Liquidity in the UK corporate bond market: evidence from trade data

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Contents

Summary

We present evidence on the evolution of liquidity in the UK corporate bond market for the period 2008–2014. On the basis of a series of widely accepted liquidity measures, we document that there is no evidence that liquidity outcomes have deteriorated in the market, despite the decline in inventory of dealers in this period. If anything, the market appears to have become more liquid in recent years.

We also document that there is little evidence that liquidity is having a larger effect on bond spreads now than a few years ago.

We do not find evidence that liquidity has become more 'flighty' in response to shocks of a mild to moderate nature, as measures of liquidity risk do not increase over the period of analysis. However, we do not claim that there are no risks associated with liquidity. Our own analysis shows that liquidity is subject to considerable deterioration if the market is under severe stress; there was considerably less liquidity in 2009/10 than either before or after this period.

Our claim is weaker: the regulatory interventions that have been introduced since the financial crisis and implemented up to the end of 2014 did not result in less liquidity in normal times and did not result in liquidity being more 'flighty' when shocks of a mild nature hit the system. Of course, our conclusions are only valid for the market and the sample period we analyse.

We are putting forward this study as a contribution to the ongoing domestic and international debate on liquidity in financial markets in which various regulators and practitioners have been involved in the last few years.

1 Overview

Purpose

The purpose of this paper is to contribute to the ongoing debate on liquidity in financial markets by shedding light on a market that has not been studied in depth. By leveraging the transaction level data available to the FCA as the national competent authority, we analyse the evolution of liquidity in UK corporate bond markets for the period 2008–2014.

Corporate bond markets are important for households and companies alike as they are used as a vehicle to invest savings and to finance projects. Negative impacts on the liquidity of such markets can therefore have significant effects on the real economy. Since the financial crisis, a number of commentators have argued that liquidity in corporate bonds has indeed declined, but this was on the basis of a number of proxy measures and anecdotal evidence.

Our study is, to our knowledge, the first systematic assessment of liquidity in UK corporate bond markets with transaction-level data.

Key findings

Inventories have declined while liquidity has remained stable

We document a decline in the inventories by UK primary dealers. On the basis of regulatory returns, we estimate that dealers held approximately £400bn of inventories on their trading books in mid-2008; this declined to £250bn at the end of 2014.

However, such decline in inventories did not imply a reduction in liquidity in the market. All the measures of illiquidity show a remarkably consistent pattern: they start from reasonably low levels at the beginning of our sample (2008 Q1), then increase for the subsequent quarters when the financial crisis hit, and subsequently decline to a very low level by the end of 2011, remaining stable ever since.

Liquidity risk does not seem to have increased

The measures of liquidity risk, i.e. the risk of changing liquidity, follow a pattern similar to the measures of liquidity levels. We do not find evidence for an increase of short-term variations in liquidity, and therefore do not find that liquidity became more ‘flighty’ since the financial crisis. In this period, some mild and moderate shocks that could have led to episodes of higher volatility did hit the system (for instance, the ‘taper tantrum’ in Q2 and Q3 of 2013 or the US treasury *flash crash* in Q4 2014), but we cannot see any meaningful spikes in the liquidity risk measures. In summary, liquidity risk remained flat since 2011. Our findings are consistent with recent evidence on the French (Autorité des marchés financiers, 2015) and the US bond markets (FINRA, 2015).

The liquidity component of yield spreads is declining or stable

Lack of liquidity in bond markets has potentially negative implications for issuers' cost of capital and, in turn, for the real economy. We therefore investigate whether liquidity is now responsible for a larger share of yield spreads than it was in the past. We cannot find such evidence to support this. For investment grade bonds, the composite liquidity measure is responsible for, on average, 0.01 basis points of the credit yield spread – not statistically different from zero. For speculative bonds, the contribution of the liquidity measure is 13.5 basis points, or 3.4% of the total spread.

We also calculate a time series for the liquidity component. Unfortunately, the sample for the initial period of analysis is too small to draw conclusions. However, the pattern followed by the estimated liquidity components for investment grade and speculative bonds from the end of 2011 up to the end of 2014 is downwards or stable. While the liquidity component of spreads for speculative bonds fluctuated, it remained stable overall, and there is evidence that the impact of liquidity on the spread of investment grade bonds declined.

Liquidity could still decline under stress

Our results do not imply that liquidity will always be there when people demand it. In fact, our own analysis shows that there was considerably less liquidity in 2009/10 than either before or after this period. Further, it is likely that a similar pattern will emerge in the future if the markets were to experience periods of extreme stress. Therefore, our results should not be misinterpreted to imply that there are no risks associated with liquidity. Our claim is weaker: there is not less liquidity in normal times and liquidity has not become more 'flighty' when shocks of a mild nature hit the system. Our evidence is not consistent with contentions that regulatory interventions have reduced liquidity in secondary bond markets, but is consistent with recent academic evidence on the effect of regulation on liquidity in the US corporate bond market (Trebbi & Xiao, 2015).

2 Research context

The importance of corporate bond markets

Corporate bond markets are an important source of financing for companies and a way for households to invest their savings. They also allow companies to fund projects without having to rely on bank loans. Understanding their functioning is therefore important for regulators, given the potential impact they have on the welfare of a number of different economic agents and the economy as a whole. A crucial aspect of a well-functioning financial market is whether it is appropriately liquid.

In recent years, a number of academic commentators and market participants suggested that the degree of liquidity in corporate bond markets was diminishing[1], with potentially adverse consequences for financial stability. Frequently, the more stringent regulation of bank capital, resulting in declining inventories of dealers, is named as a contributing factor to the decline in liquidity. Others have argued that the levels of liquidity seen before the onset of the financial crisis were artificially high because of the implicit subsidy given to 'too big to fail' banks which would then engage in 'excessive' liquidity provision.[2]

While we cannot address the question of the socially optimal level of liquidity, we do want to provide a factual basis for the discussion. Due to the limited amount of data available, most of the commentaries on UK bond markets have been based on either: 1) a few proxies for liquidity, such as the number of times a bond trades in a given time period or the overall inventories held by bond dealers; or 2) data from the US.[3]

The FCA does have access to granular trade-level information for the UK market. We can therefore contribute to the debate by calculating a number of liquidity measures for the period January 2008 to December 2014 – a period for which we hold data of sufficiently high quality. The data allows us to construct a series of measures that consider trading information and not simply quoted bid-ask spreads or other proxies for liquidity. As such, they focus specifically on the observed outcomes of the actions of traders, and give a proper representation of the market conditions experienced by market participants.

Our analysis then provides evidence on whether realised liquidity measures have been worsening since the financial crisis, and whether this has implications for the resilience of the market.

[1] See, for example, PWC, *Global Financial Market Liquidity Study* (2015).

[2] Chapter 2 of the IMF's *Global Financial Stability Report*, published in October 2015, describes the issues in detail.

[3] See, for example, FINRA (2015).

3 Method and approach

Defining and measuring liquidity

Liquidity is an important characteristic of any financial market, but it is very difficult to define precisely: different economic models yield different definitions (Hasbrouck, 2007). However, there are a number of characteristics that most of the models have in common. In a liquid market, a small change in the quantity demanded or supplied should not lead to a large change in the price of the security being traded. In a similar fashion, a liquid market is one where participants can buy or sell their securities cheaply, i.e. trading costs are low. Liquidity can also be defined dynamically: if a market is liquid, buying or selling a (reasonable amount of a) security in a short period of time should not be much more expensive than buying or selling it in a longer timeframe.

Baker (1996) mentions three relevant features of liquidity: depth, breadth and resilience. A deep market is one where there is a large quantity available to sell or purchase at prices both above and below the current market price. A broad market is one where many participants, none of which has significant influence on the price, are present. A resilient market is one where the price effects associated with trading (and not with changes in the fundamental value of a security) are small and fade quickly.

Liquidity is the result of the interaction of a number of specific features of the market: the way in which securities are traded, the kind of market participants, and the characteristics of the security itself. For example, one would expect lower levels of liquidity in bond markets than in equity markets: bonds are typically less standardised (one issuer can have many bonds outstanding) and they are often held by investors who do not want to trade the security before maturity.

Equities, on the other hand, are mostly traded on centralised exchanges and therefore data for this asset class has always been easier to obtain than for bonds. For similar reasons, most liquidity measures have been developed for equities and, although in many cases the same approach can be used to measure liquidity in bond markets, this is not always the case.

While we do not replicate exactly their analysis, our approach in this paper closely follows the one of Dick-Nielsen et al (2012).

Liquidity measures

There are many measures that can be used (Schestag et al (2014) list 21 different ones). In our study, we focus on those most commonly used in the literature, which capture the abovementioned different aspects of liquidity.

- The Amihud (2002) index, which measures the average price impact on a given day. It can therefore be considered a measure of depth and resilience.

- A measure of imputed roundtrip costs (IRC) similar to Feldhutter (2012), which is a proxy for the realised bid-ask spread and therefore transactions costs.[4]
- The Bao, Pan Wang (BPW, 2011) measure, which estimates the magnitude of price reversals.
- The turnover ratio and the number of zero trading days. These measures may capture aspects like breadth and depth of the market.

We also calculate the standard deviation of the daily Amihud and roundtrip cost measures[5] to take into account that investors may not only care about the level of liquidity at a given point in time, but also about its variability.

In addition to the measures described above, we also calculate a composite measure of liquidity that captures the most important aspect of liquidity common to all measures. It is defined as a weighted average[6] of the Amihud, BPW, Feldhutter and 'Amihud risk' measures. This measure captures a considerable share of the overall variation in liquidity measures and allows us to have a synthetic indicator of the level of liquidity in the market.

Given the nature of our dataset, all our measures are based on transactions that did take place and, as such, are 'realised' liquidity measures. Our data is not suitable for analysing whether it takes longer to execute transactions than it did in the past or whether the cost of the subset of transactions that need to be executed very quickly has increased since the crisis. Dick-Nielsen and Rossi (2016) find evidence that the cost of immediacy has increased in the US market since the crisis.

The liquidity component of bond spreads

After identifying the level of liquidity in the market, we want to understand the economic effect that liquidity or a lack thereof has for market participants – in this case, investors and issuers. We therefore compute a measure of the illiquidity component of bond (yield) spreads. The measure is defined as the differences in bond yields between a bond with average liquidity and a very liquid bond (see Appendix 2 for a detailed definition). In this way, we can estimate how much illiquidity contributes to bond spreads and determine whether the liquidity premium is changing over time.

For instance, if we were to find that the illiquidity component of spreads is increasing over time, then we may reasonably conclude that the cost of capital of issuing companies might be increasing as well. Such an increase would clearly have a knock-on effect on the real economy.

Data

Our analysis is based on data for corporate bonds for which the FCA is the national competent authority. This means that we observe all the transactions that take place in these bonds[7] and can be reasonably sure that we have a comprehensive picture of the entire market because of regulatory obligations of reporting firms.

[4] Quoted bid-ask spreads for corporate bonds are less informative, as quotes are usually non-binding and there is no minimum quantity attached to the quoted prices. Transaction costs can comprise: 1) order processing costs; 2) dealer inventory costs; 3) costs arising from asymmetric information; and 4) rents associated with market power.

[5] We do not include the standard deviation of the BPW measure as it is calculated weekly rather than daily.

[6] The weights are based on a principal component analysis.

[7] The only transactions for which we do not necessarily receive a report are those that involve two non-EEA counterparties. See the FCA's transaction reporting user manual (TRUP) for a detailed description of the reporting requirements.

The transactions reports we have available contain detailed information about the trades. As well as price and quantity, we have information on the security that is traded, the time at which the trade took place, and the counterparties to the trade.

From November 2007 to August 2011, the FCA used a system called Sabre II to collect the data, and a system called Zen since August 2011. The coverage of Zen in terms of number of corporate bonds is considerably larger than the coverage of Sabre II. The quality of the transaction reports is also higher in Zen.

Table 1: Sample characteristics

	Sabre II	Zen
Period of coverage	November 2007–August 2011	August 2011–December 2014
# of bonds	409	6,291
# of transactions	~180,000	~3,000,000
Currency		
GBP	53%	42%
EUR	31%	39%
USD	8%	15%
Other	8%	4%
Issuer industry		
Financials	92%	84%
Maturity at date of transaction		
<1 year	5%	6%
1–3 years	17%	17%
3–5 years	25%	18%
5–10 years	12%	36%
>10 years	4%	14%
N/A	37%	9%

Source: FCA, Sabre II and Zen databases

Table *1* summarises some basic information on the composition of the sample in Sabre II and Zen. The two samples are obviously different and some of the variation we observe, particularly in the period just before and just after the change from one to the other, is likely to be due to the different sample of bonds. Coverage is much improved once we move to the Zen dataset with more than 6,000 bonds active in the period August 2011 to December 2014, compared to about 400 bonds in the period November 2007 to August 2011. Approximately half of both datasets are trades carried out in GBP, with the other major currencies being Euro and US$. The vast majority of trades are carried out in bonds issued by financial companies. Maturity profiles are diverse.

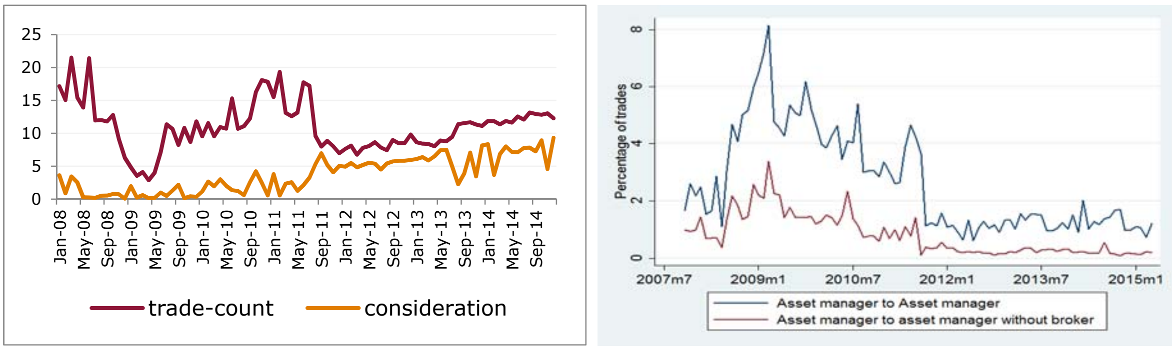
4 Results

A brief description of the UK corporate bond market

Our first result is that the structure of the UK corporate bond market has not changed markedly in the last eight years. Panel a) of Figure *1* shows that around 90% of trades are carried out off-exchange, with electronic trading platforms only slowly gaining market shares.[8] As a consequence, we do not see an increase in all-to-all trading during the last three years. All-to-all trading was, however, at higher levels during the financial crisis.[9] We also do not find evidence of high-frequency traders playing a significant role in these markets.

Figure 1: Trading venue and transaction type by transaction count

a) On-exchange trading b) All-to-all trading



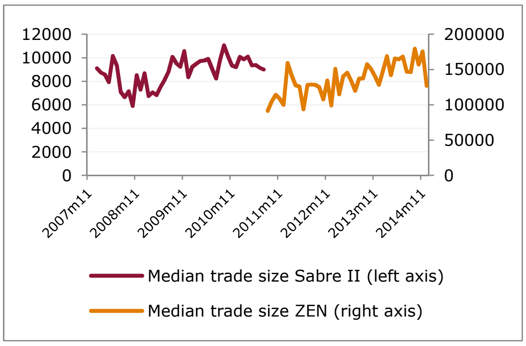
The most important players in terms of number and volume of trades are asset managers and dealers. Overall, measured by volume dealers are net sellers of bonds, while asset managers are net buyers. A likely explanation is that dealers buy the bonds at issuance (primary market activity is not included in our dataset) and then distribute them to asset managers. In addition, asset managers have to buy bonds as the ones they hold mature, and so it is not surprising that overall they are net buyers.

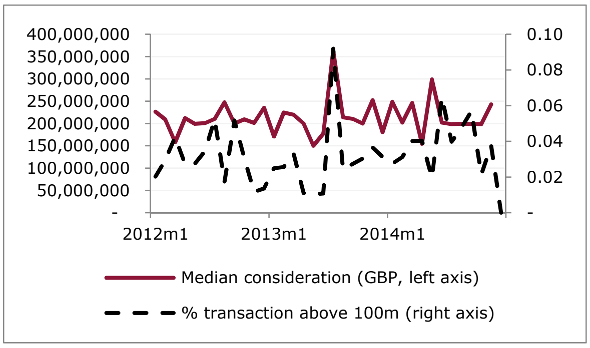
Unsurprisingly, given the structure of the corporate bond market, dealers are the main counterparties for all other players in the market.

[8] The jump in market shares around August 2011 is driven by the change from Zen to Sabre II.

[9] Shown in panel b as the percentage of trades carried out directly between asset managers. There is no difference using consideration instead of trade-counts.

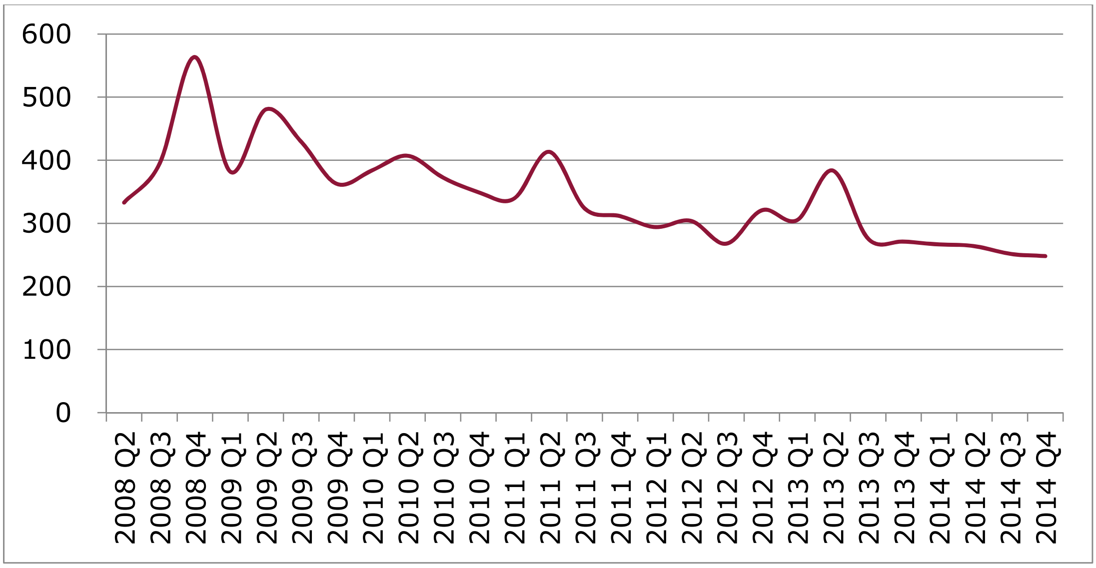
Figure 2: Trade sizes





In a less liquid, more fragmented and more transparent market, participants may be forced to cut orders into smaller pieces to reduce price impact. We have therefore calculated the median, the trimmed mean and the percentage of very large trades to look for evidence that market participants are slicing orders into smaller pieces. We have found no such evidence. In fact, the distribution of trades by size shows a trend towards larger trades. This trend is not what we would expect if liquidity were reducing. Some of the measures we used are presented in Figure 2.

Figure 3: Debt securities in dealers' trading books (£bn)



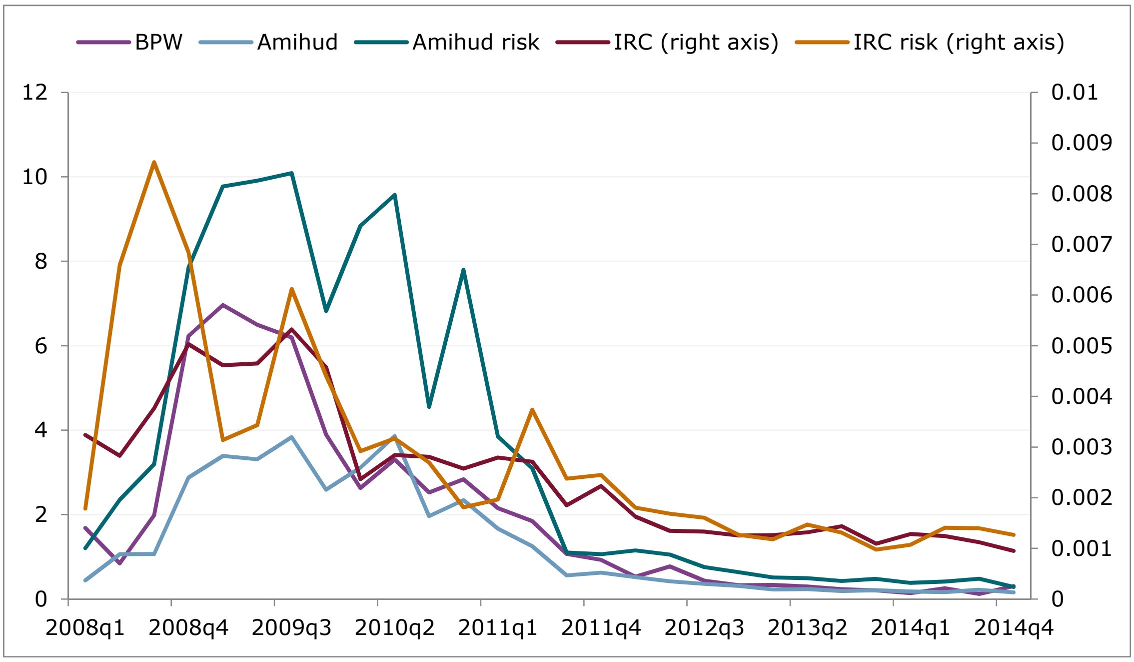
Source: FCA regulatory returns.

In the US, the Federal Reserve Bank of New York documented a reduction in the inventory of bonds held by primary dealers after the financial crisis and a stagnation of dealers' corporate bond inventories in the period 2008–2014 (Adrian, Fleming, Shachar, & Vogt, 2015). Using information from regulatory returns, we can document a similar pattern in the UK. Figure 3 shows that the amount of debt securities held by dealers has indeed declined since 2008. While in the middle of 2008 dealers had approximately £400bn of bonds on their balance sheets, they only held about £250bn at the end of 2014.

Evolution of liquidity measures

We now turn to examining how liquidity evolved in the sample period. The structural characteristics of the market have not changed materially, but is there evidence that the reduction in inventories is making it more difficult to transact?

Figure 4: Quarterly measures of liquidity



Lower values of all the measures imply a more liquid market. All the measures are quarterly averages.

Figure *4* and Figure *5* show the results of the liquidity measures discussed in Section 3. The main result that emerges from a visual inspection of these graphs is that all the measures point in the same direction: in the last few years, liquidity appears to be stable or slightly improving.

The Amihud, IRC and BPW measures (as well as the standard deviation of the former two) all show a similar pattern. Illiquidity peaked during the financial crisis and has been declining substantially since. Part of the decline observed in Q3 2011 may be mechanical because of the switch from the Sabre II dataset to the Zen dataset. As a robustness check, we also report quoted end-of-day bid-ask spreads as a liquidity measure that is independent from the FCA's sample of transaction reports.[10] The results are reported in Annex 3 and are remarkably similar to those produced by the other liquidity measures. However, these quoted bid-ask spreads suggest that today's levels of liquidity may be lower than those experienced in the years preceding the crisis.

In addition, it is somewhat comforting to see that most of the measures in the first two quarters in our sample were at a reasonably low level; they then increase for the subsequent quarters (when the crisis hit) and start declining before the switch from Sabre II to Zen.

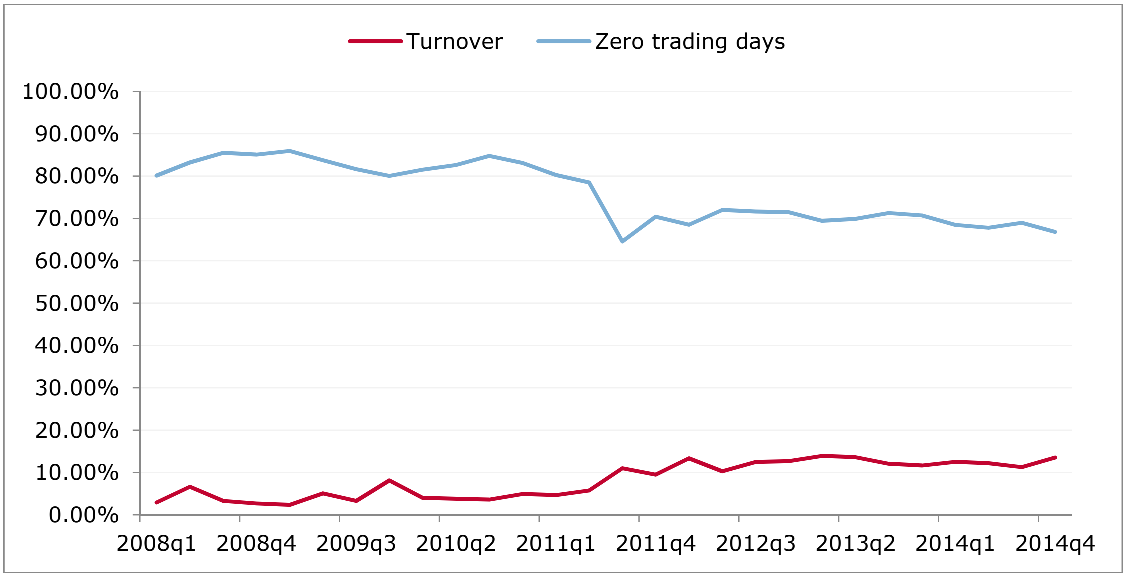
The level of the Amihud measure is difficult to interpret as it is extremely sensitive to outliers and therefore varies substantially with how we treat those outliers. The

[10] Bid-ask spreads are a measure of transaction costs. However, different to on-exchange markets, there are no firm quotes at various sizes available and we therefore do not use quoted spreads as a transaction cost measure in the main part of the paper.

reported level is winsorized at the 1% level.[11] The trend in the measure, however, is not affected by this. Similarly, the BPW measure cannot be easily expressed in monetary terms (as it is an autocovariance). However, to have an idea of the magnitude of the changes, we can rely on the measure of roundtrip costs. These declined from a peak of approximately 0.5% in Q3 2009 to 0.1% at the end of 2014.

Of particular interest, in our view, is the fact that the measures of liquidity risk follow a pattern that resembles the other measures. As such, there is no evidence that liquidity became more volatile, even though average liquidity improved. At least for the UK corporate bonds market, liquidity has not become more 'flighty' since the financial crisis. In this period, some mild and moderate shocks did hit the system, which could have led to episodes of higher volatility (for instance, the 'taper tantrum' in Q2 and Q3 of 2013 or the US treasury 'flash crash' in Q4 2014). Liquidity risk has nevertheless remained reasonably flat since 2011. However, this does not imply that liquidity will always be there under any circumstances: our own measures show that at times of extreme stress (during the financial crisis), there was considerably less liquidity in the system and it was also much more volatile than in normal periods.

Figure 5: Turnover and zero trading days



The average quarterly turnover increased from about 5% to more than 10% between 2007 and 2014, while the average number of days without trades for the average bond decreased slightly from 80% to 70% in the same period.[12] However, the interpretation of these statistics is not straightforward, as discussed above: bonds could be trading more frequently because it is more difficult to execute trades in larger sizes and the switch from Sabre II to Zen is likely to be driving the results, at least in part.

[11] That means we substitute each value above the 99th percentile and below the 1st percentile with the value at the 99th and the 1st percentile respectively.

[12] Note that these are bonds which appear in our sample, i.e. bonds which trade at least once.

Table 2: Correlation of liquidity measures

	Amihud	BPW	Zero td	Turnover	IRC	Amihud risk
BPW	0.42	1				
Zero td	0.04	0.04	1			
Turnover	-0.03	0.01	-0.33	1		
IRC	0.26	0.27	0.04	0	1	
Amihud risk	0.55	0.35	-0.04	0.01	0.18	1
IRC risk	0.35	0.38	-0.07	0.06	0.6	0.24

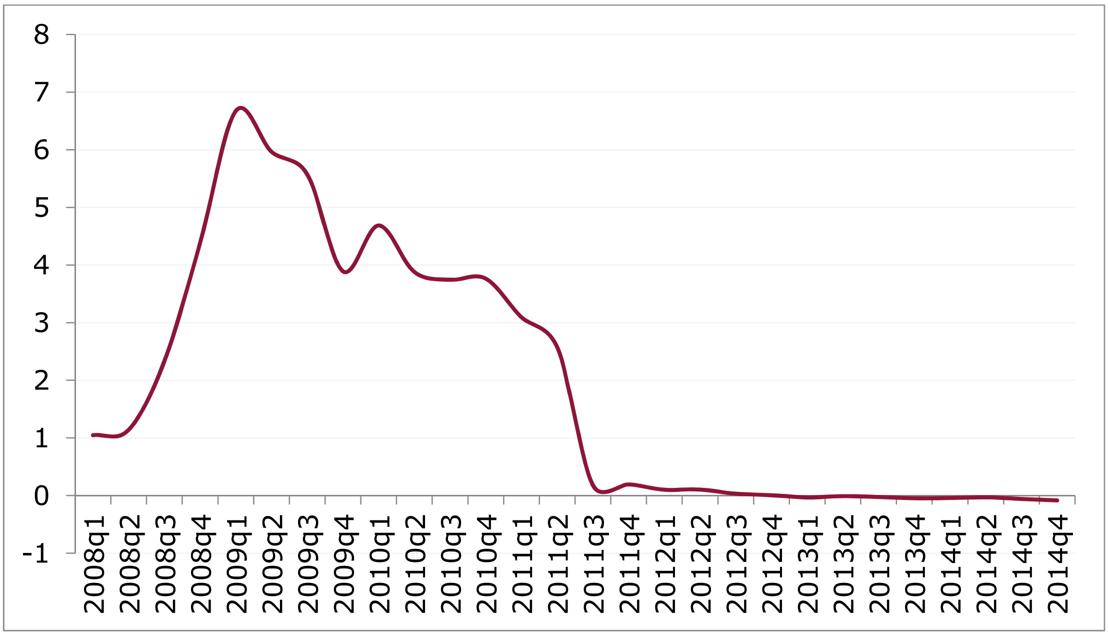
Authors' calculations.

The figures reported in Table *2* confirm that zero trading days and turnover do not seem to be measuring liquidity in a manner similar to the other measures. While the correlation between the other measures of liquidity is always quite high and positive (the lowest being 0.18 between IRC and Amihud risk), turnover and zero trading days are essentially uncorrelated with the other measures. Using a statistical method, we find the principal components of our liquidity measures. Neither turnover nor zero trading days are major drivers of this main liquidity component, and we therefore exclude them from the following analysis (see Annex 2 for more details).

The composite liquidity measure

In order to analyse the evolution of liquidity in more depth, it is helpful to capture its evolution in a single measure. Details of how this measure has been calculated are in Annex 2; the composite measure is essentially a weighted average of the Amihud, BPW, IRC and Amihud risk measures.

Figure 6: The composite liquidity measure



While Figure 6 reports the time series of the composite liquidity measures, Table 3 reports the measure for different characteristics of the underlying bonds averaged across the entire sample period.

All the results presented in the table conform to our expectations. First, the table shows that younger bonds are considerably more liquid than older ones.[13] In addition, bonds that mature in less than five years are more liquid than bonds with longer maturities and perpetual bonds have the lowest level of liquidity.[14] Finally, investment grade bonds, i.e. those bonds rated AAA to BBB, are unsurprisingly more liquid than speculative bonds. It is also worth noticing that liquidity is increasing in credit rating: the higher the issuer's rating, the higher the liquidity of the bonds.

Table 3: The composite liquidity measure

		Composite measure
Age	<3m	-0.06
	3m to 1y	-0.035
	1y to 2y	-0.01
	>2y	0.16
Maturity	0–2y	0.05
	2–5y	-0.05
	>5	0.02
	Perpetual	1.33
Rating	AAA	-0.12
	AA	-0.07
	A	-0.01
	BBB	0.03
	Speculative	0.29

Authors' calculations. Lower values of the measure imply higher liquidity.

One of the reasons for undertaking this research was the concern that a decline in inventories might be damaging liquidity in corporate bond markets. Our results do not support this concern. However, in principle, the idea that smaller inventories could result in reduced levels of liquidity makes sense. We have therefore considered what could account for the difference between the concern we explore and our finding. One possibility is that part of the reduction in inventories is due to banks reducing their proprietary trading rather than market-making activity. Another, more speculative, possibility is that recent changes in technology and data analysis allow dealers to manage their portfolios more efficiently than in the past, allowing them to provide similar levels of liquidity with smaller inventories.[15]

[13] This conclusion holds for both investment grade and speculative bonds, as shown in Figure 8 in Annex 2.

[14] This result should be interpreted with caution, as there are very few perpetuals in our sample.

[15] For instance, The Reserve Bank of Australia (2015) notes that 'Market makers are turning over their inventory more rapidly and operating more brokerage and order-driven business models.'

The liquidity component of bond spreads

Lack of liquidity in bond markets can be problematic because it has potentially negative implications for issuers' cost of capital and, in turn, for the real economy. It is therefore important for us to understand the magnitude of the component of spreads associated with the level of liquidity and whether this component has changed over time.

We follow the approach of Dick-Nielsen et al (2012) and implement a two-step procedure. First, we regress credit spreads on the measures of liquidity and a series of control variables. Second, we use the estimated coefficients to calculate the fraction of the spread due to illiquidity. More details on the procedure followed can be found in Annex 2. The results of this two-stage procedure are then used to explore the trend in the component of spreads associated with the level of liquidity.

Table 4: The impact of liquidity on bond spreads

	Coefficient	# Obs	R^2	Coefficient	#Obs	R^2
	Panel a: Investment grade			Panel b: Speculative bonds		
Composite	0.288	4,181	0.267	83.35***	436	0.311
Amihud	36.05**	8,323	0.203	118.1	1,082	0.169
BPW	8.406***	6,298	0.214	36.90**	626	0.209
IRC	6,435***	4,866	0.265	16,249***	562	0.223
Amihud risk	0.344	7,352	0.196	23.02**	846	0.176
IRC risk	5,884***	2,806	0.211	22,584**	325	0.441

We report only the coefficient of the liquidity measures. Standard errors are heroscedasticity robust and clustered at issuing firm and quarter level. Significance at 10% level is marked *, at 5% level ** and at 1% level ***.

The results of the regressions are shown in Table *4*. The composite measure, BPW, IRC and IRC risks are all positively correlated with bond yield spreads.

Overall, the results show that, as one would expect, the impact of illiquidity on bond spreads is considerably higher for speculative bonds than for highly rated ones.

Table 5: Liquidity components of bond spreads (basis points and %, 95% confidence bounds in parentheses)

	Composite	Amihud	BPW	IRC	Amihud risk
Liquidity component					
Investment grade	0.010 (0,0.31)	0.105 (0.02,0.19)	0.186 (0.1,0.27)	0.686 (0.46,0.91)	0.005 (0,0.05)
Speculative	13.49 (7.89,19.2)	0.71 (0,1.83)	3.07 (0.62,5.82	7.01 (3.38,10.79)	0.88 (0.24,1.48)
% of spread due to liquidity					
Investment grade (in %)	0.01 (0,0.27)	0.12 (0.02,0.21)	0.17 (0.09,0.25)	0.63 (0.42,0.84)	0 (0,0.05)
Speculative (in %)	3.35 (1.96,4.77)	0.26 (0,0.67)	0.87 (0.18,1.65)	3.15 (1.52,4.85)	0.22 (0.06,0.37)

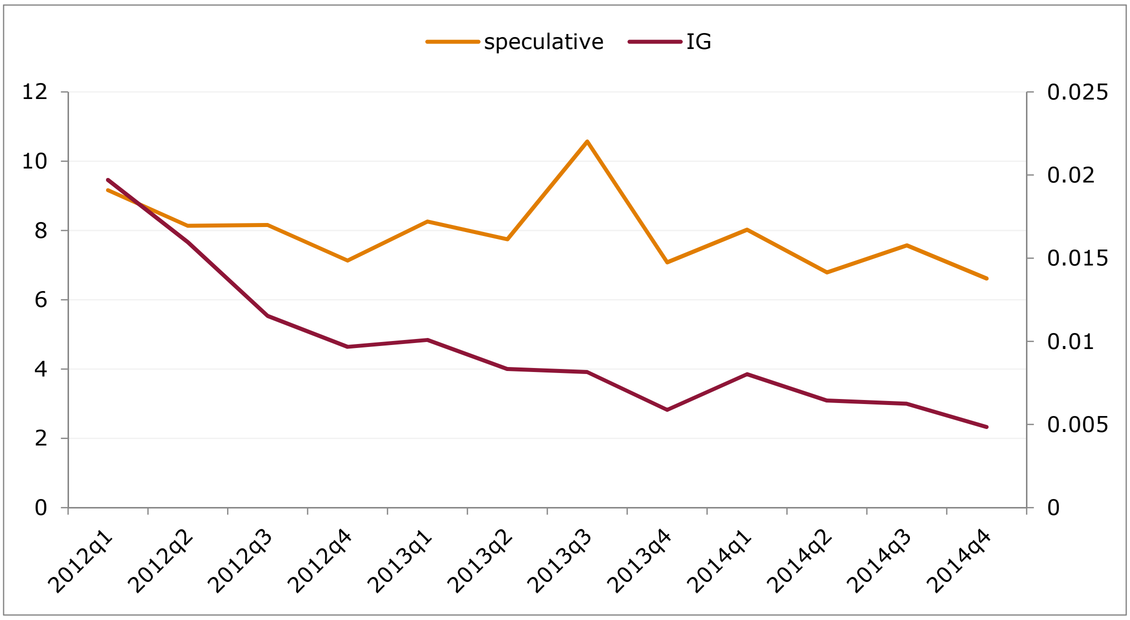
Authors' calculations.

We use the regression results to estimate the liquidity component of bond spreads. Roughly speaking, the liquidity component is the difference in bond yields between a very liquid bond and a bond with average liquidity. The results of our calculations are presented in Table *5*. They confirm that, for investment grade bonds, liquidity does not contribute much to spreads[16], while it makes a sizeable contribution to the spread of speculative ones.

For investment grade bonds, the composite liquidity measure is responsible for, on average, 0.01 basis points of the credit yield spread, which represent approximately 0.01% of the overall spread – statistically not significantly different from zero. For speculative bonds, on the other hand, the contribution of the liquidity measure is 13.5 basis points, or 3.35% of the total spread.

To establish the relevant trend, we calculate a quarterly measure of the liquidity component by repeating the calculations described above for each quarter. Unfortunately, the sample for the Sabre II data does not yield a sufficient number of observations to allow conclusions to be drawn on the effect of liquidity on spreads in this period. Therefore, we do not present results separately. However, Figure *7* shows the pattern followed by the estimated liquidity components for investment grade and speculative bonds from the end of 2011 up to the end of 2014. While the liquidity component of spreads for speculative bonds fluctuated but remained stable overall, there is evidence that the impact of liquidity on the spread of investment grade bonds seems to trend downwards.

Figure 7: Liquidity component over time by rating class



[16] In practice, by performing a wild cluster bootstrap of the regression residuals, we cannot reject the hypothesis that liquidity has no impact at all for this class of bonds. More details are in the appendix.

5 Conclusions

In this paper, we presented evidence on the evolution of liquidity in the UK corporate bond market for the period 2007–2014. On the basis of a series of widely accepted liquidity measures, we document that, although the inventory of dealers has declined in this period, there is no evidence that liquidity outcomes have deteriorated in the market. If anything, the market has become more liquid in recent few years.

We also document that there is little evidence that liquidity is having a larger effect on bond spreads now than a few years ago (although our data does not allow us to go as far back as for the general liquidity measures).

Overall, therefore, our results provide little empirical support for the view – which seems to be widespread – that liquidity in corporate bond markets has deteriorated considerably in recent years.

Nonetheless, our analysis does not imply that liquidity will always be there when investors demand it. Our measures of liquidity risk do not show a deterioration in recent years, implying that the market can withstand shocks of a mild to moderate nature. But, to use Keynes's (1936) words, 'there is no such thing as liquidity of investment for the community as a whole'. This was the case before the recent regulatory interventions that followed the financial crisis; as demonstrated by our own analysis, there was considerably less liquidity in 2009/10 than either before or after this period. Furthermore, it is likely that it will be the case in the future if the market were to experience periods of extreme stress. Therefore, we do not claim that there are no risks associated with liquidity. Our claim is weaker: the regulatory interventions that have been introduced since the financial crisis did not result in less liquidity in normal times and did not result in liquidity being more 'flighty' when shocks of a mild nature hit the system.

Annex 1: Data

Transaction reports and inventories

Transaction reports and data cleansing

We use transaction-reporting data from two FCA databases: Sabre II for the period November 2007 to August 2011 and Zen for the period August 2011 to March 2015. Zen includes all corporate bond transactions for which the FCA is the relevant competent authority, i.e. bonds for which all European Economic Area (EEA) transactions have to be reported to the FCA.

The Sabre II dataset has a more limited coverage such that we see a subset of all bonds traded, but do observe all trades in the EEA for these bonds. Unfortunately, there is also serious misreporting in Sabre II, particularly of the quantity and consideration fields.

We clean both datasets as follows: 1) We extract all instruments that are classified as bonds from the two datasets; 2) we match the instrument codes to external databases (Bloomberg, Datastream, DMO list of sovereign bond issuances) and drop all bonds that are not corporate bonds. 3) For the Zen dataset, we drop prices that are less than 30% or more than 300% of the minimum and maximum prices reported by Bloomberg. For the Sabre II dataset, we drop prices that are more than two standard deviations away from the mean and where the standard deviation of prices is greater than six. We also make some other adjustments when prices or quantities are clearly misreported. 4) We drop all trades that took place on a weekend. 5) We then run a matching algorithm that matches buyer-reported trades to seller-reported trades by price, quantity, date and counterparty names. We match around one third of the trades and then drop duplicate transaction reports.[17]

Inventory data

The inventory data presented in Figure *3* is calculated on the basis of regulatory returns available to the FCA through the GABRIEL regulatory reporting system. There are a number of ways in which one could classify firms into ‘dealers’. Our starting point was the list of the UK Debt Management Office, to which we added names from the NYFED’s list of primary dealers, as well as firms that had substantially large positions in most quarters.

[17] Note that we do not expect to be able match 100% of trades due to the reporting requirements, e.g. due to involvement of non-EEA counterparties. See FCA (2015).

Annex 2: Methodology

Liquidity measures

The Amihud measure is defined as

$$Amihud_{i,t} = \frac{1}{D_{i,t}} \frac{\sum_{d=1}^{D_{i,t}} |R_{i,t,d}|}{V_{i,t,d}}$$

Where $V_{i,t,d}$ is the face-value traded in million GBP of trade i on day t and $R_{i,t,d}$ is the return between trade i and trade $i+1$, $D_{i,t}$ is the total number of returns on day t. It measures the price impact of a trade per one million GBP traded. The intuition is that in liquid markets, prices should react relatively little when large quantities are traded.

BPW attempts to measure liquidity by estimating the negative of the autocovariance of subsequent bond returns: $\gamma_i = -cov(r_{i,t}, r_{i,t+1})$. If prices are driven by a fundamental component and a transitory (i.e. liquidity) component, then γ_i is a measure of this transitory component.[18] The measure is also closely related to the one proposed by Roll (1984). Differently from Bao et al. (2011), we do not restrict the measure to bonds traded on at least 75% of trading days.

To calculate the Feldhutter measure, we compute the costs of a roundtrip transaction. Using the counterparty identifiers available in our dataset, we identify transaction chains that start and end with a trade between a dealer and a non-dealer and involve multiple dealer-to-dealer transactions in between. We then calculate the roundtrip costs as the spread between the 'retail prices', i.e. the spread between the first and last trades in the transaction chain.

Finally, turnover is calculated as the ratio of the face value traded for a given bond and the face value issued while the zero trading days measure is simply the percentage of days for which a bond did not trade.

To account for investors' concerns about changes in liquidity, we calculate for each quarter the standard deviation of the daily changes in the Amihud and the roundtrip costs measures. This is a measure of how much liquidity changes and therefore of how much uncertainty, in terms of liquidity, is present in markets.

The composite measure of liquidity

In order to calculate the composite measure of liquidity, we have closely followed Dick Nielsen et al (2012).

[18] Fundamental does not mean that prices are driven by fundamental news in this context. We assume prices can be decomposed into a persistent component which could be interpreted as fundamental or long-lasting and a transient component which could be interpreted as liquidity.

We carried out a Principal Component Analysis[19], the results of which are presented in Table *6*. The first principal component explains 40% of the overall variation in the measure and the loadings are high for the Amihud, BPW, IRC and Amihud risk measures.

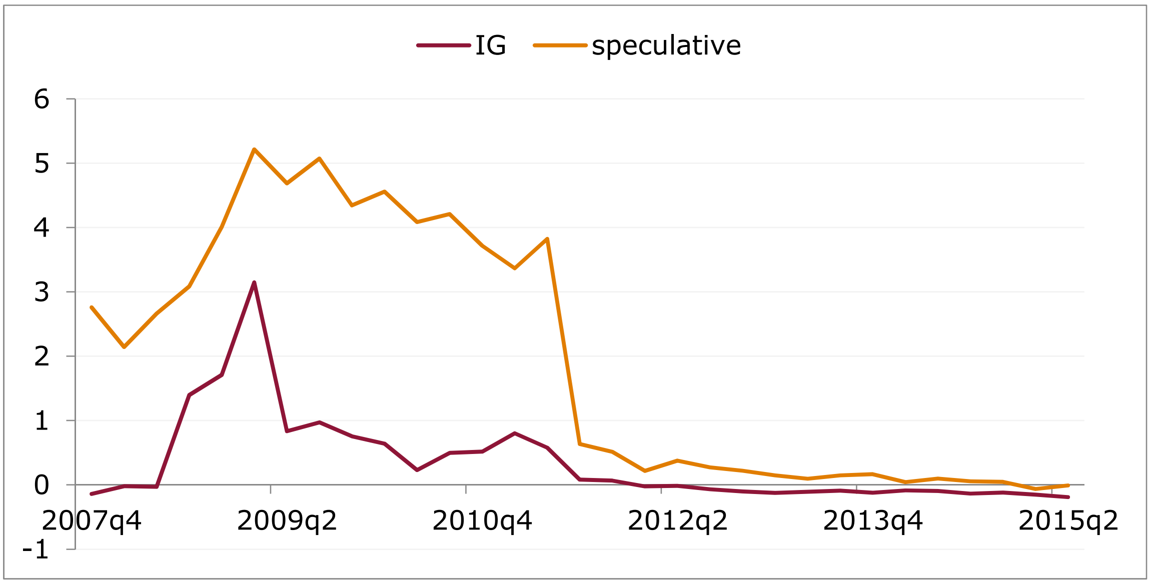
Table 6: Principal Component Analysis of liquidity measures

	PC1	PC2	PC3	PC4	PC5	PC6
Amihud	0.61	0.06	-0.26	-0.02	0.18	-0.72
BPW	0.43	0.09	0.29	0.32	-0.78	0.06
Zero td	-0.07	0.7	0.18	0.59	0.35	0
Turnover	0.05	-0.7	0.1	0.66	0.26	-0.01
IRC	0.29	-0.06	0.83	-0.35	0.32	0.02
Amihud risk	0.59	0.05	-0.33	-0.03	0.25	0.69
% explained	39%	21%	16%	13%	11%	0.9%

The 'IRC risk' measures is not included as it cannot be calculated on a daily basis due to the limited number of observations.

Weighted by their relative loadings, the composite liquidity measure is then calculated as the weighted average of the Amihud, BPW, IRC and Amihud risk measures, normalised by subtracting each measure's mean and dividing by its standard deviation. Figure *8* shows the composite measure by rating class and over time.

Figure 8: Composite liquidity measure by rating class



[19] Principal component analysis transforms a number of correlated variables into a smaller set of uncorrelated variables, which are called principal components. The first principal component accounts for as much variability in the data as possible, the second component accounts for as much of the remaining variability as possible, and so on.

Liquidity component of spreads

As discussed in the main text of the paper, we adopt a two-step procedure to estimate the liquidity component of credit spread. First, we regress corporate bond yield spreads on liquidity and a series of control variables. $Spread_{i,t} = \alpha + \gamma\, liquidity_{i,t} + \sum \beta_i\, X_i + \varepsilon_{i,t}$. The control variables X used in the regression are the ratio of operating income to sales, the ratio of long-term debt to assets, the leverage ratio, equity volatility, and four pre-tax interest coverage dummies. We also include the 10-year swap rate and the difference between the 10-year and the 1-year swap rate to control for changes to the general economic environment. We control for differences in bond characteristics by including bond rating, bond size, age, coupon and four maturity dummies.[20] We run the regression separately for investment grade and speculative bonds.

We subsequently calculate the liquidity component of bond spreads on the basis of the results of the regression. We define the liquidity component of an average bond as the difference between the 50th percentile and the 5th percentile of the distribution of liquidity components: we sort the fitted values of the regression by rating class and take the percentiles out of the two distributions. The liquidity component measures the differences in yield spreads between an average bond and a very liquid bond across two rating classes.

We then compute the fraction of the liquidity components to yield spreads by first calculating the liquidity component for each bond, then dividing by the total yield spread, and then finding the median value.

We calculate both variables for investment grade and non-investment grade bonds separately. The results are reported in Table *5* in the main text. We use this approach as it allows us to focus on the importance of liquidity by estimating directly how much it contributes to bond spreads, rather than just considering it a residual after controlling for credit risk.

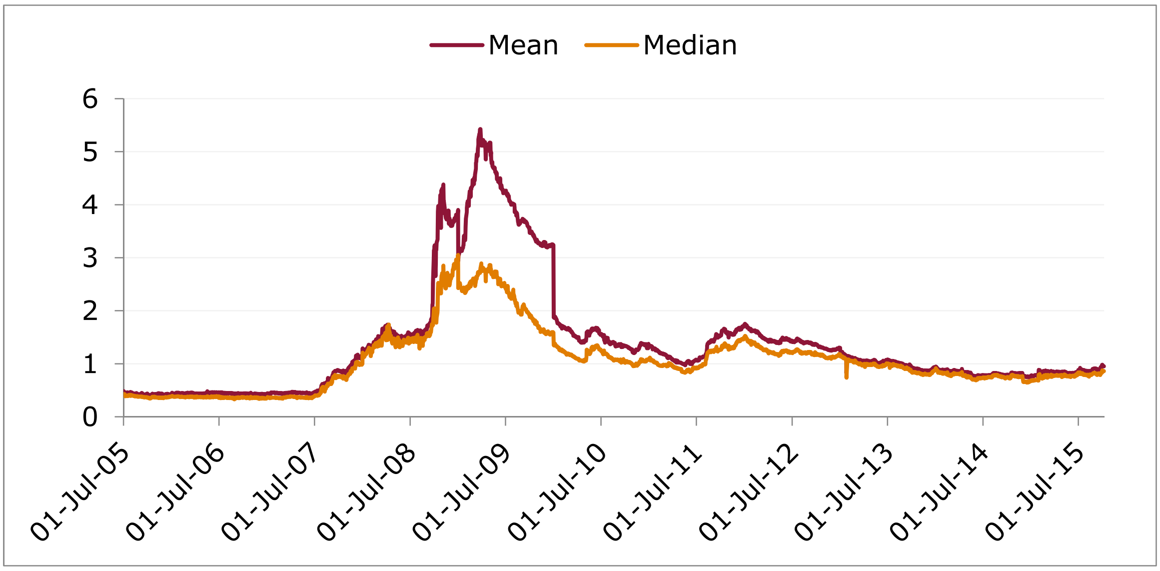
There are statistical complications associated with our analysis because not all our observations are independent. First, there are likely to be overall effects due to the state of the economy; second, the bonds issued by the same company are likely to have similar liquidity characteristics. We follow Dick-Nielsen, Feldhütter, & Lando (2012) and use two-dimensional cluster-robust standard errors. Confidence bounds, as reported in Table 5, are computed using a wild cluster bootstrap procedure. We cluster on the basis of quarters, as well as issuers.

[20] With the exception of dispersion in earnings forecasts, which is not available to us, these are exactly the same variables used in Dick-Nielsen, Feldhütter, & Lando (2012). See Dick-Nielsen, Feldhütter, & Lando (2012) for a detailed discussion of each variable.

Annex 3: Quoted spreads

As a robustness check, we use daily quoted end-of-day bid-ask spreads from Thomson Reuter's Datastream for each of the historical components of the IBOXX Sterling corporate bond index. Data is available for the period 2005–2015. Figure 9 shows the average and median quoted bid-ask spread over time.[21] The chart shows a similar pattern compared to our liquidity measures, but it does seem that bid-ask spreads have settled on a higher level than pre-crisis. Explanations for a higher level of illiquidity post-crisis compared to pre-crisis levels could be changes to inventory costs-driven market power of dealers or higher levels of asymmetric information. Such changes may have been driven by regulatory changes compared to the pre-crisis period.[22] As discussed above, quoted spreads in corporate bond markets are only a weak measure of liquidity. Similar data for the US corporate bond market does not show wider spreads before the financial crisis compared to the post-crisis period (Adrian, Fleming, Shachar, & Vogt, 2015).

Figure 9: Quoted spreads of equally weighted components of the IBOXX Sterling corporate bond index



[21] We update the index components quarterly and use equal weights when calculating the median and the average spreads.

[22] The potential effect of regulation on market making is discussed in, for example, Duffie (2012). In a report published in 2011 by Oliver Wyman (Oliver Wyman, 2011) the authors expected a significant effect on liquidity from an overly restrictive implementation of the Volcker rule in the US. However, Trevvi, & Xiao (2015) do not find evidence for structural breaks consistent with regulatory intervention affecting liquidity in the US.

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