82

Table 13 (cont'd)

Variable	Observations	Mean	Median	S.D.	Min	Max	Q1	Q3
Excess volatility relative to own time mean (pp)	50,212	36.96	33.33	33.66	0.00	100.00	0.00	63.64
Herfindahl index	50,213	0.57	0.66	0.39	0.00	1.00	0.15	1.00
Amount outstanding (in EUR mn)	50,213	310.50	66.67	596.04	0.01	13410.00	15.30	333.33
Residual maturity (days)	50,213	2548.90	829.00	11276.88	0.00	perpetual	356.00	1689.00
Issuance maturity (years)	50,213	43.55	7.01	309.05	0.82	perpetual	5.00	10.01
Issue price	50,213	98.99	100.00	5.16	65.73	102.04	99.80	100.00
Yield to maturity (pp)	42,811	1.65	0.69	3.72	-1.50	52.70	0.26	1.72
Last coupon rate (pp)	43,805	2.68	2.50	1.93	0.00	30.69	1.00	4.00
Issuance in non-Euro currency dummy	50,213	0.22	0.00	0.41	0.00	1.00	0.00	0.00
ECB rating 1 dummy	50,213	0.31	0.00	0.46	0.00	1.00	0.00	1.00
ECB rating 2 dummy	50,213	0.42	0.00	0.49	0.00	1.00	0.00	1.00
ECB rating 3 dummy	50,213	0.20	0.00	0.40	0.00	1.00	0.00	0.00
ECB rating 4 dummy	50,213	0.07	0.00	0.25	0.00	1.00	0.00	0.00
Unavailable seniority dummy	50,213	0.11	0.00	0.31	0.00	1.00	0.00	0.00
Secured debt dummy	50,213	0.05	0.00	0.21	0.00	1.00	0.00	0.00
Senior Unsecured debt dummy	50,213	0.76	1.00	0.43	0.00	1	1.00	1.00
Subordinated debt dummy	50,213	0.09	0.00	0.28	0.00	1.00	0.00	0.00
CoCo dummy	50,213	0.00	0.00	0.06	0.00	1.00	0.00	0.00
Fix coupon dummy	50,213	0.61	1.00	0.49	0.00	1.00	0.00	1.00
Floating coupon dummy	50,213	0.33	0.00	0.47	0.00	1.00	0.00	1.00
Indexed coupon dummy	50,213	0.01	0	0.09	0	1	0	0
Zero coupon dummy	50,213	0.04	0	0.20	0	1	0	0
Group A EA country dummy	50,213	0.19	0	0.39	0	1	0	0
Group B EA country dummy	50,213	0.12	0	0.32	0	1	0	0
Group C EA country dummy	50,213	0.69	1	0.46	0	1	0	1
Q4 2013 dummy	50,213	0.13	0	0.33	0	1	0	0
Q1 2014 dummy	50,213	0.12	0	0.33	0	1	0	0
Q2 2014 dummy	50,213	0.12	0	0.32	0	1	0	0
Q3 2014 dummy	50,213	0.12	0	0.32	0	1	0	0
Q4 2014 dummy	50,213	0.11	0	0.32	0	1	0	0
Q1 2015 dummy	50,213	0.11	0	0.31	0	1	0	0
Q2 2015 dummy	50,213	0.10	0	0.30	0	1	0	0
Q3 2015 dummy	50,213	0.10	0	0.30	0	1	0	0
Q4 2015 dummy	50,213	0.01	0	0.09	0	1	0	0
Q1 2016 dummy	50,213	0.09	0	0.28	0	1	0	0

*Note: perpetual bonds are assigned residual maturity value of 99,999 (days) in the sample.

Appendix C: Additional robustness checks

First stage regressions

Each model specification from Appendix A contains eight endogenous variables: seven sectoral holding variables, as well as one liquidity measure or the realized volatility variable, depending on which one of equations (1) or (2) is tested. Consequently, the first stage of the GMM or 2SLS estimations encompasses eight reduced-form regressions, where each endogenous variable is regressed on instruments and exogenous variables.

Due to the way the Z matrix¹⁸ is constructed in standard instrumental variables models, all instruments will enter the first stage regressions in place of the endogenous variables, since otherwise the endogeneity issue would persist in the first stage and fail to remove the correlation between the error term and the instrumented (fitted) variable.

The results of the first stage regressions corresponding to the main iterative GMM specifications are provided below in Tables 14-25 for the Worldwide, EU and euro area issuance samples, respectively. The results for the 2SLS and EC2SLS models are similar with regard to significance and magnitudes.

Since the first stage regressions are reduced-form, due to the fact they are projections of the endogenous variables onto a space orthogonal to the error term, little insight can be gained from the analysis of the estimates. However, it can be noted that the regressors which are the envisaged instruments for the endogenous variables are all highly statistically significant, and showcase meaningful magnitudes. The estimates of interest are marked in bold fonts in the below tables.

For example, for the worldwide issuance sample, each year (approx. 260 business days) closer to maturity widens the standardized bid-ask spread by 0.09 (approx. 15% of one standard deviation). Similarly, the effective spread is widened by 0.1 (approx. 26% of one standard deviation). The off-the-run status has the expected sign, increasing bid-ask spreads by 0.0162, and effective spreads by 0.0506 whenever the bond is off-the-run.

Regarding the excess volatility measures, it should be noted that there is a scale difference between them and the realized volatility of returns measure we are after. While the latter

¹⁸ The Z matrix contains all instruments and exogenous variables of an instrumental variable approach model.

exhibit a median of 0.1 pp. and a maximum of 8.94 pp. on the worldwide issuance sample, the excess measures are by construction bounded by 0 pp. and 100 pp., where 100 pp. means all days within a quarter have exhibited higher realized returns volatility of the ISIN relative to the comparison measure (i.e. the iBoxx benchmark or own historic volatility). Therefore, for each standard deviation increase of the excess volatility benchmark (own historic volatility) the realized returns volatility responds by an increase of about 0.01 – 0.12 pp. (0.03 pp.) or in relative terms, about 5.12% - 49.56% (12%) of one standard deviation.

The one quarter lagged holdings showcase high persistence (coefficients above 0.9), with the exception of the extra-euro area regressions, where the lagged holdings show an effect in excess of 0.5. This is to be expected, as the latter is an aggregation of various unidentifiable sectors which could distort their persistence profile.

The magnitudes of all these instruments, coupled with the fact their estimates are highly statistically significant, supports the relevance criteria. Nevertheless, we would caution on the use of these estimates for anything else than judging the quality of the instruments, as the first stage models have no structural grounding and may therefore be misspecified from a causal point of view.

Table 14: First stage regressions from the iterative GMM model of Volatility on Liquidity (Bid-Ask/Mid), Holdings and Controls
Worldwide issuance sample

	Bid-Ask/Mid	CI	Gov	IVF	MMF	ICPF	OFI	U
Residual maturity (days)	-0.000348*** (5.58e-05)	6.20e-06 (8.92e-06)	4.14e-06 (2.65e-06)	8.19e-06 (1.20e-05)	-4.69e-05*** (5.96e-06)	2.29e-05*** (7.50e-06)	-6.91e-06 (7.24e-06)	-3.86e-07* (2.07e-07)
Off the run dummy	0.0162*** (0.00940)	-0.0173 (0.0518)	-0.00120 (0.00952)	0.0259 (0.0487)	0.0467** (0.0202)	-0.0158 (0.0321)	0.00522 (0.0133)	-0.000454 (0.00129)
lag CI	-0.000108 (0.000155)	0.971*** (0.00226)	-0.000192 (0.000134)	-0.00754*** (0.000990)	-0.000368 (0.000412)	-0.00330*** (0.000598)	-0.000303 (0.000308)	0.000104*** (2.53e-05)
lag Gov	-0.00168*** (0.000579)	-0.0164*** (0.00318)	0.994*** (0.00300)	-0.00813*** (0.00156)	-0.00102* (0.000617)	-0.00146 (0.00125)	0.000157 (0.000384)	0.000134** (6.31e-05)
lag IVF	-0.000644** (0.000271)	0.00611** (0.00272)	-6.59e-05 (0.000251)	0.951*** (0.00370)	0.00413*** (0.000716)	0.00165** (0.000734)	-0.000119 (0.000346)	0.000132*** (3.89e-05)
lag MMF	-0.00301*** (0.000295)	-0.00120 (0.00719)	0.000334 (0.000234)	-0.00180 (0.00370)	0.952*** (0.0103)	-0.000491 (0.000796)	-0.00158** (0.000634)	6.12e-05 (7.38e-05)
lag ICPF	-0.000886*** (0.000249)	-0.0156*** (0.00188)	0.000433 (0.000452)	-0.00506*** (0.00127)	0.000447 (0.000388)	0.984*** (0.00194)	-0.000198 (0.000324)	0.000112*** (3.06e-05)
lag OFI	0.000257 (0.000834)	-0.00173 (0.0105)	4.86e-07 (0.000219)	0.00588 (0.00822)	0.000609 (0.000789)	0.000844 (0.00277)	0.946*** (0.0155)	0.000137** (5.75e-05)
lag U	-0.0185* (0.0106)	-0.00437 (0.193)	-0.00714 (0.0361)	0.0880 (0.133)	0.176*** (0.0545)	0.0790 (0.0506)	0.00217 (0.0193)	0.590*** (0.0634)
Excess Volatility: benchmark	0.00276*** (0.000157)	-0.000795 (0.000583)	-0.000140 (0.000171)	0.000706 (0.000580)	0.000306 (0.000188)	-4.45e-05 (0.000489)	0.000178 (0.000236)	7.01e-06 (1.70e-05)
Excess Volatility: own history	0.000189** (7.94e-05)	0.00132** (0.000567)	2.37e-05 (7.39e-05)	-6.86e-05 (0.000497)	-0.000115 (0.000256)	0.000169 (0.000356)	-0.000173 (0.000162)	-1.29e-05 (1.94e-05)
Issuance maturity (days)	-0.00107*** (0.000205)	-0.000136 (0.000418)	-0.000153 (9.69e-05)	-0.000121 (0.000439)	0.00167*** (0.000215)	-0.000800*** (0.000270)	0.000251 (0.000261)	1.17e-05 (7.44e-06)
Issuance price	-0.00326** (0.00156)	-0.00445 (0.00606)	-0.00128 (0.000818)	-0.00696 (0.00742)	0.00146 (0.00468)	-0.00917 (0.00567)	0.00233 (0.00244)	0.000266*** (7.56e-05)
Coupon rate	0.00981*** (0.00321)	-0.00838 (0.0109)	-0.00333* (0.00197)	-0.0141 (0.0101)	0.00210 (0.00424)	0.0137** (0.00631)	-0.00869** (0.00407)	7.43e-05 (0.000221)
Amounts outstanding (mn EUR)	-4.54e-05*** (5.03e-06)	0.000115*** (3.35e-05)	-1.33e-06 (3.34e-06)	5.49e-05*** (2.11e-05)	1.56e-05 (1.37e-05)	7.43e-05*** (1.44e-05)	4.23e-06 (7.66e-06)	2.52e-06*** (8.66e-07)
Herfindahl index	-0.0830*** (0.0193)	3.019*** (0.270)	-0.00843 (0.0204)	0.872*** (0.154)	-0.0636 (0.0720)	0.538*** (0.0985)	0.0127 (0.0551)	-0.0351*** (0.00535)
Yield to maturity	0.00941*** (0.00160)	-0.0265*** (0.00786)	0.000930 (0.000916)	-0.0165*** (0.00435)	-0.0112*** (0.00170)	-0.00351 (0.00269)	0.000777 (0.00108)	-5.23e-05 (5.96e-05)
Control dummies	YES	YES	YES	YES	YES	YES	YES	YES
Observations	53,457	53,457	53,457	53,457	53,457	53,457	53,457	53,457
Adjusted R-squared	0.205	0.986	0.973	0.931	0.903	0.985	0.920	0.307

Clustered standard errors in parentheses, ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively. All first stage regressions contain an intercept, as well as the following exogenous dummy variables: region identifiers (i.e. non-EU, non-euro area EU, and euro area groups B and C), CoCo, foreign exchange issuance, rating, seniority, coupon type and time.

Table 15: First stage regressions from the iterative GMM model of Volatility on Liquidity (Effective spreads), Holdings and Controls
Worldwide issuance sample

	Effective Spreads	CI	Gov	IVF	MMF	ICPF	OFI	U
Residual maturity (days)	-0.00373 *** (5.55e-05)	2.68e-06 (9.92e-06)	4.96e-06 (3.13e-06)	1.03e-05 (1.39e-05)	-5.48e-05*** (6.50e-06)	2.65e-05*** (9.32e-06)	-1.05e-05 (8.51e-06)	-4.28e-07 (2.40e-07)
Off the run dummy	0.0506 *** (0.00658)	-0.0141 (0.0528)	-0.00165 (0.0101)	0.0139 (0.0497)	0.0370 (0.0240)	-0.0167 (0.0335)	-0.00132 (0.0129)	-0.000669 (0.00144)
lag CI	-0.000330** (0.000141)	0.973 *** (0.00214)	-0.000182 (0.000137)	-0.00749*** (0.000998)	-0.000514 (0.000503)	-0.00332*** (0.000613)	-0.000355 (0.000311)	0.00011*** (2.61e-05)
lag Gov	-0.00183*** (0.000576)	-0.0154*** (0.00322)	0.994 *** (0.00324)	-0.00808*** (0.00161)	-0.000843 (0.000629)	-0.00156 (0.00128)	0.000101 (0.000385)	0.000169** (6.95e-05)
lag IVF	-0.000517** (0.000204)	0.00710*** (0.00274)	-0.000118 (0.000254)	0.952 *** (0.00341)	0.00439*** (0.000752)	0.00142* (0.000754)	-0.000193 (0.000331)	0.000132*** (3.96e-05)
lag MMF	-0.00235*** (0.000242)	-0.00556 (0.00585)	0.000155 (0.000203)	-0.00406 (0.00295)	0.959 *** (0.00867)	-0.00135* (0.000712)	-0.00161*** (0.000555)	8.00e-05 (6.23e-05)
lag ICPF	-0.00128*** (0.000210)	-0.0136*** (0.00179)	-0.000464 (0.000482)	-0.00505*** (0.00132)	0.000596 (0.000469)	0.984 *** (0.00206)	-0.000274 (0.000326)	0.000124*** (3.23e-05)
lag OFI	-0.00123*** (0.000475)	-0.00123 (0.0106)	-3.64e-05 (0.000221)	0.00575 (0.00832)	0.000544 (0.000870)	0.00180 (0.00259)	0.948 *** (0.0156)	0.000142** (5.90e-05)
lag U	-0.00725 (0.00992)	-0.0478 (0.189)	-0.00746 (0.0352)	0.0882 (0.130)	0.223*** (0.0739)	0.0667 (0.0490)	0.00229 (0.0187)	0.600 *** (0.0644)
Excess Volatility: benchmark	0.00275*** (0.000126)	-0.000409 (0.000615)	-0.000159 (0.000188)	0.000786 (0.000637)	0.000454** (0.000196)	-0.000257 (0.000530)	0.000219 (0.000259)	6.39e-06 (1.84e-05)
Excess Volatility: own history	0.000490*** (6.22e-05)	0.00133** (0.000575)	1.38e-05 (7.57e-05)	-8.26e-05 (0.000514)	-0.000223 (0.000266)	0.000208 (0.000368)	-7.98e-05 (0.000161)	-1.67e-05 (2.03e-05)
Issuance maturity (days)	-0.00118*** (0.000204)	-0.000415 (0.000561)	-0.000193* (0.000115)	-0.000152 (0.000518)	0.00196*** (0.000235)	-0.000951*** (0.000338)	0.000355 (0.000307)	1.25e-05 (8.58e-06)
Issuance price	-0.00420*** (0.00140)	-0.00567 (0.00617)	-0.00130 (0.000854)	-0.00514 (0.00766)	0.000889 (0.00486)	-0.00947 (0.00584)	0.00195 (0.00253)	0.000257*** (7.91e-05)
Coupon rate	0.0177*** (0.00223)	-0.000103 (0.0112)	-0.00369* (0.00219)	-0.0131 (0.0104)	0.00242 (0.00467)	0.0144** (0.00657)	-0.00607 (0.00402)	-2.22e-05 (0.000244)
Amounts outstanding (mn EUR)	-2.73e-05*** (3.74e-06)	0.000108*** (3.37e-05)	-1.89e-06 (3.32e-06)	4.88e-05** (2.13e-05)	1.98e-05 (1.44e-05)	7.60e-05*** (1.49e-05)	5.07e-06 (7.69e-06)	2.43e-06*** (8.70e-07)
Herfindahl index	-0.00331 (0.0134)	2.833*** (0.259)	-0.00985 (0.0205)	0.865*** (0.155)	-0.000164 (0.0844)	0.514*** (0.1000)	0.0153 (0.0521)	-0.0368*** (0.00556)
Yield to maturity	0.00127 (0.00132)	-0.0246*** (0.00785)	0.00101 (0.000942)	-0.0145*** (0.00405)	-0.0112*** (0.00180)	-0.00260 (0.00262)	0.000122 (0.000907)	-3.04e-05 (5.82e-05)
Control dummies	YES	YES	YES	YES	YES	YES	YES	YES
Observations	51,542	51,542	51,542	51,542	51,542	51,542	51,542	51,542
Adjusted R-squared	0.225	0.986	0.971	0.933	0.920	0.984	0.926	0.315

Clustered standard errors in parentheses, ***, **, * and * denote statistical significance at the 1%, 5% and 10% levels, respectively. All first stage regressions contain an intercept, as well as the following exogenous dummy variables: region identifiers (i.e. non-EU, non-euro area EU, and euro area groups B and C), CoCo, foreign exchange issuance, rating, seniority, coupon type and time.

Table 16: First stage regressions from the iterative GMM model of Bid-Ask/Mid on Volatility, Holdings and Controls

	Worldwide issuance sample						
	Volatility of daily returns						
	Gov	IVF	MMF	ICPF	OFI	U	
Excess Volatility: benchmark	0.00340*** (6.62e-05)	0.000706 (0.000580)	0.000306 (0.000188)	-4.45e-05 (0.000489)	0.000178 (0.000236)	7.01e-06 (1.70e-05)	
Excess Volatility: own history	0.000820*** (2.45e-05)	0.00132*** (7.39e-05)	-0.000115 (0.000256)	0.000169 (0.000356)	-0.000173 (0.000162)	-1.29e-05 (1.94e-05)	
lag CI	-4.20e-05 (2.87e-05)	0.971*** (0.000192)	-0.000368 (0.000412)	-0.00330*** (0.000598)	-0.000303 (0.000308)	0.000104*** (2.53e-05)	
lag Gov	-0.000339*** (8.21e-05)	0.994*** (0.00300)	-0.00102* (0.000617)	-0.00146 (0.00125)	0.000157 (0.000384)	0.000134*** (6.31e-05)	
lag IVF	2.88e-05 (5.03e-05)	0.0611*** (0.00272)	0.00413*** (0.000716)	0.00165*** (0.000734)	-0.000119 (0.000346)	0.000132*** (3.89e-05)	
lag MMF	-0.000318*** (5.96e-05)	-0.00120 (0.00719)	0.952*** (0.0103)	-0.000491 (0.000796)	-0.00158** (0.000634)	6.12e-05 (7.38e-05)	
lag ICPF	-0.000152*** (5.64e-05)	-0.0156*** (0.00188)	0.000447 (0.000388)	0.984*** (0.00194)	-0.000198 (0.000324)	0.000112*** (3.06e-05)	
lag OFI	7.82e-05 (0.000146)	-0.00173 (0.0105)	0.000609 (0.000789)	0.000844 (0.00277)	0.946*** (0.0155)	0.000137** (5.75e-05)	
lag U	-0.00169 (0.00475)	-0.00437 (0.193)	0.176*** (0.0545)	0.0790 (0.0506)	0.00217 (0.0193)	0.590*** (0.0634)	
Residual maturity (days)	-0.000195*** (2.38e-05)	6.20e-06 (8.92e-06)	-4.69e-05*** (5.96e-06)	2.29e-05*** (7.50e-06)	-6.91e-06 (7.24e-06)	-3.86e-07* (2.07e-07)	
Off the run dummy	0.00483** (0.00199)	-0.0173 (0.0518)	0.0467** (0.0202)	-0.0158 (0.0321)	0.00522 (0.0133)	-0.000454 (0.00129)	
Issuance maturity (days)	-0.000714*** (8.63e-05)	-0.000136 (0.000418)	0.00167*** (0.000215)	-0.000800*** (0.000270)	0.000251 (0.000261)	1.17e-05 (7.44e-06)	
Issuance price	-0.00272*** (0.000394)	-0.00445 (0.00606)	0.00146 (0.00466)	-0.00917 (0.00567)	0.00233 (0.00244)	0.000266*** (7.56e-05)	
Coupon rate	0.00526*** (0.00121)	-0.00838 (0.0109)	0.00210 (0.00424)	0.0137** (0.00631)	-0.00869** (0.00407)	7.43e-05 (0.000221)	
Amounts outstanding (mn EUR)	-8.77e-06*** (1.19e-06)	0.000115*** (3.35e-05)	1.56e-05 (1.37e-05)	7.43e-05*** (1.44e-05)	4.23e-06 (7.66e-06)	2.52e-06*** (8.66e-07)	
Herfindahl index	-0.0147*** (0.00372)	3.019*** (0.270)	-0.0636 (0.0720)	0.538*** (0.0985)	0.0127 (0.0551)	-0.0351*** (0.00535)	
Yield to maturity	0.00412*** (0.000610)	-0.0265*** (0.00786)	-0.0112*** (0.00170)	-0.00351 (0.00269)	0.000777 (0.00108)	-5.23e-05 (5.96e-05)	
Control dummies	YES	YES	YES	YES	YES	YES	
Observations	53,457	53,457	53,457	53,457	53,457	53,457	
Adjusted R-squared	0.655	0.986	0.903	0.985	0.920	0.307	

Clustered standard errors in parentheses, ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively. All first stage regressions contain an intercept, as well as the following exogenous dummy variables: region identifiers (i.e. non-EU, non-euro area EU, and euro area groups B and C), CoCo, foreign exchange issuance, rating, seniority, coupon type and time.

Table 17: First stage regressions from the iterative GMM model of Effective Spreads on Volatility, Holdings and Controls
Worldwide issuance sample

	Volatility of daily returns							U	
	Excess Volatility: benchmark	Excess Volatility: own history	lag CI	lag Gov	lag IVF	lag MMF	lag ICPF	lag OFI	U
Excess Volatility: benchmark	0.00329*** (6.29e-05)	-0.000409 (0.000615)	0.000786 (0.000637)	0.000454** (0.000196)	-0.000257 (0.000530)	0.000219 (0.000259)	6.39e-06 (1.84e-05)		
Excess Volatility: own history	0.00798*** (2.23e-05)	0.00133** (0.000575)	-8.26e-05 (7.57e-05)	-0.000223 (0.000266)	0.000208 (0.000368)	-7.98e-05 (0.000161)	-1.87e-05 (2.03e-05)		
lag CI	-4.71e-05* (2.85e-05)	0.973*** (0.00214)	-0.000182 (0.000137)	-0.000514 (0.000503)	-0.000332*** (0.000613)	-0.000355 (0.000311)	0.000111*** (2.61e-05)		
lag Gov	-0.000341*** (7.97e-05)	-0.0154*** (0.00322)	0.994*** (0.00324)	-0.000843 (0.000629)	-0.000156 (0.00128)	0.000101 (0.000385)	0.000169** (6.95e-05)		
lag IVF	-3.05e-06 (4.92e-05)	0.00710*** (0.00274)	0.952*** (0.000254)	0.00439*** (0.000752)	0.00142* (0.000754)	-0.000193 (0.000331)	0.000132*** (3.96e-05)		
lag MMF	-0.000212*** (4.91e-05)	-0.00556 (0.00585)	-0.00406 (0.00203)	0.959*** (0.00867)	-0.00135* (0.000712)	-0.000161*** (0.000555)	8.00e-05 (6.23e-05)		
lag ICPF	-0.000172*** (5.58e-05)	-0.0136*** (0.00179)	-0.00505*** (0.000482)	0.000596 (0.000469)	0.984*** (0.00206)	-0.000274 (0.000326)	0.000124*** (3.23e-05)		
lag OFI	1.75e-05 (0.000128)	-0.00123 (0.0106)	0.00575 (0.00832)	0.000544 (0.000870)	0.00180 (0.00259)	0.948*** (0.0156)	0.000142** (5.90e-05)		
lag U	-0.00166 (0.00470)	-0.0478 (0.189)	0.0882 (0.130)	0.223*** (0.0739)	0.0667 (0.0490)	0.00229 (0.0187)	0.600*** (0.0644)		
Residual maturity (days)	-0.000218*** (2.22e-05)	2.68e-06 (9.92e-06)	1.03e-05 (1.39e-06)	-5.48e-05*** (6.50e-06)	2.65e-05*** (9.32e-06)	-1.05e-05 (8.51e-06)	-4.28e-07* (2.40e-07)		
Off the run dummy	0.00699*** (0.00190)	-0.0141 (0.0528)	0.0139 (0.0497)	0.0370 (0.0240)	-0.0167 (0.0335)	-0.00132 (0.0129)	-0.000669 (0.00144)		
Issuance maturity (days)	-0.000794*** (8.05e-05)	-0.000415 (0.000561)	-0.000193* (0.000115)	0.00196*** (0.000235)	-0.000951*** (0.000338)	0.000355 (0.000307)	1.25e-05 (8.58e-06)		
Issuance price	-0.00278*** (0.000396)	-0.00567 (0.00617)	-0.00514 (0.00766)	0.000889 (0.00486)	-0.00947 (0.00584)	0.00195 (0.00253)	0.000257*** (7.91e-05)		
Coupon rate	0.00483*** (0.00105)	-0.000103 (0.0112)	-0.00369* (0.00219)	0.00242 (0.00467)	0.0144** (0.00657)	-0.00607 (0.00402)	-2.22e-05 (0.000244)		
Amounts outstanding (mn EUR)	-8.09e-06*** (1.10e-06)	0.000108*** (3.37e-05)	-1.89e-06 (3.32e-06)	1.98e-05 (1.44e-05)	7.60e-05*** (1.49e-05)	5.07e-06 (7.69e-06)	2.43e-06*** (8.70e-07)		
Herfindahl index	-0.0123*** (0.00344)	2.833*** (0.259)	-0.00985 (0.0205)	-0.000164 (0.0844)	0.514*** (0.1000)	0.0153 (0.0521)	-0.0368*** (0.00556)		
Yield to maturity	0.00374*** (0.000556)	-0.0246*** (0.00785)	0.00101 (0.000942)	-0.0112*** (0.00180)	-0.00260 (0.00282)	0.000122 (0.000907)	-3.04e-05 (5.82e-05)		
Control dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	51,542	51,542	51,542	51,542	51,542	51,542	51,542	51,542	51,542
Adjusted R-squared	0.659	0.986	0.971	0.920	0.984	0.926	0.315		

Clustered standard errors in parentheses, ***, **, * and * denote statistical significance at the 1%, 5% and 10% levels, respectively. All first stage regressions contain an intercept, as well as the following exogenous dummy variables: region identifiers (i.e. non-EU, non-euro area EU, and euro area groups B and C), CoCo, foreign exchange issuance, rating, seniority, coupon type and time.

Table 18: First stage regressions from the iterative GMM model of Volatility on Liquidity (Bid-Ask/Mid), Holdings and Controls

	Bid-Ask/Mid	CI	Gov	IVF	MMF	ICPF	OFI	U
Residual maturity (days)	-0.000301*** (5.95e-05)	1.36e-05 (1.42e-05)	5.77e-06 (4.25e-06)	1.93e-05 (1.83e-05)	-5.42e-05*** (8.90e-06)	3.06e-05*** (1.13e-05)	-1.05e-05 (1.10e-05)	-4.16e-07 (2.53e-07)
Off the run dummy	0.0216*** (0.0095)	-0.0126 (0.0846)	0.00191 (0.0160)	0.0799 (0.0684)	0.0450 (0.0335)	0.000909 (0.0527)	-0.00749 (0.0177)	0.00121 (0.00188)
lag CI	-0.000160 (0.000156)	0.972*** (0.00231)	-0.000140 (0.000136)	-0.00306*** (0.000745)	-0.000202 (0.000426)	-0.00249*** (0.000573)	-0.000287 (0.000298)	9.81e-05*** (2.66e-05)
lag Gov	-0.00137** (0.000562)	-0.0158*** (0.00322)	0.995*** (0.00259)	-0.00444*** (0.00110)	-0.000685 (0.000674)	-0.00128 (0.00112)	-4.16e-05 (0.000356)	0.000160** (6.71e-05)
lag IVF	-0.00101*** (0.000275)	0.00869*** (0.00322)	4.88e-05 (0.000249)	0.958*** (0.00367)	0.00404*** (0.000811)	0.00216*** (0.000797)	-0.000450 (0.000387)	0.000158*** (4.85e-05)
lag MMF	-0.00393*** (0.000346)	0.0102 (0.00937)	0.000295 (0.000311)	0.00212 (0.00467)	0.936*** (0.0134)	0.000790 (0.00102)	-0.00162** (0.000805)	3.12e-05 (9.58e-05)
lag ICPF	-0.00097*** (0.000249)	-0.0133*** (0.00197)	0.000612 (0.000543)	-0.00222** (0.00109)	0.000812* (0.000418)	0.964*** (0.00215)	-0.000374 (0.000336)	9.93e-05*** (3.20e-05)
lag OFI	2.07e-05 (0.000906)	0.000263 (0.0115)	-1.17e-05 (0.000245)	0.00716 (0.00873)	0.000549 (0.000846)	0.000542 (0.00284)	0.945*** (0.0168)	0.000129** (5.07e-05)
lag U	-0.0325*** (0.00941)	-0.0161 (0.0239)	-0.00387 (0.0477)	-0.0188 (0.163)	0.171*** (0.0635)	0.0868* (0.0475)	0.0171 (0.0216)	0.520*** (0.0706)
Excess Volatility: benchmark	0.00246*** (0.000176)	-0.00123 (0.000912)	-0.000245 (0.000274)	0.000124 (0.000766)	0.000185 (0.000276)	-0.000288 (0.000715)	0.000318 (0.000369)	-2.64e-05 (1.64e-05)
Excess Volatility: own history	0.000357*** (9.28e-05)	0.00168** (0.000799)	8.80e-05 (0.000105)	0.000230 (0.000620)	0.000188 (0.000349)	0.000367 (0.000481)	-0.000129 (0.000223)	-2.58e-05 (2.62e-05)
Issuance maturity (days)	-0.000900*** (0.000219)	-0.000388 (0.000567)	-0.000210 (0.000153)	-0.000559 (0.000661)	0.00195*** (0.000321)	-0.00109*** (0.000409)	0.000367 (0.000399)	1.29e-05 (8.92e-06)
Issuance price	-0.00453*** (0.00171)	-0.00401 (0.00658)	-0.00151 (0.000938)	-0.00106 (0.00711)	0.000712 (0.00547)	-0.00363 (0.00345)	0.00265 (0.00282)	0.000301*** (8.77e-05)
Coupon rate	0.00833** (0.00375)	-0.0166 (0.0166)	-0.00411 (0.00250)	-0.0191 (0.0147)	-0.00884 (0.00607)	0.0143 (0.00928)	-0.0113** (0.00552)	-0.000321 (0.000326)
Amounts outstanding (mn EUR)	-3.63e-05*** (5.14e-06)	0.000125*** (4.43e-05)	-3.48e-06 (4.53e-06)	-1.33e-05 (2.31e-05)	2.24e-05 (1.87e-05)	7.16e-05*** (1.79e-05)	6.32e-08 (8.87e-06)	3.49e-06*** (1.17e-06)
Herfindahl index	-0.0616*** (0.0200)	3.118*** (0.297)	-0.0178 (0.0227)	0.283** (0.137)	-0.147* (0.0770)	0.432*** (0.103)	-0.0157 (0.0593)	-0.0346*** (0.00561)
Yield to maturity	0.00466*** (0.00120)	-0.0254*** (0.00932)	0.00103 (0.00108)	-0.0141*** (0.00457)	-0.00850*** (0.00164)	-0.00115 (0.00294)	0.00168 (0.00109)	1.70e-05 (5.75e-05)
Control dummies	YES	YES	YES	YES	YES	YES	YES	YES
Observations	35,742	35,742	35,742	35,742	35,742	35,742	35,742	35,742
Adjusted R-squared	0.174	0.984	0.975	0.950	0.890	0.985	0.934	0.249

Clustered standard errors in parentheses, ***, **, * and * denote statistical significance at the 1%, 5% and 10% levels, respectively. All first stage regressions contain an intercept, as well as the following exogenous dummy variables: region identifiers (i.e. non-euro area EU, and euro area groups B and C), CoCo, foreign exchange issuance, rating, seniority, coupon type and time.

Table 19: First stage regressions from the iterative GMM model of Volatility on Liquidity (Effective spreads), Holdings and Controls

	EU issuance sample							
	Effective Spreads	CI	Gov	IVF	MMF	ICPF	OFI	U
Residual maturity (days)	-0.000251*** (3.84e-05)	8.01e-06 (1.59e-05)	7.05e-06 (5.02e-06)	2.15e-05 (2.14e-05)	-6.34e-05*** (8.85e-06)	3.42e-05** (1.41e-05)	-1.31e-05 (1.32e-05)	-3.73e-07 (2.87e-07)
Off the run dummy	0.0669*** (0.00846)	-0.00282 (0.0847)	0.00230 (0.0168)	0.0509 (0.0693)	0.0344 (0.0389)	-0.000259 (0.0543)	-0.0117 (0.0172)	0.000628 (0.00213)
lag CI	-0.000396*** (0.000140)	0.974*** (0.00219)	-0.000127 (0.000138)	-0.00308*** (0.000755)	-0.000332 (0.000524)	-0.00252*** (0.000588)	-0.000306 (0.000303)	0.000105*** (2.75e-05)
lag Gov	-0.00158*** (0.000583)	-0.0149*** (0.00329)	0.995*** (0.00279)	-0.00441*** (0.00109)	-0.000551 (0.000708)	-0.00133 (0.00115)	-5.37e-06 (0.000368)	0.000195*** (7.38e-05)
lag IVF	-0.000743*** (0.000209)	0.00974*** (0.00323)	1.29e-07 (0.000253)	0.959*** (0.00133)	0.00428*** (0.000846)	0.00187** (0.000813)	-0.000451 (0.000377)	0.000151*** (4.93e-05)
lag MMF	-0.00330*** (0.000286)	0.00560 (0.00809)	9.01e-05 (0.000284)	0.000133 (0.00385)	0.941*** (0.0119)	0.000141 (0.000901)	-0.00179** (0.000726)	4.04e-05 (8.48e-05)
lag ICPF	-0.00118*** (0.000193)	-0.0113*** (0.00190)	0.000653 (0.000583)	-0.00248** (0.00116)	0.000944* (0.000502)	0.984*** (0.00230)	-0.000417 (0.000345)	0.000108*** (3.37e-05)
lag OFI	-0.00162*** (0.000459)	0.00116 (0.0116)	-4.78e-05 (0.000247)	0.00737 (0.00888)	0.000530 (0.000933)	0.00154 (0.00264)	0.949*** (0.0170)	0.000131** (5.34e-05)
lag U	-0.0246*** (0.00701)	-0.0704 (0.233)	-0.00481 (0.0463)	-0.0180 (0.158)	0.233** (0.0937)	0.0770* (0.0451)	0.0177 (0.0207)	0.539*** (0.0736)
Excess Volatility: benchmark	0.00273*** (0.000128)	-0.000569 (0.000948)	-0.000271 (0.000296)	0.000225 (0.000842)	0.000332 (0.000267)	-0.000647 (0.000768)	0.000306 (0.000409)	-2.86e-05 (1.77e-05)
Excess Volatility: own history	0.000533*** (7.63e-05)	0.00158** (0.000800)	6.58e-05 (0.000106)	0.000301 (0.000636)	7.13e-05 (0.000354)	0.000425 (0.000490)	-5.59e-06 (0.000219)	-3.15e-05 (2.71e-05)
Issuance maturity (days)	-0.000745*** (0.000145)	-0.000571 (0.000702)	-0.000266 (0.000181)	-0.000618 (0.000779)	0.00227*** (0.000320)	-0.00125** (0.000508)	0.000437 (0.000476)	1.09e-05 (1.01e-05)
Issuance price	-0.00570*** (0.00155)	-0.00524 (0.00666)	-0.00151 (0.000982)	0.000687 (0.00738)	0.000158 (0.000571)	-0.00378 (0.00356)	0.00238 (0.00292)	0.000287*** (9.29e-05)
Coupon rate	0.0151*** (0.00243)	-0.00928 (0.0174)	-0.00477* (0.00283)	-0.0119 (0.0150)	-0.00880 (0.00673)	0.0145 (0.00939)	-0.00893 (0.00551)	-0.0000398 (0.000370)
Amounts outstanding (mn EUR)	-2.05e-05*** (4.20e-06)	0.000120*** (4.43e-05)	-4.28e-06 (4.40e-06)	-1.84e-05 (2.38e-05)	2.65e-05 (1.91e-05)	7.58e-05*** (1.84e-05)	8.25e-08 (8.82e-06)	3.34e-06*** (1.16e-06)
Herfindahl index	0.0129 (0.0134)	2.930*** (0.285)	-0.0201 (0.0230)	0.283** (0.138)	-0.0935 (0.0878)	0.417*** (0.104)	-0.00476 (0.0575)	-0.0359*** (0.00586)
Yield to maturity	0.000812 (0.00137)	-0.0228** (0.00905)	0.00108 (0.00109)	-0.0112*** (0.00411)	-0.00870*** (0.00175)	0.000131 (0.00277)	0.00140 (0.000942)	3.47e-05 (5.40e-05)
Control dummies	YES	YES	YES	YES	YES	YES	YES	YES
Observations	34,860	34,860	34,860	34,860	34,860	34,860	34,860	34,860
Adjusted R-squared	0.164	0.985	0.974	0.951	0.902	0.984	0.938	0.263

Clustered standard errors in parentheses, ***, **, * and * denote statistical significance at the 1%, 5% and 10% levels, respectively. All first stage regressions contain an intercept, as well as the following exogenous dummy variables: region identifiers (i.e. non-euro area EU, and euro area groups B and C), CoCo, foreign exchange issuance, rating, seniority, coupon type and time.

Table 20: First stage regressions from the iterative GMM model of Bid-Ask/Mid on Volatility, Holdings and Controls

	Volatility of daily returns							EU issuance sample						
	CI	Gov	IVF	MMF	ICPF	OFI	U	CI	Gov	IVF	MMF	ICPF	OFI	U
Excess Volatility: benchmark	0.00348 *** (8.47e-05)	-0.000245 (0.000274)	0.000124 (0.000766)	0.000185 (0.000276)	-0.000288 (0.000715)	0.000318 (0.000369)	-2.64e-05 (1.64e-05)	-0.00123 (0.000912)	-0.000245 (0.000274)	0.000124 (0.000766)	0.000185 (0.000276)	-0.000288 (0.000715)	0.000318 (0.000369)	-2.64e-05 (1.64e-05)
Excess Volatility: own history	0.000823 *** (2.96e-05)	8.80e-05 (0.000105)	0.000230 (0.000620)	0.000188 (0.000349)	0.000367 (0.000481)	-0.000129 (0.000223)	-2.58e-05 (2.62e-05)	0.00168** (0.000799)	8.80e-05 (0.000105)	0.000230 (0.000620)	0.000188 (0.000349)	0.000367 (0.000481)	-0.000129 (0.000223)	-2.58e-05 (2.62e-05)
lag CI	-6.63e-05** (2.99e-05)	-0.000140 (0.000136)	-0.00306*** (0.000745)	-0.000202 (0.000426)	-0.00249*** (0.000573)	-0.000287 (0.000298)	9.81e-05*** (2.66e-05)	0.972 *** (0.00231)	-0.000140 (0.000136)	-0.00306*** (0.000745)	-0.000202 (0.000426)	-0.00249*** (0.000573)	-0.000287 (0.000298)	9.81e-05*** (2.66e-05)
lag Gov	-0.000329*** (8.33e-05)	0.995 *** (0.00259)	-0.00444*** (0.00110)	-0.000685 (0.000674)	-0.00128 (0.00112)	-4.16e-05 (0.000356)	0.000160** (6.71e-05)	-0.0158*** (0.00322)	0.995 *** (0.00259)	-0.00444*** (0.00110)	-0.000685 (0.000674)	-0.00128 (0.00112)	-4.16e-05 (0.000356)	0.000160** (6.71e-05)
lag IVF	3.08e-06 (5.42e-05)	4.88e-05 (0.000249)	0.958 *** (0.00367)	0.00404*** (0.000811)	0.00216*** (0.000797)	-0.000450 (0.000387)	0.000158*** (4.85e-05)	0.00869*** (0.00322)	4.88e-05 (0.000249)	0.958 *** (0.00367)	0.00404*** (0.000811)	0.00216*** (0.000797)	-0.000450 (0.000387)	0.000158*** (4.85e-05)
lag MMF	-0.000390*** (6.84e-05)	0.0102 (0.00937)	0.000295 (0.00467)	0.936 *** (0.0134)	0.000790 (0.00102)	-0.00162** (0.000805)	3.12e-05 (9.58e-05)	0.0102 (0.00937)	0.000295 (0.00467)	0.000295 (0.00467)	0.936 *** (0.0134)	0.000790 (0.00102)	-0.00162** (0.000805)	3.12e-05 (9.58e-05)
lag ICPF	-0.000131** (6.20e-05)	-0.0133*** (0.00197)	-0.00222** (0.00109)	0.000812* (0.000418)	0.984 *** (0.00215)	-0.000374 (0.000336)	9.93e-05*** (3.20e-05)	-0.0133*** (0.00197)	-0.00222** (0.00109)	0.000812* (0.000418)	0.984 *** (0.00215)	-0.000374 (0.000336)	-0.000374 (0.000336)	9.93e-05*** (3.20e-05)
lag OFI	2.65e-05 (0.000158)	0.000263 (0.0115)	0.00716 (0.00873)	0.000549 (0.000846)	0.000542 (0.00284)	0.945 *** (0.0168)	0.000129** (5.07e-05)	0.000263 (0.0115)	0.00716 (0.00873)	0.000549 (0.000846)	0.000542 (0.00284)	0.000542 (0.00284)	0.945 *** (0.0168)	0.000129** (5.07e-05)
lag U	-0.00592*** (0.00169)	-0.0161 (0.0239)	-0.0188 (0.163)	0.171*** (0.0635)	0.0868* (0.0475)	0.0171 (0.0216)	0.520 *** (0.0706)	-0.0161 (0.0239)	-0.0188 (0.163)	0.171*** (0.0635)	0.0868* (0.0475)	0.0868* (0.0475)	0.0171 (0.0216)	0.520 *** (0.0706)
Residual maturity (days)	-0.00018*** (2.79e-05)	1.36e-05 (1.42e-05)	1.93e-05 (1.83e-05)	-5.42e-05*** (8.90e-06)	3.06e-05*** (1.13e-05)	-1.05e-05 (1.10e-05)	-4.16e-07 (2.53e-07)	1.36e-05 (1.42e-05)	1.93e-05 (1.83e-05)	1.93e-05 (1.83e-05)	-5.42e-05*** (8.90e-06)	3.06e-05*** (1.13e-05)	-1.05e-05 (1.10e-05)	-4.16e-07 (2.53e-07)
Off the run dummy	0.00462* (0.00247)	-0.0126 (0.0846)	0.0799 (0.0684)	0.0450 (0.0335)	0.00909 (0.0527)	-0.00749 (0.0177)	0.00121 (0.00188)	-0.0126 (0.0846)	0.0799 (0.0684)	0.0450 (0.0335)	0.00909 (0.0527)	0.00909 (0.0527)	-0.00749 (0.0177)	0.00121 (0.00188)
Issuance maturity (days)	-0.000659*** (0.000101)	-0.000388 (0.000567)	-0.000210 (0.000661)	0.00195*** (0.000321)	-0.00109*** (0.000409)	0.000367 (0.000399)	1.29e-05 (8.92e-06)	-0.000388 (0.000567)	-0.000210 (0.000661)	0.00195*** (0.000321)	-0.00109*** (0.000409)	-0.00109*** (0.000409)	0.000367 (0.000399)	1.29e-05 (8.92e-06)
Issuance price	-0.00289*** (0.000434)	-0.00401 (0.00658)	-0.00106 (0.00711)	0.000712 (0.00547)	-0.00363 (0.00345)	0.00265 (0.00282)	0.000301*** (8.77e-05)	-0.00401 (0.00658)	-0.00106 (0.00711)	0.000712 (0.00547)	-0.00363 (0.00345)	-0.00363 (0.00345)	0.00265 (0.00282)	0.000301*** (8.77e-05)
Coupon rate	0.00485*** (0.00164)	-0.0166 (0.0166)	-0.0191 (0.0147)	-0.00884 (0.00607)	0.0143 (0.00928)	-0.0113** (0.00552)	-0.000321 (0.000326)	-0.0166 (0.0166)	-0.0191 (0.0147)	-0.00884 (0.00607)	0.0143 (0.00928)	0.0143 (0.00928)	-0.0113** (0.00552)	-0.000321 (0.000326)
Amounts outstanding (mn EUR)	-1.11e-05*** (1.37e-06)	0.000125*** (4.43e-05)	-1.33e-05 (2.31e-05)	2.24e-05 (1.87e-05)	7.16e-05*** (1.79e-05)	6.32e-08 (8.87e-06)	3.49e-06*** (1.17e-06)	0.000125*** (4.43e-05)	-1.33e-05 (2.31e-05)	2.24e-05 (1.87e-05)	7.16e-05*** (1.79e-05)	7.16e-05*** (1.79e-05)	6.32e-08 (8.87e-06)	3.49e-06*** (1.17e-06)
Herfindahl index	-0.0152*** (0.00412)	3.118*** (0.297)	0.283** (0.137)	-0.147* (0.0770)	0.432*** (0.103)	-0.0157 (0.0593)	-0.0346*** (0.00561)	3.118*** (0.297)	0.283** (0.137)	-0.147* (0.0770)	0.432*** (0.103)	0.432*** (0.103)	-0.0157 (0.0593)	-0.0346*** (0.00561)
Yield to maturity	0.00354*** (0.000615)	-0.0254*** (0.00932)	-0.0141*** (0.00457)	-0.00850*** (0.00164)	-0.00115 (0.00294)	0.00168 (0.00109)	1.70e-05 (5.75e-05)	-0.0254*** (0.00932)	-0.0141*** (0.00457)	-0.00850*** (0.00164)	-0.00115 (0.00294)	-0.00115 (0.00294)	0.00168 (0.00109)	1.70e-05 (5.75e-05)
Control dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	35,742	35,742	35,742	35,742	35,742	35,742	35,742	35,742	35,742	35,742	35,742	35,742	35,742	35,742
Adjusted R-squared	0.609	0.984	0.950	0.890	0.985	0.934	0.249	0.609	0.984	0.950	0.890	0.985	0.934	0.249

Clustered standard errors in parentheses, ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. All first stage regressions contain an intercept, as well as the following exogenous dummy variables (i.e. non-euro area EU, and euro area groups B and C), CoCo, foreign exchange issuance, rating, seniority, coupon type and time.

Table 21: First stage regressions from the iterative GMM model of Effective Spreads on Volatility, Holdings and Controls

	Volatility of daily returns							EU issuance sample						
	CI	Gov	IVF	MMF	ICPF	OFI	U	CI	Gov	IVF	MMF	ICPF	OFI	U
Excess Volatility: benchmark	0.00339 ^{***} (7.29e-05)	-0.000569 (0.000948)	0.000271 (0.000296)	0.000225 (0.000842)	0.000332 (0.000267)	-0.000647 (0.000768)	-2.86e-05 (1.77e-05)	0.00811 ^{***} (2.60e-05)	6.58e-05 (0.000106)	0.000301 (0.000636)	7.13e-05 (0.000354)	0.000425 (0.000490)	-5.59e-06 (0.000219)	-3.15e-05 (2.71e-05)
Excess Volatility: own history	-6.89e-05 ^{**} (2.94e-05)	0.974 ^{***} (0.00219)	-0.000127 (0.000138)	-0.000308 ^{***} (0.000755)	-0.000332 (0.000524)	-0.00252 ^{***} (0.000588)	0.000105 ^{***} (2.75e-05)	0.995 ^{***} (0.00329)	0.995 ^{***} (0.00279)	-0.00441 ^{***} (0.00109)	-0.000551 (0.000708)	-0.00133 (0.00115)	-5.37e-06 (0.000368)	0.000195 ^{***} (7.38e-05)
lag Gov	-0.000337 ^{***} (8.03e-05)	0.00560 (0.00809)	0.000133 (0.00385)	0.000109 (0.00428 ^{***})	0.00115 (0.000846)	0.00187 ^{***} (0.000813)	0.000151 ^{***} (4.93e-05)	1.29e-07 (0.000253)	0.959 ^{***} (0.000253)	0.959 ^{***} (0.00372)	0.00428 ^{***} (0.000846)	0.00187 ^{***} (0.000813)	-0.000451 (0.000377)	0.000151 ^{***} (4.93e-05)
lag IVF	-4.37e-05 (5.31e-05)	0.00974 ^{***} (0.00323)	9.01e-05 (0.00284)	0.959 ^{***} (0.00109)	0.00428 ^{***} (0.000846)	0.00187 ^{***} (0.000813)	0.000151 ^{***} (4.93e-05)	1.29e-07 (0.000253)	0.959 ^{***} (0.000253)	0.959 ^{***} (0.00372)	0.00428 ^{***} (0.000846)	0.00187 ^{***} (0.000813)	-0.000451 (0.000377)	0.000151 ^{***} (4.93e-05)
lag MMF	-0.000295 ^{***} (5.75e-05)	0.00560 (0.00809)	0.000133 (0.00385)	0.000109 (0.00428 ^{***})	0.00115 (0.000846)	0.00187 ^{***} (0.000813)	0.000151 ^{***} (4.93e-05)	1.29e-07 (0.000253)	0.959 ^{***} (0.000253)	0.959 ^{***} (0.00372)	0.00428 ^{***} (0.000846)	0.00187 ^{***} (0.000813)	-0.000451 (0.000377)	0.000151 ^{***} (4.93e-05)
lag ICPF	-0.000169 ^{***} (6.04e-05)	-0.0113 ^{***} (0.00190)	-0.00248 ^{***} (0.00116)	-0.00248 ^{***} (0.00116)	0.000944 [*] (0.000502)	0.984 ^{***} (0.00230)	0.000108 ^{***} (3.37e-05)	-0.0113 ^{***} (0.00190)	0.000653 (0.000583)	-0.00248 ^{***} (0.00116)	0.000944 [*] (0.000502)	0.984 ^{***} (0.00230)	-0.000417 (0.000345)	0.000108 ^{***} (3.37e-05)
lag OFI	-5.50e-05 (0.000137)	0.00116 (0.0116)	0.00737 (0.00888)	0.000530 (0.000933)	0.00154 (0.00264)	0.00154 (0.00264)	0.000131 ^{**} (5.34e-05)	-4.78e-05 (0.000247)	-0.000247 (0.000247)	0.00737 (0.00888)	0.000530 (0.000933)	0.00154 (0.00264)	0.0177 (0.0170)	0.000131 ^{**} (5.34e-05)
lag U	-0.00604 ^{***} (0.00163)	-0.0704 (0.233)	-0.00481 (0.0463)	-0.0180 (0.158)	0.233 ^{**} (0.0937)	0.0770 [*] (0.0451)	0.539 ^{***} (0.0736)	-0.00481 (0.0463)	-0.00481 (0.0463)	-0.0180 (0.158)	0.233 ^{**} (0.0937)	0.0770 [*] (0.0451)	0.0177 (0.0207)	0.539 ^{***} (0.0736)
Residual maturity (days)	-0.000201 ^{***} (2.15e-05)	8.01e-06 (1.59e-05)	7.05e-06 (5.02e-06)	2.15e-05 (2.14e-05)	-6.34e-05 ^{***} (8.85e-06)	3.42e-05 ^{**} (1.41e-05)	-3.73e-07 (2.87e-07)	-0.000201 ^{***} (2.15e-05)	7.05e-06 (5.02e-06)	2.15e-05 (2.14e-05)	-6.34e-05 ^{***} (8.85e-06)	3.42e-05 ^{**} (1.41e-05)	-1.31e-05 (1.32e-05)	-3.73e-07 (2.87e-07)
Off the run dummy	0.00373 ^{**} (0.00184)	-0.00282 (0.0847)	0.00230 (0.0168)	0.0509 (0.0693)	0.0344 (0.0389)	-0.00259 (0.0543)	0.000628 (0.00213)	0.00373 ^{**} (0.00184)	0.00230 (0.0168)	0.0509 (0.0693)	0.0344 (0.0389)	-0.00259 (0.0543)	-0.0117 (0.0172)	0.000628 (0.00213)
Issuance maturity (days)	-0.000731 ^{***} (7.80e-05)	-0.000571 (0.000702)	-0.000266 (0.00181)	-0.000618 (0.000779)	0.00227 ^{***} (0.000320)	-0.00125 ^{**} (0.000508)	1.09e-05 (1.01e-05)	-0.000731 ^{***} (7.80e-05)	-0.000266 (0.00181)	-0.000618 (0.000779)	0.00227 ^{***} (0.000320)	-0.00125 ^{**} (0.000508)	0.000437 (0.000476)	1.09e-05 (1.01e-05)
Issuance price	-0.00307 ^{***} (0.000434)	-0.00524 (0.00666)	-0.00151 (0.00982)	0.000687 (0.00738)	0.000158 (0.00571)	-0.00378 (0.00356)	0.000287 ^{***} (9.29e-05)	-0.00307 ^{***} (0.000434)	-0.00151 (0.00982)	0.000687 (0.00738)	0.000158 (0.00571)	-0.00378 (0.00356)	0.00238 (0.00292)	0.000287 ^{***} (9.29e-05)
Coupon rate	0.00484 ^{***} (0.00156)	-0.00928 (0.0174)	-0.00477 [*] (0.00283)	-0.0119 (0.0150)	-0.00880 (0.00673)	0.0145 (0.00939)	-0.000398 (0.000370)	0.00484 ^{***} (0.00156)	-0.00477 [*] (0.00283)	-0.0119 (0.0150)	-0.00880 (0.00673)	0.0145 (0.00939)	-0.00893 (0.00551)	-0.000398 (0.000370)
Amounts outstanding (mn EUR)	-1.00e-05 ^{***} (1.27e-06)	0.000120 ^{***} (4.43e-05)	-4.28e-06 (4.40e-06)	-1.84e-05 (2.38e-05)	2.65e-05 (1.91e-05)	7.58e-05 ^{***} (1.84e-05)	3.34e-06 ^{***} (1.16e-06)	-1.00e-05 ^{***} (1.27e-06)	-4.28e-06 (4.40e-06)	-1.84e-05 (2.38e-05)	2.65e-05 (1.91e-05)	7.58e-05 ^{***} (1.84e-05)	8.25e-08 (8.82e-06)	3.34e-06 ^{***} (1.16e-06)
Herfindahl index	-0.0127 ^{***} (0.00381)	2.930 ^{***} (0.285)	-0.0201 (0.0230)	0.283 ^{**} (0.138)	-0.0935 (0.0878)	0.417 ^{***} (0.104)	-0.0359 ^{***} (0.00586)	-0.0127 ^{***} (0.00381)	-0.0201 (0.0230)	0.283 ^{**} (0.138)	-0.0935 (0.0878)	0.417 ^{***} (0.104)	-0.00476 (0.0575)	-0.0359 ^{***} (0.00586)
Yield to maturity	0.00317 ^{***} (0.000560)	-0.0228 ^{**} (0.00108)	0.00108 (0.00109)	-0.0112 ^{***} (0.00411)	-0.00870 ^{***} (0.00175)	0.000131 (0.00277)	3.47e-05 (5.40e-05)	0.00317 ^{***} (0.000560)	-0.0228 ^{**} (0.00108)	-0.0112 ^{***} (0.00411)	-0.00870 ^{***} (0.00175)	0.000131 (0.00277)	0.00140 (0.000942)	3.47e-05 (5.40e-05)
Control dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	34,860	34,860	34,860	34,860	34,860	34,860	34,860	34,860	34,860	34,860	34,860	34,860	34,860	34,860
Adjusted R-squared	0.616	0.985	0.974	0.951	0.902	0.984	0.263	0.616	0.985	0.974	0.951	0.984	0.938	0.263

Clustered standard errors in parentheses, ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. All first stage regressions contain an intercept, as well as the following exogenous dummy variables: region identifiers (i.e. non-euro area EU, and euro area groups B and C), CoCo, foreign exchange issuance, rating, seniority, coupon type and time.

Table 22: First stage regressions from the iterative GMM model of Volatility on Liquidity (Bid-Ask/Mid), Holdings and Controls
Euro Area issuance sample

	Bid-Ask/Mid	CI	Gov	IVF	MMF	ICPF	OFI	U
Residual maturity (days)	-0.000353*** (8.51e-05)	1.15e-05 (2.44e-05)	1.06e-05 (7.32e-06)	2.59e-05 (3.26e-05)	-7.08e-05*** (1.07e-05)	5.24e-05*** (2.00e-05)	-1.63e-05 (2.02e-05)	-5.50e-07* (3.33e-07)
Off the run dummy	0.0132*** (0.00371)	-0.0614 (0.113)	-0.00132 (0.0231)	0.103 (0.0858)	0.0241 (0.0396)	0.000950 (0.0664)	-0.0215 (0.00211)	-0.000750 (0.00211)
lag CI	-0.000179 (0.000164)	0.973*** (0.00242)	-0.000126 (0.000136)	-0.000887 (0.000647)	-7.50e-05 (0.000378)	-0.00189*** (0.000549)	-0.000228 (0.000324)	5.11e-05*** (1.92e-05)
lag Gov	-0.00129** (0.000579)	-0.0154*** (0.00332)	0.996*** (0.00259)	-0.00346*** (0.00106)	-0.000223 (0.000674)	-0.00143 (0.000916)	-4.24e-05 (0.000360)	8.81e-05 (5.86e-05)
lag IVF	-0.000964*** (0.000338)	0.0126*** (0.00394)	0.000180 (0.000298)	0.962*** (0.00416)	0.00353*** (0.000708)	0.00214** (0.000918)	-0.000421 (0.000496)	7.61e-05* (4.31e-05)
lag MMF	-0.00459*** (0.000427)	0.0222* (0.0119)	0.000319 (0.000380)	0.00810 (0.00506)	0.928*** (0.0138)	0.000637 (0.00116)	-0.00145 (0.000970)	2.76e-05 (0.000117)
lag ICPF	-0.000985*** (0.000284)	-0.0116*** (0.00219)	0.000825 (0.000672)	-0.000805 (0.00122)	0.00117*** (0.000432)	0.984*** (0.00236)	-0.000387 (0.000420)	5.11e-05* (2.79e-05)
lag OFI	-0.000420 (0.000986)	0.00467 (0.0133)	3.58e-05 (0.000264)	0.00978 (0.00998)	0.00120 (0.000951)	0.000285 (0.00320)	0.941*** (0.0194)	7.34e-05 (4.78e-05)
lag U	-0.0305* (0.0160)	-0.125 (0.394)	-0.0961 (0.0706)	0.00562 (0.281)	0.248*** (0.0909)	0.0451 (0.0630)	-0.00621 (0.0280)	0.499*** (0.0675)
Excess Volatility: benchmark	0.00236*** (0.000210)	-0.00112 (0.00120)	-0.000446 (0.000363)	0.000444 (0.00103)	0.000120 (0.000303)	-0.00139 (0.000935)	0.000579 (0.000571)	-2.95e-05* (1.59e-05)
Excess Volatility: own history	0.000433*** (0.000110)	0.00158* (0.000917)	6.30e-05 (0.000130)	-0.000254 (0.000687)	1.61e-05 (0.000389)	0.000589 (0.000552)	-0.000211 (0.000279)	-4.86e-06 (2.48e-05)
Issuance maturity (days)	-0.00105*** (0.000311)	-0.000312 (0.000908)	-0.000376 (0.000264)	-0.000784 (0.00118)	0.00254*** (0.000387)	-0.00188*** (0.000723)	0.000568 (0.000730)	1.79e-05 (1.17e-05)
Issuance price	-0.00132 (0.00226)	-0.0123 (0.0101)	-0.00204 (0.00147)	-0.00750 (0.00693)	0.000469 (0.00880)	-0.0119** (0.00540)	0.00231 (0.00187)	0.000363*** (9.74e-05)
Coupon rate	0.000565 (0.00462)	-0.0368* (0.0219)	-0.00465 (0.00338)	0.0111 (0.0149)	-0.00471 (0.00809)	0.0274** (0.0123)	-0.0132* (0.00760)	-0.000847** (0.000365)
Amounts outstanding (mn EUR)	-4.41e-05*** (8.28e-06)	0.000311*** (7.63e-05)	-4.59e-06 (8.48e-06)	-5.96e-05* (3.39e-05)	5.17e-05 (3.18e-05)	9.14e-05*** (2.99e-05)	-7.76e-06 (1.70e-05)	6.06e-06*** (1.66e-06)
Herfindahl index	-0.0691*** (0.0247)	3.605*** (0.366)	-0.0229 (0.0277)	0.00344 (0.141)	-0.157* (0.0872)	0.332*** (0.112)	-0.0326 (0.0764)	-0.0263*** (0.00454)
Yield to maturity	0.00390*** (0.00128)	-0.0196** (0.00787)	0.00104 (0.00124)	-0.0103*** (0.00362)	-0.00670*** (0.00167)	-0.000560 (0.00318)	0.00226* (0.00127)	7.80e-05 (5.15e-05)
Control dummies	YES	YES	YES	YES	YES	YES	YES	YES
Observations	27,637	27,637	27,637	27,637	27,637	27,637	27,637	27,637
Adjusted R-squared	0.162	0.984	0.977	0.957	0.896	0.985	0.929	0.222

Clustered standard errors in parentheses, ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. All first stage regressions contain an intercept, as well as the following exogenous dummy variables: region identifiers (i.e. euro area groups B and C), CoCo, foreign exchange issuance, rating, seniority, coupon type and time.

Table 23: First stage regressions from the iterative GMM model of Volatility on Liquidity (Effective spreads), Holdings and Controls
Euro area issuance sample

	Effective Spreads	CI	Gov	IVF	MMF	ICPF	OFI	U
Residual maturity (days)	-0.00302*** (4.96e-05)	9.31e-07 (2.39e-05)	1.18e-05 (7.80e-06)	2.52e-05 (3.43e-05)	-7.42e-05*** (1.18e-05)	5.59e-05*** (2.10e-05)	-2.00e-05 (2.15e-05)	-5.38e-07 (3.42e-07)
Off the run dummy	0.0519*** (0.108)	-0.0516 (0.112)	-0.000286 (0.0243)	0.0588 (0.0859)	0.0121 (0.0414)	0.00626 (0.0679)	-0.0219 (0.0239)	-0.000703 (0.00215)
lag CI	-0.000431*** (0.000146)	0.975*** (0.00229)	-0.000106 (0.000139)	-0.000903 (0.000661)	-8.40e-05 (0.000390)	-0.00184*** (0.000560)	-0.000281 (0.000331)	5.53e-05*** (1.96e-05)
lag Gov	-0.00156** (0.000617)	-0.0147*** (0.00333)	0.995*** (0.00279)	-0.00336*** (0.00112)	-4.73e-05 (0.000691)	-0.00142 (0.000943)	-8.56e-06 (0.000368)	0.000111* (6.24e-05)
lag IVF	-0.000382 (0.000258)	0.0143*** (0.00401)	0.000112 (0.000305)	0.961*** (0.00431)	0.00389*** (0.000759)	0.00203** (0.000923)	-0.000429 (0.000494)	6.54e-05 (4.39e-05)
lag MMF	-0.00402*** (0.000357)	0.0157 (0.105)	9.76e-05 (0.000348)	0.00586 (0.00428)	0.933*** (0.0134)	0.000193 (0.00101)	-0.00178** (0.000900)	4.18e-05 (0.000103)
lag ICPF	-0.00107*** (0.000218)	-0.00951*** (0.00213)	0.000887 (0.000728)	-0.000849 (0.00129)	0.00138*** (0.000469)	0.984*** (0.00253)	-0.000438 (0.000431)	5.29e-05* (2.91e-05)
lag OFI	-0.00196*** (0.000442)	0.00539 (0.0135)	6.35e-06 (0.000266)	0.0103 (0.0102)	0.00117 (0.000994)	0.00163 (0.00297)	0.945*** (0.0197)	7.39e-05 (4.95e-05)
lag U	-0.0197* (0.0117)	-0.201 (0.372)	-0.0924 (0.0673)	0.0121 (0.267)	0.354** (0.142)	0.0256 (0.0579)	-0.00428 (0.0260)	0.533*** (0.0762)
Excess Volatility: benchmark	0.00286*** (0.000153)	-0.000155 (0.00121)	-0.000470 (0.000379)	0.000258 (0.00109)	5.27e-05 (0.000322)	-0.00175* (0.000980)	0.000624 (0.000596)	-2.92e-05* (1.69e-05)
Excess Volatility: own history	0.000573*** (9.06e-05)	0.00145 (0.000909)	3.15e-05 (0.000131)	-0.000147 (0.000709)	1.43e-05 (0.000392)	0.000637 (0.000558)	-8.69e-05 (0.000273)	-9.76e-06 (2.54e-05)
Issuance maturity (days)	-0.000550*** (0.000186)	-0.000422 (0.000974)	-0.000433 (0.000282)	-0.000692 (0.00124)	0.00265*** (0.000424)	-0.00205*** (0.000762)	0.000682 (0.000777)	1.72e-05 (1.21e-05)
Issuance price	0.000454 (0.00166)	-0.0108 (0.0104)	-0.00217 (0.00154)	-0.00693 (0.00727)	0.000180 (0.00919)	-0.0115** (0.00556)	0.00202 (0.00188)	0.000344*** (0.000103)
Coupon rate	0.0113*** (0.00295)	-0.0276 (0.0225)	-0.00534 (0.00374)	0.00886 (0.0161)	-0.00398 (0.00892)	0.0271** (0.0121)	-0.0116 (0.00765)	-0.000964** (0.000396)
Amounts outstanding (mn EUR)	-1.67e-05*** (6.23e-06)	0.000296*** (7.63e-05)	-6.35e-06 (8.03e-06)	-6.47e-05* (3.45e-05)	6.06e-05* (3.21e-05)	9.26e-05*** (3.06e-05)	-6.04e-06 (1.64e-05)	5.59e-06*** (1.70e-06)
Herfindahl index	0.0230 (0.0158)	3.382*** (0.353)	-0.0265 (0.0278)	-0.00223 (0.144)	-0.113 (0.0886)	0.313*** (0.115)	-0.0177 (0.0739)	-0.0268*** (0.00472)
Yield to maturity	0.000860 (0.00141)	-0.0162*** (0.00727)	0.000109 (0.00124)	-0.00863*** (0.00334)	-0.00672*** (0.00172)	0.00103 (0.00295)	0.00178 (0.00112)	8.02e-05* (4.81e-05)
Control dummies	YES	YES	YES	YES	YES	YES	YES	YES
Observations	27,008	27,008	27,008	27,008	27,008	27,008	27,008	27,008
Adjusted R-squared	0.141	0.985	0.975	0.957	0.909	0.984	0.933	0.251

Clustered standard errors in parentheses, ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. All first stage regressions contain an intercept, as well as the following exogenous dummy variables: region identifiers (i.e. euro area groups B and C), CoCo, foreign exchange issuance, rating, seniority, coupon type and time.

Table 24: First stage regressions from the iterative GMM model of Bid-Ask/Mid on Volatility, Holdings and Controls
Euro area issuance sample.

	Volatility of daily returns	CI	Gov	IVF	MMF	ICPF	OFI	U
Excess Volatility: benchmark	0.00324 *** (7.01e-05)	-0.00112 (0.00120)	-0.000446 (0.000363)	0.000444 (0.00103)	0.000120 (0.000303)	-0.00139 (0.000935)	0.000579 (0.000571)	-2.95e-05* (1.59e-05)
Excess Volatility: own history	0.000798 *** (2.75e-05)	0.00158* (0.000917)	6.30e-05 (0.000130)	-0.000254 (0.000687)	1.61e-05 (0.000389)	0.000589 (0.000552)	-0.000211 (0.000279)	-4.86e-06 (2.48e-05)
lag CI	-5.71e-05* (3.25e-05)	0.973 *** (0.00242)	-0.000126 (0.000136)	-0.000887 (0.000647)	-7.50e-05 (0.000378)	-0.00189*** (0.000549)	-0.000228 (0.000324)	5.11e-05*** (1.92e-05)
lag Gov	-0.000320*** (8.65e-05)	-0.0154*** (0.00332)	0.996 *** (0.00259)	-0.00346*** (0.00106)	-0.000223 (0.000674)	-0.00143 (0.000916)	-4.24e-05 (0.000360)	8.81e-05 (5.86e-05)
lag IVF	3.01e-05 (6.57e-05)	0.0126*** (0.00394)	0.000180 (0.000298)	0.962 *** (0.00416)	0.00353*** (0.000706)	0.00214** (0.000918)	-0.000421 (0.000496)	7.61e-05* (4.31e-05)
lag MMF	-0.000485*** (7.00e-05)	0.0222* (0.0119)	0.000319 (0.000380)	0.00810 (0.00506)	0.928 ** (0.0138)	0.000637 (0.00116)	-0.00145 (0.000970)	2.76e-05 (0.000117)
lag ICPF	-0.000176** (7.36e-05)	-0.0116*** (0.00219)	0.000825 (0.000672)	-0.000805 (0.00122)	0.00117*** (0.000432)	0.984 *** (0.00236)	-0.000387 (0.000420)	5.11e-05* (2.79e-05)
lag OFI	-6.00e-05 (0.000168)	0.00467 (0.0133)	3.58e-05 (0.000264)	0.00978 (0.00998)	0.00120 (0.000951)	0.000285 (0.00320)	0.941 *** (0.0194)	7.34e-05 (4.78e-05)
lag U	-0.00914*** (0.00237)	-0.125 (0.394)	-0.0961 (0.0706)	0.00562 (0.281)	0.248*** (0.0909)	0.0451 (0.0630)	-0.00621 (0.0280)	0.499 *** (0.0675)
Residual maturity (days)	-0.000236*** (2.19e-05)	1.15e-05 (2.44e-05)	1.06e-05 (7.32e-06)	2.59e-05 (3.26e-05)	-7.08e-05*** (1.07e-05)	5.24e-05*** (2.00e-05)	-1.63e-05 (2.02e-05)	-5.50e-07* (3.33e-07)
Off the run dummy	0.00539*** (0.00195)	0.0614 (0.113)	-0.00132 (0.0231)	0.103 (0.0858)	0.0241 (0.0396)	0.000950 (0.00664)	-0.0215 (0.0247)	-0.000750 (0.00211)
Issuance maturity (days)	-0.000864*** (8.08e-05)	-0.000312 (0.000908)	-0.000376 (0.000264)	-0.000784 (0.00118)	0.00254*** (0.000387)	-0.00188*** (0.000723)	0.000568 (0.000730)	1.79e-05 (1.17e-05)
Issuance price	-0.00199*** (0.000477)	-0.0123 (0.0101)	-0.00204 (0.00147)	-0.00750 (0.00693)	0.000469 (0.00880)	-0.0119** (0.00540)	0.00231 (0.00187)	0.000363*** (9.74e-05)
Coupon rate	0.00324 (0.00233)	-0.0368* (0.0219)	-0.00465 (0.00338)	0.0111 (0.0149)	-0.00471 (0.00809)	0.0274** (0.0123)	-0.0132* (0.00760)	-0.000847** (0.000365)
Amounts outstanding (mn EUR)	-4.67e-06*** (1.58e-06)	0.000311*** (7.63e-05)	-4.59e-06 (8.48e-06)	-5.96e-05* (3.39e-05)	5.17e-05 (3.18e-05)	9.14e-05*** (2.99e-05)	-7.76e-06 (1.70e-05)	6.06e-06*** (1.66e-06)
Herfindahl index	-0.0121** (0.00514)	3.605*** (0.366)	-0.0229 (0.0277)	0.00344 (0.141)	-0.157* (0.0872)	0.332*** (0.112)	-0.0326 (0.0764)	-0.0263*** (0.00454)
Yield to maturity	0.00289*** (0.000627)	-0.0196** (0.00787)	0.00104 (0.00124)	-0.0103*** (0.00362)	-0.00670*** (0.00167)	-0.000560 (0.00318)	0.00226* (0.00127)	7.80e-05 (5.15e-05)
Control dummies	YES	YES	YES	YES	YES	YES	YES	YES
Observations	27,637	27,637	27,637	27,637	27,637	27,637	27,637	27,637
Adjusted R-squared	0.615	0.984	0.977	0.957	0.896	0.985	0.929	0.222

Clustered standard errors in parentheses, ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively. All first stage regressions contain an intercept, as well as the following exogenous dummy variables: region identifiers (i.e. euro area groups B and C), CoCo, foreign exchange issuance, rating, seniority, coupon type and time.

Table 25: First stage regressions from the iterative GMM model of Effective Spreads on Volatility, Holdings and Controls
Euro area issuance sample.

	Volatility of daily returns							
	CI	Gov	IVF	MMF	ICPF	OFI	U	
Excess Volatility: benchmark	0.00320 *** (6.87e-05)	-0.000470 (0.000379)	0.000258 (0.00109)	5.27e-05 (0.000322)	-0.00175* (0.000980)	0.000624 (0.000596)	-2.92e-05* (1.69e-05)	
Excess Volatility: own history	0.000773 *** (2.43e-05)	3.15e-05 (0.000909)	-0.000147 (0.000709)	1.43e-05 (0.000392)	0.000637 (0.000558)	-8.69e-05 (0.000273)	-9.76e-06 (2.54e-05)	
lag CI	0.975 *** (3.20e-05)	-0.000106 (0.000139)	-0.000903 (0.000661)	-8.40e-05 (0.000390)	-0.00184*** (0.000560)	-0.000281 (0.000331)	5.53e-05*** (1.96e-05)	
lag Gov	-0.000312*** (8.51e-05)	0.995 *** (0.00279)	-0.00336*** (0.00112)	-4.73e-05 (0.000691)	-0.00142 (0.000943)	-8.56e-06 (0.000368)	0.000111* (6.24e-05)	
lag IVF	1.35e-05 (6.58e-05)	0.000112 (0.000305)	0.961 *** (0.00431)	0.00389*** (0.000759)	0.00203*** (0.000923)	-0.000429 (0.000494)	6.54e-05 (4.39e-05)	
lag MMF	-0.000406*** (5.96e-05)	0.0157 (0.0105)	0.00586 (0.00428)	0.933 *** (0.0134)	0.000193 (0.00101)	-0.00178** (0.000900)	4.18e-05 (0.000103)	
lag ICPF	-0.000192*** (7.16e-05)	-0.00951*** (0.00213)	-0.000849 (0.00129)	0.00138*** (0.000469)	0.984 *** (0.00253)	-0.000438 (0.000431)	5.29e-05* (2.91e-05)	
lag OFI	-0.000111 (0.000148)	0.00539 (0.0135)	0.0103 (0.0102)	0.00117 (0.000994)	0.00163 (0.00297)	0.945 *** (0.0197)	7.39e-05 (4.95e-05)	
lag U	-0.00916*** (0.00221)	-0.201 (0.372)	0.0121 (0.267)	0.354** (0.142)	0.0256 (0.0579)	-0.00428 (0.0260)	0.533 *** (0.0762)	
Residual maturity (days)	-0.000231*** (2.08e-05)	9.31e-07 (2.39e-05)	2.52e-05 (3.43e-05)	-7.42e-05*** (1.18e-05)	5.59e-05*** (2.10e-05)	-2.00e-05 (2.15e-05)	-5.38e-07 (3.42e-07)	
Off the run dummy	0.00728*** (0.00224)	-0.0516 (0.112)	0.0588 (0.0859)	0.0121 (0.0414)	0.00626 (0.0679)	-0.0219 (0.0239)	-0.000703 (0.00215)	
Issuance maturity (days)	-0.000850*** (7.67e-05)	-0.000422 (0.000974)	-0.000692 (0.00124)	0.00265*** (0.000424)	-0.00205*** (0.000762)	0.000682 (0.000777)	1.72e-05 (1.21e-05)	
Issuance price	-0.00194*** (0.000458)	-0.0108 (0.0104)	-0.00693 (0.00727)	0.000180 (0.000919)	-0.0115** (0.00556)	0.00202 (0.00186)	0.000344*** (0.000103)	
Coupon rate	0.00313 (0.00218)	-0.0276 (0.0225)	0.00886 (0.0161)	-0.00398 (0.00892)	0.0271** (0.0121)	-0.0116 (0.00765)	-0.000964** (0.000396)	
Amounts outstanding (mn EUR)	-4.17e-06*** (1.52e-06)	0.000296*** (7.63e-05)	-6.47e-05* (3.45e-05)	6.06e-05* (3.21e-05)	9.26e-05*** (3.06e-05)	-6.04e-06 (1.64e-05)	5.59e-06*** (1.70e-06)	
Herfindahl index	-0.00977** (0.00482)	3.382*** (0.353)	-0.00223 (0.144)	-0.113 (0.0886)	0.313*** (0.115)	-0.0177 (0.0739)	-0.0268*** (0.00472)	
Yield to maturity	0.00273*** (0.000587)	-0.0162** (0.00727)	-0.00863*** (0.00334)	-0.00672*** (0.00172)	0.00103 (0.00295)	0.00178 (0.00112)	8.02e-05* (4.81e-05)	
Control dummies	YES	YES	YES	YES	YES	YES	YES	
Observations	27,008	27,008	27,008	27,008	27,008	27,008	27,008	
Adjusted R-squared	0.625	0.985	0.957	0.909	0.984	0.933	0.251	

Clustered standard errors in parentheses, ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively. All first stage regressions contain an intercept, as well as the following exogenous dummy variables: region identifiers (i.e. euro area groups B and C), CoCo, foreign exchange issuance, rating, seniority, coupon type and time.

Results using less conservative market data restrictions

In the interest of using a sample which is free from outliers, our main results are estimated using a dataset which enforces several restrictions on the market data side. Some of these constraints may lead to a sample populated by the most liquid issuances. As a robustness check, we verify that the relationships we identify hold also for an unfiltered sample.

To this end, we construct an alternative sample, where the observations that contain prices which do not vary for three days in a row, as well as quarters for which we do not have at least 20 business days' worth of data are no longer eliminated from the sample. This leads to a gain of 24,958 ISIN-quarter observations relative to the original dataset, with the quarterly distribution depicted in Table 26. The drop in the number of observations for 2015q4 is still present, despite a gain of 118 data points and is driven in both cases by data availability at the source.

Table 26: Distribution of SHSS ISIN-quarter datapoints, unrestricted market data

date	without market data or under ECB non-standard purchases	with market data (in the estimation sample)	Total
2013q4	92,110	12,917	105,027
2014q1	93,828	13,816	107,644
2014q2	95,706	13,870	109,576
2014q3	95,742	13,862	109,604
2014q4	93,705	13,227	106,932
2015q1	94,578	12,501	107,079
2015q2	94,885	12,245	107,130
2015q3	92,670	12,096	104,766
2015q4	82,123	2,287	84,410
2016q1	97,073	12,031	109,104
Total	932,420	118,852	1,051,272

Table 28¹⁹ shows that the results for the liquidity equation are by and large in line with the original iterative GMM specifications for all issuance samples considered. The main sectors identified as relevant for the liquidity and volatility conditions of secondary bank bond markets, IVF and MMF, are highly statistically significant and their effect is slightly larger, albeit within the same order of magnitude as the main sample results.

The volatility equations for the alternative sample are presented in Table 29. The estimates for the main sectors identified by our analysis maintain their statistical significance and sign for this sample, while their magnitudes are smaller. This effect can be explained by the fact the new data points, which are primarily based on prices that do not exhibit variation from

¹⁹ Figures are bolded only if the results are statistically significant for both liquidity measures tested and for all samples considered.

day to day, have a downward biasing effect on the volatility measure since the latter is the realized standard deviation of daily returns (see Table 27).

Table 27: Mean and median of market conditions variables by sample; original sample values in parentheses

	EA	EU	Worldwide
Mean: Bid-Ask/Mid price	0.5432215 (0.3956833)	0.5636658 (0.3978056)	0.5487845 (0.3889574)
Median: Bid-Ask/Mid price	0.2893209 (0.2271355)	0.3028342 (0.2260259)	0.2759487 (0.20795)
Mean: Effective Spread	0.7719597 (0.3492168)	0.7593806 (0.3497587)	0.7293757 (0.3383855)
Median: Effective Spread	0.3003359 (0.2226167)	0.3112443 (0.2218015)	0.2861933 (0.2143902)
Mean: Volatility	0.0014937 (0.1459716)	0.0016667 (0.1588018)	0.0017929 (0.1724935)
Median: Volatility	0.0007325 (0.0787342)	0.0007813 (0.0863194)	0.0007933 (0.0992256)

However, in relative terms, the volatility results are comparable. Using the new sample's median, for example, we can see that for the worldwide issuances a 10 pp. increase in the holdings of the IVF sector (for the case of a representative bond with volatility at the median of the new sample) leads to an increase in the realized volatility of 12.86% (13.61%) depending on which liquidity measure we use as a control. For the original sample, this effect was somewhat smaller at 5.3% (5.8%).

Similarly, for the case of MMFs, a 10 pp. increase in holdings leads to an increase of 24.58% (13.36%) in volatility, whereas the original sample places these figures around 15.12% (15.02%). The remaining sectors and issuance sub-samples see a relative effect in line with the main findings, albeit adjusted in magnitude due to the new scaling induced by the non-varying data points.

Table 28: Regression of Liquidity measures on Volatility, Holdings and Controls					
	Bid-Ask/Mid			Effective spreads	
	Worldwide issuance	European Union issuance	Euro Area issuance	Worldwide issuance	European Union issuance
Volatility	75.5608004 *** (5.1372840)	76.2420389 *** (5.9382874)	83.7157779 *** (7.7880287)	71.8443022 *** (13.3972172)	72.5733169 *** (16.8866465)
CI	-0.0012744 *** (0.0004501)	-0.0009074 *** (0.0003422)	-0.0007951 ** (0.0003673)	-0.0020272 ** (0.0009167)	-0.0021870 ** (0.0008872)
Gov	0.0006205 (0.0009829)	0.0008508 (0.0008163)	0.0007828 (0.0007684)	-0.0043347*** (0.0013965)	-0.0055337*** (0.0014739)
IVF	-0.0023749 *** (0.0005090)	-0.0020526 *** (0.0004232)	-0.0019654 *** (0.0004696)	-0.0062629 *** (0.0009030)	-0.0063236 *** (0.0009865)
MMF	-0.0045528 *** (0.0005424)	-0.0047536 *** (0.0005214)	-0.004910 *** (0.0006323)	-0.0062598 *** (0.0010456)	-0.0061930 *** (0.0012011)
ICPF	-0.0006317 (0.0006069)	-0.0002470 (0.0006013)	-0.0002117 (0.0006578)	-0.0047109*** (0.0010897)	-0.0045120*** (0.0011746)
OFI	0.0017292 (0.0018127)	0.0022255 (0.0019230)	0.0014423 (0.0020728)	-0.0037913** (0.0016477)	-0.0041627** (0.0017197)
U	-0.0004552 (0.0005779)	-0.0000399 (0.0005564)	-0.0001708 (0.0006830)	-0.0035944*** (0.0010061)	-0.0038291*** (0.0011116)
Controls	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES	YES
ISIN-Quarter observations	82,238	61,309	48,923	87,394	66,330
ISINs	20,872	15,447	12,162	22,229	16,670
Hansen J statistic,	1.8933	1.3704	1.4579	1.1016	0.9104
chi(1)	(p = 16.88)	(p = 24.17)	(p = 22.73)	(p = 29.39)	(p = 34.00)
Estimation method	iGMM	iGMM	iGMM	iGMM	iGMM
Standard Errors	Clustered (1426 bank IDs)	Clustered (628 bank IDs)	Clustered (450 bank IDs)	Clustered (1430 bank IDs)	Clustered (629 bank IDs)
					Clustered (450 bank IDs)

Standard errors in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Where: CI = Credit Institutions, Gov = Government, IVF = Investment Funds, MMF = Money Market Funds, ICPF = Insurance Corporations and Pension Funds, OFI = Other Financial Institutions, U = unidentified sectors outside the euro area. The effects are relative to the holdings of the Non-financial Private Sector.

Table 29: Regression of Volatility on Liquidity, Holdings and Controls Unrestricted market data sample					
	Volatility of daily returns			Volatility of daily returns	
	Worldwide issuance	European Union issuance	Euro Area issuance	Worldwide issuance	European Union issuance
Bid-Ask/Mid	0.0046151*** (0.0006826)	0.0048388*** (0.0009075)	0.0038655*** (0.0009745)	0.0019132*** (0.0004922)	0.0017404*** (0.0005467)
Effective spreads					0.0011607*** (0.0004101)
CI	0.0000052** (0.0000021)	0.0000037** (0.0000018)	0.0000029* (0.0000017)	0.0000031 (0.0000023)	0.0000028 (0.0000018)
Gov	-0.0000052 (0.0000044)	-0.0000069* (0.0000039)	-0.0000049 (0.0000031)	0.0000070*** (0.0000025)	0.0000057** (0.0000026)
IVF	0.0000102*** (0.0000026)	0.0000090*** (0.0000027)	0.0000067*** (0.0000026)	0.0000108*** (0.0000029)	0.0000093*** (0.0000031)
MMF	0.0000195*** (0.0000038)	0.0000211*** (0.0000052)	0.0000149*** (0.0000055)	0.0000106*** (0.0000037)	0.0000086** (0.0000041)
ICPF	0.0000016 (0.0000028)	-0.0000001 (0.0000028)	0.0000006 (0.0000025)	0.0000070*** (0.0000026)	0.0000054** (0.0000026)
OFI	-0.0000044 (0.0000082)	-0.0000082 (0.0000088)	-0.0000052 (0.0000077)	0.0000092** (0.0000037)	0.0000084** (0.0000036)
U	0.0000048* (0.0000028)	0.0000034 (0.0000028)	0.0000022 (0.0000026)	0.0000106*** (0.0000023)	0.0000107*** (0.0000026)
Controls	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES
Regional FE	YES	YES	YES	YES	YES
ISIN-Quarter observations	82,238	61,309	48,923	87,394	66,330
ISINs	20,872	15,447	12,162	22,229	16,670
Hansen J statistic, chi(1)	1.1075 (p = 29.26)	2.010 (p = 15.62)	0.1157 (p = 73.38)	0.8122 (p = 36.75)	1.9701 (p = 16.04)
Estimation method	iGMM	iGMM	iGMM	iGMM	iGMM
Standard Errors	Clustered (1426 bank IDs)	Clustered (628 bank IDs)	Clustered (450 bank IDs)	Clustered (1430 bank IDs)	Clustered (629 bank IDs)
					Clustered (450 bank IDs)

Standard errors in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Where: CI = Credit Institutions, Gov = Government, IVF = Investment Funds, MMF = Money Market Funds, ICPF = Insurance Corporations and Pension Funds, OFI = Other Financial Institutions, U = unidentified sectors outside the euro area. The effects are relative to the holdings of the Non-financial Private Sector.

Acknowledgements

This paper has benefitted from insightful comments and suggestions from Jan Pieter Krahnert and Simone Manganelli. We are also grateful for very useful comments and discussions with Ivan Alves, Mahir Binici, Lorenzo Cappiello, Horst Entorf, Alvaro Santos Rivera, Eugen Tereanu and further colleagues at the ECB. The kind help on dataset related issues from Urszula Kochanska, Christian Perales, Linda Fache Rousová and the ECB's Market Data team are gratefully acknowledged. All remaining errors are our own. The views expressed in the paper are those of the authors and do not necessarily reflect those of the ECB.

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ISBN 978-92-899-3538-8

ISSN 1725-2806

doi:10.2866/46155

QB-AR-19-057-EN-N